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VOL. XII

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by FRANK D. GRAHAM, B.S., M.S., M.E., E.E.

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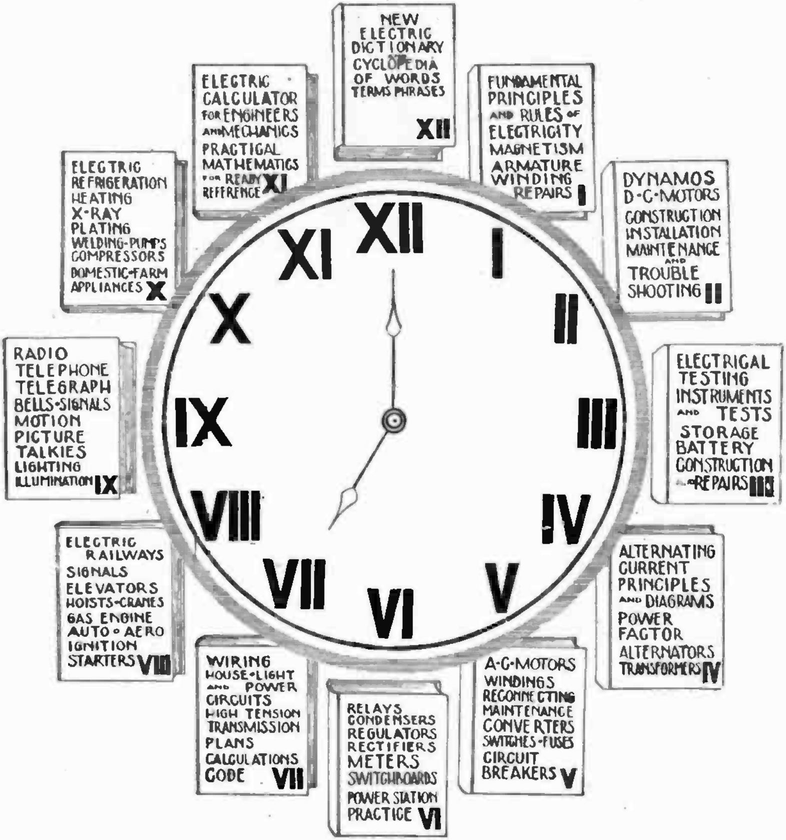

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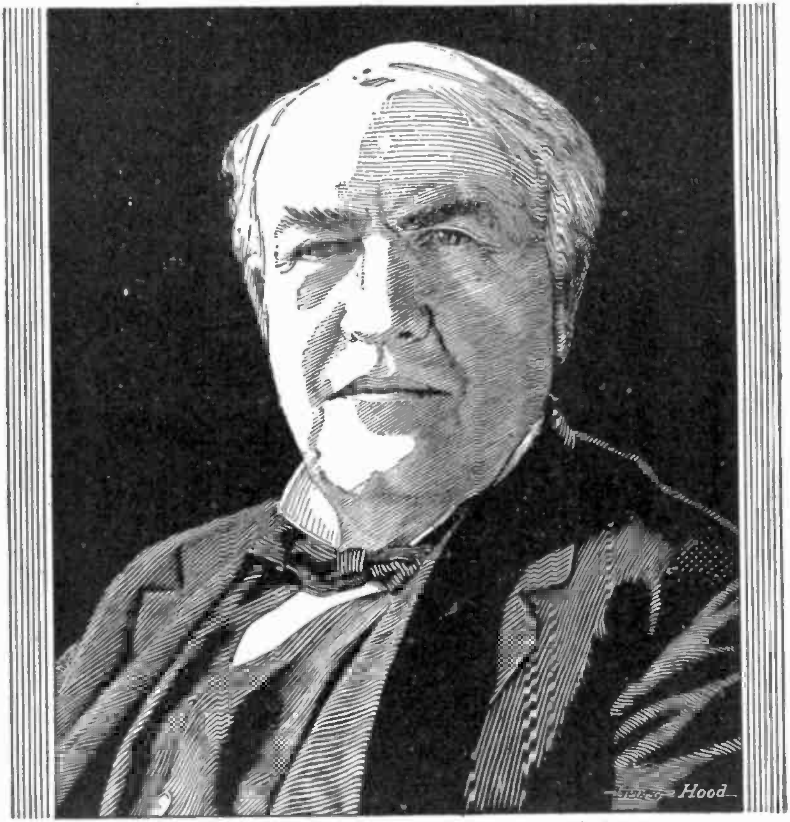

THOMAS ALVA EDISON
EXEMPLAR OF ELECTRICAL PROGRESS

"FOR ONE WORD A MAN IS OFTEN DEEMED TO BE WISE, AND FOR ONE WORD HE IS OFTEN DEEMED TO BE FOOLISH. WE OUGHT TO BE CAREFUL, INDEED, WHAT WORDS WE USE."

AUDELS NEW ELECTRIC SCIENCE DICTIONARY

DEFINING OVER 9000

WORDS, TERMS AND PHRASES

USED IN

THEORETICAL AND APPLIED ELECTRICITY

By

FRANK D. GRAHAM, B.S., M.S., M.E., E.E.

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LOOK WITHIN

TRADE MARK

FOREWORD

The purpose of this book is twofold: 1. A ready reference book which presents in alphabetical order the language of electrical science in a handy form so that any word, term, or phrase is readily available and easily understood. 2. A book for study, or search for unfamiliar words, terms or phrases. The student will quickly and easily increase his electrical knowledge by searching for terms which he cannot define.

The author's method is to first give a concise definition of the term, and where necessary to follow this with a brief statement of the basic principles involved and information calculated to arouse interest so that the student will more readily remember the meaning and significance of the term with one reading. In this way, the reader will quickly develop the ability to use appropriate words and terms to explain simple or complex ideas.

Every effort has been made to include terms in current use.

This book contains in addition to the great number of electrical definitions, numerous terms in related and independent subjects, such as: mathematics, chemistry, physics, mechanical engineering, etc., which makes the work valuable, not only as a reference book but one in which the reader can find miscellaneous information.

James Watt, the Scottish engineer and inventor, in whose honor the electrical unit *watt* was named and who showed the world how to use steam expansively in a steam engine, once said: "The supreme excellency in machinery is in its simplicity." In this connection it would be well for electrical engineers. standardization committees, etc., to note that Watt's statement should be applied to electrical terms and definitions.

There is no necessity for "high brow" language in defining terms; the author employs the simplest language possible in defining terms so that everyone can understand them.

There are a number of terms which if they had never been introduced, to use the language of Gilbert, " would never be missed." For instance, such a clumsy expression as *electro-motive force*, could well be replaced by the word *pressure* or *voltage*. Moreover, in this case, according to Houston: "The term is an unfortunate one. Strictly speaking, electromotive force is not a force at all; at least, it is not a force in the Newtonian sense, where force is only that which acts on *matter*."

The author considers as particularly objectionable such terms as:

DIRECT CURRENT GENERATOR

ALTERNATING CURRENT GENERATOR

Why not use in place, such simple words as:

DYNAMO

ALTERNATOR

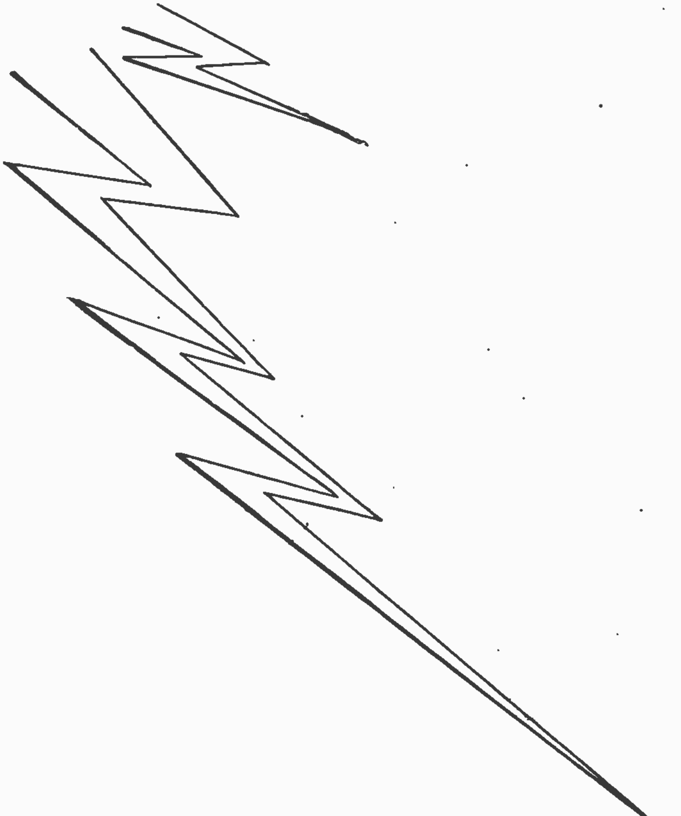
There is no reason for using three words in place of one.

There are numerous other long and clumsy terms in the same class that would never be missed.

Do not use questionable terms simply because others do so, but select simple and short terms. The supreme excellency in technical language is obtained only when it is made simple.

The "power of suggestion," that is, blindly following the practice of others without considering whether it be wise or objectionable is a stumbling block to engineering progress.

FRANK D. GRAHAM



OUTLINE HISTORY OF ELECTRICITY

William Gilbert, born 1540, died 1603, English physicist, published his observations in 1600 in a book entitled, "De Magnete." This is among the earliest printed records relating to electricity. Gilbert is credited with introducing the name "electrica" or "electrics" to describe those bodies which possess the amber attraction. Gilbert made and described many experiments with the compass. His work led to further study by other philosophers who discovered other electric and magnetic truths. Gilbert disposed of a number of false ideas connected with electric and magnetic phenomena. He made valuable investigations on the nature and properties of magnetic poles and showed that many other substances besides amber become electrified by rubbing.

It is recorded in history that Thales, a Greek mathematician and philosopher, who first observed the phenomenon of artifically excited electrical energy when he noted that amber, if rubbed, has an attraction for light objects. About the time of Thales, Aristotle is reported to have said, "The stone has a soul, since it moves iron." It is supposed that he referred to the lodestone, or particular variety of iron ore called "magnetite" which possessed the power of attracting similar pieces or smaller particles of iron. The city of Magnesia produced the best specimens of this stone and accordingly the term magnetism and magnet presumably take their names from Magnesia.

Gilbert in his compass experiments, discovered that the magnetic action of a magnet is strongest at the ends or poles, and that if a magnet be broken in two or more pieces, two or more magnets are produced having the strongest magnetic force at the ends.

Gilbert also discovered that the magnetic attraction of a lodestone for iron particles cannot be cut off by the interposition of any substance except iron and also that the iron particle is magnetized before it touches the magnet, having a polarity opposite to that of the magnet. Therefore, the "north" pole of a magnet induces in the approaching iron particle, a "south" pole, and these two unlike poles attract each other. Thus the important principle of magnetization by induction was established.

It is thought that the Chinese and seafaring men of Northern European countries were the first to adopt a piece of magnetized iron for use as a mariner's compass. The first description of the device, however, was made by Alexander Neckham, an English monk. In 1180, he assumed a knowledge of the facts that if a natural magnet, or lodestone, be suspended and free to turn about a vertical axis, the same portion of the magnet will always point to the north, and that a piece of iron rubbed with a lodestone will acquire temporarily the properties of the lodestone.

The transmission of electricity by a "conductor" is attributed to Otto von Guericke (burgomaster of Magdeburg). In 1660 he made the important discovery that, just as Gilbert found that magnetism passes from one end of an iron rod to the other, the electric attraction appeared at the distant end of the thread. Thus was established the principle that electric attraction could be "conducted" and made evident at a point distant from its source. In this primitive laboratory in Magdeburg, therefore, was born "electrical transmission of energy."

In 1729, Stephen Grey, an Englishman, first called attention to the difference between conductors and insulators of electricity (the latter ignorantly called "non-conductors"). His experiments demonstrated that while linen, hemp or metal would conduct electricity, silk was an insulator.

An important discovery was made in the year 1745 by Bishop Von Kleist, dean of the Cathedral of Comin, Pomerania. He discovered the Leyden jar condenser. Some of the most interesting advances in electrical science in modern times, especially in the radio field, have been founded on the basic principles of the Leyden jar.

The famous kite experiment was made by Benjamin Franklin in 1752, who by aid of his silken kite discovered that lightning and the artificial discharge from the Leyden jar are identical. The practical application he made as the result was the invention of the lightning rod. This was about 150 years since Gilbert's classic discoveries in magnetism. The sum of practical electrical knowledge at that time was contained in the writings of Gilbert and Franklin.

The *voltaic pile*, an important invention was due to Alexander Volta, who made the discovery in 1796. Volta's pile, first exhibited in 1880, consisted of a series of discs of silver, zinc and cloth, wet with salt water. The discs were about an inch in diameter and were assembled in a column in regular order—silver, zinc, cloth, repeated until the desired number was reached.

The origin of the arc light is credited to Sir Humphrey Davy, who discovered in 1809 that a bright light is produced at a break in the circuit of a sufficiently powerful pile. He showed at the Royal Institution in London the brilliant light of the voltaic arc which he established between two sticks of carbon, with a pile formed of 2,000 couples. Strictly speaking, this was not the first arc light, yet it was undoubtedly the first time it was publicly shown in such a way as to demonstrate its possibilities as an artificial illuminant. While many attempts were made from this it was not until nearly seventy years later that the problem was solved.

There were early differences of opinion on the magnetic needle. Gilbert had shown the many points of difference between electrical and magnetic phenomena and had disproved the belief of the early philosophers that electric and magnetic attractions were identical, yet the opinion prevailed among many experimenters that there was a definite relation between magnetism and electricity.

One day in 1819, while addressing his students, Hans Christian Oersted (professor of physics in the University of Copenhagen) happened to hold a wire connected to a voltaic pile over a large magnetic needle which had come to rest in its normal position on the lecture table. To the astonishment of the professor, the needle swung about and took up a position at right angles to the wire. Oersted promptly began a series of experiments to establish the relation he suspected between magnetic and electrical phenomena. He found that if he reversed the current, the needle deflected in the opposite direction. If the current flow remained unchanged and the wire was moved from above the needle to below it, the direction of deflection also reversed.

After carefully repeating Oersted's experiments and making many of his own, Andre Marie Ampere, professor of mathematics in the Ecole Polytechnique of Paris, published his theory of these phenomena. His famous rule for the direction of movement of the needle in Oersted's original experiment was: *Imagine yourself swimming in the wire in the direction of the current and facing the needle, then the north pole will be deflected toward your left hand*. Carrying his work further, Ampere made the important discovery that currents in opposite directions repel, and that currents in the same direction attract each other.

From this he developed the theory which resulted in his construction of a long spiral coil of wire called a "solenoid" which, when connected to a battery, showed all the characteristics of a magnet.

The famous Ohm's law which states that: amperes = volts ÷ ohms was stated in 1827 by Dr. George Simon Ohm of Berlin as the result of mathematical computations verified by experiment. While this law is fundamental and universal, it applies only to direct currents. Another law is necessary to express similar relations for alternating currents.

The electro-magnet was discovered in 1825 by William Sturgeon, an English electrician, who placed an iron bar within a solenoid and found that the solenoid acquired a magnetic strength many hundred times that of the solenoid alone; and that when the current supply was cut off, the magnetism of the bar disappeared. These cored solenoids were called electro-magnets by Sturgeon and are to-day important parts of nearly all electrical apparatus.

Joseph Henry, the American physicist, constructed an electro-magnet on a large scale in 1830. It consisted of 700 feet of wire weighing 60 lbs. and it could support a ton weight when charged with electric current from a few cells of battery. The electro-magnet later made the telegraph possible. Henry was made a professor at Princeton in 1832, and during his experimenting there, he devised an arrangement of batteries and electro-magnets embodying the principle of the telegraph relay which made possible long distance transmission. He was the first to observe magnetic self-induction in oscillating electric discharges (1842) and other electrical phenomena.

A primary cell of importance especially for the closed circuit working of the telegraph, was invented by Daniell in 1836. The characteristic of the cell is to furnish a small current of long duration. Several inventors claimed credit for the invention of the telegraph, but Samuel Finley Breese Morse prior to 1837 had devoted much thought and attention to the elements of his final invention, for the honor of which the scientific world at last awarded him credit. He has told how the terms of the invention took root in his mind in 1832, on board the packet ship "Sully" while en route from Havre, France, to New York City. During the voyage Morse made many sketches of his telegraphic apparatus. He wrote: "I also drew in my sketch book modes of interring the conductors in tubes in the earth, and, soon after landing, planned and drew out the method upon posts."

Morse completed his first telegraph instrument in 1835, three years after the "Sully" arrived in New York. It was in 1837, however, before his instruments and system were exhibited to the public generally. The Morse system of telegraphy included an electro-magnet, to the armature of which was attached a stylus, or pen, that recorded on a ribbon of paper, drawn beneath it, a series of dots and dashes corresponding to the letters of the alphabet. Thus, as Prof. J. D. Forbes observes, in the "Encyclopedia Britannica," "The telegraphs of Morse have the inestimable advantage that they preserve a permanent record of the dispatch they convey."

In the development of telegraph systems, the duplex method of sending two messages simultaneously over the same wire is due to Edison.

The first successful telephone was introduced by Alexander Graham Bell in 1876, who is generally credited as being the discoverer of electrical transmission of sound. However, as far back as 1854, Charles Bourceul, a Frenchman, wrote: "Suppose a man speak near a movable disc sufficiently flexible to lose none of the vibrations of the voice, and that this device alternately make and break the current from a battery; you may have at a distance another disc which will simultaneously execute the same vibrations." Bourceul seems to have been content to express his idea in words, and no record exists of any attempt by him to try out such a device.

Johann Philip Reis, a poor German school teacher, was the next telephone pioneer. He developed a telephone which would transmit musical sounds, after a fashion, but only an occasional word of an attempted conversation.

The Reis receiver was based on a discovery of Prof. Page of Salem, Mass., who found that an audible click occurred in the core of an electro-magnet when it was suddenly magnetized and demagnetized. The receiver devised by Reis was mounted on a sounding box and had a knitting needle for a core. Having established a proper electrical circuit between the Reis transmitter and receiver, it was found that when a musical sound was made, the membrane vibrated and this vibration was transmitted to the receiver, where the knitting needle core gave off a series of clicks at the same rate. Its lack of ability to reproduce the "quality" of sound made the Reis telephone a failure as a transmitter of speech.

Although the principle of the electric dynamo was discovered by Michael Faraday and described in a paper read before the Royal Society of Great Britain in 1831, it remained for Edison to incorporate the idea into a commercially success ful machine.

Edison's invention of the incandescent lamp is perhaps his greatest achievement. In the early development there were strung in a few houses and along the streets of Menlo Park the first hundred lamps, and so great was the interest created by this wonderful experiment in the little, unknown village that over 3,000 people went out from New York on the last night of 1879 to see the new invention.

The origin of the electric motor is due to Oersted who in 1819 wrote that: "the electric conflict acts in a rotating manner." September 3, 1821, Oersted succeeded in arranging a pendulum-like wire to swing in a circle around the pole of a magnet whenever current flowed through the wire. This was the first electric motor. The electric motor promptly began to develop when it was found that the dynamo and the motor are virtually the same machine.

Frank J. Sprague was a pioneer in the beginning of the electric railway. In 1887 he began the installation at Richmond, Va., of a complete system, comprising the building of a generating station, erection of overhead lines, and the equipment of 40 cars, each with two 7½ horse power motors on plans largely new and untried. The overhead trolley system, under a pressure of 450 volts, with the track rails forming the return circuit, was used.

The introduction of alternating current was due to the difficulties of transmitting direct current long distances because of voltage limitation of dynamos with resulting prohibitive expense of conductors large enough to transmit the current economically. George Westinghouse was the pioneer in this development. The first experimental alternating system was started in Great Barrington, Mass., March 16, 1886. The first commercial system was put into operation in Buffalo, N. Y., November 30, 1886.

Stanley was the first in the United States to achieve success with what he called a *converter* which we now know as a *transformer*. The first transformers built by Stanley converted a primary pressure of 500 volts to a secondary pressure of 100 volts, and each had a capacity sufficient to supply secondary current to 25 sixteen candle power incandescent lamps.

Dr. Jacobi in 1831 invented the processes of electrotyping and electroplating.

The so-called *storage* or secondary battery was brought out by Plante in 1859. The popular impression prevails that a secondary battery "stores" electricity, but according to Dr. Edwin J. Houston such is not the case. Dr. Houston said: "A storage battery cannot any more properly be said to store electricity than a music box can be said to store sound when mechanical power is applied to wind its driving spring. What the storage battery actually stores is the energy of the charging current.

The first steam turbine direct connected to an alternator was installed in a central station in Hartford, Conn., in 1901. As compared with the reciprocating engine, it was soon realized that the steam turbine, with its lower first cost, smaller dimensions, and its evident availability for use in larger sizes as experience pointed the way, would become the prevailing type of prime mover for generating electricity on a larger scale.

Heinrich Rudolf Hertz, a German physicist, is credited with the discovery of electro-magnetic waves (1888) which form the basis of radio telegraphy. He found that waves produced by the spark of a simple device called an oscillator could be detected by a loop or square or wire known as the resonator.

Guglielmo Marconi in 1896 took out the first patent ever granted for a practical system of radio telegraphy. In July, 1897, in demonstrating before the Italian Government, he covered 12 miles between warships, and he began to install a number of his sets for lighthouses.

Dr. Albert Einstein discards the theory of the ether usually presented by writers in an attempt to explain radio transmission. Dr. Einstein derides radio's ethereal medium as fiction, calling it a makeshift fabricated to explain something for which scientists have not had the correct explanation.

Steinmetz said: *There are no ether waves*. He explained that radio and light waves are merely properties of an alternating electro-magnetic field of force which extends through space. Scientists, he contended, need no idea of ether. They can think better in the terms of electro-magnetic waves.

The invention of the *Crookes tube* by Sir William Crookes led directly to the development by Sir J. J. Thomson of the now generally accepted *electron theory*.

The invention of the radio three element vacuum tube is due to Dr. Lee De Forest. De Forest devices completely revolutionized the radio art. All radio broadcasting apparatus is built upon his audion inventions.

Wilhelm Konrad Roentgen, while professor of physics in the University of Wurtzburg in Bavaria, began in 1895 investigations of the cathode rays of a Crookes tube, resulting in the discovery of a new and remarkable form of radiation now known as Roentgen or X-rays. They are useful in locating foreign objects in the human body, dislocations, fractures, etc. The rays are also useful in dentistry, and the metal industry. In boiler construction, welded seams which are replacing riveted seams, are tested for flaws with X-rays.

An outstanding feature of the developmental work during the year 1932 was the exceptional emphasis placed on the improvement of equipment for the modernization of industrial plants, in line with the program of the National Committee on Industrial Rehabilitation. The apparatus designed for this purpose included not only new types of motors but also ingenious control devices, in many of which there were practically applied in new ways the unique characteristics of the electronic tube.

Emerson says: *"The origin of most words is forgotten. Each word was a stroke of genius, and became current because at its origin it symbolized the object to the first speaker and to the hearer."*

AUDELS NEW ELECTRIC DICTIONARY

A

A —1. An abridged symbol for a.c. (alternating current) sometimes used. Objectionable.
2. Symbol for ampere, the practical unit of electric current.

A, or AN.—An abbreviation sometimes used in medical electricity for anode.

a.—1. Symbol for acceleration.
2.—Symbol for angle.

A, B, AND C RADIO BATTERIES.—The three elements of the common vacuum tube, filament, plate and grid are often designated by the letters A, B and C. The order in which the letters are assigned corresponds to the historical development of the tube. The heated filament is comparatively an old device and the battery which lights it is known as the filament battery or A battery. The plate was the second element to be invented and any battery used in the plate circuit is a B battery. A later invention is the grid and the battery in the grid circuit is termed a C battery. The B battery connected in the plate circuit, maintains the plate at proper pressure and supplies the energy which operates the head phones or loud speaker.

A BATTERY.—A radio battery used to heat the filament in the tube to the point where it will expel sufficient electrons to permit the B battery to function. It has no other purpose. There are two general types; a, dry; b, storage. Storage batteries are required for the economical operation of all radio tubes which use more than ¼ ampere for lighting filaments.

AB.—A prefix attached to the units of the practical system to indicate electric units of the c.g.s. electro-magnetic system, as abampere.

ABAMPERE.—Ten amperes. The c.g.s. unit of current used in special theoretical work.

ABCOULOMB.—The c.g.s. electromagnetic unit of quantity, being the quantity of electricity which passes any section of an electric circuit in one second when the current is one abampere.

ABFARAD.—The c.g.s. electro-magnetic unit of capacitance, being the capacity of a condenser when a charge of one abcoulomb produces a difference of pressure between the terminals of one abvolt.

ABOHM.—The c.g.s. electro-magnetic unit of resistance, being the resistance of a conductor when, with an unvarying current of one abampere flowing through it, the pressure difference between the ends of the conductor is one abvolt.

ABRASION OF INSULATION.—The wearing away of any insulating covering as the result of rubbing or chafing against a hard surface.

ABSCISSA.—The distance of any point from the axis of ordinates (the Y axis) measured on a line parallel with the the axis of abscissae (the X axis). Note that the abscissa is always mentioned first, that is, before the ordinate.

ABSOLUTE.—A term applied to a system of magnitudes when all are defined in terms of the fundamental units without the introduction of multiples or submultiples.

ABSOLUTE BLOCK SYSTEM.—A system of automatic railway signaling, in which only one train at a time is permitted to enter one of the sections or blocks into which the track is divided. When the signal shows red, or danger, the train must come to a dead stop, with no part of it beyond the signal, and wait until it gets a clear signal.

ABSOLUTE ELECTROMETER.—A form of electrometer which measures the voltage difference directly in the units of the centimeter-gram-second (c.g.s.) system of measurement.

ABSOLUTE EXPANSION.—The expansion of a liquid, regardless of the dimensions of the receptacle which contains it.

ABSOLUTE GALVANOMETER.—A measuring instrument, which tells the strength of an electric current by the direct application of Ohm's law; that is, voltage =current×resistance, its constants being known.

ABSOLUTE INCLINOMETER.—An instrument which indicates the inclination of an air craft with reference to the vertical.

ABSOLUTE INSULATION.—The total insulation of an electric circuit.

ABSOLUTE OR "PRACTICAL" AMPERE.—One tenth of an abampere.

ABSOLUTE OR "PRACTICAL" COULOMB.—One tenth of an abcoulomb.

ABSOLUTE OR "PRACTICAL" FARAD.—One billionth part (10^{-9}) of an abfarad.

ABSOLUTE OR "PRACTICAL" HENRY.—One billion (or 10^9) abhenrys.

ABSOLUTE OR "PRACTICAL" JOULE.—Ten million (or 10^7) ergs.

ABSOLUTE OR "PRACTICAL" OHM.—One billion (or 10^9) abohms.

ABSOLUTE OR "PRACTICAL" VOLT.—One hundred million (or 10^8) abvolts.

ABSOLUTE OR "PRACTICAL" WATT.—Ten million (or 10^7) ergs per second.

ABSOLUTE OR PRACTICAL WATT HOUR.—3,600 joules.

ABSOLUTE PERMISSIVE BLOCK SYSTEM. A system of automatic single track railway signaling designed to afford: a, full overlap protection for opposing movements, and b, protection same as on double track for following movements.

ABSOLUTE PRESSURE.—That measured from the true zero or point of no pressure. It is equal to the pressure indicated upon a gauge, plus that of the atmosphere, which is usually taken approximately as 14.7 (standard value 14.696) lbs. per sq. in. Thus 68 lbs. gauge pressure is 82.7 (or 83) lbs. absolute.

ABSOLUTE TEMPERATURE.—In physics, the actual temperature of anything, reckoned from absolute zero. It is taken as the temperature indicated by the thermometer or similar instrument, to which is added 273° Centigrade or 459.6 Fahr. being the difference between absolute zero and the zeros of the respective thermometric scales which are arbitrarily fixed.

ABSOLUTE UNITS.—The units of the centimeter gram second (c.g.s.) system of measurement as distinguished from units defined with reference to arbitrary standards.

ABSOLUTE ZERO.—In physics, temperature, or the heat which it represents, is regarded as a manifestation of molecular activity in any substance, the higher the temperature, the greater the motion or vibration among the molecules of which every solid, liquid or gaseous body is composed. Experiments have demonstrated that a gas expands when at the freezing point and under constant pressure 1/491.6 of its volume for each increase of 1° Fahr., in pressure.

ABSORBED WAVE.—In radio, that portion of a wave which is dissipated in a medium against which it strikes.

ABSORPTION CURRENT.—1. The small decreasing current which follows the first rush of current upon charging or discharging of a condenser. These currents are called dielectric absorption because they seem to be absorbed by the condenser's dielectric and then to be released.

2. In radio, an oscillating circuit tuned to a frequency to absorb and dissipate energy taken from another circuit by coupling.

ABSORPTION DYNAMOMETER.—An instrument for measuring power, in which the energy of a revolving wheel or shaft is absorbed by the friction of a brake. The typical form of absorption dynamometer is the prony brake, which consists of a lever of definite length in frictional contact with a wheel or shaft and having adjustable screws by means of which the intensity of the friction may be varied. The end of the lever is attached to scales and the friction measured, from which the brake horsepower can be calculated. A brake dynamometer.

ABSORPTION MODULATION.—In a coupled radio circuit containing means for modulation, variation of antenna power in the transmitting circuit. Heising modulation.

ABSORPTION OF GASES.—In physics, the property which all liquids possess, in greater or less degree, of taking a certain quantity of gas into chemical combination with themselves. Heat is given off during this process of absorption, and should it afterwards be desired to separate the gases, an equivalent amount of heat to that given off, must be applied to the liquid.

ABSORPTION SIGNALING.—In radio, continuous wave signals generated by changes in transmitting circuit frequency. The waves of one frequency are radiated and those of the other, absorbed in an auxiliary circuit.

ABSORPTION SYSTEM OF REFRIGERATION.—A system of refrigeration whose working principle may be stated as the alternate repulsion and absorption of ammonia gas by the alternate heating and cooling of ammonia water. The essential parts of the system are: a, generator; b, condenser; c, expansion coils; d, absorber; e, pump; f, exchanger or intercooler.

ABSORPTION WAVE TRAP.—A resonant circuit inductively coupled to an aerial circuit. Used to absorb waves of undesired frequency.

ABVOLT.—The c.g.s. unit of pressure. It is the pressure induced when an inductor cuts one line of force per second. The abvolt is a very small unit; 100,000,000 or 10^8 abvolts$=1$ volt.

A. C.—Abbreviation for alternating current.

ACCELERATING CONTACTOR OR RELAY.—One which causes the operation of a succeeding device in the starting sequence after the proper conditions have been established.—NEMA.

ACCELERATION.—In physics, the rate at which the velocity of a body increases per unit of time. Also used to denote the rate of decrease in the velocity of a body or negative acceleration.

ACCELERATION DUE TO GRAVITY.—In the case of falling bodies, the acceleration due to gravity is 32.16 ft. per second in one second; this is indicated by the symbol g. The value of g increases with the latitude and decreases with the elevation. At the latitude of Philadelphia 40° its value is 32.16. At Paris 48° 50′ N., $g=980.87$ cm$=32.181$ ft. For all ordinary calculations for the United States, g is generally taken at 32.16.

ACCELEROMETER.—An airplane instrument for indicating, measuring or recording accelerations.

ACCENT.—In mathematics, a mark placed at the right hand of a letter, and a little above it, to distinguish magnitudes of a similar kind expressed by the same letter, but differing in value.

ACCEPTOR.—Radio apparatus consisting of an inductance and capacity tuned to resonance with the desired signal and connected in series with the lead in wire.

ACCEPTOR CIRCUIT.—In radio, a discriminating, series resonance circuit consisting of an inductance or coil and a capacity or condenser in series with each other. Such a circuit may be tuned to resonance with a frequency and its opposition to flow of current at that frequency is at a minimum.

ACCUMULATOR.—A term sometimes applied to a storage battery. The storage battery now in general use has electrodes consisting of lead plates and an electrolyte consisting of dilute sulphuric acid.

ACETATE OF COPPER.—A substance commonly known as **verdigris**. It is prepared by exposing copper plates to the vapor of acetic acid and the action of the air; it is much used in electroplating.

ACETIMETER.—A graduated instrument for measuring the strength of acetic or other acids. Also called **acetometer**.

ACETYLENE GENERATOR.—A closed vessel in which acetylene gas may be continually produced by the action of water on calcium carbide, in quantities sufficient to supply a certain number of lamps, the gas being supplied under a uniform pressure. The generators are commonly made of small size.

ACHROMATIC.—Free from color; a term applied to a medium which transmits light, without decomposing it into its prismatic colors.

ACID BATH.—An acid solution for cleansing the surfaces of gold, silver, copper, brass and zinc objects, preparatory to electroplating; acid pickle.

ACID DEPOLARIZER.—An acid, such as nitric acid, sometimes introduced into a primary cell to prevent polarization.

ACIDIMETER.—An instrument for determining the purity or strength of acids, founded on the principle that the strength of any sample of acid is proportionate to the quantity of carbonic acid gas which it disengages from a carbonate of soda or potash.

ACKNOWLEDGE. — In automatic train control, the operation by the engineman of a specific part of the automatic train control apparatus, in order to prevent an application of the brakes by the device.

ACKNOWLEDGER.—In automatic train control, an electrical contactor operated by a lever. It is used to prevent an automatic application of the brakes when passing a caution or a stop signal. If the lever of an acknowledger be held down for a longer period than 15 seconds, an automatic brake application will result.

ACKNOWLEDGING OR FORESTALLING WHISTLE.—In automatic train control, an air operated whistle which is sounded when a restrictive signal is acknowledged.

ACLINIC LINE.—An imaginary line on the earth's surface passing through points having no magnetic inclination or dip. Also called magnetic equator.

ACME STANDARD 29° THREAD.—This thread has been devised to take the place of the square thread. It has the same depth as the square thread, but is stronger, as the bottom of the thread is wider than the square thread. The sides of this thread are at the same inclination as is now generally adopted in cutting worms.

ACOUMETER.—An electric instrument for measuring the acuteness of the sense of hearing. Also called acousimeter.

ACOUSTIC FEED BACK.—In radio, a hook up for transferring sound waves from a loud speaker to a microphone in the same system.

ACOUSTIC FREQUENCY. — A frequency that is audible; audio frequency as distinguished from radio frequency.

ACOUSTIC RADIATOR.—In a loud speaker, that part where the sound waves originate.

ACOUSTIC RESONANCE.—A condition which exists when direct and reflected sound waves are in phase.

ACOUSTIC SYNCHRONIZER.—A sounding device for indicating the synchronous relation between two alternators by becoming silent at synchronism.

ACOUSTIC WAVE.—A sound wave.

ACOUSTICON.—A very sensitive telephone transmitter and receiver. With this device those who are deaf or hard of hearing can be supplied with the degree of amplified sound that they require. The portable instruments are made as small and as light as possible, and are connected by silk insulated cords to a vest pocket dry cell battery. The public building outfits are connected with insulated wires like telephones, the receivers being available to those who occupy the seats and the one central transmitter being placed on the speaker's platform. The wiring is so arranged that there is one transmitter and battery source of electrical supply to which a number of receivers are wired in parallel.

ACTINIC RAYS.—A light ray toward and beyond the violet end of the spectrum which affects a photographic plate and produces other chemical effects; ultra violet rays.

ACTINO DIELECTRIC.—A dielectric that is photo conductive.

ACTINO ELECTRIC EFFECT.—The property of some special materials such that when an electric current is impressed on them, the resistance of the material changes with the light. In the photo electric cell a current flow occurs only on exposing the cell to a source of light.

ACTINO ELECTRICITY.—Electricity produced by the action of radiant energy upon crystals.

ACTINOGRAPH.—1. An instrument for measuring and registering the chemical influence of rays of light.

2. An instrument for recording the variation in heat intensity of the sun's rays. Also called actinometer.

ACTINOPRAXIS.—Actino-therapy.

ACTINOTHERAPY.—The therapeutic use of actinic rays.

ACTIVE CURRENT.—In an alternating current, a component in phase with the pressure; the working component as distinguished from the idle or wattless component; also called the energy or active component.

ACTIVE MATERIAL.—In a storage cell, the formed "paste" which fills the grid. It is capable of changing its nature and appearance by reason of the flow of electric current and of being endowed with a potential energy for redeveloping the electric current by a secondary chemical change.

ACTIVE MOLECULES. — The molecules which are broken up into their constituent ions during the process of electrolysis.

ACTIVE POLAR SURFACE.—The surface of a magnet at its poles.

ACTIVE PRESSURE.—1. In an a. c. circuit, the pressure which produces a current, as distinguished from the pressure impressed upon the circuit; the active voltage.

2. That component of the impressed pressure necessary to overcome resistance. Also called ohmic drop.

ACTIVE TRANSDUCER.—A type in which the power supplied to the second system is obtained from a local source and is controlled by the power from the first system.

ACTIVE WIRE.—1. The wire of an armature winding which produces useful voltage as distinguished from dead or idle wire.
2. That portion of the winding in which induction takes place.

ACTUATOR.—In automatic train control an air operated differential piston and mechanism mounted on the automatic brake valve. Its purpose is to move the rotary valve to the service position automatically when air is exhausted from behind the large piston. The actuator is designed to be used with or without a means for limiting the service application to a pre-determined brake pipe pressure reduction.

ACUTE ANGLE.—An angle less than a right angle; that is, less than 90 degrees.

ADAPTER.—Any device by means of which a part may be utilized in another manner, as for instance, a fitting for a tube base or socket to allow a phonograph to be connected to the tube's grid circuit.

ADDITION.—Uniting two or more numbers or groups of objects of the same kind into one. The number obtained by adding is called the sum. Symbol +.

ADHESION, ELECTRIC.—The attraction between bodies due to unlike charges of electricity carried by them.

ADHESION, MAGNETIC.—The attraction between bodies due to the force of magnetic flux in them.

ADIABATIC.—Descriptive of any physical change which takes place without a transfer of heat. In physics, when a gas is compressed or expanded, if the heat due to compression be not taken away or fresh heat not supplied to make up for that lost by internal work during expansion, the compression or expansion is accompanied by a change of temperature, the gas becoming hot or cold according as the gas is compressed or expanded.

ADIABATIC CURVE.—A curved line, as in an indicator diagram, exhibiting the variations in pressure and volume in a fluid which is expanded or compressed adiabatically, that is, without receiving or giving up heat. This curve differs from the hyperbolic or isothermal curve.

ADIATHERMANCY.—The quality of being impervious to heat.

ADJUSTABLE SPEED MOTOR.—1. One whose speed can be varied over a considerable range, but when once adjusted remains practically unaffected by the load, such as a shunt motor with field resistance control designed for a considerable range of speed adjustment.—NEMA.
2. A motor in which the speed can be adjusted over a considerable range by: a, shifting the pole pieces; b, shifting the armature.

ADJUSTABLE VARYING SPEED MOTOR.—One whose speed can be adjusted gradually over a considerable range but when once adjusted for a given load will vary in considerable degree with change in load; such as a compound wound d. c. motor adjusted by field control or a slip ring induction motor with rheostatic speed control.

ADJUSTING COMMUTATOR BRUSHES.—The adjustment of the brushes upon the commutator requires careful attention if sparking is to be avoided. There are two adjustments to be made: a, for pressure; b, for lead. The brushes must have the proper angular advance (positive or negative according to whether the machine is a dynamo or motor) to prevent sparking. Setting marks are usually cut in the collar of the commutator next to the bearing, to facilitate the correct setting of the brushes.

ADMIRALTY UNIT.—.0011 microfarad; A British unit of capacity.

ADMITTANCE.—The apparent conducting power of an alternating current circuit; the reciprocal of the impedance. A circuit having low impedance is said to have high admittance.

ADSORPTION.—The action of a body in condensing and holding a gas upon it.

ADVANCE OF SPARK.—In ignition, turning the contact breaker so that the spark will ignite the charge earlier during the compression stroke.

ADVANCED QUADRATURE.—In an alternating current, a phase difference of ninety degrees in advance of a succeeding phase.

AEO LIGHT.—In sound picture apparatus, a bulb of glass or quartz about 1⅛ ins. in diameter and 6 ins. long, in which two electrodes are mounted close to the rounded end of the bulb. During the manufacture of the "light" the oxide coated U-shaped cathode is activated, and a gas consisting mainly of helium is placed in the bulb at a pressure required to produce a concentrated glow about the cathode under an applied pressure of about 350 volts and a current of about 10 milliamperes. In use for sound recording the Aeo light is maintained luminous by an exciting battery. Sound currents are superimposed on this luminous discharge causing it to modulate and vary in intensity in accordance with the original variations.

AEOLOTROPIC.—Having different properties in different directions.

AEPINUS CONDENSER.—An apparatus, consisting essentially of two insulated brass discs with a plate of glass between them, used to illustrate by experiment the action of an electric condenser.

AERIAL.—1. A conductor or system of conductors for radiating or receiving radio waves. There are many types of aerial.
2. The elevated conductor portion of a condenser antenna.

AERIAL CIRCUIT.—The aerial and the circuit from the aerial to ground including any tuning devices such as coils, inductances or condensers, etc.

AERIAL CLASSIFICATION.—There are numerous types of radio aerial to meet different conditions. Aerials may be classified:
1. According to the number of wires as, a, single wire; b, multi-wire.
2. According to location, as, a, outside; b, inside; c, underground.
3. According to shape, as, a, inverted L; b, tee (T); c, cage; d, fan; e, umbrella; f, loop (solenoid, spiral and pancake), etc.

AERIAL COUPLING. — Connecting the aerial to the first tuned circuit of a receiver by interposing inductance or capacity or both.

AERIAL HEIGHT.—Within certain limits it is claimed that increase in height increases the range.

AERIAL INSTALLATION.—The wire should be sufficiently taut to prevent undue vibration or swinging and properly insulated. There should be a good soldered connection of the lead in to the aerial.

AERIAL LENGTH.—For best results make the aerial as short as will permit reception from the desired stations. A 30 foot wire is considered a short aerial. In congested districts a short aerial should be used. The selectivity of the set depends largely on the length of aerial, some sets having two or more aerials of different lengths.

AERIAL LOCATION.—1. The best location of the aerial depends on local conditions, each installation presenting its own problems.
2. In general when satisfactory reception is not obtained, the trouble may be rectified by changing the direction of the aerial; if possible place the aerial at right angles to its former position.
3. Erect the aerial as far from other wires as possible.
4. Do not place an aerial under or above power wires; select a direction as nearly as possible at right angles to other wires.

AERIAL SWITCH.—A double throw switch for connecting the aerial to the receiver, or for grounding the aerial.

AERIAL TUNING CONDENSER.—In radio, a variable condenser in the aerial circuit for adjusting the natural period of the receiving circuit to the period of the incoming waves or signals coming from the aerial.

AERIAL WIRE.—An overhead wire.

AERIFORM.—Having the form or nature of air or gas. The prefix aer, in many words, signifies of or pertaining to the atmosphere or other gases.

AERO-DYNAMICS.—That branch of pneumatics which treats of air and other gases in motion, and their mechanical effects.

AERO-FERRIC INDUCTANCE.—Inductance in coils having a magnetic circuit completed through both air and iron.

AEROFOIL.—A lifting surface or wing of an air plane.

AEROMETER.—An apparatus for weighing and estimating the tension of air or other gases; an instrument for ascertaining the mean bulk of air or gases in pneumatic experiments.

AERONAUTIC SPARK PLUG.—A heavy duty plug designed to withstand high compression and great heat. It has such features as: heat radiation fins on the shell; baffle plate to keep oil from the mica; brass or copper stem for heat conductivity; swaged electrode at bottom of stem, etc.

AEROPHORE.—In spinning factories, a device used to moisten the air to counteract the electricity produced by the friction of the machinery.

AEROTRON.—In radio, a name sometimes given to a three element tube.

AESTHESIOMETER.—An instrument for determining sensibility of touch.

AETHRIOSCOPE.—A thermometeric instrument used to measure minute changes in the heat radiated from the sky.

A.f.—Audio frequency.

AFFINITY.—In chemistry, the property or force by which differing elements or groups of elements, when brought into contact, unite to form a new compound; chemical attraction.

AFTER BURNING.—A defect in the working of internal combustion engines consisting of sluggish and prolonged combustion.

AFTER COOLER.—A species of surface condenser in which compressed air is cooled after compression, this having a refrigerating effect when the air is once more expanded. The use of the after cooler permits the compression to be more on adiabatic lines than when a water jacket is employed.

AFTER FIRING.—In a gas engine the continued burning of the charge after release, or opening of the exhaust valve. This is usually caused by the delayed ignition or combustion of the previous charge, due to a mixture that is too rich or too weak, hence it burns slowly with continued combustion after passing into the exhaust.

AFTER GLOW.—A form of fluorescence sometimes seen in a vacuum tube after the electric current has ceased.

AGEING OF MAGNET.—Subjecting a magnet to the process of increasing its magnetic permanency.

AGEING OF TRANSFORMER CORES.—The deterioration of cores by use. The magnetic properties of the iron gradually decay and the loss of energy by hysteresis becomes greater; magnetic fatigue.

AGEING OF TUBE.—1. A condition indicated by decreased brilliancy. It results from deterioration of the filament and a deposit on the bulb.

2. In tube manufacture, subjecting the tube to a period of normal service to determine and correct the operating characteristics.

AGGLOMERATE LECLANCHE CELL.—A variety of Leclanche cell which does away with the porous inner jar, using instead a mass of manganese dioxide and carbon solidified by pressure.

AGONIC LINE.—An imaginary line drawn through points on the earth's surface where the magnetic needle points to the true north, or where the declination of the needle is zero.

A. H.—Abbreviation for ampere hour.

A. I. E. E.—Abbreviation for American Institute of Electrical Engineers.

AILERONS.—Movable hinged surfaces for control of rolling or banking of an air plane; wing flaps.

AIR.—1. The atmosphere which envelops the earth.

2. A gas consisting of a mechanical mixture of 23% of oxygen (by weight), 76% nitrogen, and 1% argon. Carbonic acid is present to the extent of about .03 or .04% of the volume. Obscure constituents are .01 per oent krypton, with small amounts of several other gases.

AIR AND OIL BREAK.—The choice between the two as a medium in which to break the arc, formed when a circuit is broken, depends upon the service conditions. The large amount of space required in order to be certain that the arc will be broken in open air, limits the use of air break switches to comparatively low voltage. The air break switch, however, may be enclosed by some form of cover for the purpose of protecting the operator or to prevent unauthorized operation.

AIR BLAST TRANSFORMER.—A transformer through which a blast of air is driven by a blower for cooling.

AIR BRAKES.—1. A system of brakes which operates by the expansive property of compressed air. In operation, free air is compressed by a suitable pump located upon the engine and is stored until needed for use. When it is necessary to apply the brakes, a portion of the stored air is allowed to pass into the brake cylinder. This cylinder is fitted with a piston which the escaping air moves outward. It is so connected with the brakes that its movement is communicated to the shoes and applies them.

2. The air principle of operating four wheel brakes is not as yet applied in general to pleasure cars. They are used on commercial trucks and trailer equipment, motor coaches, and fire apparatus of large size.

AIR BREAK SWITCH.—One in which the arc formed in opening is ruptured in air.

AIR CELL.—A primary cell of the depolarizer type in which oxygen extracted from the air by a special carbon electrode is used as the depolarizer.

AIR CHURNING.—The agitation of the air surrounding a rotating armature, which interferes with the efficiency of the machine.

AIR CIRCUIT BREAKER.—A type of switch designed to break the circuit in the open air or in an enclosed air space. The air circuit breaker is a simple piece of electrical apparatus. The straight over current type consists of one or more current carrying parts bridging across contact studs, and an electro-magnet so arranged that on the occurrence of a current greater than that which the breaker is "set" to guard against, the circuit is opened. By this arrangement, valuable electrical machinery is protected against the injurious effects caused by over current, short circuits or other abnormal conditions.

AIR COMPRESSOR.—A machine driven by steam, gas engine or electric motor, by which air is compressed in a receiver so that its expansion may be utilized as a source of power at distances.

AIR CONDENSER.—A radio condenser in which the conducting plates or sheets of metal are separated by air.

AIR CONDITIONING.—The treatment to which atmospheric air is subjected in order to regulate its temperature and humidity, and to make it pure, also called "manufactured weather."

AIR COOLED TRANSFORMER.—A type cooled by currents of air without regard to the manner in which the air is circulated. There are two methods of circulating the air, as by, a, natural draught; b, forced draught, or air blast.

AIR COOLING.—1. Reducing the temperature of a transformer or other electrical apparatus by causing air currents to pass over the heated surfaces.

2. The system of cooling an internal combustion engine cylinder by directing air against its surface.

AIR DAMPING.—Arresting the oscillations of the moving parts of an electric measuring instrument by the use of a vane turning in a chamber of air.

AIR EXPANSION LIGHTNING ARRESTER.—A variety of lightning arrester in which air is caused to expand by the heat of the discharge with sufficient force to blow out the arc.

AIR FILM OF LAMP CHAMBER.—A film of air that clings to the inner walls of an incandescent lamp bulb despite the efforts of the air pump to exhaust it.

AIR FLOW RELAY.—A type designed to protect air cooled apparatus as transformers, etc. A counter-weighted aluminum vane is pivoted on needle points and so adjusted that the minimum desired air flow will raise the vane, thus tilting the mercury tube switch suspended beneath the pivot points and thus make or break the electric circuit to an electric signal lamp or alarm bell.

AIR GAP.—1. Any open space in a circuit occupied solely by air.

2. In a dynamo or motor the narrow space between the outer surface of the armature and the pole pieces, forming the non-metallic portion of the magnetic circuit.

3. In a spark plug, the space between the points of the two electrodes. This space offers so much resistance to the flow of an electric current that a very high pressure is required to cause the current to span or jump the air gap and produce a spark, hence the name high tension ignition or jump spark ignition. The overcoming of the very high resistance of the gap results in intense heat, that is, a spark.

AIR GAP ARRESTER.—A lightning arrester based on the air gap principle. The method is to connect a discharge air gap between some point on an electric conductor and the ground. The resistance thus interposed between the ground and the conductor is such that any voltage very much in excess of the maximum normal will cause a discharge to ground, whereas at other times, the conductor is ungrounded because of the air gap. This forms the principle of air gap arresters.

AIR LOCK.—An air tight antechamber of a submarine caisson, for graduating the air pressure.

AIRPLANE AERIAL.—A type usually consisting of a weighted wire suspended from an air plane. When placed on a wing it is called skid fin aerial.

AIRPLANE EFFECT.—The error, caused by inclination of the airplane aerial which is introduced in determining the beacon direction.

AIR POCKET.—1. A local movement of the air causing an air plane to drop.

2. In water supply piping, installation without proper pitch, permitting accumulation of air in the pipes.

AIRPOISE.—An instrument to measure the weight of air.

AIR PORT.—A large level field with special lighting for the safe take off or landing of air planes either during the day or at night.

AIR PRESSURE.—The pressure ordinarily taken as equal to 14.7 lbs. per sq. in., exerted by the atmosphere upon the earth's surface at sea level; atmospheric pressure. The standard atmosphere which by definition$=$29.921 ins. of mercury$=$14.696 lbs. per sq. in. that is 1 in. of mercury$=14.696 \div 29.921 = .49116$ lbs. per sq. in.

AIR PUMP.—A pump for exhausting the air from a closed chamber or vessel in order to produce a vacuum. The function of an air pump used with a surface condenser is to abstract the water condensed (that is, the condensate) and the air which was originally contained in the water when it entered the boiler. In the case of jet condensers, it pumps out in addition to the condensate, the cooling or injection water and the air which it contained. Erroneously called vacuum pump.

AIR SPACE CABLE.—A submarine cable containing a core made up of several conductors separated from one another by a series of air spaces of cellular form.

AIR SPACE INSULATION.—Still air, that is, air without motion, is a good insulator; therefore, an air space is frequently constructed for that purpose in covering engine cylinders or insulating refrigerators. But, as a slight difference in temperature will set up air currents between the two sides, it has been found advisable to pack the space with some extremely porous or fibrous material, such as sawdust, slagwool or charcoal, which, although permeated with air, completely checks all motion in it.

AIR THERMOMETER.—As gases are more regular in their expansion than liquids, air is sometimes used in a thermometer bulb where small differences in temperature are to be measured with precision.

AIR VANE DAMPING.—A frictional resistance for reducing the revolutions of an air vane.

AIR WASHING OF LAMP FILAMENT.—The deteriorating action of the residue of gaseous matter in the vacuum chamber of an incandescent lamp upon the filament.

A. L. A. M.—Abbreviation for Association of Licensed Automobile Manufacturers. The A. L. A. M. was merged with the non-licensed manufacturers association, after the Selden patent expired, into what is now the N. A. C. C. (National Automobile Chamber of Commerce).

ALARM WIRES OF SUBMARINE CABLE.—Special wires run through the fibre which separates the core of a submarine cable from the outer sheathing, so adjusted as to give an alarm when injured by an accident to the cable, in order that repairs may be made before the core itself suffers damage.

ALEXANDERSON ALTERNATOR.—A high frequency machine used in radio telegraphy. It operates at great speed and with its multiplicity of field poles is capable of frequencies as high as 200,000 cycles.

ALEXANDERSON MODULATION.—A system in which variation of direct current at the modulating frequency alters the impedance of a transmitter circuit which includes a winding on the same iron core carrying the modulating current winding.

ALGEBRA.—That branch of mathematics in which letters, signs and figures are used in making calculations instead of only signs and figures as in arithmetic. By the aid of algebra it is possible to express obscure or involved quantities which are set down as equations and the problem solved by treating the equations according to certain definite rules.

ALIGN.—To arrange, place or form in line; as, to align shafting.

ALIGNING CONDENSER.—A small capacity, adjustable condenser connected in parallel with one unit of a gang condenser so that the total capacity of the section may be adjusted to allow simultaneous tuning with other sections.

ALIGNMENT.—1. The line to which adjustment is made, or things are arranged in line.

2. The drawing of an imaginary straight line through two or more points or objects.

ALIVE.—A term sometimes used to describe a circuit or wire charged with electricity.

ALKALI.—Chemically, a substance which yields hydroxyl, on being dissolved in water. The characteristics of alkalis are a caustic taste; the neutralization of acids, forming a salt and water by the process; an alkali will turn red litmus paper blue.

ALKALIMETER.—The object of this instrument is to ascertain the value of the alkalis of commerce. The strength of alkali is inferred from the amount of acid required to neutralize it.

ALKALINE BATH.—A solution of caustic soda or caustic potash for removing grease from the surfaces of objects to be electroplated.

ALKALINE STORAGE BATTERY.—A type of storage battery using an alkali electrolyte instead of acid. Introduced by Edison.

ALL DAY EFFICIENCY.—The average efficiency of an electrical apparatus during the 24 hours of a continuous day's operation.

ALL DAY EFFICIENCY OF TRANSFORMERS.—The ratio of the total watt hour output of a transformer to the total watt hour input taken over a working day. To compute this efficiency it is necessary to know the load curve of the transformer during a day.

ALLOTROPY.—Many elements have the property of existing in more than one form. This phenomenon is called allotropy. Oxygen, O_2, exists in the allotropic modification, ozone (O_3). Carbon exists as diamond, graphite, and charcoal. Phosphorus exists as yellow and red phosphorus. Evidently the physical properties of the allotropic modifications of an element are very different. The chemical properties are different in degree: thus, charcoal burns easily, diamond with difficulty.

ALLOY.—1. A compound of two or more metals formed by fusion, as of copper and tin, to form gun metal. When mercury is one of the constituents the resulting metal is termed an amalgam.

ALPHA RAYS.—One of the three types of rays emitted by radio-active substances; alpha rays are regarded as positively charged material particles. They are given off with great velocity, having small penetrating power, but great power to ionize a gas.

ALTAZIMUTH.—An instrument used to determine the altitudes and azimuths of the heavenly bodies.

ALTERNATING.—A term used with a large number of electrical and magnetic quantities to denote that their magnitudes vary continuously, passing repeatedly through a definite cycle of values in a definite interval of time.

ALTERNATING CURRENT.—1. A current which reverses its direction in a periodic manner, rising from zero to maximum strength, returning to zero, and then going through simiiar variations in strength in the opposite direction; these changes comprise the cycle which is repeated with great rapidity. The properties of alternating currents are more complex than those of direct currents, and their behavior more difficult to predict. This arises from the fact that the magnetic effects are of far more importance than those of steady currents. Alternating current is classed as: a, single phase; b, two phase; c, three phase; d, polyphase.

2. A periodic current which has alternately positive and negative values.

ALTERNATING CURRENT, ADVANTAGES.—As compared with d. c. the advantages of a. c. are: the reduced cost of transmission by use of high voltage transformers, facility of transforming from one voltage to another (either higher or lower) for different purposes. The size of wire needed to transmit a given amount of electrical energy (watts) with a given percentage of drop, being inversely proportional to the square of the voltage employed, the great saving in copper by the use of alternating current at high pressure must be apparent. This advantage can be realized either by a saving in the weight of wire required, or by transmitting the current to a greater distance with the same weight of copper.

ALTERNATING CURRENT AMMETERS AND VOLT METERS.—Indicating instruments which indicate virtual values of the current or pressure respectively, that is, they indicate, the square reot of the mean square of a variable quantity.

ALTERNATING CURRENT ARC.—A voltaic arc produced by an alternating current. In an a. c. arc lamp the current forms no crater on either carbon, but uniformly tapers each one, thus causing a more horizontal dissemination of light.

ALTERNATING CURRENT; DISADVANTAGES.—As compared with d. c. the disadvantages of a. c. are: the high pressure which renders it dangerous, and requires more efficient insulation; alternating current cannot be used for such purposes as electro-plating, charging storage batteries, etc.

ALTERNATING CURRENT EFFECTS.—There are several effects of the a.c. to consider in determining the size of wires. Accordingly, allowance must be made for: a, self-induction; b, mutual induction; c, power factor; d, skin effect; e, corona effect; f, foucault or eddy currents; g, frequency; h, resistance; i, dielectric hysteresis.

ALTERNATING CURRENT ELEVATOR MOTORS.—The two types suitable for elevator drive are the squirrel cage and the slip ring induction motor. The squirrel cage motor is used extensively up to about 20 h.p. because of its simplicity and because it requires only a relatively simple form of controller as it is generally thrown across the line with no starting resistor. In actual service the power consumption of the squirrel cage motor is slightly higher than that of the slip ring machine, but due to the lack of slip rings and fewer controller parts it is somewhat more reliable. The slip ring motor for the same rating has a somewhat lower power factor than the squirrel cage motor. A.c. motors of the two speed type are being used successfully on elevators whose car speeds are as high as 400 feet per minute.

ALTERNATING CURRENT FILAMENT TUBE.—One in which the a. c. is applied directly to the filament.

ALTERNATING CURRENT INTERLOCKING.—Wherever a reliable source of a. c. power is available, an a. c. interlocking system has the following advantages over one using d. c.: a, the power equipment is simplified; b, power losses between source of supply and interlocking units operated are reduced to a minimum; c, a. c. track circuits insure maximum safety and economy. Signal lights may be controlled over a separate wire in order that this circuit can be opened during the daytime if desired.

ALTERNATING CURRENT MOTORS; CLASSIFICATION. — There are many types of a. c. motors to meet the requirements of all classes of industrial drive and for use on the various kinds of alternating circuits. A. c. motors may be classed as:

1. Synchronous motors.
   a. Plain.
   b. Super-synchronous.
2. Asynchronous motors.
   a. Induction motors.
      Squirrel cage, single and double —internal resistance — external resistance (slip ring)—split or single phase—polyphase.
   b. Commutator motors.
      Series — compensated — shunt— repulsion—repulsion start induction—repulsion induction.

ALTERNATING CURRENT RECLOSING RELAY.—One which controls the reclosing of an a. c. circuit interrupter.—NEMA.

ALTERNATING CURRENT RELAYS.—The classification refers to the kind of current used on the auxiliary circuit. In some cases direct current is used to energize the trip gear of the circuit breaker or oil switch, and in others, alternating current. A. c. and d. c. relays are respectively known as circuit opening and circuit closing relays.

ALTERNATING CURRENT SYSTEMS.— The various systems may be classed as follows:

1. With respect to the arrangement of the circuit, as a, series; b, parallel; c, series parallel; d, parallel series.

2. With respect to transformation, as, a, non-transformer; b, transformer.

3. With respect to the mode of transmitting the energy, as, a, constant pressure; b, constant current.

4. With respect to the kind of current, as a, single phase (two wire, three wire); b, monocyclic; c, two phase (three wire, four wire, five wire); d, three phase (three wire, four wire, six wire, star connection, delta connection, star delta connection, delta star connection); e, multi-phase (of more than three phases).

5. With respect to transmission and distribution, as a, frequency changing; b, phase changing; c, converter; d, rectifier.

ALTERNATING CURRENT TRACK CIRCUITS.—In railway signal systems, the principle of a. c. track circuits is similiar to that of d. c. circuits. The high tension signal voltage is stepped down from the signal mains by means of transformers to the required working pressure for the track circuits. A. c. track circuits for use on electric lines are divided into two classes: single rail and double rail.

ALTERNATING CURRENT TRACK RELAYS.—Used in railway signal systems. There are three important types known as:

1. Galvanometer relay;
   a. Ironless.
   b. Iron.
2. Vane relay;
   a. Single element.
   b. Double element.
3. Polyphase relay.

ALTERNATING CURRENT TUBE.—Any radio detector or amplifier vacuum tube in which the heat required for emission of electrons is obtained from alternating current whether the current is applied directly to the filament or to another element to heat the filament.

ALTERNATING CURRENT WATT HOUR METERS.—Registering instruments consisting essentially of: a, a motor whose speed is proportional to the power to be measured, and b, a registering mechanism connected thereto by suitable gearing. There are several types of a. c. watt hour meters, which may be classified as: a, induction type, and b, Faraday disc type.

ALTERNATING CURRENT WINDINGS. —The windings for alternators and a. c. motors are substantially alike. Most a. c. windings are of the open circuit type, that is, there is a continuous path through the wire of the coils of each phase of the winding with the ends of this path forming two free ends. Such a winding does not close upon itself. Alternator windings are usually described in terms of the number of slots per phase per pole. For instance, if the armature of a 20 pole three phase machine have 300 slots, it has 15 slots per pole or 5 slots per each phase per pole, and will be described as a five slot winding. Therefore, in order to trace the connections of a winding, it is necessary to consider the number of slots per pole for any one phase.

ALTERNATING CYCLE.—In an alternating current, a series of current changes which are regularly repeated. The cycle begins with zero current which rises to a positive maximum, falls to zero again, thence to a negative maximum and returns to zero; the completion of the cycle is called a period and the number of periods accomplished in a second, the frequency of the alternations. The maximum value of voltage or current attained is the amplitude.

ALTERNATING DISCHARGE.—An electric discharge which rapidly reverses its direction; an oscillatory discharge.

ALTERNATION.—The changes which alternating current undergoes in rising from zero to maximum pressure and returning back to zero; that is, a single positive or negative "wave" or half period.

ALTERNATIVE COMPOUND WINDING.—A winding for a compound dynamo in which the series winding is tapped. Leads from the taps are connected to a multi-point switch. This switch permits the series coils to be either short circuited in part or cut out of the circuit entirely while the machine is charging the storage battery, being again cut into circuit when the machine is required to furnish current for the lamps.

ALTERNATIVE PATH.—A course taken by a disruptive discharge through a medium offering less resistance than the direct conducting path; a short circuit.

ALTERNATOR.—A machine for furnishing an alternating current. Alternators are classified with respect to the current as: 1, single phase; 2, two phase; or 3, polyphase; with respect to construction as: a, those with stationary field magnet and rotating armature; b, those with rotating field magnet and stationary armature; c, those with both field magnet and armature stationary, but having revolving inductors made up of appropriate pieces of iron. Alternators are usually multipolar, having north and south poles alternating around the field. The field magnets are often excited by a separate dynamo.

ALTERNATOR RATING.—Manufacturers usually rate their alternators as producing so many kilovolt amperes instead of kilowatts to avoid disputes.

ALTERNATOR SELECTION.—In practice, alternators are wound for one, two or three phases. Three phase machines are more commonly supplied and in many cases it will pay to install them in preference to single phase, even if they be operated single phase temporarily. For a given output, three phase machines are smaller than single phase and the single phase load can usually be approximately balanced between the three phases. Moreover, if a three phase machine be installed, polyphase current will be available in case it may be necessary to operate polyphase motors at some future time.

ALTERNATOR TRANSMITTER.—One supplied with radio frequency power generated by a radio frequency alternator.

ALTERNATOR VOLTAGE REGULATION BY VARIABLE EXCITATION.—A system adapted to plants where it is necessary to run motors and other station auxiliaries from the exciter bus. A booster for boosting the alternator field excitation is used, separately excited by a small dynamo, which, in turn, has its field excited from the difference in voltage between a point on either a resistance connected across the exciter bus, or if a storage battery be used, the middle tap from the battery, and a point of variable voltage on a series of three resistances connected across the exciter bus, so that the booster can be excited with either polarity, as required.

ALTERNATOR VOLTAGE REGULATORS IN PARALLEL.—Successful operation of regulators in parallel depends primarily on the control of the circulating current that may flow between two or more alternators or the proper division of the reactive currents in the system as a result of momentary differences in excitation.

ALTIGRAPH.—A recording altimeter. A chart driven by clockwork, usually graduated in feet or meters.

ALTIMETER.—An instrument for measuring or indicating the elevation of air craft above a given datum plane.

ALTITUDE.—The elevation of an object above its base, or the perpendicular distance between the top and bottom of a figure.

ALUMINUM.—A metal of a silvery white color; much used for electrical conductors, etc., on account of its lightness, also in alloys with copper to form a tenacious non-corrodible bronze. It is a good conductor of heat and electricity.

ALUMINUM BRONZE.—A beautiful golden colored bronze, composed of 90 parts copper to 10 of aluminum. Its tenacity largely depends upon the purity of the copper from which it is alloyed. Aluminum bronze wires are free from corrosion, hence, they are suitable for guy wires in a system of overhead construction, but the low conductivity of bronze excludes them from use as line wires.

ALUMINUM RECTIFIER.—An electrolytic rectifier having one of its elements composed of aluminum.

ALUMINUM WIRE.—An electric conductor composed of commercially (99%) pure aluminum. As compared with copper, aluminum wire has 62% conductivity and costs more than twice as much per pound, yet its weight is only 50% that of copper wire

ALUNDUM.—Artificial corundum made in the heat of an electric furnace; used as an abrasive.

AMALGAM.—A combination of mercury or quicksilver with other metals.

AMALGAM BOND.—A form of railway track bond, employing a spiral spring containing a soft amalgam placed between the fishplate and rail.

AMALGAMATED ZINC.—To "amalgamate" a piece of zinc, dip it into dilute sulphuric acid to clean its surface, then rub a little mercury over it by means of a piece of rag tied on to the end of a stick, and lastly, leave the zinc standing for a short time in a dish to catch the surplus mercury as it drains off. It is thought that amalgamating the zinc prevents local currents by the amalgam mechanically covering up the impurities on the surface of the zinc and preventing their coming into contact with the liquid.

AMBER.—A yellowish, or reddish brown translucent fossil resin, easily electrified by friction.

AMBIENT TEMPERATURE.—The temperature of the air or water which, coming into contact with the heated parts of a machine, carries off their heat. Ambient temperature is commonly known as "room temperature" in connection with air cooled apparatus not provided with artificial ventilation. The N.E.M.A. rule specifies that the standard ambient temperature of reference, when the cooling medium is air, shall be 40° C.

AMBIENT TEMPERATURE OF REFERENCE.—The maximum ambient temperature at which a piece of apparatus can operate successfully under full rated conditions. If this maximum ambient temperature be exceeded and the conditions or rating produce the permissible temperature rise the maximum permissible actual temperature will be exceeded and a deterioration of the insulation will result. Such a condition may also obtain in any piece of apparatus when it is operated within the maximum ambient temperature of 40° C. at voltages and frequencies other than normal. No correction need be made for the deviation of the ambient temperature of the cooling medium from the standard ambient temperature of reference.

AMBIENT TEMPERATURE OF TEST.—A machine may be tested at any convenient ambient temperature but whatever may be the value of this ambient temperature the permissible rises of temperature must not exceed those specified.

AMBROIN.—A trade name for an insulating compound formed by mixing together fossil, copal, mica and other ingredients, and heating the mixture under pressure. Ambroin has the following characteristics claimed for it: it will resist extreme high temperatures; is not affected by moisture, can be moulded and machined, and will not shrink.

AMERICAN TELEGRAPHIC CODE.—The American Morse code or alphabet.

AMERICAN "TWIST JOINT."—A simple method of connecting the ends of two sections of wire by tightly twisting the ends around each other for a few turns; the Western Union wire joint.

AMERICAN WIRE GAUGE.—(A.w.g. or B & S.) was devised by J. R. Brown, one of the founders of the Brown and Sharpe Manufacturing Co. in 1857. It speedily superseded the Birmingham wire gauge in the U. S., which was then in general use. It is perhaps more generally known by the name "Brown and Sharpe Gauge" and that name should be used to avoid confusion. It ranges from No. 0000, with a diameter of .46 in. to No. 36, with a diameter of .005 in.

AMMETER.—A commercial form of galvanometer so constructed that the deflection of the needle indicates directly the strength of current in amperes. A good ammeter should have a very low resistance so that very little of the energy of the current will be absorbed; the needle should be dead beat, and sufficiently sensitive to respond to minute variations of current. According to principle of operation, ammeters are classed as: 1, moving iron; 2, moving coil; 3, solenoid or plunger; 4, magnetic vane; 5, hot wire or thermal; 6, electrostatic; 7, astatic; 8, inclined coil; 9, fixed and movable coil. Many ammeters consist of moving coil milli-voltmeters connected to the terminals of shunts through which the currents to be measured are passed. The shunts are made of a high resistance alloy, and since the resistance remains constant the drop in voltage between its terminals will be proportional to the currents passing through the shunts. This type is used for direct currents only. For alternating currents the electro-magnetic system is generally employed.

AMMETER READINGS. — For precision measurements, an ammeter should be cut out of circuit except while taking a reading, because of the error introduced by the heating effect of the current. In an ammeter having a capacity of 50 amperes, the error thus introduced will be less than 1 per cent if connected continuously in circuit with a current not exceeding three-quarters of this capacity. All ammeters of 100 amperes capacity may be used indefinitely in circuit with less than 1 per cent error up to one-half its capacity, and for five minutes at three-quarters capacity without exceeding the 1 per cent limit.

AMMETERS AND VOLT METERS.—A volt meter measures pressure, while an ammeter measures current. As actually constructed, most volt meters are simply special forms of ammeter. An ammeter has a coil of heavy wire of a few turns connected in series in the circuit, whereas a volt meter has a high resistance or fine wire coil of a great number of turns connected in parallel or across the circuit.

AMMONIA.—A colorless gas with a characteristic pungent odor (hartshorn), and a marked alkaline taste. It has a specific gravity of 8.5 (hydrogen being 1) and is lighter than air. It burns in oxygen, producing water and nitrogen, and is a powerful base, combining with all acids to form salts. Ammonia is easily liquefied at ordinary temperatures, a pressure of seven atmospheres being sufficient; it is also the most soluble of gases, one volume of water dissolving over 800 volumes of it at ordinary temperature.

AMMONIA COMPRESSION REFRIGERATION.—In this system anhydrous ammonia (ammonia containing no water) is used as the refrigerant. The cycle is as follows: The ammonia vapor is compressed to about 150 lbs. pressure and is then allowed to flow into a cooler or surface condenser where the heat due to the work of compression is withdrawn by the circulating water and the vapor is condensed to a liquid. It is then allowed to pass through an expansion cock and to expand in the piping, thereby withdrawing heat from the "brine" with which the pipes are surrounded. This brine is then circulated by pumps through coils of piping and produces the refrigerating effect. The expanded ammonia gas is then drawn into the compressor under a suction of from 5 to 20 lbs., thus completing the cycle of operations.

AMMONIUM CHLORIDE.—Also known as sal ammoniac and as muriate of ammonia. A white solid obtained whenever hydrochloric acid and ammonia are brought together; it is usually produced by neutralizing the distillate from ammoniacal gas liquor with this acid, concentrating the resulting liquid. It is also found in volcanic deposits, and was the first ammonium salt discovered. It is largely used in electric work as the electrolyte in Leclanche primary cell.

AMMONIUM CHLORIDE CELL.—A type of primary cell for open circuit work having zinc-carbon electrodes and an electrolyte of ammonium chloride (sal ammoniac.) The Leclanche cell is an example of this type.

AMORTISSEUR.—An arrangement of copper rods in the pole faces of a dynamo so as to dampen the oscillations of the magnetic flux at the commutator, and thus reduce the tendency to sparking at the brushes.

AMORTISSEUR WINDING.—A "winding" similar to the squirrel cage winding of an induction motor, embedded in the field pole pieces of an alternator or synchronous condenser to prevent hunting. In operation the heavy currents induced in the amortisseur winding when the machines get out of step tend to quickly re-establish the phase relation.

AMPERAGE.—The strength of an electric current measured in amperes.

AMPERE.—The practical unit of electric current; it is the current produced by a pressure of one volt in a circuit having a resistance of one ohm. An ampere is that quantity of electricity which will deposit .005084 grain of copper per second. It is one-tenth the c.g.s. electromagnetic unit of current strength. That is one ampere = .1 abampere. According to Ohm's law: $I = E \div R$, that is,

$$\text{amperes} = \text{volts} \div \text{ohms}.$$

AMPERE, ANDRE MARIE.—Born 1775, died 1836. A French physicist, distinguished for his researches in electro-dynamics. He first propounded the theory of electro-dynamics (1820), known as Ampere's theory. Ampere was the inventor of the astatic needle. He was the first to show that two parallel conductors carrying currents traveling in the same direction attract each other, while if traveling in opposite directions repel each other. He also formulated the theory that there were currents of electricity circulating in the earth in the direction of its diurnal revolution which attracted the magnetic needle and advanced the view that electricity and magnetism were identical.

AMPERE FOOT.—The product of one ampere multiplied by one foot. The unit ampere foot is used in figuring motor circuits or circuits designed to carry a mixed load.

AMPERE HOUR.—The quantity of electricity passed by one ampere of current in one hour; being equal to 3,600 coulombs. Of course 3,600 coulombs of electricity may be obtained in any desired time. It all depends on the rate of flow or the current strength in amperes. For instance, 2 amperes in ½ hour, or 4 amperes in ¼ hour will also give one ampere-hour of 3,600 coulombs.

AMPERE HOUR EFFICIENCY OF STORAGE BATTERY.—The ratio of the ampere hours obtained from a storage battery to the ampere hours required to charge it; the quantity efficiency as distinguished from the energy; or watt hour efficiency.

AMPERE HOUR METER.—A meter for determining the amount of electrical power consumed, measured in ampere hours.

AMPERE METER.—1. An instrument which measures the current strength directly in amperes. Also called ammeter.

2. The product of one ampere times one meter, i.e., one ampere meter is a current of one ampere strength flowing through a conductor one meter long.

AMPERE SECOND.—One ampere maintained for one second. It is the practical unit of electrical quantity called the coulomb; named after Charles Augustin Coulomb, the French physicist.

AMPERE TURNS.—A total of magnetic force equal to the product of the number of turns in a magnetic coil multiplied by the current strength in amperes. One ampere turn is equal to one ampere flowing through one turn.

AMPERE'S EXPERIMENTS. — Following Oersted's discovery, Ampere began his investigations. He reversed Oersted's experiment and showed the action of a magnet on a movable circuit by means of a rectangular movable frame suspended from mercury cups. When a magnet is placed near this frame and current is flowing, the frame will be attracted by the magnet.

AMPERE'S RULE.—If a man could swim in a conductor with the current, then the north seeking (+) pole of a magnetic needle placed directly ahead of him, will be deflected to the left, while the south seeking (—) pole will be urged to the right.

AMPERE'S THEORY OF MAGNETISM.—A theory advanced by Ampere that around each molecule of a magnetic substance there circulates continually an electric current and that the process of magnetization consists in arranging these currents so that they all take the same direction.

AMPLIFICATION.—In radio, the increase in voltage, current, or power of a signal. The strengthening of radio signals so that the more distant stations can be heard, and the sound augmented. The simplest set possessing amplification is the tuning coil set with a vacuum tube detector.

AMPLIFICATION CONSTANT.—In radio, if the grid voltage of a tube be changed there will be a resulting change in the plate current. This change in the plate current may be overcome by a corresponding decrease or increase in the plate voltage. The ratio of the change in plate voltage to the change in grid voltage is the amplification constant. That is: amplification constant = change in plate voltage ÷ change in grid voltage. The amplification constant depends only on the construction of the tube, and is practically independent of the way it is measured.

AMPLIFICATION FACTOR.—1. A coefficient representing the increase in strength of either voltage or amperage or both in a radio signal when passed through a tube, transformer or other amplifying device. Symbol mu.

2. The ratio of the alternating voltage appearing in the plate circuit to the alternating voltage applied to the control grid when the plate load is an infinite impedance.

AMPLIFICATION WITH TUBE DETECTOR.—The simplest radio set possessing amplification is the combination of the tube and tuning coil. By using another tube or several additional tubes this amplification may be carried still further, for it is merely necessary to feed the output of one tube into the grid of the next tube. In this way the incoming radio wave may be repeated and built up; that is, the characteristics of the incoming wave may be reproduced by an exactly similar wave of enormously greater magnitude.

AMPLIFIER.—A device for increasing the amplitude of electric current, voltage, or power, through the control by the input power of a larger amount of power supplied by a local source to the output circuit. An amplifier consists of one or more amplifier tubes with the necessary associated circuits to accomplish amplification.

AMPLIFIER ACTION OF VACUUM TUBE.—In radio, the increase in power or voltage of incoming signals under proper conditions, the increasing signals produce comparatively larger changes in the current at the plate and hence larger changes in output voltage.

AMPLIFYING TRANSFORMER.—In radio, a step up transformer usually an audio frequency transformer.

AMPLIFYING TUBE.—One which is used to increase the voltage, current or both in its grid circuit. A radio tube used to increase the voltage or power of incoming signals. The amplifying action of the tube means its ability to use input power (the power of the signals delivered to the tube) to control a local source of power such as the B battery power used on the plate of the tube, and deliver increased power.

AMPLITUDE.—The greatest value of the current strength attained during the cycle of an alternating current.

AMPLITUDE DISTORTION.—A form of radio wave distortion due to a change of ratio between high voltages in the applied signals and the low voltages. This changes the shape of the sound wave.

AMPLITUDE OF SIMPLE HARMONIC MOTION.—The greatest distance of an oscillating point from its mean position.

AMPLITUDE OF VIBRATION.—The maximum value of a vibration or wave motion on either side of its zero point.

AMYL-ACETATE.—A distilled mixture of amyl-alcohol, sulphuric acid and sodium acetate. It is used as the illuminant in the Hefner-Alteneck amyl-acetate standard lamp.

AMYLOID.—A preparation for incandescent lamp filaments; it consists of a thread formed by a solution of cellulose, or a cotton thread which has been dipped into sulphuric acid and parchmentized or converted into a state resembling cellulose.

ANALOGOUS POLE.—A magnetic pole. That pole of a pyro-electric substance, like tourmaline, which acquires a positive electrification while the temperature of the crystal is rising.

ANALYSIS.—In chemistry, the resolution of a compound into its parts or constituent elements. Such analysis may be qualitative, showing the nature of the various bodies only, proving their presence by tests; or it may be quantitative, in which the exact proportions of the different constituents are ascertained by a series of refined eliminatory processes accompanied by weighing on delicate balances.

ANALYSIS, ELECTRIC.—The resolving of a substance into its elements by means of electricity.

ANALYTICAL GEOMETRY.—That branch of geometry in which position is indicated by algebraic symbols and the reasoning conducted by analytic operations.

ANALYZER, ELECTRIC.—A radio testing set.

ANCHOR.—Tie wires employed in a trolley system for binding the trolley wire to the posts in order to give it the proper tension.

ANCHOR GAP.—In radio, a small spark gap in the antenna circuit used to automatically disconnect the transmitting circuit when the receiver is being used.

ANCHOR LOG.—A log buried in the earth, or sunk in concrete, to act as an anchor for the guy wires of a telegraph pole.

ANCHOR PLUG RECEPTACLE.—A variety of wall socket for an incandescent lamp.

ANCHOR STRAIN EAR.—A trolley ear for holding an overhead trolley wire at the proper tension.

ANELECTROTONUS.—The decrease of irritability of a nerve when near an anode.

ANEMOMETER.—An instrument for measuring the velocity of the wind; a wind gauge.

ANEROID ALTIMETER.—An instrument for determining the elevation of air craft, the indications of which depend on the deflections of a pressure sensitive element.

ANEROID BAROMETER.—An instrument for indicating atmospheric pressure. The action of the aneroid depends on the pressure of the atmosphere on a circular metallic box hermetically sealed and having a slightly elastic top, the vacuum serving the same purpose as the column of mercury in the ordinary barometer.

ANGLE.—Two straight lines (sides) emanating from one point (the vertex) when only the difference of their direction is considered and not their length.

ANGLE BOX.—In conduit work, a metal box of rectangular cross section having its ends containing the outlets at right angles. The box is lined with an insulating material and is used for splicing or "pulling-in" conductors.

ANGLE, ELECTRIC.—A measure of lag or lead between alternating current and voltage. If the base line of the sine curve for one cycle be divided into 360°, then the angle between current and voltage is the number of degrees on the base line between the points where the current and voltage curves intersect the base line.

ANGLE OF DECLINATION.—The angle between the magnetic meridian of a place and its geographic meridian, as shown by the deviation of the magnetic needle; the angle of variation.

ANGLE OF DEFLECTION.—The angle through which the pointer of a galvanometer or beam of light is turned by the applied current. The angle is stated as the number of scale divisions from the zero division of the scale.

ANGLE OF DIP.—The angle which a magnetic needle makes with the horizon when the vertical plane in which it turns corresponds with the magnetic meridian; the angle of inclination; the dip.

ANGLE OF INCIDENCE.—In optics the angle at which a ray strikes a surface. In the case of a mirror or other reflecting surface, the angle of reflection is equal to the angle of incidence.

ANGLE OF INCLINATION.—1. The angle formed by a magnetic needle with a horizontal line passing through the point of support of the needle, when the latter is free to move in a vertical plane. Also called angle of dip.

2. The angle which a magnetic needle makes with the horizon.

3. The angle at which a wing of an airplane is inclined to the line of flight.

ANGLE OF LAG.—A measure of phase difference between alternating current and voltage when the current lags behind the impressed pressure. It is the distance in degrees between the beginning of the current curve and the voltage curve. In the actual alternator if the current lag, say 23° behind the pressure, it means that a given coil on the armature rotates 23° from its position of zero induction before the current starts.

ANGLE OF LEAD.—1. In dynamo operation, the angle between the normal neutral plane and the commutating plane. In the operation of a dynamo since the field, on account of armature reaction, is twisted around in the direction of rotation, the proper position for the brushes is no longer in the normal neutral plane, but lies obliquely across, a few degrees in advance. Hence, for sparkless commutation, the commutating plane is a little in advance of the normal neutral plane, the lead being measured by the angle between these planes. For sparkless commutation, the angle of lead varies with the load.

2. A measure of phase difference between alternating current and voltage when the current lead is in advance or leads the impressed pressure. It is the distance in degrees between the beginning of the current curve and the voltage curve.

ANGLE OF REPOSE.—The greatest angle with the horizontal at which a mass of material, as in a cut or embankment, will lie without sliding. Also called angle of friction.

ANGLE OF TORSION.—The angle through which one end of a body, as a silk fiber or wire, is twisted while the other end is held fast. The torsion, due to the twisting, forms the controlling force in the operation of some of the electrical measuring instruments.

ANGSTROM UNIT.—A unit of length (one ten millionth of a millimeter) used to express the wave length of light. Thus, a certain part of the green in the spectrum has a wave length of 5,500 Angstrom units. 1,000 Angstrom units (A) = 100 millimicrons = .1 micron.

ANGULAR ACCELERATION.—The rate at which the angular velocity of a body increases per unit of time.

ANGULAR ADVANCE.—In steam engine valve gears, the number of degrees the eccentric must be moved forward from a position at right angles to the crank to give the valve its linear advance. In the case of direct valve gears, that is, those not having rocker arms which reverse the motion, the engine will run in the direction in which the eccentric is moved to its position of angular advance.

ANGULAR PITCH.—On an armature the distance between the sides of a coil of the winding as measured in terms of the number of slots; also called spread of the coil. Theoretically this is equal to the pitch of the poles.

ANGULAR VELOCITY.—The angle through which any radius of a body turns in a second. Usually expressed in radians.

ANHYDRIDE.—A class of chemical compounds which are regarded as molecules of water from which the hydrogen has been taken and an acid or basic element has been substituted for the hydrogen.

ANHYDROUS AMMONIA. — In refrigeration, ammonia freed from any water which it might contain; as, the dry gas leaving the analyzer of an absorption refrigerating apparatus.

ANIMAL ELECTRICITY.—Several species of creatures inhabiting the water have the power of producing electric discharges by certain portions of their organism. The best known of these are the Torpedo, the Gymnotus, and the Silurus, found in the Nile and the Niger. The Electric Ray is provided with an electric organ consisting of laminæ composed of polygonal cells to the number of 800 or 1000, or more, supplied with four large bundles of nerve fibres; the under surface of the fish is —, the upper +. In the Surinam eel, the electric organ goes the whole length of the body along both sides. It is able to give a very severe shock, and is a formidable antagonist when it has attained its full length of 5 or 6 feet.

ANIMAL MAGNETISM.—A term formerly applied to hypnotism or mesmerism.

ANIMAL OILS.—Lubricating oils for machinery obtained from animal tissues, the principal being sperm, ordinary whale, neatsfoot, seal. The animal oils do not dry and therefore do not gum, but they decompose and generate fatty acids which corrode metal work with which they come in contact and produce also residual deposits.

ANION.—1. A free negative atom in a solution, which travels toward the anode when the solution is subject to electrolysis.

2. A negative atom which, in a vacuum tube, moves toward the electrode (anode) through which current enters.

ANIONIC CURRENT.—That portion of the electric current carried by the anion.

ANISOTROPIC.—Having different electrical, optical and other physical properties in different directions; non-isotropic; æolotropic opposed to isotropic.

ANNEALED WIRE.—Wire which has been softened by heating. Soft drawn wire.

ANNEALING.—The process of gradually heating and gradually cooling glass, metals or other substances to reduce brittleness and increase flexibility, strength, etc.

ANNEALING ARMOR PLATE.—The spot to be treated is brought to a temperature of about 1,000° F. The current used is equivalent to 40,000 amperes per square inch, a density which is only possible by the use of cooling by water circulation. The operation generally takes seven minutes.

ANNEALING FURNACE.—A furnace in which metals are heated nearly to fluidity, and then allowed to cool slowly, so as to render them less brittle or to make them malleable; or, as with glass, a furnace in which the heat is retained for a considerable period in order that the process of cooling may be lengthened.

ANNEALING POT.—A closed pot set in a furnace, and used for exposing an object to heat without forming a scale of oxide. Pots for annealing wire are made ring shaped, so as to receive, with as little vacant space as possible, the wire which is coiled therein. The smaller the amount of air in the closed pot, the less the deterioration of the wire by exposure of its heated surface.

ANNUAL LOAD FACTOR.—The ratio of the average daily output of an electric plant for one year to the maximum output at any one time.

ANNUAL VARIATIONS.—The periodic variations of the earth's magnetic declination which occur each year.

ANNUNCIATOR.—A fitting attached to an electric or pneumatic call system, in which a shutter, falling in one of a series of windows in a frame, discloses number of the telephone subscriber, apartment, etc., whence the call has been made.

ANNUNCIATOR CLOCK, ELECTRIC.—An electric clock operating an annunciator, and closing certain circuits at set times.

ANNUNCIATOR RELAY.—A non-automatic reset device which gives individual visual indications upon the functioning of lock out protective devices, and may also be arranged to perform the lock out function in the master control circuit.—NEMA.

ANNUNCIATOR WIRE.—A conductor used in the wiring of electric bells or other low voltage circuits, but large quantities are also used as connecting wires for blasting purposes. The paraffined wire should be used only in dry places. The weatherproof finish may be used in damp places, but where actually exposed to the weather or extreme humidity the conductors should not be twisted or otherwise fastened tightly together.

ANODE.—1. In general, the electrode through which a direct current enters a liquid, gas, or other discrete part of an electrical circuit.

2. In an electrolytic cell, the electrode from which during electrolysis electrons flow into the external circuit or through which a positive current enters the electrolyte.

3. In a vacuum tube, the positive electrode or plate.

4. In an X-ray tube, the target or anti-cathode, that is, the electrode on which cathode rays are focussed and from which roentgen rays are emitted. It is usually of a heavy metal such as tungsten.

ANODE DISSIPATION METHOD.—In this method of measuring the radio frequency power delivered by a transmitter, which is applicable only in the case of transmitters using water cooled tubes, the total power delivered to the filament and plate circuits is measured. The power dissipated by the cooling fluid is also observed and the difference between this and the total power delivered to the filament and plate circuits gives the sum of the radio frequency power delivered by the transmitter into its load circuit, and the loss in the output or coupling circuits.

ANODE EFFECT.—In electrolysis, sparking between the anode and the bath, with a simultaneous increase in voltage across the electrodes. This sparking is to a certain extent prevented by maintaining the proper concentration of the depolarizer in the electrolyte.

ANODE RAY CURRENT.—In a rarefied gas, a current of positively charged particles.

ANODIC RAYS.—The radiation from the anode or positive electrode in a vacuum tube.

ANOMALOUS POLE.—Two similarly free poles placed together in an anomalous magnet.

ANSWERING BOARD.—A separate panel at the lower part of a multiple telephone switchboard on which the answering jacks are mounted.

ANTENNA.—A conductor or system of conductors for radiating or receiving radio waves.

ANTENNA INDUCTANCE.—In radio, the self-inductance of the antenna proper and the lead-in wires.

ANTENNA LOADING INDUCTANCE.—In radio, the loading inductance coil of an inductance antenna.

ANTHONY BRIDGE.—A type of bridge similar to the so called Wheatstone bridge. The latter is in fact a modification of the Anthony bridge.

ANTHRACITE.—A hard coal containing 90 to 95% of carbon, and very little hydrocarbons, consequently burning with a short flame and without smoke. The different sizes of screened anthracite coal may be taken as follows: egg, 2½-1¾ ins.; stove, 1¾-1¼ ins.; chestnut, 1¼-¾ inch; pea, ¾-½ inch; buckwheat, ½-⅜ inch; rice, ⅜-⅛ inch. Lump and broken coal are larger sizes than egg.

ANTI-CAPACITY SWITCH.—One having its legs widely separated to reduce capacity.

ANTI-CATHODE.—In a vacuum tube, a second aluminum plate fixed near the middle of the bulb, upon which the rays from the cathode are focussed.

ANTI-FRICTION METAL.—A questionable term applied to the various tin-lead alloys uses to line journal boxes of machinery; as, white metal, babbitt metal, etc. There is no such thing as a frictionless bearing.

ANTI-HUM.—A contrivance for reducing the humming noise occurring in an overhead wire as the result of vibration; it consists of a galvanized iron shackle set into the line and fitted with a cushion for deadening the vibration. A short piece of wire looped past it preserves the circuit intact.

ANTILOGOUS POLE.—That pole of a pyroelectric substance, like tourmaline, which acquires a negative electrification when the temperature of the crystal is rising, and a positive electrification when it is falling.

ANTIMONY.—A metal, hard, brittle, resembling tin in its fracture, and of a color more resembling tin than lead. Its specific gravity is 6.6 and its melting point 842° F. (Authorities differ widely on this point.) It is used as a hardening ingredient in lead and tin alloys, such as babbitt and various other antifriction metals.

ANTIMONY DETECTOR.—In radio, a type of crystal detector in which contact is formed between silicon and antimony.

ANTI-NODES.—In a train of waves or oscillations, points of greatest amplitude half way between the nodes. Sometimes called loops.

ANTI-PARALLEL SYSTEM.—A distribution system in which the current is admitted at the opposite ends of the two conductors of the circuit so as to produce a pressure difference that is relatively even between the conductors.

ANVIL OF TELEGRAPH KEY.—The metallic surface upon which the front end of a telegraph key descends under pressure of the operator's finger.

APERIODIC.—1. The quality of being devoid of periodic motion; as, when an index needle that has been deflected comes to rest without swinging.

2. In radio, untuned.

3. Not resonant at any one frequency. Having no natural frequency.

APERIODIC CIRCUIT.—A non-resonant circuit.

APERIODIC DAMPING.—Critical Damping.

APERIODIC GALVANOMETER.—A thoroughly damped or dead beat galvanometer, which gives its reading with only a slight oscillation of the needle before coming to rest.

APERIODIC VOLT METER.—A volt meter in which an aluminum disc moving in the field of an electro-magnet is employed to damp the deflection of the needle.

A-POLE.—A double telegraph pole resembling the letter A in shape; an A-mast.

APOTHECARIES' FLUID MEASURE

60 minims (♏)	make	1 fluidrachm (dram)	f ʒ
8 fluidrachms	"	1 fluidounce........	f ℥
16 fluidounces	"	1 pint.............	O
8 pints	"	1 gallon.........	Cong.

Unit equivalents

Cong.	O	f ℥	f ʒ	♏
			1 =	60
		1 =	8 =	480
	1 =	16 =	128 =	7,680
1 =	8 =	128 =	2,048 =	61,440

Scale.—Ascending, 60,8,16,8; descending, 8,16,8,60.

APOTHECARIES' MEASURE

20 grains (gr.)	make	1 scruple........	sc. or ℈
3 scruples	"	1 dram.........	dr. or ʒ
8 drams	"	1 ounce.........	oz. or ℥
12 ounces	"	1 pound troy....	lb. or ℔

Unit equivalents

lb.	oz.	dr.	sc.	gr.
			1 =	20
		1 =	3 =	60
	1 =	8 =	24 =	480
1 =	12 =	96 =	288 =	5,760

Scale.—Ascending, 20,3 8,12; descending, 12,8,3,20.

"A" POWER SUPPLY.—In radio, the source which provides current for heating the filament of a vacuum tube.

APPARENT COEFFICIENT OF MAGNETIC INDUCTION.—The apparent permeability or ratio existing between the magnetization produced, and the magnetizing force producing such magnetization of a paramagnetic substance as influenced by the existence of eddy currents in the substance itself.

APPARENT CUT OFF.—In valve gears, the point (expressed as a fraction of the stroke) at which the valve closes the port (line and line position) to the admission of steam to the cylinder. This does not represent the actual point at which steam is cut off when clearance is considered.

APPARENT EFFICIENCY.—The efficiency of a machine in an alternating current circuit considered with reference to its apparent power.

APPARENT INDUCTANCE.—In radio, that inductance, which, with respect to tuning, is equivalent to the resultant inductance corresponding to the true inductance of the coil and its distributed capacity.

APPARENT POWER.—In a reactive alternating current circuit, the product of the amperes multiplied by the volts, as distinguished from the true power as indicated by a watt meter.

APPARENT RESISTANCE.—A term used to denote the opposition to current flow, or impedance in an alternating current circuit. Usually called the spurious resistance.

APPARENT SLIP.—In propeller propulsion, the difference between the speed of the boat and the speed of the propeller, that is, the product of the pitch of the propeller by the number of revolutions. Thus, say a 20×30 propeller (20 in. diameter with a pitch of 30 ins.) would theoretically travel with the boat 30 ins. per revolution. At 500 r.p.m. it would travel in one minute $30 \times 500 \div 12 = 1{,}250$ feet, or in one hour $1{,}250 \times 60 \div 5{,}280 = 14.2$ miles —this is the theoretical speed of the propeller. It should be carefully noted that when the word slip is used unqualified it means the apparent slip. Now in the example if the slip be say 10% then the distance travelled by the boat would be

$$14.2 \times .9 = 12.8 \text{ mile per hour,}$$

thus, there is a loss of $14.2 - 12.8 = 1.4$ miles per hour due to the 10% slip.

APPARENT WATTS.—In an a. c. circuit, the watts obtained by multiplying together the simultaneous volt meter and ammeter readings, that is: virtual volts ×virtual amperes. When the current is not in phase with the pressure, the product of volts and amperes as indicated by the volt meter and ammeter must be multiplied by a coefficient called the power factor in order to obtain the true watts, or actual power available.

APPLIANCE BRANCH CIRCUITS.—Circuits supplying energy either to permanently wired appliances or to attachment plug receptacles, that is, appliance or convenience outlets or to a combination of permanently wired appliances and additional attachment plug outlets on the same circuit; such circuits to have no permanently connected lighting fixtures.

APPLIED MECHANICS.—The principles of mechanics as applied to constructing machinery; practical mechanics.

APPROACH, DETECTOR AND SECTIONAL ROUTE LOCKING.—That feature of automatic lever locking by trains, which is peculiar to the action of trains prior to their entrance upon the switches of the interlocking, is generally referred to as approach locking, and embraces also the automatic announcement of trains. That feature which involves the action of lever locks by train movement over the switches of the interlocking, is generally termed detector locking and sectional route locking. The latter feature embraces, beside the automatic locking and releasing of switch levers, the semi-automatic control of signals by trains through the medium of track circuits common to both.

APPROACH LIGHTING.—A system of railroad signal lighting employing a lamp which is lighted automatically on the approach of a train.

APPROACH LOCKING.—In railway interlocking, a system which provides that while a train is approaching an interlocking signal which indicates proceed, the switches over which this signal governs train movement cannot be changed in position.

APPROVED.—Acceptable to the authority enforcing a Code.

APRON GRAPNEL.—A grappling iron for picking up cables, having its hooks protected by a metallic apron which leaves just space enough between it and the ends of the hooks to admit the cable.

AQUA AMMONIA.—Water which contains ammonia in solution.

AQUA FORTIS.—Commercial nitric acid, consisting of 70% acid and 30% water. So called by the old alchemists (strong water), on account of its property of acting on metals.

AQUA REGIA.—Royal water, a mixture of two parts nitric acid with four parts of hydrochloric acid, so called by the alchemists as it dissolves gold, "the king of metals."

A. R. A.—Abbreviation for American Railway Association (formerly Railway Signal Association).

ARAGO'S DISC.—An apparatus for illustrating the effect of induced currents, discovered by Arago in 1824. A copper disc is caused to rotate with great velocity under a magnetic needle, a sheet of glass being interposed to prevent air disturbances from the rotating disc. The needle is then seen to turn in the direction of rotation, and, if the speed of the disc be high enough, finally to rotate with it.

ARAGO'S ROTATIONS EXPLAINED.—The magnetic field cutting a rotating copper disc produces eddy currents therein and the reaction between the latter and the field causes the disc to follow the rotations of the field. The induction motor is a logical development of the experiment of Arago, which so interested Faraday while an assistant in Davy's laboratory and which led him to the discovery of the laws of electro-magnetic induction.

ARBORESCENT DEPOSITS. — Branching deposits occurring in electro-metallurgy, resembling trees in shape.

ARC.—1. In electric lighting, a stream of incandescent vapor connecting the terminals of a lamp when they have been drawn apart and having sufficient voltage maintained between them. The luminosity of the arc is due partly to the vapor which contains volatilized particles from the terminals, and partly to the incandescence of the terminals themselves.

2. Any flashing occurring between the terminals of an electric circuit when the circuit has been interrupted.

3. Any portion of the circumference of a circle, the curved boundary of a segment, or that part of the circumference cut off by any angle.

ARC BLOW PIPE.—An electric welder designed to overcome the difficulty in the Benardos process of the extreme concentration of heat in the portion of the metal which forms one pole of the arc. In principle, when a magnet or electromagnet is brought near an electric arc, the latter is deflected in trying to set itself in a direction at right angles to its length and to the magnetic lines of force.

ARC CIRCUIT CUT OUT.—A cut out set in an arc light circuit connected in series, to prevent the entire circuit breaking when any lamp happens to go out.

ARC CONVERTER.—In radio, a form of oscillator utilizing an electric arc for the generation of alternating or pulsating current.

ARC FURNACE.—A type of electric furnace employing an electric arc, the material operated upon being in the arc circuit.

ARC GENERATOR.—A machine which produces high frequency current for radio transmission by the method of arc discharge.

ARC LAMP.—A device in which light is produced by the flow of electricity across a gap between two electrodes; some of the electrode material being gradually vaporized to form an arc stream. The common forms are: a, open carbon; b, enclosed carbon; c, flaming arc; d, mercury vapor, and e, magnetite or luminous.

ARC LIGHT.—The light of the voltaic arc. The term "arc" is applied on account of the bow like course taken by the flame between the terminals of the two electrodes, and "voltaic" because it was first produced by the use of the battery invented by Volta.

ARC LIGHT REGULATOR.—An automatic mechanism for keeping the carbons of an arc lamp fed towards each other as they waste away, so as to preserve the proper width of the arc.

ARC OF CONTACT.—1. That portion of the circumference of a pulley which is in contact with a belt or rope. Thus, with two pulleys of uniform size the belt will touch half the circumference of each, and the arc of contact for each pulley will be 180°.

2. In gearing, that part of the pitch line through which two engaging teeth pass while in contact.

ARC OF SWING.—The arc, or portion of a circle described by the swing of a deflected index needle; as, of a galvanometer needle.

ARC RESISTANCE.—The resistance to the flow of current offered by the voltaic arc. The resistance of the intervening air is so high that it causes great heating, and hence produces an intense light. If the carbons of a commercial lamp be one thirty-second of an inch apart, the resistance may be one and a half ohms.

ARC STRIKING MECHANISM.—The mechanism in an arc lamp by means of which the carbon points are separated upon passage of the current so that an arc may be formed between them.

ARC TRANSMITTER.—A machine which generates undamped oscillations, and is used for radio transmission of considerable power. The machine in operation produces a powerful electric discharge in a gap separating two electrodes.

ARC WELDING.—A method of welding in which the metal to be united is fused by the heat of an electric arc.

ARCH GAUGE.—An instrument for measuring the pressure of illuminating gas, where the index scale is in the form of an arch.

ARCING.—1. The stream of metallic vapor which bridges switch contacts as they separate. Since the electric current cannot be stopped instantly when the circuit in which it is flowing, is broken, an arc is formed as the switch contacts separate; this tends to burn the contacts, and to short circuit, the severity of such action depending on the voltage the length of the break line, etc.

2. The production of arcs at the brush contacts between the brushes and the commutator of an armature. The causes of arcing are: a, bad adjustment of brushes; b, bad condition of brushes; c, bad condition of commutator; d, overload of dynamo; e, loose connections, terminals, etc.; f, breaks in armature circuit; g, short circuits in armature circuit; h, short circuits or breaks in field magnet circuit. To remedy excessive arcing, first look at the ammeter to see if an excessive amount of current is being delivered; second, see if the brushes make good contact with the commutator, and if the latter have a bar too high, or too low, and an open circuit. Incorrectly called sparking.

AREOMETER.—An instrument for measuring the specific gravity of liquids. It is practically the same as the hydrometer, the only difference, if any, being that the areometer has the thermometer within its own stem, thus permitting temperature and gravity to be read from one instrument.

AREOMETRIC METHOD.—The method of determining the specific gravity or specific volume of liquids by suspending in them a solid of known weight.

ARGAND BURNER.—A lamp having a tubular wick contained between two concentric metal tubes, and a central air supply; a gas-burner of similar pattern in which the gas is supplied to the flame through the ring between the concentric tubes.

ARGON.—A colorless gas much resembling nitrogen, which was discovered as a constituent of the atmosphere by Lord Rayleigh and Professor Ramsay in 1894. It is present in ordinary air to the extent of 0.9 per cent, and is the most inert substance known, as, up to the present, it has refused to combine with any other substance. Argon gas is used in argon gas bulb rectifiers. It can be obtained by passing electric sparks through air in presence of caustic potash, and gradually adding oxygen until all the nitrogen has been converted into potassium nitrite and nitrate.

ARGON GAS BULB RECTIFIER.—An exhausted glass bulb, containing argon gas, used as a rectifier. An example is the "Tungar" rectifier consisting essentially of one or two bulbs, a transformer and an enclosing case. In operation when the filament is energized, the space between the electrodes acts as an electric valve of low resistance, allowing current to flow only from anode to cathode. Therefore, only uni-directional or direct current can flow from the battery charger. The transformer serves three purposes: First, it adjusts the voltage of the alternating supply to that required by the batteries; second, it furnishes a separate source of excitation for the filament; and third, it insulates the batteries from the supply current. Various battery voltages are used. 24 and 48 volt systems predominate, although 12 volts is often used on small and 110 volts on large systems.

ARM OR LEVER BRUSH HOLDER.—A commutator brush holder in which the brush is firmly attached to the extremity of a rigid arm capable of movement about the brush spindle, except in so far as it is restrained by a spring.

ARMATURE.—1. A piece of steel or soft iron, or a collection of such, so placed as to be acted upon by a permanent or electro-magnet.

2. In a magneto or dynamo, a core of metal around which is a wire winding, constructed to rotate near the poles of a magnet.

3. A piece of soft iron joining the poles of a horse shoe magnet to preserve the magnetism.

4. In a dynamo or alternator, that part of the machine in which currents are induced.

5. In an induction motor, the squirrel cage.

ARMATURE BARS.—Heavy bars or strips of copper, used instead of copper wire as the inductors (erroneously called conductors) in certain large types of drum armature.

ARMATURE BORE.—The opening between the pole pieces of a dynamo or motor within which the armature rotates; the armature hole.

ARMATURE COIL.—1. That portion of an armature winding passed over in following the course of the winding from one segment of the commutator to the next.

2. A section of armature winding prepared on a form to the exact shape required to fit into the slots of the armature core.

ARMATURE CONSTRUCTION.—An armature is made up of: a, shaft; b, core; c, spider, and in large machines; d, winding; e, commutator. The core is made of stampings of thin wrought iron or mild steel. The numerous discs stamped from the sheet metal are threaded on the shaft, forming a practically solid metal mass, and held together by end plates and through bolts. The thickness of the laminæ is from .014 to .025 ins. corresponding to 27 and 22 B. & S. gauge, respectively; 27 gauge being mostly used. The winding is placed in slots and connections made with the commutator.

ARMATURE CORE.—The inner laminated iron body of an armature of a dynamo or other rotating machine on which the winding is placed.

ARMATURE CORE DISCS.—Discs punched out of sheet iron for building up laminated armature cores.

ARMATURE FAULTS.—In general when an armature stops generating, the trouble is due to either a ground, a short circuit or an open circuit; that is, a ground results when there is contact between steel and copper somewhere in the armature; a short circuit or short, when copper touches copper; and an open circuit or open, when a wire is loose or broken.

ARMATURE HEATING.—The causes of abnormally high temperature are: eddy currents; moisture; short circuits; unequal strength of magnetic poles; operation above rated voltage and below normal speed.

ARMATURE INDUCTORS.—The insulated coils or bars bound to an armature core, in which the electric pressure is induced when the armature is rotated in the magnetic field; armature coils or windings. Incorrectly called conductors.

ARMATURE LOSSES. — The mechanical power delivered to the pulley of a dynamo is always in excess of its electrical output on account of numerous mechanical losses due to: a, friction of bearings; b, friction of commutator brushes; c, air friction, and electrical losses, due to: a, armature resistance, b, hysteresis; c, eddy currents. The mechanical losses are small in comparison with the electrical losses.

ARMATURE OF HOLTZ MACHINE.—Small tongues of paper, serving the purpose of replenishers, which project through the winders in the stationary glass plate.

ARMATURE OF MAGNET.—A piece, or mass, of soft iron or steel placed across the poles of a horse shoe magnet to act as a "keeper," by which the magnetization is preserved.

ARMATURE QUILL.—A ventilated or unventilated structure upon which an armature and commutator are assembled together, and which in turn may be mounted on the armature shaft. —**NEMA.**

ARMATURE REACTION.—Distortion of the magnetic field due to cross magnetization of the armature by the induced current flowing in the winding. The effect of armature reaction is to require more power to drive the machine. In accordance with Lentz' Law: Every conductor carrying a current creates a magnetic field around itself, whether it be embedded in iron or lie in air. Armature inductors, therefore, create magnetic fluxes around themselves, and these fluxes will, in part, interfere with the main flux from the poles of the field magnet, tending: 1, to distort, or 2, to weaken the field. Armature reaction is especially marked in slotted armatures.

ARMATURE REACTION IN MOTORS.—In the operation of a motor the cross magnetization or the reaction between the armature and field magnets distorts the field in a similar manner as in the operation of a dynamo. A current supplied from an outside source magnetizes the armature of a motor and transforms it into an electro-magnet, whose poles would lie nearly at right angles to the line joining the pole pieces, were it not for the fact that negative lead must be given to the brushes. If the brushes be given positive lead, the cross magnetizing force is converted into one that tends to increase that of the field magnets, while if they be given negative lead, it tends to demagnetize the field magnets.

ARMATURE SLEEVE.—An unventilated support on which armature laminations are or may be mounted and which in turn is mounted on the armature shaft.—**NEMA.**

ARMATURE SLOTS.—Slots in the core of an armature to admit the winding coils.

ARMATURE SPIDER.—A ventilated support upon which armature laminations are mounted, and which in turn is mounted on the armature shaft.—**NEMA.**

ARMATURE STAMPINGS.—Discs stamped or punched out of sheet iron for building up armature cores; armature core discs.

ARMATURE TEMPERATURE RISE. — Whenever a mass of metal is rapidly rotated in a magnetic field, its temperature rises, the heat being the direct result of currents of electricity which are induced in the metal and known as Foucault or eddy currents. Their initial direction is at right angles to the lines of force of the magnetic field, and also at right angles to the direction in which the mass moves. It is possible to melt a piece of metal which fuses at a low temperature by simply spinning it rapidly in a very strong field. In order to reduce the heating by eddy currents, armatures are laminated.

ARMATURE TROUBLES.—A large proportion of the mishaps and breakdowns which occur with dynamos and motors arise from causes more strictly within the province of the man in charge than in that of the designer. The armature, being a complex and delicately built structure, is subject in operation to various detrimental influences giving rise to faults. The following are the various electrical and mechanical armature troubles: Electrical Troubles: a, grounds; b, short circuits; c, open circuits. Mechanical Troubles: a, dirty or burned commutator; b, oily commutator; c, commutator out of round; d, bent shaft; e, high mica; f, worn bearings.

ARMATURE TURNS.—The turns, or loops, of the armature windings.

ARMATURE VARNISH.—An insulating varnish sometimes used for coating the armature windings as a protection against moisture.

ARMATURE WINDING.—Coils of insulated wire wound around an iron core, and so arranged that electric currents are induced in the wire when the armature is rotated in a magnetic field or the field magnets rotated and armature held stationary. The wires are properly called inductors and not conductors, as is very frequently done. There is a great variety of windings, to meet the many service requirements.

ARMORED CABLE.—A cable in which the conductor or conductors are covered by a specially wound steel casing. Single strip armored cable is formed of one continuous strip, with the edges rolled over to fit together; the convolutions are rounded. Double strip armored cable has armor formed of two channel shaped metal strips, wound so that their upturned edges face and engage each other, giving an armor of double thickness and great flexibility. While wiring with armored cable has not the advantage of the conduit systems, namely, that the wires can be withdrawn and new wires inserted without disturbing the building in any way whatever, yet it has many of the advantages of the flexible steel conduit, and it has some additional advantages of its own.

ARMORED CONDUCTOR.—A conductor protected by a metallic sheathing.

ARMORED PUMP VALVES.—India-rubber valves moulded upon an internal disc of sheet steel. The disc is stamped with notches and projections, and copper plated to secure the adhesion of the rubber, which is vulcanized after moulding.

ARMS OF BRIDGE.—The three known resistances which, together with the unknown resistance to be measured, form the system of conductors in a Christie or so-called Wheatstone bridge.

ARMSTRONG CIRCUITS.—Numerous radio circuits are due to E. H. Armstrong, the important ones being: a, regenerative; b, super-regenerative; c, super-heterodyne.

ARRESTER PLATE.—One of the metallic plates of a comb lightning arrester, especially the one connected to ground.

ARRIVAL CURVE.—In submarine cable working, a curve illustrating the slow growth of the current at the end of the line. This slow growth is largely obviated by the use of condensers.

ARTIFICIAL ANTENNA.—In radio, a test antenna having resistance, inductance and capacity equivalent to the actual antenna. Also called mute, phantom, dummy or mock antenna.

ARTIFICIAL CABLE.—In duplex submarine cable working, a series of resistance coils combined with condensers to produce a balance in resistance and capacity with the real cable, and corresponding to the artificial line in overland telegraphy.

ARTIFICIAL CARBONS. — Manufactured carbon rods for arc lamps. There is a great variety of methods of manufacture; but, in general, graphite from gas retort carbon is used as the basis, being ground up and mixed with pure carbon powder, after which a paste is formed by the use of some adhesive mixture, and the rods are shaped by moulding, squeezing or forcing through a die plate.

ARTIFICIAL FAULT IN CABLE.—A fault intentionally created in a cable for the purpose of making experimental tests.

ARTIFICIAL LINE.—In duplex telegraphy, a set of coils of fine wire of high resistance designed to balance the resistance of the main line; a rheostat or resistance box.

ARTIFICIAL MAGNET.—A magnet which has magnetism acquired by an artificial process of magnetization, as distinguished from a natural magnet or magnetite; sometimes called lodestone.

ARTIFICIAL SILK.—A fibre of silky appearance produced from specially prepared cellulose.

A. S. A.—Abbreviation for American Standards Association.

ASBESTOS.—A fibrous variety of ferromagnesium silicate, the fibres being usually so fine as to be flexible and easily separated by the finger. It is found in Italy, Canada, Cape Colony, United States and elsewhere. Asbestos can be spun into yarn which may be plaited to form piston rod packings, etc.

ASBESTOS CARTRIDGE.—A fireproof covering for the fuse in cut outs, encasing the fuse from ferrule to ferrule. As soon as the fuse blows, the asbestos closes the path and renders an arc impossible.

ASBESTOS PORCELAIN.—A porous compound containing asbestos and resembling porcelain, for making the porous jars for primary cells.

ASCENDING CURRENT.—Formed by placing the positive electrode upon the periphery of a nerve and the negative over the trunk of the nerve or over the nerve center.

ASH PIT.—The space beneath the fire bars in a furnace. As normally made, it constitutes a dry ash pit; when a trough is placed below the bars to cool them by evaporation of a sheet of water, it is said to be a wet ash pit. The practice of operating boilers with dry ash pits, especially at high rates of combustion is the cause of sagging grate bars.

ASPECT RATIO.—The long span of the wing surface of an air plane divided by the width.

ASPIRATOR.—A device closely resembling an ejector, in which water passes through a nozzle, whose outlines conform to the vena contracta. This device induces a suction current in a connecting pipe and exhausts the air, thus creating a high vacuum. The steam ejector, used in connection with the vacuum brake, is also a type of aspirator.

ASSEMBLED OR FED-IN WINDING.—An a. c. winding possible with open or only partially closed slots, in which coils previously formed are introduced, only a few inductors at a time if necessary. They are inserted into the slots from the top, the slot being provided with a lining of horn fibre or other suitable material, which is finally closed over and secured in place by means of a wedge, or by some other suitable means.

ASTATIC.—Deprived of directive power; a term used especially of a magnetic needle which has had its directive power neutralized.

ASTATIC COILS.—Neutralizing coils used in measuring inductance. When connected together they neutralize each other's effect.

ASTATIC COUPLE.—Two magnets of equal strength so placed one above the other in a vertical plane as to completely neutralize each other's effects.

ASTATIC GALVANOMETER.—A type of galvanometer having astatic needles to neutralize the earth's magnetism. The astatic needles consist of a combination of two magnetic needles of equal size and strength, connected rigidly together with their poles pointing in opposite and parallel directions. Used in zero methods to detect small currents.

ASTATIC MULTIPLIER.—A name sometimes given to a galvanometer having an astatic needle or circuit.

ASTATIC NEEDLES.—A form of magnetic needle for use in sensitive galvanometers; it consists essentially of two needles of equal size and strength bound together, one above the other, in reversed positions so that each counter-balances the effect of the earth's magnetism upon the other.

ASTATIC SUSPENSION.—A method of suspending the needle of a galvanometer so as to overcome the effect of the earth's magnetism.

ASTATICIZE.—To eliminate all magnetic directive power due to the earth's magnetism.

ASTIGMATIC LENS.—One which has the inherent defect of not sharply focussing the entire image.

A. S. T. M.—American Society for Testing Materials.

ASYMPTOTE.—A line which approaches nearer and nearer to a given curve, but never meets it; as, the axis of the hyperbola.

ASYNCHRONOUS.—Not in step. For instance an induction motor does not rotate in step with the rotating magnetic field, as distinguished from a synchronous motor which does. Hence induction motors are sometimes called asynchronous motors.

ASYNCHRONOUS ALTERNATOR.—A type in which the rotating magnet with definite poles, is replaced by a rotor having closed circuits. In general construction, they are similar to induction motors having short circuited rotors; for these alternators, when operating as motors, run at a speed slightly below synchronism and act as alternators when the speed is increased above that of synchronism. Machines of this class are not self-exciting, but require an alternating or polyphase current previously supplied to the mains to which the stationary armature is connected.

ASYNCHRONOUS MOTOR.—An induction motor; so called because the armature does not turn in synchronism with the rotating field, or, in the case of a single phase induction motor, with the reciprocating field.

ASYNCHRONOUS ROTARY DISCHARGE.—A spark gap alternator with spark frequency different from the alternator frequency.

A. T.—Abbreviation for ampere turn.

ATMOSPHERE.—The air in which we live and which we breathe, whose weight presses on our bodies internally and externally and so is not perceived. Besides oxygen, nitrogen, argon, etc., there is present in the atmosphere about .04% by volume, of carbon dioxide, a variable amount of aqueous vapor, ammonia in various forms, and solid matter or dust.

ATMOSPHERIC ABSORPTION.—In radio transmission, loss of wave power due to atmospheric conductivity.

ATMOSPHERIC ELECTRICITY.—The free electricity always found in varying quantities in the atmosphere. The phenomena of atmospheric electricity are of two kinds; there are the well-known manifestations of thunder storms; also, the phenomena of continual slight electrification in the air best observed when the weather is fine; the auroras constitute a third branch of the subject.

ATMOSPHERIC PRESSURE.—1. The pressure of the atmosphere at sea level is about 14.7 lbs. per sq. in.; for a rough approximation it may be assumed that the pressure decreases ½ lb. per sq. in. for every 1000' ft. of ascent.

2. In steam engineering, the weight of the atmosphere pressing upon the exhausting side of a steam engine piston; this weight, or pressure can be partially removed with the aid of a condenser.

ATMOSPHERICS.—In radio, static interference due to waves produced by storms, electric disturbance in the atmosphere.

ATOM.—The smallest particle of matter that can exist and still retain its identity as an element. An atom is formed of positive and negative particles of electricity, that is, of protons and electrons.

ATOMIC THEORY.—According to Dalton's "Atomic Theory" (published in 1800), matter is divisible up to a certain point only, the ultimate particles being called atoms. Atoms of the same element are all alike; but an atom of one element differs from an atom of another element in weight and in chemical properties Where chemical combination occurs between two elements, it does so by means of their component atoms. This last statement accounts for the Law of Multiple Proportions. Late experimenters have succeeded in splitting atoms, thus disproving part of Dalton's theory.

ATOMIC WEIGHT.—A relative weight assigned to the atoms of the various elements, representing: a, its weight as compared with that of an atom of hydrogen; b, the smallest quantity by weight of the element that can enter or leave a compound, the combining quantity of hydrogen equaling unity; c, the specific gravity of the body, as compared with hydrogen, when in a state of gas or vapor.

ATOMIZING CARBURETER.—A type of carbureter for internal combustion engines, in which the liquid fuel is converted into a fine spray and mixed with the proper proportion of air; known also as spray carbureter.

ATONIC INTERRUPTER.—An interrupter for induction coils which can be adjusted so as to operate at any desired frequency throughout a wide range.

ATTENUATION.—In radio transmission, decrease in wave amplitude with increasing distance from the source at which the amplitude is constant.

ATTENUATION EQUALIZER.—A device for equalizing the transmission loss of all frequencies within a given range. It consists of a system of inductances, capacities and resistances.

ATTRACTED DISC ELECTROMETER.—A form of absolute electrometer, consisting of two metal discs, one poised horizontally at a small distance above the other and surrounded by a guard ring placed in metallic contact with it by a fine wire, the other supported on an insulated stand; the attraction of the lower plate upon the upper may be measured by changing the distance of the lower, by a micrometer screw, until the electric attraction balances the forces which act to raise the upper disc above the guard ring.

ATTRACTION AND REPULSION.—In static electricity, these terms signify that one body is charged to a higher pressure than the other, that is, by rubbing, some of the charge is taken from one body and transferred to the other. Franklin called the electricity excited upon glass by rubbing it with silk positive electricity, and that produced on resinous bodies by friction, with wool or fur, negative electricity.

ATTRACTION OF GRAVITATION.—That force which draws a body toward the center of the earth, commonly called the weight of the body. The force of gravity is represented by the letter g, which stands for the acceleration per second of a falling body due to gravity, the value of g increases with the latitude and decreases with the elevation. At the latitude of Philadelphia, 40° its value is 32.16. At sea level 32.174.

AUDIBLE.—In radio, signals that can be heard by ear. The range of frequencies which the average person can hear is from about 20 cycles to 17,000 cycles, but a comparatively large amount of sound energy is required before the ear can detect sound of extremely low or extremely high frequencies. The ear is most sensitive to frequencies between 500 cycles and 7,000 cycles; also, the ear is most sensitive to changes of pitch and changes of intensity of sound in this same band of frequencies.

AUDIBILITY METER.—A device consisting of a variable resistance shunted across a telephone receiver and connected to the radio receiving apparatus for the purpose of comparing the strength of signals from different stations.

AUDIO FREQUENCY.—The term applied to currents pulsating at audible frequencies. Different limits are given by different authorities.

AUDIO FREQUENCY AMPLIFICATION.—In radio, the amplification of the low frequency pulsations leaving the detector tube before being fed to the loud speaker.

AUDIO FREQUENCY AMPLIFIER. — In radio, apparatus for increasing the volume or loudness of audio frequency signals. Audio amplifiers are connected in the detector circuit in place of phones and each stage consists of an audio frequency transformer, a vacuum tube with socket and control rheostat. This is a transformer coupled amplifier. Another much used method is known as "resistance coupled amplifier."

AUDIO-FREQUENCY CHOKE.—An inductance coil used to reduce the flow of audio frequency current.

AUDIO FREQUENCY OSCILLATOR.—A radio device used for testing amplifying characteristics of all apparatus used in audio frequency receivers and for testing loud speakers. Used also with head phones to trace open and grounded circuits.

AUDIO FREQUENCY TRANSFORMER.—One used in an audio frequency amplifier circuit to couple the circuit to the detector circuit. Audio transformers have an iron core.

AUDIO METER.—An instrument for testing hearing.

AUDION.—A name for a radio vacuum tube detector introduced by Dr. Lee De Forest.

AUDIOTRON.—A three element radio tube.

AUDIPHONE.—A fan shaped instrument, usually of thin hard rubber, which, when held against the upper teeth, conveys sound vibrations to the auditory nerve, and thus aids the hearing.

AURAL RADIO RANGE.—In aviation, an audio frequency radio range for reception with telephone receivers.

AURORA.—Sheets, streamers or streaks of pale light often seen displayed in the skies of the northern and southern hemispheres in the direction of the polar regions; the **aurora borealis** and the **aurora australis.**

AURORA AUSTRALIS.—Lights similar to the aurora borealis, seen at night in extreme southern latitudes; the **southern lights.**

AURORA BOREALIS.—Luminous phenomena often observed at night in northern latitudes in the direction of the magnetic north, and attributed to disturbances of an electric nature; the **northern lights.**

AURORA GLORY.—The crown shaped arc of light observed in the heavens during the occurrence of the aurora.

AURORA POLARIS.—A general name for the northern and southern lights.

AURORAL ARCH.—An arch of light sometimes formed by the aurora.

AURORAL BANDS.—Parallel streamers of light often observed in connection with the aurora.

AURORAL CORONA.—A crown like form sometimes taken by the light of the aurora.

AURORAL CURTAIN.—A broad sheet of auroral light resembling a curtain.

AURORAL STORM.—A magnetic storm accompanying the appearance of the aurora.

AUTO-COHERER.—In radio, a type of coherer with automatic action for releasing the particles that cling together when the circuit is made. Obsolete.

AUTODYNE RECEPTION.—In radio, the reception of wave signals by combining the received frequency with another frequency. (produced in the detector circuit) so as to produce a beat frequency. Sometimes called auto-heterodyne reception.

AUTO-EXCITATION.—Self-magnetizing of the field magnets of a dynamo. Also called self-excitation.

AUTOGENOUS SOLDERING.—The art or process of lead burning, whereby two pieces of lead are fused together by means of a hydrogen flame.

AUTOGENOUS WELDING.—A method of welding which consists in uniting the metal pieces by means of a torch flame. The heat is obtained by means of an oxy-acetylene torch whose flame has a temperature of 6,300° Fahr.

AUTO-HETERODYNE RECEPTION.—Autodyne reception.

AUTO IGNITER.—A small magneto or dynamo for electric ignition of gasoline and petroleum engines, the armature of the igniter is geared to the fly wheel, thus supplying electricity as long as the engine revolves, and doing away with batteries, etc.

AUTOMATIC AIR BRAKE.—The term automatic as applied to air brakes means that in case of accident such as the parting of a train, bursting of an air pipe, etc., the brake is automatically applied. To accomplish the automatic application of the brake in case of accident, it is necessary to provide on each car: a, an auxiliary reservoir, and b, a triple or distributing valve.

AUTOMATIC BLOCK SIGNALS.—A system of railway signals whose primary function is the spacing of trains a safe distance apart, and the transmission of information to the engineer as to the presence of other trains which are about to interfere with his speed or movement. The important feature of automatic signaling is that the passage of a train controls and actuates the operation of the signals, dispensing with the human agency, and providing for the protection of trains from following ones.

AUTOMATIC CALL BOX.—An apparatus fitted to a public telephone instrument by means of which a person may secure its use by simply dropping a coin into the box.

AUTOMATIC CHEMICAL TELEGRAPHY.—Automatic telegraphy employing a chemically prepared paper ribbon on which the messages are recorded.

AUTOMATIC CLUTCH.—In a split phase motor a device which allows the armature to turn free on the shaft until it accelerates almost to running speed.

AUTOMATIC CONTACT BREAKER.—An automatic device operated by an electro-magnet for opening and closing an electric circuit in quick succession; a vibrating contact.

AUTOMATIC CONTROL.—An electrical or mechanical device or assembly of such devices to secure automatic operation of a machine to meet certain requirements. For instance, on an automobile storage battery system, automatic control is secured by a reverse current circuit breaker or discriminating cut out which disconnects the battery from the charging dynamo circuit, when, due to slow motion of the car, the voltage of the dynamo drops below that of the storage battery.

AUTOMATIC CUT-OFF ENGINE.—A term applied to a steam engine in which the cut off is varied, according to the load, by means of a governor. In a loose sense, the term is confined to a small or medium size one valve high (rotative) speed engine in which the cut off is varied by a swinging (or shifting) eccentric controlled by a fly wheel governor. This valve gear varies the cut off by the method of combined variable throw and variable angular advance.

AUTOMATIC CUT OUT.—An electrical adjustment for automatically removing any electrical part or connection from a circuit at the required moment.

AUTOMATIC CUT OUT FOR BATTERY.—An automatic switch connected with a storage battery for cutting out the charging current in case the voltage of the battery fall below that of the charging dynamo. The current will be reversed, that is, current from the battery will flow through the dynamo and if the latter stop, will burn out the winding.

AUTOMATIC CUT OUT FOR SERIES INCANDESCENT LAMP.—A device which acts automatically, when the circuit through a lamp is broken, and short circuits it.

AUTOMATIC DIAL TELEPHONE.—In this system all calls within a specified "local" area are handled exclusively by automatic switching apparatus, there being no operators required as in the manual system. Calls to more distant points, however, are routed through a special "A" operator who, besides taking care of the connection, makes out a ticket for a "toll" charge against the calling subscriber. The special "A" board is also employed for emergency connections and assistance calls from the subscribers in the same central office area. Besides the special "A" operators in a dial central office, there are a number of girl operators working at "cordless" B-positions.

AUTOMATIC ELECTRIC CRANE BRAKE.—Usually consists of a band brake which is normally kept on by a spring or weight and released by an ironclad solenoid, or it may be a disc brake in which the discs are normally pressed together by a spring, an electro-magnet being provided to pull back the pressure plate and release the discs. The coil of the solenoid or electro-magnet is in circuit with the hoisting motor, so that when current is switched on to the motor, the brake is released, and when it is switched off, the brake is applied. This makes an excellent safety device but as it can only be off or full on, it cannot be used to regulate the descent of the load when lowering.

AUTOMATIC ELECTRIC RAILWAY SIGNAL SYSTEM.—A system of electric signals used to prevent trains approaching each other too closely while running upon the same track; the block system.

AUTOMATIC ELECTRO-MAGNETIC BRAKE.—An electric crane hoisting motion brake. It consists of a band brake which is normally kept on by a spring or weight and released by an ironclad solenoid, or it may be a disc brake in which the discs are normally pressed together by a spring, an electro-magnet being provided to pull back the pressure plate and release the discs. The coil of the solenoid or electro-magnet is in circuit with the hoisting motor, so that when current is switched on to the motor, the brake is released, and when it is switched off, the brake is applied. This makes an excellent safety device, but as it can only be off or full on, it cannot be used to regulate the descent of the load when lowering.

AUTOMATIC INDICATING GRAPNEL.—In submarine cable work, a grapnel fitted with electrical connections so that it gives a signal upon the cable ship the moment the cable is caught.

AUTOMATIC INKER.—In telegraphy, a siphon recorder which acts automatically.

AUTOMATIC INTERRUPTER.—An electromagnetic vibrator.

AUTOMATIC LEVELING.—Bringing an elevator to a floor stop by automatic electric control Various methods are employed such as: a, auxiliary motor micro-drive; b, leveling with main motor; c, with two speed motor.

AUTOMATIC LEVELING DEVICE.—An elevator control device consisting of a suitably placed cam for each floor, and a switch carried on the car, with an arm and roller to engage the cam. When a stop is to be made the switch contact is in circuit. When no stop is to be made the switch contact is ineffective even though the cam caused the usual movement of the switch arm. This device is widely used on push button elevators as a stopping switch. The difference between a straight push button elevator and an automatic leveling push button elevator lies chiefly in the provision for a very low stopping speed in the latter, with close regulation on this speed.

AUTOMATIC MAKE-AND-BREAK.—A device actuated by an electro-magnet for automatically closing and opening a circuit.

AUTOMATIC OVERLOAD SWITCH.—An automatic switch set into the discharge circuit of a storage battery, which opens the circuit when an excessively high current is being drawn from the cells.

AUTOMATIC PAPER WINDER.—A reel for automatically winding the paper ribbon of a telegraph recorder.

AUTOMATIC PREPAYMENT TELEPHONE.—A public telephone set, containing a mechanism by means of which a coin, deposited in a slot, registers prepayment before the line can be used.

AUTOMATIC REGULATION.—A method of making a dynamo self-regulating so as either to send a constant current through the external circuit under varying resistances, or to maintain a constant voltage at its terminals under like variations of resistance. In cases where an approximately constant current is to be maintained in a circuit, as in series arc circuits, the adjustment of the resistance of the variable shunt is, as a rule, effected automatically by means of some electro-magnetic device, actuated by solenoids placed in the main circuit.

AUTOMATIC REGULATION OF MOTOR.—A self-regulation of a motor for the purpose of preserving its speed constant.

AUTOMATIC REGULATOR.—An electro-magnetic device, actuated by solenoids placed in the main circuit, and used to maintain an approximately constant current; as, in series arc lighting circuits.

AUTOMATIC REPEATER.—A type adapted to single telegraph working. It consists of a transmitter having a second lever placed above the regular armature lever in such a position that one electro-magnet is employed to work both. There are three distinct pairs of circuits: a, main; b, local; c, shunt.

AUTOMATIC SIGNALING.—Sending telegraphic messages by machines instead of by hand; automatic telegraphy.

AUTOMATIC START POLYPHASE MOTOR.—A motor which, compared with a squirrel cage motor of conventional design, starts with a high resistance rotor and low current, then is automatically changed to have a low resistance rotor which gives normal squirrel cage operating characteristics.—NEMA.

AUTOMATIC STARTER.—One designed to automatically control the acceleration of a motor.—NEMA.

AUTOMATIC SUB-STATION.—A station having an assemblage of contactors, relays and other devices for automatic control. The automatic station is usually started by a load demand on that part of the system within its particular district. This is accomplished by a voltage relay, actuated from the trolley. The stopping indication is given by the operation of an underload relay when the load diminishes to an uneconomical point. Starting and stopping of the station may also be accomplished by means of one of several remote control systems or by a time switch.

AUTOMATIC SUPERVISING EQUIPMENT.—For remote control of sub-stations an equipment which provides the dispatcher with a means of selectively controlling devices in the sub-stations and automatically gives him a visual indication of the sub-station apparatus by means of standard indicating lamps located in cabinets at his office. The several types of equipment are known as: a, synchronous visual type; b, code visual type; c, audible type; d, synchronous selector type.

AUTOMATIC SWITCH.—A switch which opens and closes automatically at required times. One form of switch used as a cut out for dynamos consists of an electro-magnet, fixed upon a slate base, and an iron armature fixed to the ends of the pivoted levers of the switch. The electro-magnet is connected in series with the switch and armature circuit, and while the voltage of the machine to which the instrument is connected remains at its normal value, the current flowing in its coils is sufficiently strong to enable it to hold up the iron armature against its pole pieces. If from any cause the voltage of the machine be reduced, the current flowing in its armature is decreased also, until when it falls below a certain pre-determined minimum value, the strength of the electro-magnet has been so far diminished that it can no longer hold up the armature against the weight of the levers; the latter therefore drop and switch the machines out of circuit.

AUTOMATIC SYNCHRONIZER.—A phase indicator consisting essentially of two solenoids acting on cores on opposite ends of a rocker arm.

AUTOMATIC TELEGRAPH TRANSMITTER.—A transmitter for automatic telegraphy, consisting of a clockwork or other mechanism which draws a strip of paper perforated with the message under a series of contacts.

AUTOMATIC TELEGRAPHY.—A method of telegraphy by which messages, previously perforated upon a strip of paper, are transmitted automatically by passing the strip under suitable contacts.

AUTOMATIC TELEPHONE DIAL.—A device consisting of a rotating disc (finger wheel) with a spring and a cam lever. When a number is dialed the finger wheel is pulled around to the finger stop, and then let go. The spring now pulls the finger wheel back to its original position and in doing so the cam, which is attached to the finger wheel, causes a set of springs to separate and to come together successively opening and closing the circuit of the line, thereby generating pulses. The number of pulses generated is equal to the figure under the hole into which the finger is placed. The return speed of the finger wheel is controlled by a governor so that when "O" is dialed the finger wheel will return to normal in one second, or 10 pulses are generated in one second.

AUTOMATIC TELEPHONE EXCHANGE.—A method of making connections between telephone subscribers by switches operated from the subscribers' instruments, and thus doing away with the services of an exchange operator.

AUTOMATIC TELEPHONE FINDER.—A switching mechanism associated with a circuit, designed to move over a number of terminals to which are connected circuits, over any one of which a signal to start the switch may be transmitted, in order to find the specific circuit from which the starting signal has come and connect it to the circuit associated with this finder switch.

AUTOMATIC TELEPHONE HOOK. — The hook upon which the telephone receiver is hung when not in use, and which being depressed by the weight of the receiver automatically disconnects the instrument, making connections again when the receiver is lifted off and the hook rises.

AUTOMATIC TELEPHONE SELECTOR.—A switching mechanism associated with a circuit, designed to move over a number of terminals to which are connected groups of circuits in order to select a particular group of circuits in accordance with signals received over the circuit associated with this selector, and then to choose from the group an idle circuit and connect to it the circuit, associated with this selector.

AUTOMATIC TELEPHONE SWITCH.—The switch operated automatically by the raising or lowering of the hook on which the receiver hangs when not in use.

AUTOMATIC TIME CUT OUT.—An automatic device for effecting disconnections in a circuit at a set time.

AUTOMATIC TRAIN CONTROL.—A control system whose object is to enforce the observance of the speed restricting indications of wayside signals by compelling the engineer to perform some manual act called acknowledging when passing such signals. By speed restricting indications is meant both the caution and stop indications of wayside signals.

AUTOMATIC TRAIN CONTROL APPARATUS.—Devices for train protection consisting of a, the receiver; and b, inductor. In operation, when the receiver carried by a locomotive approaches an unwound inductor or a wound inductor on open circuit, a surge of magnetic flux builds up in the secondary coil and produces a negative current in the relay. This negative current is sufficient to allow the relay to open, and once open stays open until restored, due to its being a stick relay.

AUTOMATIC TRANSMITTER.—A telegraph device in which a transmitting or sending key is operated mechanically.

AUTOMATIC VARIABLE RELEASE AIR BRAKE.—A type of automatic brake provided with a triple valve designed to give a full or restricted release of the brakes as desired. This feature is useful in obtaining the accurate stops so important in stations where individual cars are required to stop opposite certain definite points.

AUTOMATIC VOLTAGE REGULATOR.—A device for the accurate regulation of voltage across the terminals of alternators. It operates by rapidly opening and closing a shunt circuit across the exciter field rheostat. The rheostat is first turned until the exciter voltage is greatly reduced and the regulator circuit is then closed. This short circuits the rheostat through contacts in the regulator and the voltage of the exciter and alternator immediately rise. At a predetermined point the regulator contacts are automatically opened and the field current of the exciter must again pass through the rheostat. The resulting reduction in voltage is arrested at once by the closing of the regulator contacts which continue to vibrate in this manner and keep the alternator voltage within the desired limits.

AUTOMATIC VOLUME CONTROL.—A radio self-acting device which maintains the output constant within relatively narrow limits while the input voltage varies over a wide range.

AUTOMOBILE.—A self propelled vehicle whose power plant usually consists of a gas engine, delivering its power to the rear wheels through: a, transmission; b, clutch; c,. shaft with universal joints, and d, final drive and differential gear. Eight cylinder engines are largely used.

AUTOMOBILE DYNAMO REGULATION.—On automobiles, owing to the variable speed of a charging dynamo, some form of regulation is necessary to maintain: a, constant voltage; b, constant amperage; c, constant voltage and constant amperage. To accomplish this regulation the following methods are used: a, electro-magnetic method; b, inherent method.

AUTOMOBILE HEATING MEDIUMS. — There are three mediums used for heating cars: a, hot water; b, hot air; c, exhaust gases from the engine.

AUTOMOBILE HEATING BY EXHAUST GASES.—A system in which the exhaust pipe is connected to pipe radiators and heated by passing more or less of the hot gases through the radiators.

AUTOMOBILE HEATING BY HOT AIR.—In this system a portion of the exhaust pipe is surrounded by a jacket from which hot air is taken for heating the car.

AUTOMOBILE HEATING BY HOT WATER.—In this system a circulation of hot water through pipe radiators is secured by connecting an inlet from the top of the rear cylinder and outlet at the bottom of the radiator. Improved fin heating radiators are now available with forced air circulation by means of a small fan motor located behind the radiator.

AUTOMOBILE WIRING.—There are five different kinds of wire or cable used: 1, low tension or primary ignition cable; 2, high tension ignition cable on secondary circuit; 3, lighting cable for lights; sizes 16 to 10; 4, storage battery flexible multiwire cable, size No. 1 or No. 0.

AUTO-PED.—A small motor cycle having no seat, the operator standing on two foot boards.

AUTOPLEX RADIO RECEIVER.—A one tube super-regenerative receiver designed to operate a loud speaker.

AUTOPLEX RECEIVER.—A radio super-regenerative receiver employing one vacuum tube.

AUTO RECEIVER.—A recording radio receiver.

AUTO-REVERSIBLE TELE-RADIOPHONE. A photophone capable of sending a number of messages at once, either in the same direction or in opposite directions.

AUTO-TELEGRAPHY.—Automatic telegraphy.

AUTO-TRANSFORMER.—A type of transformer in which one winding serves for both primary and secondary. On account of its simplicity it is made cheaply. Auto-transformers are used where the ratio of transformation is small, as a considerable saving in copper and iron can be effected, and the whole transformer reduced in size as compared with one having separate windings. The two ends of the coil are connected to the primary wires. For the secondary circuit one wire is connected to one end of the coil and the other to some intermediate point depending on the desired ratio of transformation.

AUTO-TRANSFORMER OR COMPENSATING STARTING METHOD.—A method of starting an induction motor which consists of reducing the pressure at the field terminals by interposing an impedance coil across the supply circuit and feeding the motor from variable points on its windings.

AUTO-TRANSFORMER STARTER. — One having an auto-transformer to furnish a reduced voltage for starting. The device includes the necessary switching mechanism and is frequently called a compensator or auto-starter.—NEMA.

AUXILIARY AIR GAP.—In gas engine ignition, an air gap placed in the secondary circuit in series with the spark plug. Its object is to prevent any leakage of current in case of defective plug insulation by preventing the flow of the secondary current until the voltage has been raised enough to suddenly break down the resistance of the auxiliary air gap, and also that of the plug. This results in a discharge, through the air gap of the plug, instead of short circuiting over the sooted surfaces of the plug insulation.

AUXILIARY ALARM TELEGRAPH. — A provision in fire alarm signaling to prevent the repetition of signals over all the circuits from interfering with other incoming signals.

AUXILIARY BUS BAR.—A bus bar in a central station connected with a pressure other than the central station pressure.

AUXILIARY MOTOR MICRO-DRIVE.—A system of elevator control in which a small constant speed motor is geared down so as to drive the elevator at an exceedingly low speed (low enough so as to make a final stop from this speed in a very short distance) just before stopping. This motor, because it runs without resistance at its most favorable point, has very close regulation, and the low speed or leveling speed is substantially independent of load. The auxiliary motor is not geared permanently to the main motor, but is connected only when leveling, by means of an electric clutch, which also acts as a brake on the main motor.

AUXILIARY RELAY.—One which assists another relay in the performance of its function and which operates in response to the opening or closing of the operating circuit.—NEMA.

AUXILIARY SWITCH.—One actuated by some main device, for signaling, interlocking, etc.—NEMA.

AVERAGE PRESSURE.—The mean load, in lbs. per sq. in. upon a piston throughout its stroke. Usually called mean pressure.

AVERAGE VOLTS AND AMPERES.—Since the sine curve is used to represent the alternating current, the average value may be defined as: the average of all the ordinates of the curve for one half of a cycle. The average value is used in some calculations but, like the maximum value, not very often. The relation between the average and virtual value is of importance as it gives the form factor. Calling maximum value 1, average value=.637.

AVOGADRO'S LAW.—A law of physics, that at the same temperature and pressure equal volumes of different gases contain the same number of molecules. Hence, the molecular weights of gases are proportional to their densities.

AVOIRDUPOIS WEIGHT TABLE.

16	drachms, or		
437.5	grains	=1	ounce
16	ounces	=1	pound
100	pounds	=1	hundred weight
2000	pounds	=1	short ton
2240	pounds	=1	long ton

Unit equivalents

			oz.	dr.
		lb.	1=	16
	cwt.	1=	16=	256
T.	1=	100=	1,600=	25,600
1=	20=	2,000=	32,000=	512,000

Scale—ascending, 16, 16, 100, 20; descending, 20, 100, 16, 16.

A. W. G.—Abbreviation for American wire gauge; the Brown & Sharpe wire gauge. The American Standard.

AXES OF CO-ORDINATES.—Two intersecting lines, one vertical, called the axis of ordinates, the other horizontal, called the axis of abscissas, by means of which the location of a point in a plane may be determined. The angle of intersection of the axes is usually taken as a right angle in which case the axes are said to be rectangular; with any other angle the axes are called oblique.

AXIAL CURRENT.—A current which has the same direction as the lines of magnetic force.

AXIAL FLOW.—A term applied to that class of turbine in which the fluid passes through the motor in a direction parallel with its axis, like the Jonval or Parsons. Also termed parallel flow.

AXIAL PITCH.—In machinery, the pitch of a screw measured in a direction parallel with the axis. The term is specially applied to many-threaded screws to distinguish the pitch of a single turn only, from that termed divided axial pitch and from the common pitch.

AXIOM.—A self-evident truth; a proposition or principle that needs no demonstration.

AXIS.—1. The straight line, real or imaginary, passing through a body on which it revolves, or may be supposed to revolve.

2. A straight line with respect to which the different parts of a magnitude are symmetrically arranged; as, the axis of a cylinder, i. e., the straight line joining the centers of the two ends; the axis of a cone, i. e., the straight line joining the vertex and the center of the base; the axis of a circle, any straight line passing through the center. Plural, axes.

AXIS OF ABSCISSÆ.—The horizontal axis of co-ordinates.

AXIS OF ORDINATES.—The vertical or inclined axis of co-ordinates.

AXLE LIGHTING CONTROL.—For proper control of an axle lighting plant as used on railway cars, the following equipment is essential: a, pole changer; b, discriminating cut out or reverse current circuit breaker; c, dynamo regulator; d, lamp regulator. The pole changer keeps the direction of the current constant into the battery When the train reverses, the discriminating cut out breaks the charging circuit and prevents the battery discharging through dynamo when speed is too low. The dynamo regulator maintains constant voltage at varying speed. The lamp regulator maintains the lamp voltage constant with changes in the battery voltage.

AXLE LIGHTING SYSTEMS.—The term "axle" as popularly applied to car lighting systems includes such equipments as those having a dynamo under each car belted to a pulley on one of the car wheel axles and wired to charge a storage battery. The essential parts are: a, dynamo; b, axle pulley belt drive; c, storage battery; d, discriminating cut out, or reverse current circuit breaker; e, regulators; f, lighting fixtures; g, pole changer; h, switches, fuses, etc.

AYRTON GALVANOMETER SHUNT.—A shunt devised by Ayrton and Mather in 1894, in which the coils are so arranged that their relative multiplying powers, whatever may be the actual resistance of the galvanometer, are always the same, so that it can be used with any galvanometer; the universal shunt.

AYRTON PERRY WINDING.—One composed of two conductors and so connected in parallel that the current flows in opposite directions in the conductors, thus neutralizing inductance.

AZIMUTH.—1. In determining the location of distant objects; as in astronomy, the arc of the horizon intercepted between the meridian of a place and a great circle passing through the zenith and the object observed.

2. The quadrant of an azimuth circle.

AZIMUTH AND RANGE TELEGRAPH.—A telegraph employed on a warship for signaling to the gunners both the azimuth and range of the enemy's position.

AZIMUTH CIRCLE.—A great circle passing through the zenith, or point directly overhead, and the nadir, or point directly underneath, cutting the horizon at right angles.

AZIMUTH COMPASS.—A compass resembling the mariner's compass, but having the card divided into degrees instead of rhumbs, and having vertical sights, used for taking the magnetic azimuth of a heavenly body, in order to find, by comparison with the true azimuth, the variation of the mariner's needle.

AZIMUTH DIAL.—A dial whose stile or gnomon is at right angles to the plane of the horizon; used in navigation and surveying.

AZIMUTH TELEGRAPH.—A telegraph employed on a warship for signaling to the gunners the azimuth of the enemy's position.

AZOTE.—The French name for nitrogen, frequently encountered in scientific articles translated from that language. Azotic acid is nitric, azote of potash is potassium nitrate, etc.

B

B.—1. Abbreviation for Baume, referring to the hydrometer scale.

2. The symbol for magnetic induction or magnetic flux density.

b.—Symbol for susceptance; mho.

B.A.—Abbreviation for British Association.

B.A. AMPERE.—The standard ampere fixed by the British Association for the Advancement of Science.

B.A. OHM.—The unit of resistance adopted by the British Association in the year 1865, but now superseded by the International ohm. It is equal to .9866 International ohm.

B.A.u.—Abbreviation for British Association unit.

B. & S.—Abbreviation for Brown & Sharpe wire gauge.

BABBITT METAL.—An alloy, named for its inventor, composed of tin, copper and antimony in varying proportions, used for bearings of machines; also known as white metal, and anti-friction metal.

B BATTERY.—A radio battery which furnishes the electrical energy which actuates the loud speaker or phones of the radio set. Without the B battery the radio set would be dumb. Through the delicate control of the grid element of the tube on the electron flow from filament to plate, the B battery energy is released in modulated strains corresponding exactly to the sounds introduced into the transmitter at the broadcasting station.

B BATTERY ELIMINATOR.—A device which receives alternating current from the house lighting supply, transforms it to proper voltage and converts it to direct current for the plate of a vacuum tube, thus avoiding the use of a battery. It is sometimes called B power supply.

BACK AMPERE TURNS.—On an armature, turns of the winding which act in opposition to the magnetic flow set up between the field magnets.

BACK COUPLING.—In radio, a method of taking part of the energy of the output circuit and applying it to the input circuit of the same system; regenerative coupling.

BACK CURRENT.—The current which results from those portions of alternations which are not completely suppressed by the valve action of a rectifier.

BACK END OF ARMATURE.—The end of a dynamo or motor armature opposite to the commutator or front end.

BACK FIRING.—The ignition of the charge of a gas engine at such a point in the cycle that the motion of the engine is reversed. This disorder occurs sometimes in starting the engine due to too slow cranking together with too much advance of the spark. During cranking the spark should be fully retarded, otherwise ignition will occur during the compression so soon that the impulse will overcome the momentum of the fly wheel and start the engine in the reverse direction. When this occurs the operator is liable to serious injury.

BACK KICK.—The result of back firing during cranking of a gas engine. If back firing should occur while the operator is holding the crank, it produces a back kick, which is liable to dislocate his shoulder or do other injury unless the crank throw off automatically.

BACK LASH.—1. In machinery, the reaction or striking back of a piece of machinery, wheel, piston, etc., when the power makes a temporary pause, or a change of motion occurs. It is a consequence of bad fitting or wear, and in the latter case, indicates that the parts should be set up.

2. A shop term for the lost motion caused by the wearing of screw threads, knuckle joints, etc.

BACK OF MACHINE.—Usually the end opposite the commutator or collector rings.—NEMA.

BACK OSCILLATION.—In radio the back flow or kick back of the high frequency current of a spark gap transmitting circuit condenser which flows back through the secondary of the transformer instead of taking its normal path across the gap. It is liable to pierce the transformer insulation.

BACK PITCH.—The winding pitch of the back end of the armature, that is, the end opposite the commutator end.

BACK PRESSURE.—In a steam engine, the pressure on the opposite side of the piston, which opposes a resistance to the working stroke of the steam. This back pressure may be due to the pressure in a receiver, as in the high pressure cylinder of a compound engine; to that of the atmosphere, as in a non-condensing engine; or to that of an imperfect vacuum, as in a condensing engine.

BACK PRESSURE VALVE.—1. A valve designed to prevent the back flow of liquids or fluids in a pipe, resembling a check or non-return valve. Especially used with heating systems.

2. In a marine plant, especially where the air pump is operated by the main engine, a back pressure valve should always be provided on the exhaust pipe as a relief, as in the case of flooding, serious damage might occur.

BACK SHOCK.—When a charged conductor is suddenly discharged, the induced charges of opposite sign in neighboring bodies may also discharge into the earth or into other conducting bodies. This back shock is sometimes felt by persons standing on the ground when some distant object has been struck by lightning. Also called, return shock.

BACK SHUNT SIGNALING.—In radio, a name sometimes given to absorption signaling.

BACK STOP OF KEY.—A metal stop upon which the back of a telegraph key rests when released.

BACKGROUND NOISES.—In sound picture recording, noise resulting principally from casual variations in the light transmission of both positive and negative films.

BACKING METAL.—The metal used for backing up the thin copper shell of an electrotype.

BACKING PAN.—The shallow iron pan in which an electrotype shell is set for the "backing up" process.

BACKWARD LEAD OF BRUSHES.—A displacement of the brushes on the commutator of a motor, back of the normal neutral plane. Backward lead is preferably called negative lead.

BACKWARD PITCH.—A left handed pitch of armature windings as seen from the commutator end.

BAD EARTH.—A name given to a condition of the ground which renders it a poor conductor of electricity.

BAFFLE PLATE.—A thin plate or diaphragm used to deflect or retard the course of gases, etc.; as, the baffle plates inside a furnace door or those fitted on the tubes of a watertube boiler.

BAILEY'S BEADS.—The phenomenon during an eclipse, of the breaking up of the thin solar crescent into beads of light, round or oblong. This occurs immediately before totality, and is ascribed to the roughness of the moon's surface.

BAIN TELEGRAPH CODE.—An early telegraph code adapted for use in Bain's automatic system.

BAIN'S CHEMICAL RECORDER.—A mechanism for recording a telegraphic message in colored dots and dashes upon a strip of sensitized paper by the electrolytic effect of the current upon the chemical solution with which the paper is saturated.

BAIN'S PRINTING SOLUTION.—The solution employed by Bain in chemically preparing paper for his chemical recorder.

BAKELITE.—Trade name for material composed chiefly of a phenol compound; chemical name oxybenzlmethylenglycol anhydride. It is manufactured in many forms and is a good insulating compound.

BALANCE.—1. In physics, a state of equilibrium or counterpoise; said to exist when the forces and momentum of a mechanism are so adjusted that motion is uniform and unattended by vibration or percussion.

2. A delicate form of scales adapted for the minute measurements of chemical and experimental work.

BALANCE BEAM METER.—A prepayment electricity meter consisting of a balance lever or beam at one end of which is attached a copper plate immersed in a solution of copper sulphate contained in a copper box. The action of the meter depends on the electrolysis of copper sulphate with copper electrodes. When a coin is placed in the slot it falls into a cup and its weight brings down the arm and copper plate. This automatically completes a circuit, when the current is used, causing copper to be deposited on the copper box from the copper plate, until the latter has lost sufficient weight to bring the lever again into balance which breaks the circuit, thus cutting off the current supply.

BALANCE GALVANOMETER.—A galvanometer for indicating when the voltage developed by a dynamo is equal to the bus bar voltage, when a fresh dynamo is to be switched into a circuit for the purpose of increasing the load.

BALANCE INDICATOR.—1. An indicator to show the occurrence of an electric balance.

2. In the three wire system, an instrument to show when a balance of the voltages of the two sides of the system is reached.

BALANCE PHOTOMETER.—A photometer which measures the intensity of light by its action upon iodide of nitrogen.

BALANCE WHEEL.—In machinery, a wheel which imparts regularity to the movements of any engine or machine; a fly wheel.

BALANCED ARMATURE RADIO LOUD SPEAKER.—A type which has an armature pivoted at its center between the poles of a permanent magnet and provided with a coil through which the signal current flows, so that the reaction between the magnetic field due to this current and that due to the permanent magnet causes the armature to oscillate about its pivot. These movements of the armature are communicated to the diaphragm by means of the link connection. In operation when a signal current flows through the coil, a magnetic field is produced, which magnetizes the soft iron armature. The poles react on the poles of the permanent magnet and attraction between the unlike poles and repulsion between the like poles take place. The amount of pull or movement is proportional to the current flowing through the coil, so the armature moves in accordance with the variations in the current.

BALANCED CIRCUIT.—1. An electric circuit so adjusted with respect to neighboring circuits as to escape the influence of mutual induction.

2. A three wire circuit having the same load on each side of the neutral wire, as a three wire lighting circuit on an automobile.

BALANCED DETECTOR.—In radio receivers, a type for reducing strays, consisting of two opposed rectifying detectors so connected as to let static effects partially neutralize each other.

BALANCED DRAUGHT.—A method of accelerating combustion in steam boilers which is a combination of forced draught and induced draught, designed to overcome the objectionable features of each, by maintaining the pressure between the furnace and smoke flue at practically atmospheric pressure, or just enough vacuum to carry off the gases. Balanced draught is obtained by the automatic regulation of both the supply of air to the furnace and the escape of gases from the furnace in such manner as to maintain at all times a constant predetermined draught in the furnace for all rates of combustion. Its principle is to supply all the air needed for perfect combustion but no more, and at the same time maintain as little suction as possible or just enough to carry off the gases as fast as they are formed.

BALANCED POLYPHASE SYSTEM.—A polyphase system of electric distribution having current and phase symmetrically distributed through all its branches; balanced multiphase.

BALANCED REACTION COIL.—A choking coil in connection with an alternating current transformer which preserves the current in the secondary circuit uniform under changing loads.

BALANCED RELAY.—A relay having its armature passive when equal currents traverse both coils in opposite directions around the core.

BALANCED RESISTANCE.—An unknown resistance which has been balanced by the known resistances of a Christie or so-called Wheatstone bridge.

BALANCED SYSTEM.—1. A system of electric transmission constructed with such precision as not to be liable to induction disturbances from other circuits.

2. In a three wire system of electric lighting, a condition existing when the number of lamps on the two sides of the neutral wire are equal.

BALANCER.—1. Apparatus used to render a direction finder more accurate in determining direction.

2. A special machine frequently employed in parallel wire systems with great success. The simplest case is the employment of a balancer upon the three wire system.

BALANCER.—A radio direction finder device for determining direction with precision.

BALANCING.—In radio, neutralizing the internal capacity effect in a vacuum tube. Any method of eliminating interference.

BALANCING AERIAL.—In radio, a system of two aerials, one for receiving the desired signals and one for the interfering signals. By adjusting the electromagnetic coupling the interfering signals may be balanced out.

BALANCING COILS.— On a three wire system, coils connected to slip rings of a slip ring commutator dynamo and to the neutral wire.

On balanced load. the coils take a small alternating exciting current from the collector rings as any transformer does when connected to an a. c. line with its secondary open. When an unbalanced load comes on, the current in the neutral divides, half going to each coil. This enters the coil at the middle point and half flows each way through the coil and the slip rings into the armature winding. The unbalanced current is thus fed back directly into the dynamo armature continuously.

BALANCING METHOD.—In measuring resistances with a bridge, a method of balancing the four resistances of the arms so that a sensitive galvanometer, properly connected in the circuit, will show no deflection.

BALANCING OF TELEGRAPH LINES.—In duplex and quadruplex telegraphy, a balance of resistance and static capacity maintained between the main line and the artificial line, so that the action of the home transmitting instruments does not operate the home relays.

BALANCING THERMOPILE.—A thermoelectric battery so arranged as to measure very small differences in the temperatures of two bodies. Also called differential thermopile.

BALANCING TRANSFORMER.—A synchronizer consisting of two transformers having their primaries connected. one to a loaded dynamo and the other to an idle dynamo, their secondaries connected in series through a lamp; when the secondaries are cross connected, the lamp burns brilliantly; when in straight series the lamp is dark at synchronism.

BALATA.—An elastic gum, obtained from a tree which grows in Venezuela, the Guianas and the West Indies. It resembles india rubber and guttapercha, having the elasticity of the former and the ductility of the latter. It is largely used as an insulating medium in electrical practice.

BALL AERIAL.—One consisting of a hollow metallic ball insulated from its support and having attached a lead in wire for connection to the receiver.

BALL AND SOCKET JOINT.—A joint in which a ball or spherical object is placed within a socket recessed to fit it, thus permitting free motion in any direction within certain limits. A ball and socket mounting is usually applied to shafting supports to make them self-adjusting.

BALL BEARING.—A bearing whose journal works upon rings of balls which roll easily in their grooves or races. Rolling friction is thus substituted for sliding friction, thereby eliminating a considerable amount of the total friction. In construction, the balls are sometimes kept from coming in contact with each other by a circular cage.

BALL JOINT.—A universal joint, sometimes employed in piping. The globular end is retained in its hollow seating with a gland screwed over it.

BALL LIGHTNING.—A kind of lightning in the form of balls of fire which move along slowly and then explode with a loud report. It is of rare occurrence.

BALLAST.—In the Nernst lamp, a resistance consisting of iron wire in a glass tube containing nitrogen in series with the glower. The resistance of the ballast increases with the temperature, while that of the glower diminishes, so that a balance results between them and the current becomes constant.

BALLAST COIL.—A resistance unit for limiting the current in a circuit. One form consists of a coil of iron wire wound around a porcelain spool. Its operation is based on the fact that the iron wire will allow only a certain number of amperes to pass, after which it suddenly increases in resistance, so that in case the voltage rises, the excess current will heat the wire and the resulting increase of resistance, limits the flow.

BALLAST COIL.—A device consisting of an iron coil wound around a porcelain core used to limit the current from a dynamo running at variable speed as in automobile battery charging. The operation of the device depends upon the property of iron of increasing greatly in electrical resistance at a certain critical temperature just below the red heat. Below this "critical" point, the resistance is practically constant. At and beyond the critical temperature the resistance increases enormously with each degree of temperature increase.

BALLAST RESISTOR.—1. A resistor placed in some radio circuits as a neutralizer, for instance, in a transmitting arc circuit to partly neutralize the arc's negative resistance.

2. A resistor used to absorb slight fluctuations of voltage across terminals of apparatus such as Nernst lamps, mercury vapor lamps, etc.

BALLAST TUBE.—A radio tube containing a device for automatically regulating the filament current of vacuum tubes to a constant value. The ballast element is a resistor whose resistance changes with temperature changes due to the current.

BALLISTIC GALVANOMETER.—A type of galvanometer designed to measure the strength of momentary currents, such for instance, as the discharge of a condenser. If a momentary current be passed through a ballistic galvanometer, the impulse given to the needle does not cause appreciable movement to the magnetic system until the current ceases, owing to the inertia of the heavy moving parts, the result being a slow swing of the needle.

BALLISTIC PENDULUM.—An early apparatus for measuring the velocity of projectiles; it consists of a heavy pendulum which is swung, or thrown, by the force of a projectile striking against it.

BALLOON BUOY.—A balloon shaped buoy employed in submarine cable operations.

BAMBOO FILAMENT.—An early form of incandescent lamp filament devised by Edison. It consists of fibre derived from the bamboo and subjected to the carbonizing process.

BANCA TIN.—Tin ore from Malacca and Banca; it is the purest ore known and is valued accordingly. It is sold in blocks weighing from 40 to 120 pounds each.

BAND ARC LAMP.—An arc lamp in which the upper carbon is fed down by the action of a copper strip or band connected with the carbon holder.

BAND EXCLUSION FILTER.—A radio device which opposes currents of certain frequencies, but allows passage through the circuit of all currents of frequencies either higher or lower than the band which the filter is designed to exclude.

BAND OF FREQUENCIES.—A range of frequencies between two given limits. Also called band of wave lengths.

BAND PASS FILTER.—In radio, a discriminating filter which rejects current at all frequencies except those within a given range or band.

BAND SELECTOR CIRCUIT.—In radio, a filter system which allows only a predetermined range of frequencies to reach the r. f. amplifier.

BAND SPECTRUM.—A spectrum of light in which the colors, instead of shading into one another, as in a continuous spectrum, are broken into broad lines or bands.

BANJO.—In pole line construction, a contrivance for tightening a wire, consisting of a drum mounted upon a kite shaped board.

BANK.—To tilt sideways in turning an airplane.

BANK CABLE.—A telephone cable which connects a switch bank to a terminal rack.

BANK OF LAMPS.—A cluster of electric lamps mounted upon a single base, used to indicate the voltage of a dynamo which is about to be switched into a circuit; also called battery of lamps.

BANK OF TRANSFORMERS.—A number of transformers grouped together for convenience in changing the pressure.

BANKED BATTERY.—1. A battery which distributes electricity to several separate circuits.

2. A battery having its cells connected in parallel.

BANKED WINDING.—A form of winding designed to reduce distributed capacity by having single turns wound successively in each of two or more layers, the entire winding proceeding from one end of the coil to the other without return.

BANKING TRANSFORMERS.—The process of bringing together a group of transformers to form a "bank."

BAR.—A unit of atmospheric pressure of the c. g. s. system equal to one megadyne per square centimeter.

BAR ARMATURE.—An armature having inductors (erroneously called conductors) of copper strips or bars, as distinguished from a wire wound armature.

BAR HANGER.—In house wiring, a device for supporting outlet boxes. The hanger is attached to floor beams.

BAR MAGNET.—One in the form of a short straight bar.

BAR WINDINGS.—Copper strips or bars used instead of wire windings, as inductors upon an armature, erroneously called conductors.

BARAD.—A unit of pressure in the c. g. s. system equal to one dyne per square centimeter.

BARB BOLT.—In machinery, one having jagged edges to prevent retraction after driving; a rag bolt.

BARE CABLE.—Any group of wires twisted together helically, or composed of any number of such groups. The term wire indicates the individual solid wires in a cable.

BARFF'S PROCESS.—A process employed to protect iron from rust. The iron is first heated to redness and steam is then passed over it. The steam being decomposed by the iron, oxygen is liberated which immediately attacks the iron and forms a protective coating of magnetic or black oxide.

BAROGRAPH.—A recording barometer in which the motions of an aneroid are conducted by linkwork to a tracing point, moving it over a traveling roll of graduated paper, thus registering variations n atmospheric pressure.

BAROMETER.—An instrument for measuring the pressure of the atmosphere. The mercurial barometer is a glass tube 33 to 34 inches high, sealed at the top, filled with pure mercury and inverted in an open cup of mercury. A graduated scale on the instrument permits observations of the fluctuations in the height of the mercurial column, which is highest when the atmosphere is dry, weighing more than when saturated with aqueous vapor, which is lighter than air. The pressure of the atmosphere is ordinarily taken as 14.7 lbs. per sq. in. The "standard atmosphere" which by definition =29.921 ins. of mercury=14.696 lbs. per sq. in., that is 1 in. of mercury=14.696÷29.921=.49116 lbs. per sq. in.

BAROMETERIC CONDENSER.—A type of steam condenser in which the condensing vessel is elevated to such a height that the column formed by the discharged water is sufficient to overcome atmospheric pressure, thus forming virtually a water barometer, with a height of 34 ft., hence the name barometric condenser.

BAROMETRIC GRADIENT.—In meterology the difference of barometric pressure in a given distance measured between two isobars.

BAROSCOPE.—A weather glass.

BARRAGE RECEIVER.—A radio receiver hooked up to two aerials, the purpose of which is to neutralize signals coming from an undesired station by reversal of phase in one circuit.

BARREL WINDING.—A form of armature winding in which the inductors are arranged in two layers and carried out obliquely on an extension of the cylindrical surface of the drum to meet and connect with radial risers. Barrel winding has been very widely adopted, although it involves an increased length of armature, this gives additional cooling surface and provides for good ventilation. In barrel winding, the coil ends must of necessity be arranged in two layers, but the method may be used for either one or two coils per slot.

BARRIER.—An insulating block placed between switch contacts of opposite polarity so that they may be placed close together without danger of a flash over. Its object is to reduce the width of the switch base, thus making the switch more compact. According to the Code: Barriers designed to be placed between poles of switches at hinge jaws shall be of such size and so located as to provide a separation between contact parts measured in the shortest insulating surface path over the barrier equal to that required for switches without barriers, and to provide a separation between other current carrying parts.

BARRING ENGINE.—A small auxiliary engine used to revolve large stationary engines, either to turn them in the proper position for starting, or to move them during overhaul.

BARROW REEL.—A reel employed in pole line construction for carrying a coil of wire upon a wire barrow.

BASE.—In chemistry, a body which can combine with an acid to form a salt and water. Bases are classified as follows: a, Oxides, such as quicklime or magnesia; b, slaked lime; c, hydrates, as caustic soda; d, a class represented by ammonia and its derivatives. Certain bases are caustic, possess an alkaline or astringent taste, and turn red litmus paper blue, these being more popularly known as alkalis.

BASE PLATE.—A heavy iron piece used as a foundation for a machine; specifically, a casting provided with horizontal adjusting wedges, which is used to support pillow-blocks when mounted in wall boxes or on pedestals.

BASIS METAL.—In electroplating, the metal upon which another metal is to be deposited.

BASKET WOUND COIL.—A method of winding which has for its object the reduction of distributed capacity. The winding is such that adjacent turns are spaced some distance apart.

BASTARD OR SHORT WINDING.—A form of armature winding in which the end connectors project from the inductors in straight lines parallel with the shaft and then are bent inward. It has the effect of being somewhat shorter than the barrel winding. In order to secure better ventilation, it is usual to combine a bastard winding at the rear end of the armature with a barrel winding at the commutator end. This class of winding is used only with bar armatures.

BAT BOLT.—In machinery, a bolt barbed or jagged at its butt or tang, to retain it within an object cast, or solidified about it.

BATCH WORKING.—A method of despatching telegraph messages by sending them in "batches" in one direction, and a number in turn in the other direction, as opposed to up and down working.

BATH.—1. Any receptacle containing a liquid, fluid or molten metal, into which articles are dipped in manufacturing processes, to clean their surfaces, or to cover them with a coating of the fluid body; as in tinning.

2. In electroplating, a vessel containing an acid solution of some metal, in which articles are immersed for the purpose of covering them with the coat of the metal in solution, by electro deposition.

3. A bath, fitted with connections and electrodes for treating patients with electricity; an electro-therapeutic bath.

BATTERY.—A number of primary or secondary cells, grouped together as a single source of electricity. A term commonly, though incorrectly, applied to a single cell.

BATTERY ELIMINATOR.—A power unit.

BATTERY GAUGE.—A simple handy form of galvanometer for ordinary use in testing electric batteries.

BATTERY METER.—A small instrument about the same size and shape as a watch for testing the voltage and amperage of batteries. As usually constructed, its range will cover two cells of a primary or one cell of a storage battery.

BATTERY MOTOR.—A motor capable of being driven by the voltage generated by an electric battery.

BATTERY MUD.—A muddy sediment consisting of metallic copper, deposited by the zinc in a gravity cell after wasteful action.

BATTERY PROTECTOR.—An automatic device for opening the circuit when a battery is accidentally grounded.

BATTERY RAILWAY SYSTEM.—A system of electric traction by storage batteries carried on the cars; storage battery traction.

BATTERY SET.—A radio receiver whose current source is a battery either primary or secondary or both.

BATTERY SOLUTION.—The solution which acts chemically upon the metallic plates in a battery cell, and thus generates the electric current; the electrolyte.

BATTERY SYRINGE.—A device for the purpose of handling the electrolytic solution either when filling or emptying a battery cell.

BATTERY VOLTAGE FOR IGNITION.—It is a mistake to use a higher voltage than that for which the coil is designed, because it does not improve the spark and the contact points of the vibrator will be burned more rapidly; moreover, the life of the battery will be shortened.

BATTERY ZINCS.—The negative (—) electrodes of a primary battery.

BAUME'S HYDROMETER.—Two different instruments are known by this name, one for liquids heavier than water and the other, more generally used, for those liquids lighter than water. In the first, the hydrometer floats at 0° in pure water and the stem is usually graduated up to 66°, which equals the specific gravity of sulphuric acid. With the second, the stem shows 10° in pure water, and is graduated up to 90°. To avoid long stems, instruments of both types are made to cover only a small range of degrees, one hydrometer being employed for use from 10° to 40°, and another to show from 40° to 70°.

BAUXITE.—A mineral from which aluminum is derived. The ore, which occurs in the southern states of the U. S., is first treated by chemical processes to remove the impurities and reduce it to aluminum oxide, commonly known as alumina. Alumina is then acted upon by electrolysis with high temperature and pure metallic aluminum is deposited.

BAY BOLT.—A bolt with a barbed shank.

BEACON.—An electric lighting device, or assembly of devices, designed to give a light or lights for the purpose of indicating a geographical location or direction for air ports or airway service.

BEAD AREOMETER.—A variety of areometer or hydrometer containing beads of different specific gravities for the purpose of readily ascertaining the density of the solution in a storage battery cell; a bead hydrometer.

BEAD LIGHTNING.—An unusual form of lightning flash having the appearance of a broken line, suggesting a resemblance to a string of beads.

BEADED TUBES.—The ends of boiler tubes after being expanded are beaded or rounded with a beading tool, just as rivet heads are finished with a die or snap.

BEAKER.—A cylindrical glass vessel having a wide flanged foot and a lip for pouring. Much used for containing or measuring liquids in a laboratory, being generally graduated to mark its contents in cubic centimeters.

BEAM SCANNING.—In the original television system, the subject was scanned by a beam of light and the reflected light was employed to actuate the photo-electric cells. The reflected light, after being picked up by a bank of large photo-electric cells, was converted into variations of electric current. Sufficiently amplified, this current controlled the brightness of a Neon lamp at the receiving station. The Neon lamp when scanned by a moving aperture in synchronism with the initial beam of light, appeared to the observer to recreate the original object.

BEARING PRESSURE.—1. In mechanics, the action of force of bearing or resting; as, the pressure of a beam on a wall.

2. The pressure of a revolving shaft upon its bearing; usually measured in lbs. per sq. in. of projected area.

3. For steam engines of merchant and naval vessels, the allowable pressure on bearing surface in lbs. per sq. in. of projected surface, according to Prof. Bragg are: Using mean loads: a, merchant: crank pin 20 to 250; main bearings, 200 to 350; b, naval: crank pin 250 to 300; main bearings, 250 to 500.

BEARING SURFACE.—The projected area of the surface upon which a shaft rotates.

BEAT FREQUENCY.—In radio, a frequency obtained by combining the received frequency with another frequency produced in the receiver detector circuit. A frequency obtained in a heterodyne receiver.

BEAT FREQUENCY RECEIVER.—A superheterodyne radio receiving set.

BEAT RECEPTION.—A name sometimes given to heterodyne reception.

BEATS.—In radio, a resultant set of oscillations due to two sets of oscillations of different frequencies in the same system.

BECQUEREL'S LAWS OF THERMO-ELECTRICITY.—1. If the junctions of circuit of two metals be kept at temperatures t_1 and t_2, the volts generated is the same as the sum of the volts of two circuits of the same metals working at temperatures t_1 and t_2 where 0 is an intermediate temperature.

2. The interposition of a number of different metals in a circuit originally containing two only in series, makes no difference in the volts if all the junctions be at one temperature.

BECQUEREL RAYS.—The invisible radiations of radium, uranium and other radioactive substances. They are capable of passing through opaque bodies, acting on photographic plates and discharging electrified bodies. Discovered in 1896 by Antoine Henry Becquerel.

BED PLATE.—A casting forming the foundation of a dynamo, or other machine, and so designed as to give the proper support to the shaft bearings and other parts resting upon it.

BEDDING.—A term which indicates the relation between the cross sectional area of an armature or field winding when wound square, and when wound in some other way. In the square order of bedding, the degree of bedding equals zero.

BEDDING BRASSES.—The operation of adjusting the journals of a shaft and its bearings to each other. After the machine work has been completed as accurately as possible, the shaft is smeared with red marking, placed in its bearings and rotated; when taken apart the points in contact have displaced the marking, and these high places are reduced with scrapers until, after repeated trials, both surfaces present a uniform appearance.

BEG OR BEGA.—A prefix often used with a physical unit to designate a quantity a billion times as great.

BEGADYNE.—A force equal to one billion dynes.

B ELIMINATOR.—A device to supply the proper B battery voltage to radio receivers without the use of a B battery. These eliminators are designed to plug in on 110 volt d.c. or 110 volt a.c. lines.

BEL. 1.—The fundamental division of a logarithmic scale for expressing the ratio of two amounts of power, the number of bels denoting such a ratio, being the logarithm to the base 10 of this ratio. Let P and P^1 designate two amounts of power and n the number of bels denoting their ratio, then $n = \log_{10} (P \div P^1)$.

2. A transmission unit in the decimal system equal to ten decibels, the latter being the commonly used unit.

BELL.—An electric device in which a hammer is vibrated so that it beats against a bell. It operates by an electro-magnet which attracts an armature or piece of soft iron forming part of the hammer lever, the attraction ceasing when the circuit is broken by the contact breaker, the hammer being drawn back to its original position by a spring whereby the circuit is closed and the operation repeated.

BELL ALARM SWITCH.—One controlled by the automatic opening of a circuit breaker designed to close the circuit to a cell or other audible signalling device. —NEMA.

BELL AND SPIGOT JOINT.—The customary method of jointing cast iron gas or water pipes. Spun yarn is first stemmed into the bottom of the annulus formed by the spigot of one length and the bell of the next. A mould of fire clay is placed over the end of the pipe and the remainder of the groove poured full of molten lead. When cool, the fire clay is removed and the lead caulked around the joint, beginning at the bottom.

BELL ARMATURE.—A bar of soft iron to which the hammer lever of an electric bell is attached; it is held in position between the electro-magnet and contact breaker pin by a flat spring attached to the frame of the bell.

BELL HANGER'S JOINT.—A method of connecting the ends of wires by making one twist and not less than five turns of each wire around the other (the distinction between a twist and a joint should be understood). The bell hanger's joint was, as its name implies, originally intended for bell circuits, however on account of its being not only electrically and mechanically strong, but also compact, it has numerous other uses where the tensile stress is not too great.

BELL METAL.—A bronze containing about 80% copper and 20% tin, zinc being added for large church bells, while chimes are cast from 87½% copper and 12½% tin.

BELL PULL, ELECTRIC.—A mechanism for ringing an electric bell by the action of a pull.

BELL RINGING TRANSFORMER.—A small transformer designed to furnish current at proper voltage for ringing electric bells.

BELL SHAPED MAGNET.—A peculiar form of horseshoe magnet, shaped like a split cylinder, for use in certain varieties of galvanometers.

BELLING.—In cable jointing, the flaring out of the end of the lead sheath. A blunt nosed tool of hard wood or fibre is used. In performing this operation, care should be taken not to cut the insulation.

BELLINI-TOSI DIRECTION FINDER.—A device for finding the direction of transmitted radio signals. It consists of two triangular loops crossed at right angles and connected to a goniometer.

BELT.—A band of leather or other flexible substance, passing around two pulleys, communicating motion from one to the other. Belts can be made of any flexible material, cloth, rubber, leather, and can be run in any way, at any angle, of any length, and any speed. The working adhesion of a belt to the pulley will be in proportion both to the number of square inches of belt contact with the surface of the smaller pulley, and also to the arc of the circumference of the pulley embraced by the belt. This adhesion forms the basis of correct calculation in ascertaining the width of belt necessary to transmit a given horse power.

BELT CIRCUIT.—A circuit for electric lighting connected in series, and forming an extended loop instead of running in two neighboring parallel lines.

BELT CLAMP.—A device consisting of a stretching frame, the two ends of which are coupled by screwed bars; used for pulling the two ends of a belt together with the proper tension, when lacing or joining the ends.

BELT DRESSING.—A paste applied as a preservative to leather driving belts, rendering them soft and pliable, thus securing better adhesion and improved driving power. The best compounds are a mixture of fish and animal oils; say, cod liver oil and tallow, melted together and incorporated while warm, cooling to an ointment. This is worked into both sides of the belt with a square brush, such as is used for polishing shoes. Boiled linseed oil is said to be the best dressing for cotton belting.

BELT DRIVE.—A method of power transmission largely used where room is available for adequate length of belt. Pulleys must be properly aligned. Do not tighten belt any more than necessary to prevent slipping. Vertical belt drive should be avoided. Have reasonable distance between pulley centers.

BELT FASTENER.—A device or contrivance for uniting the ends of belting, many diverse types being used as a substitute for leather laces.

BELT LACING.—Thongs of soft oil tanned leather used to fasten driving belts, being threaded from hole to hole in either end of the same.

BELT POWER TRANSMISSION RULE.—A single belt one inch wide and traveling 1,000 ft. per min. will transmit one horse power; a double belt under the same conditions will transmit two horse power. A pulley is driven by a belt by means of the friction between the surfaces in contact. Let T be the tension on the driving side of the belt and T^1 the tension on the loose side; then the driving force $=T-T^1$. Taking T at 34 lbs. and T^1 at 1 lb.; hence driving force $=34-1=33$ lbs. Since the belt is traveling at a velocity of 1,000 ft. per min., the power transmitted$=33$ lbs. x 1,000 ft.$=33,000$ ft. lbs. per min.$=1$ horse power.

BELT SLIPPER.—A device for putting on a belt while the driver is in motion. It consists of a cone and shield, which revolves upon a stem, thus yielding easily to the pull of the belt. A staff or handle of any convenient length can be fastened to the socket.

BELT STRETCHER.—In millwrighting, a mechanism employed to stretch new leather belting. Usually belts are stretched by being suspended in a loop from above and loaded with weights. All new belts must be stretched before using, otherwise they will soon have to be taken up, shortened and relaced.

BELT TENSION.—The ultimate strength of leather belts varies from 3,000 to 5,000 lbs. per sq. in. At the laced joints the strength is only 30% of those values, or from 900 to 1,500 lbs. per sq. in. The working tension should not exceed about 300 lbs. a sq. in. A good rule is 20 lbs. per in. of width for each 1/16 in. in thickness of the belt.

BELTS AND PULLEYS.—To calculate size of pulleys, the following formula is used:

$$D=\frac{dr}{R} \qquad (1)$$

in which D=diameter of driver pulley
d= " " driven "
R=revolutions per minute of driver pulley
r=revolutions per minute of driven pulley

The following formulæ are derived from equation (1)

$$d=\frac{DR}{r}$$

$$R=\frac{dr}{D}$$

$$r=\frac{DR}{r}$$

BENCH BOARD OR CONTROL DESK.—A switchboard having a horizontal or slightly inclined section for mounting control switches, indicating lamps and instrument switches and furnished with or without vertical instrument sections.—NEMA.

BENDING STRESS.—In physics, a force acting upon some member of a structure tending to deform it by bending or flexure, the effect of this force causes bending strain on the fibers of the material of which the part is composed.

BENT ULTRA SHORT WAVES.—Marconi is credited with having sent radio ultra short waves of 57 centimeters (about ½ a meter or 22 ins. wave length) beyond the horizon and still noted reception. The transmission distance in this case was 167 miles.

BERNADOS PROCESS.—A method of welding in which the metal to be welded is connected to one pole of an electric circuit. When iron or steel is being welded, for which a high temperature is needed, the metal is made the positive and the carbon the negative. In the case of lead or any metal requiring a comparatively low temperature, this polarity is reversed. This process is of considerable value in the filling up of blow holes, cracks, etc., in steel castings. The carbon, which is held in a suitable holder. with hand shield, is placed in contact with the metal and withdrawn a short distance, the arc following and being maintained generally from ¾ to 1½ inches in length. By withdrawing the carbon from the work, the current ceases. The arc is moved about until the whole surface on which it plays becomes molten and where necessary, additional metal in the form of rod or small pieces is melted in.

BESSEMER PROCESS.—A method of producing mild steel directly from cast iron. The process is carried on in a converter, an egg-shaped retort, swinging upon trunnions, through which a powerful current of air is blown. The converter is charged with molten iron from the blast furnace while in a horizontal position, and is swung into the vertical as the blast is applied. The silicon floats as slag on the surface and is removed separately; the oxygen of the air burns away other impurities and combines with the carbon. The spectroscope is used to watch the mouth of the converter, to notify when the carbon disappears from the spectrum of the flame; when freed from carbon, the converter is swung through a small arc and a measured quantity of ferro manganese or spiegeleisen added to insure the right percentage of carbon, the blast being once more applied to effect thorough incorporation. Subsequently the converter is lowered horizontally and emptied into ladles, whence its contents are cast as ingots.

BEST BEST IRON WIRE.—A superior grade of iron wire intermediate in quality between extra best best and best.

BEST IRON WIRE.—The poorest grade of iron wire for electrical purposes, so called in distinction from best best and extra best best.

BETA RAYS.—Those composed of negative particles of electricity; that is, electrons.

BETA RAYS.—One of the three types of rays emitted by radio active substances. Beta rays are regarded as negatively charged material particles given off with very great velocity, having moderate penetrating power, comparatively small power to ionize a gas, small effect on a photographic plate, a velocity equal to that of light; in fact, they are practically identical with cathode rays except in velocity of motion. Beta rays have greater penetrating power than alpha rays and like them, are deflected by a magnet.

BETTY.—A round iron bar flattened to a chisel like expansion at one end and used generally for the application of a large leverage for a temporary purpose.

BEVEL GEARING.—An arrangement of gear wheels for the transmission of motion from one shaft to another, almost any angle being included by adaptations of the principle. Usually the shafts are at right angles to each other.

BEVEL SQUARE.—A square whose blade may be set to any required angle in the stock that holds it.

BEVERAGE AERIAL.—A wave aerial.

B.h.p.—Abbreviation for brake horse power.

BIAS.—In a radio vacuum tube, difference of voltage between two elements as between filament and grid. (See negative grid bias and positive grid bias.)

BIAS DETECTOR.—A radio vacuum tube employing the principle of plate current detection.

BIAS OF RELAY TONGUE.—In duplex telegraphy, a one sided adjustment of the armature or tongue of the polarized relay, such that when no current flows it rests against the nearest pole or the insulated stop.

BIASING RESISTOR.—A radio resistance used to obtain a voltage drop for grid bias.

BI-CARBONATE OF LIME.—In steam engineering, the principal compound to whose deposition the incrustation of steam boilers and water pipes is due. It is at first held in solution in the water as a bi-carbonate, by the excess of carbonic acid. This excess being driven off by heat, the carbonate of lime remains as a floury or muddy deposit, its precise condition varying with the nature of the salts with which it is usually accompanied. In the presence of heat it hardens and forms an injurious scale.

BICHROMATE CELL.—A single fluid cell consisting of two plates of gas retort carbon as the negative element, and between them a single plate of zinc; the exciting liquid is composed of a saturated solution of potassium bichromate in water and strong sulphuric acid; also known as **Poggendorf's cell.**

BICHROMATE OF POTASH. — Properly, potassium bichromate, the salt of chromic acid, with the metal potassium. It is a red crystalline solid, soluble in water but insoluble in alcohol and very poisonous. The bichromate is used in analyzing iron, as a reagent in various processes, and in primary batteries.

BICRO.—A prefix often used with a physical unit to designate **one-billionth part** of that unit.

BIFILAR CONTROL OF GALVANOMETER NEEDLE.—A method of controlling the needle of a galvanometer so that it is restored to its original position, after deflection, by the action of the two threads in bifilar suspension.

BIFILAR SUSPENSION.—Suspencion by two equally long threads, as a means of measuring forces of rotation.

BIFILAR WINDING.—A method of winding resistance coils in which the wire is doubled before it is laid on, so as to overcome self induction.

BIGHT.—The loop in a cable or wire.

BILGRAM DIAGRAM.—A graphical method of proportioning slide valves for a giver steam distribution. As compared with other diagrams (especially the Zeuner diagram) the Bilgram diagram has the following advantages: The lead is laid off from a fixed line, the port opening from a fixed point, and the cut off position of the crank is located. The lap circle is then drawn tangent to these lines and the problem is solved. Moreover, the awkward conception of the backward rotation of the crank is obviated. Finally, these marked advantages are not accompanied by any compensating disadvantages whatever.

BILLI CONDENSER.—A low capacity variable condenser consisting of two brass tubes, one of which is arranged to slide in and out of the other. This type condenser is now obsolete for radio circuits.

BIMETALLIC HELIX.—A coil composed of wires of two different metals which are so joined that the spiral is acted on by the unequal expansion or contraction of the two wires.

BIMETALLIC THERMOMETER.—A thermometer composed of a bar of two metals having different rates of expansion, brazed together or built into a helix or spiral which, under torsion brought about by changes of temperature, moves an index upon a scale.

BIMETALLIC THERMOSTAT.—A thermostat for opening or closing an electric circuit by the action of the temperature upon a spring or scale of two different metals welded together.

BIMETALLIC WIRE.—A steel wire with an external coating of copper. It can be used for long spans on account of the high tensile strength of the steel. Also called composite wire.

BINARY COMPOUNDS.—The term used by Berzelius (1831) to distinguish electro-positive and electro-negative compounds from all others, particularly organic compounds. The term is now obsolete.

BINDER PULLEY.—A pulley, the sole function of which is to bind or tighten a belt or cord on its driving and driven pulleys, when owing to extension or shrinkage of the belt or cord, the tension becomes variable in amount. The binder pulley is properly made adjustable. Usually called idler.

BINDING COILS.—Coils of wire wound outside the windings of an armature to hold them firmly in place against the loosening tendency of the centrifugal force of the rotation.

BINDING POST.—A metal post furnished with a screw for securing the end of wires on radio and other electrical apparatus.

BINNACLE.—A stand or case for a ship's compass, provided with lamps for illuminating the dial and usually located beside the steering wheel.

BINOCULAR COILS.—Two separate and parallel coils placed side by side.

BIOSCOPY, ELECTRIC.—The application of an electric current to the nerves or muscles of the human body to determine whether or not life is extinct in doubtful cases of apparent death.

BIPHASE.—A term sometimes used for two phase; as, a biphase alternating current.

BIPOLAR.—Having two magnetic poles; dipolar.

BIPOLAR ARMATURE WINDING.—Winding an armature in such a manner as will adapt it for use in a bipolar magnetic field.

BIPOLAR RECEIVER.—A form of telephone receiver in which both poles of the electro magnet are presented to the diaphragm in order to strengthen the field; a double pole or two pole receiver.

BIRD CAGE.—A laceration of a submarine cable in which the sheathing is torn away and the conductors protrude like a wire cage.

BIRMINGHAM WIRE GAUGE.—Formerly the English standard for wire and sheet metals, but now employed for the latter only. Its numbers run from 0000 to 36, the former equaling .454 inch and the latter .004 inch. The B.w.g. is now replaced as a standard in Great Britain by the Imperial Wire Gauge, legalized in 1884.

BISECT.—To divide into two equal parts.

BISECTING SCALE.—A flat scale in a measuring instrument fully and symmetrically divided on each side of its center line. It is usually graduated for ¼ inch, ½ inch and 1 inch scale.

BISMUTH.—A very brittle crystalline metal of a grayish white color, tinged with pink or red. It is a remarkable metal for two properties; its specific gravity decreases under pressure and it expands on cooling. Various compounds of bismuth with other metals melt at points below that of boiling water. Wood's metal, of 4 bismuth, 2 lead, 1 tin, 1 cadmium (all by weight) melts and remains fluid at 142° F. Bismuth is used in many alloys under the name of expansion metal.

BISMUTH SPIRAL.—An instrument containing a spiral of bismuth, a conducting metal, for the purpose of measuring intense magnetic fields.

BITUMEN.—1. A mineral pitch or asphalt; the residue of forms of petroliferous deposits, whose more volatile constituents have evaporated by the processes of nature. A general name for asphalt, tar and pitch.

2. A pigment or paint resembling sepia made by grinding asphalt with a drying oil.

BITUMEN.—Tar, pitch or asphalt.

BIVALENT.—In chemistry, a term applied to an atom having a valence, or combining capacity of two units; i. e., having a capacity to unite with two atoms of hydrogen. An ion is bivalent, or can combine with two hydrogen atoms, if it carry two electric charges.

BLACK BODIES.—Those which neither reflect nor transmit radiation, but which are capable of absorbing all the radiant energy striking them. An opening to a comparatively large and deep chamber which contains no concentrated source of radiation can be considered as the nearest approach to a black body.

BLACK BODY PHOTOCELL.—One in which light is completely absorbed by repeated back and forth reflections within the cell.

BLACK DEPOSIT.—A dark colored sediment that is deposited in the process of electro-plating when too strong a current is applied to the bath; also called **burnt deposit.**

BLACK LEAD.—One of the natural forms of carbon. Used with or without the addition of oil for coating the faces of cast iron chilling moulds, also as a lubricant.

BLACK LEADING MACHINE.—A machine used in the process of electrotyping for depositing a layer of graphite over the face of the wax impression to render it capable of conducting electricity.

BLACK LIGHT.—Radiant energy that fails to produce light. Ultra-violet rays.

BLACK OILS.—In lubrication, crude mineral oils of good body which have been subjected to one series of purification only, to remove their mechanical impurities and volatile oils, but which have not been filtered to improve the color. They are used for cylinder lubrication.

BLACK RED HEAT.—That temperature of wrought iron or steel in which the red color is just visible by daylight. It may be roughly taken as corresponding with 1,000 degrees Fahr.

BLADE.—The movable contact member of a switch.

BLAKE TRANSMITTER.—A carbon telephone transmitter, until recently almost universally used in the United States. It is based upon the principle that when two pieces of carbon lie loosely together, differences of pressure at the contact cause variations in electrical resistance.

BLANK BOLTS.—In machinery, the rough forgings of bolts previous to screwing.

BLANKETING.—In radio, interference of waves coming from a powerful transmitting station with those of weaker stations, rendering reception difficult or impossible.

BLASTING, ELECTRIC.—The use of electricity for igniting the explosives in blasting; heavy wires are carried from a current source at a distance to a special fuse in which a fine platinum wire is joined in the circuit. The great resistance of the fine wire causes it to heat when the current flows, and being surrounded by an easily combustible substance to serve as a priming, ignites this and sets fire to the explosive charge.

BLEACHING, ELECTRIC.—A process of bleaching by the action of electrolysis.

BLEEDER.—In marine practice, a valve on a small pipe line from boiler to condenser to save loss of feed water when the safety valve blows off. By opening bleeder valve, the boiler is relieved of excess steam which is condensed, the condensate being returned to the boiler.

BLENDE.—1. A mineral also called by miners **mock lead; false galena** and **black jack.** It is a zinc sulphide, but often contains some iron. Its color is usually yellow, brown or black, and its luster resinous.

2. A general term for some minerals, chiefly metallic sulphides, which have a somewhat brilliant but non-metallic luster.

BLIMP.—A small non-rigid air ship.

BLISTER COPPER.—Fine copper which has been roasted to expel sulphur, and melted, being then cast into slabs preparatory to refining. The gases escaping from the molten copper give it a blistered appearance, hence the name; this blister copper is about 96% pure, and its subsequent refining is done by electrolysis.

BLISTER STEEL.—Steel made by the first process in the production of carbon or tool steel, by heating wrought iron in intimate contact with charcoal. Its surface is covered with blisters caused by the formation and bursting of vesicles filled with gaseous carbon.

BLOCK.—1. In typography, a term including wood cuts, or the hardwood on which they are engraved; zincotypes, electrotypes, etc.

2. In railway signaling, the extent of track between two signal posts or towers, forming one of the sections in the block system of signaling.

BLOCK AND TACKLE.—A term including the block and the rope wove through it, for hoisting or obtaining a purchase.

BLOCK SIGNAL.—A set of semaphores or lamps automatically operating at the terminals of a block or section in the block system of railway signaling.

BLOCK SYSTEM.—A method of railway working, in which the line is sub-divided into short sections or blocks, each of which is protected by signals, so arranged that there shall be only one train in a section at a time.

BLOCKED IMPEDANCE.—The impedance of an electro-acoustic transducer measured at the terminals of its electrical system when the impedence of the attached mechanical system is infinite, or vice versa.

BLOCKING CONDENSER.—1. An electrolytic condenser used to prevent flow of current in one direction.

2. In radio, a condenser used to stop the flow of d.c. in a circuit without interfering with the flow of a.c.

BLONDLOT RAYS. — Radiations having similar properties to light rays, but having a shorter wave length, rendering certain bodies luminous. They are given off from luminous bodies, magnetic fields, certain non-luminous bodies in a state of stress, ferments and animal and vegetable tissues; also called n-rays.

BLOOD STONE.—A name often given to hematite, the oxide of iron, because of the natural blood red color which the ore often has.

BLOOM.—A mass of wrought iron from the puddling furnace in the form of an oblong block.

BLOW OFF.—In steam engineering, a term applied to the act of letting out water and steam from a boiler to carry off accumulated mud and scale. Near the bottom of the boiler is a cock valve and opening this the force of the steam drives much of the accumulated scale, etc., with the water and steam out of the boiler.

BLOW OUT COIL.—In an electric car controller, a coil inserted below the reversing drum for blowing out the electric arc between the contact fingers and the drum strips whenever the circuit is broken.

BLOW OUT MAGNET.—In an electric railway controller, an electro-magnet inserted to blow out an arc that might arise between the contact fingers: a magnetic blow out.

BLOW PIPE, ELECTRIC.—An air blast effect produced at the tip of a highly electrified pointed conductor by the convective discharge.

BLOWING OFF.—Emitting steam at the waste pipe through the safety valve lifting under excessive pressure.

BLOWING POINT.—The strength of an electric current necessary to "blow," or melt, a fuse.

BLOWING THROUGH.—In steam engineering, the sending of steam through the cylinders and valves, to warm the engine before starting, thus eliminating a large amount of condensate, which otherwise might more than fill the clearance space with possibility of cracking the cylinder heads in starting.

BLUE GLOW.—The appearance of the interior of a vacuum tube when gas is undergoing ionization. It is caused by low vacuum or too high voltage.

BLUE HEAT.—A low heat, noticeable in iron and steel as they cool down from a red or working heat; it is unsafe to hammer or work these metals at this temperature on account of the distress to the fibers. If anything cannot be bent or flanged at a red heat, it should be wrought cold and then annealed.

BLUE POLE OF MAGNET.—A term sometimes used to denote the south pole of a magnet.

BLUESTONE.—A name sometimes given to copper sulphate in crystalline form; also called blue vitriol.

BLUESTONE CELL.—A gravity cell containing a copper plate in a solution of copper sulphate at the bottom of the jar, and a zinc plate in a diluted solution of zinc sulphate above it. It is so called from the name "bluestone" or "blue vitriol" by which copper sulphate is popularly called; the crow foot cell.

BOARD MEASURE RULE.—Multiply length in ft. by width in ft. of the board and multiply this product by 1 for board an inch or less than an inch in thickness, and by the thickness in inches and fractions of an inch for board over 1 in. in thickness.

BOARD OF TRADE UNIT (B. O. T.).—1000 watt hours or 1 1-3 horse power.

BOBBIN.—The depolarizing mix in a dry cell which is moulded around the central positive electrode.

BOBBIN, ELECTRIC.—A spool wound with insulated wire for an electro-magnet.

BODY CAPACITY.—That existing between a radio set and a person's body; noticeable sometimes in tuning.

BODY PROTECTOR.—A short circuiting device for protecting the vital parts of the human body against the passage of an electric current in case of accidental contact.

BODY SKID.—Flexible support usually placed in front of the landing gear of an air plane.

BOILER.—A vessel in which water is evaporated into steam for the generation of power, for heating purposes, etc. The various types may be classified under three heads: a, fire tube or shell boilers, in which the water is contained within more or less cylindrical vessels traversed by tubes, through which the flame and heated gases of combustion pass to impart their heat to the water; b, water tube boilers, in which the water is contained within the tubes, the products of combustion circulating around them on courses determined by suitable baffles; c, flash boilers, composed of small pipes or tubes and no steam or water drum, the steam being generated as the water traverses the length of pipe or tube.

BOILER COMPOUND.—A chemical put into a boiler for the purpose of preventing incrustation.

BOILER FEED, ELECTRIC.—A mechanism operated by electricity for automatically supplying a boiler with water when the level has fallen to a given point.

BOILER FIRING METHODS.—Boilers may be fired by hand or by mechanical stokers. Firing by hand is a laborious and as usually done, an inefficient process. There are four methods of hand firing, each of which has its advantages and faults. These methods are:

1. Spreading methods: a, even spread; b, alternate side spread; c, alternate front and back spread. The spreading or alternate method of firing gives higher efficiency, higher CO_2, lower temperature of exit gases and generates steam more uniformly than does the coking method, due to more uniformity in furnace temperature. The Bureau of Mines states that about the same amount of slicing and raking is required in either coking or spreading methods (of course excluding in this the leveling required in the coking method).

2. Coking method. This method of firing produces less clinker, since the leveling of the fire at the firing period shakes more ash through the grate, and lower CO_2, due to longer firing period results, with a tendency to admit excess air, through the thin spots. The analysis of ash shows no difference in the amount of combustible for the two methods of firing.

BOILER HORSE POWER.—The evaporation of 30 pounds of water from an initial temperature of 100° F. to steam at 70 pounds gauge pressure, which (as accepted by the A. S. M. E. Power Plant Code Committee), is equivalent to 34.5 pounds of water evaporated per hour from a feed water temperature of 212° into dry steam at the same temperature. A prominent builder of marine machinery says in his catalogue: "We do not place a horse power rating on our boilers. The term as applied to marine boilers in particular, leaves room for serious misunderstanding, for it is the design, size and details of the engine that determines the power." There is nothing the matter with the term as it is just as definite a unit as the pound, or gallon—it is the ignorance of the user that causes the confusion. On this account the manufacturer was no doubt justified in side-stepping the term boiler horse power.

BOILER HORSE POWER BUILDERS RATING.—Not less than one-third square foot of grate surface should be furnished per horse power with ordinary chimney draught, not exceeding .3 in. of water column at the damper, for anthracite coal, and for poor varieties of soft coal, high in ash, with ordinary furnaces. Less grate surface may be allowed for high grade soft coal and for forced draught.

BOILING.—1. A change of state which occurs when the temperature of a liquid is raised to the boiling point.

2. The rapid evolution of gas in a storage cell due to too great charging current.

BOILING OUT.—In cable splicing, after penciling, the joints should be boiled out with hot condulatum 240° F. using a dipper. Condulatum is a by-product of petroleum. After boiling out, paint with hot condulatum.

BOILING POINT.—The temperature at which a liquid begins to boil. The boiling point varies with the pressure and with the nature of the fluid; thus, the boiling point of ether is 95° F., of water 212° F., under pressure of one atmosphere.

BOLE.—A proposed C. G. S. unit of momentum, equal to one gram-kine, or one gram moving with a velocity of one centimeter per second.

BOLITHO CIRCUIT.—An English radio super-regenerative circuit.

BOLOMETER.—An instrument of great sensitiveness, consisting essentially of a Wheatstone bridge having two strips of blackened platinum foil inserted in the arms, for measuring minute quantities of heat energy by the changes of electrical resistance produced in a metallic conductor by variations of temperature; a thermal balance.

BOLT.—A discharge of lightning; as, a flash of lightning.

BOMBARDMENT.—1. In a vacuum tube the forcible projection of negative electrons from the hot filament against the plate.

2. In physics, the very rapid striking of the molecules of a gas against each other or against the walls of a containing vessel.

BOND TESTER.—In electric traction, a device for testing the electric conductivity of rail bonds.

BONDED RAILS.—Rails in a railway system so connected at their joints by bonds (i. e., short pieces of copper wire riveted into the adjoining ends) as to preserve the conducting capacity of the tracks.

BONDED TO CAPACITY.—In rail bonding, an efficiency of joint such that the resistance of the bond wires is equal to the resistance of the same length of rail between the pin connections of the bond wires. A bonded rail in which the resistance of the bond equals that of a length of the rail equal to the distance between the bond pin connectors.

BONDING.—A method of connecting metallic parts together so that the conductivity of the joint is equal to that of the part itself, as in rail bonding.

BONNET.—1. A cap put over a pile to prevent splintering or damage when driving.

2. A cover, raised in the middle, as those used to guide and enclose the tail end of a steam engine valve spindle, or the drum-shaped covers of a piston valve casing.

3. The cover over a pump valve box, or of a slide valve casing.

BONY CURRENT.—An electric current between two parts of a bone of a newly killed animal, due to a difference of pressure existing between them.

BOOK CONDENSER.—A two plate variable condenser having the plates hinged together like the leaves of a book with dielectric attached to one plate or supported between the plates.

BOOSTER.—In general a dynamo inserted in series in a circuit, to raise its voltage. It may be driven by an electric motor, in which case it is sometimes called a motor-booster. The function of a booster is to add to an electric pressure derived from another source. Boosters are classified as: a, series; b, shunt; c, compound; d, differential; e, constant current; f, separately excited.

BOOSTER CHARGE.—A method of charging a storage battery at a high rate for a short interval.

BOOSTER SYSTEM.—Long feeders having the pressure raised at distant points by inserting a booster to compensate for drop.

BOOSTER TRANSFORMER.—One whose output is used to raise the voltage of a line.

BORDER LINE RAYS.—Grenz rays.

BOREAL POLE.—That pole of a magnet which points southward.

BORING POLES.—In transmission line construction a hole should be bored for a ⅝ in. cross arm bolt in the center of each gain. The hole should be so bored that when the cross arm is drawn up tight, the bolt will be at right angles to the face of the cross arm. Where practicable, holes for cable suspension clamp bolts and pole steps should be bored before the pole is erected. The last operation completes the work of framing.

BORNITE.—A mineral having a metallic blue lustre and composed of sulphide of iron and copper. In radio this mineral is used with zincite or copper pyrites as a crystal detector.

BOTTLE.—A slang name for a radio vacuum tube especially a transmitting tube.

BOUGIE DECIMALE.—The standard French candle, having a value nearly equal to the British standard candle, and equivalent to 1/20 of the platinum or Violle standard, the pyr.

BOUGIE METER.—A French unit of illumination; it is the light of the standard French candle at a distance of one meter.

BOUND CHARGE OF ELECTRICITY.—The condition of an electric charge on a conductor placed near another conductor, but separated from it by a medium through which electrostatic induction can take place. When a charged conductor is placed near another conductor, but separated from it by a dielectric or medium through which induction can take place, an opposite charge is induced in the neighboring conductor. This charge is so held or bound on the conductor by the mutual attraction of the opposite charge that it is not discharged on connection with the earth unless both conductors are simultaneously touched by any good conductor.

BOUND ELECTRIFICATION.—The condition of a charge of electricity on the surface of a conductor when it is attracted by the presence of a neighboring charge of the opposite kind.

BOURDON'S GAUGE.—The commonest instrument for measuring the pressure of steam, water, air or other fluid. Its essential part is a metal tube of a flattened oval section, which is bent to a curve, the free end being closed, the fixed end open to the pressure. The pressure tends to straighten the bent tube, and its consequent movement is communicated by means of linkage, a toothed sector and a pinion, to the axis of a needle or pointer; this moves around a graduated dial, registering the pressure of the fluid.

BOW GEAR.—A method of rigging the bow of a cable ship for conveniently handling the cable laying operations.

BOW TROLLEY.—A form of trolley employed in interurban and trunk line electric traction. It consists of a pivoted frame carrying a curved or looped contact piece which provides a sliding surface to rub against the overhead wire. It is controlled by compressed air.

BOX AERIAL.—A radio loop aerial. The frame being so constructed that when the wire is wound upon it, it forms four sides of a box.

BOX BRIDGE.—A commercial form of bridge in which the resistance coils and accessories are contained in a box provided with necessary plugs and connections; a box balance.

BOX BRUSH HOLDER.—A commutator brush holder in which the brush is free to move up and down in the box, so far as it is not restrained by a spring rigidly secured to the extremity of the arm which carries the brush box.

BOX NUT.—In machinery, a nut made for the covering and protection of the end of a bolt. It is similar to an ordinary nut, with the addition thereto of a dome shaped closed end.

BOX RELAY.—A form of telegraphic relay for use in special cases, having a wooden box set over the coils in order to amplify the signals so that they may be clearly audible; a telegraphic box sounder.

BOX SPANNER.—A socket wrench or T-spanner; having a socket to fit the nut, and a shank vertical to it, either turned by means of a toggle or by the T-handle. Used for turning nuts sunk in a recess below the surface of the piece.

BOXING THE COMPASS.—Repeating in succession the names of all the 32 points or rhumbs of the mariner's compass in their exact order. Boxing the quadrant from North to East the rhumbs are: N, N by E, N-NE, NE by N, NE, NE by E, E-NE, E by N, E.

BOYLE'S LAW.—At constant temperature the pressure of a gas is inversely proportional to its volume. Thus, if a cu. ft. of air at 10 lbs. absolute pressure be compressed to ½ cu. ft. the pressure will be 20 lbs. absolute. That is

$$1 \text{ cu. ft.} : \tfrac{1}{2} \text{ cu. ft.} = X \text{ lbs.} : 10 \text{ lbs.}$$
$$.5X = 10$$
$$X = 20$$

It should be understood that absolute pressure (not gauge pressure) must be taken.

BRACKET ARM.—In overhead line construction, a pole cross arm stiffened by a bracket support.

BRACKET ARM HANGER.—An insulating device for supporting a trolley wire from the end of a bracket arm, consisting of a metal hood carrying a steel bolt embedded in insulating material, for screwing into the boss of the suspension ear.

BRACKET POLE.—In overhead line construction, a pole carrying one or more brackets for supporting the wires.

BRACKET SUSPENSION EAR.—A suspension ear for a trolley wire attached to a bracket arm hanger.

BRACKET TELEPHONE.—A telephone transmitter mounted upon a hinged arm to permit adjustment to the height of the user; an adjustable telephone arm.

BRADFIELD INSULATOR.—A radio lead in insulator consisting of an ebonite tube having zinc cone and ebonite spark discs. Used to prevent aerial becoming grounded due to continuous stream of rain.

BRAID.—A plaited covering.

BRAIDED CABLE.—A cable in which the wires are interlaced or plaited instead of twisted.

BRAIDED WIRE.—An electric conductor protected by an interwoven insulating covering.

BRAKE.—1. A contrivance for checking or controlling the speed of a vehicle or machine by means of friction applied to a drum, or wheel; the friction is applied either by means of a band or by pressure on a shoe.

2. A contrivance for measuring the useful effort of a prime mover by the substitution of measurable friction for the external load. It consists essentially of a band, usually of steel, shod with wooden blocks, which encircles a fly wheel or pulley, the friction of the brake sustaining an arm or lever, to the ends of which either weights or a steelyard are attached.

3. A device consisting of a shoe which is made to bear on the circumference of a wheel by the attraction of an electro-magnet.

BRAKE DISC.—A disc shaped electro-magnet sometimes used in the brake of an electric car.

BRAKE HORSE POWER.—The useful horse power supplied by an engine or other prime mover as ascertained by the application of a brake, or absorption dynamometer. The excess of the indicated horse power over that given by the brake, represents the power required to move the engine itself, and is generally spoken of as internal load or friction.

BRAKE HORSE POWER FORMULA.—The method of calculating brake horse power is given as pony brake formula.

BRAKE OR ABSORPTION DYNAMOMETER.—A device in which the power of a rotating shaft or wheel is absorbed or converted into heat by the friction of a brake.

BRAKING.—In electric braking, using the motors as dynamos, driving them by the energy due to the momentum of the cars. For braking, all the motors are in parallel and connected to the brake magnets through resistance which is varied as the car speed is reduced. It is necessary to reverse the motors to make them "pick up" as dynamos. The external resistance of the brake magnets absorbs the energy they generate.

BRANCH. — 1. An electrical conductor which branches off from the principal conductor.

2. A main conductor which is tapped for the distribution of the current in a parallel system.

BRANCH BLOCK.—A block of porcelain in which grooves and recesses are cut for conveniently connecting branch wires to a main; allowing, also, for the insertion of safety fuses in the connections.

BRANCH BOX.—A box for holding a branch block.

BRANCH CIRCUIT.—That portion of a wiring system extending beyond the final automatic overload protective device of the circuit.

BRANCH COUPLING BOX.—A coupling box for the ready connection of the house service wiring with the mains running under the street.

BRANCH CURRENT.—In a divided circuit, the current divides, a portion of which flows through each branch, the relative strengths of current in the two branches being proportional to their conductances and inversely proportional to their resistances.

BRANCH CUT OUT.—A safety fuse inserted at the point where a branch wire taps a main.

BRANCH TERMINAL MULTIPLE SWITCHBOARD.—A switchboard for the three wire multiple system in which the jacks for each subscriber are connected in parallel.

BRANCHING BOARDS.—Telephone switchboards employed in the multiple system.

BRANCHING TELEPHONE SYSTEM.—A system in which the branch multiple terminal or three wire system is used.

BRANDING, ELECTRIC.—A method of marking with a hot iron in which the tool is made red hot by an electric current.

BRASS.—A yellow alloy composed of copper and zinc in various proportions. In some grades tin or lead in small amounts is added. When zinc is present in small percentages the color of brass is nearly red; ordinary brass for piping, etc., contains from 30% to 40% of zinc. Brass can be readily cast, rolled into sheets, or drawn into tubes, rods and wire of small diameter. The composition of brass is determined approximately by its color. Red contains 5% of zinc; bronze color, 10%; light orange, 15%; greenish yellow, 20%; yellow, 30%; yellowish white, 60%. The so-called low brasses contain 37% to 45% of zinc; being suitable for cold rolling.

BRASS PLATING.—Depositing a layer of brass upon an object by an electric current passing through a brass solution; also called brassing.

BRASS TUBING.—Used in engineering for cutting off into hand railings, sheathing, distance pieces, etc. Its thickness is given by the wire gauge. The common tube is soldered or brazed; but the best tubes as used for condensers are solid drawn, and usually made of a special alloy. Do not confuse a tube with a pipe.

BRASS WELDING.—It is difficult to weld brass due to the vaporization of the zinc content when subjected to the temperature of the electric arc. The addition of metal to brass can be done successfully, but the metal from a brass electrode cannot be added to parent metal of the same composition.

BRASSES.—Bearing steps cast from an alloy of copper and zinc. Generally, all loose bearing pieces or steps are termed brasses, though they are most usually made either of bronze or gun metal, a copper tin alloy, or else of cast iron or steel fitted with recesses filled with a white or anti-friction metal, composed of tin, zinc, antimony or lead, with occasionally copper.

BRAZING.—The art or process of joining metals together. The parts to be united are cleaned, covered with borax as a flux, the spelter or brass alloy is placed on the joint, which is heated until the spelter runs in, when it is allowed to set, superfluous brass being afterwards filed off.

BRAZING METAL.—An alloy composed of 84% of copper and 16% of zinc. Flanges for copper pipes are cast from this, the percentage of copper having to be high to withstand the localized heat of brazing to the tube.

BREAD AND BUTTER CABLE.—A term describing a variety of submarine cable lightly sheathed with alternate layers of wire and yarn.

BREADTH COEFFICIENT OF ARMATURE COIL.—The ratio of the volts of an armature coil to the volts which would be produced in that coil, but for the loss due to the breadth of the windings.

BREADTH OF COIL.—The surface extent occupied by the windings about an armature measured along the circumference of the armature.

BREAK.—1. Any discontinuity in an electric circuit.

2. The operation of breaking an electric circuit by a switch or circuit breaker. There are several methods as: a, in air; b, in oil; c, magnetic; d, horn.

BREAK DOWN SWITCH.—A type of switch used to enable a three wire system to be readily converted into a two wire system by making such connections of the bus bars as to throw one of the dynamos out of the circuit in case of a breakdown.

BREAK DOWN TORQUE.—The maximum torque a motor will develop with full voltage without a sudden drop in speed.

BREAK DOWN VOLTAGE.—The voltage required to puncture a dielectric or insulator.

BREAK IMPULSE.—In a telephone circuit, an impulse due to a temporary interruption of current.

BREAK-IN.—An arrangement whereby the transmitting key automatically disconnects the receiving set from the aerial and substitutes the transmitting set.

BREAK JOINT.—In building and engineering, so arranging the parts of a structure that two or more successive joints may not come in line with each other, the object being to increase the strength.

BREAK SIGNAL.—In telegraphy, a signal to indicate a space or break in the despatch, as between the address and the message, or the message and the signature.

BREAKS IN ARMATURE CIRCUIT.—In dynamo operation, a break will cause serious flashing or sparking at the brushes, which cannot be suppressed by adjusting the rocker. As a rule, it results in the production of "flats" upon one or more bars of the commutator. To remedy this fault, place one of the brushes of each set a little in advance of the others, so as to bridge the gap.

BREAKER.—In ignition, a name usually given to the automatic switch which breaks the primary circuit at the time of spark.

BREAKING DOWN OF DIELECTRIC.—The weakening effect of persistent electric pressure upon a dielectric whereby charges can finally penetrate its mass.

BREAKING DOWN OF INSULATION.—The deterioration of an insulation which finally permits the escape of electricity through it.

BREAKING DOWN POINT.—In physics, that point in the stressing of a material in which the deformation increases very suddenly. It occurs immediately beyond the elastic limit and is marked by a well defined and sudden curve in the stress strain diagram.

BREAKING IN.—In telegraphy, interrupting a despatch in the course of transmission by the attempt of an operator at another point in the line to use the wire at the same time.

BREAKING STRENGTH.—In mechanics, the ultimate resistance to rupture of a piece of material of specified size; usually expressed as ability to resist tensile stress, but also to be considered with regard to shearing or compressive stresses.

BREAST PLATE.—A support for a telephone transmitter adjustable to the breast of an operator.

BREAST WHEEL.—A type of water wheel intermediate between the over shot and under shot. The water strikes it at a point 30° to 45° from its summit, for a high breast; at the level of its axle for a low breast. The wheel revolves in a curved bed or breast of masonry or timber.

BREATH FIGURES.—Images produced by the moisture of the breath upon the surface of glass on the spots where an electrified object, such as a coin, had previously rested.

BREEZE, ELECTRIC.—A term used to denote air currents from a pointed conductor due to mutual repulsion between the electricity collected on the point of the conductor and the electrified air particles near the point. Also called, electric wind.

BREGUET'S MANIPULATOR.—The sending apparatus of Breguet's step by step system of telegraphy.

BRICK.—A rectangular block of clay, moulded to regular sizes and burnt to give it hardness and durability. Standard sizes are: common brick, 8 x 2¼ x 3¾; pressed brick: 8⅜ x 4⅛ x 2⅜ and 8⅜ x 4 x 2¼; Roman brick, 12 x 4 x 1½.

BRIDGE.—An arrangement of resistances combined with a battery and galvanometer devised by Christie, but wrongly credited to Wheatstone. It is used for the measurement of electric resistance. It consists essentially of two "proportional arms" of such values that one arm has one, ten, one hundred or one thousand times the resistance of the other arm. A third arm is divided into tenths, units, tens, hundreds and thousands of ohms. The unknown resistance to be measured is the fourth arm.

BRIDGE ARMS.—The balancing arms of an electric bridge.

BRIDGE BALANCE OF TELEGRAPH LINE.—In duplex telegraphy, a balance based upon the principle of the Christie or so-called Wheatstone bridge, such that the home receiving instruments, while ready to respond to signals received, will not respond to those transmitted from the home end.

BRIDGE CIRCUIT.—In radio, a feed back neutralizing circuit.

BRIDGE DUPLEX TELEGRAPH.—A system based on the principle of the Christie or so-called Wheatstone bridge. In the system a relay is placed in the cross wire of a Christie bridge and the key is so arranged that connection is made with the battery before the line leading to the earth is broken. Adjustable resistance coils are placed in the arms of the bridge and a wire connects the key with one arm of the bridge, which is completed at the opposite end by a suitable arrangement. If the resistances be equal, the relays will not operate when the current is transmitted, but since the earth is employed to complete the circuit, they will respond to the received current, thus enabling each operator to send and receive signals at the same time. The bridge duplex system is used in the operation of submarine telegraph cables.

BRIDGE METHOD.—A method of measuring the resistance in a circuit by means of the Christie or so-called Wheatstone bridge.

BRIDGE OF FUSE.—A narrow space in a safety fuse connection filled in with a composition suitable for developing the heat of the electric current.

BRIDGE SYSTEM OF QUADRUPLEX TELEGRAPHY.—An adaptation of the method of duplex telegraphy to quadruplex telegraphy.

BRIDGE WALL.—A transverse wall of fire brick placed in the throat of a boiler furnace, at the end of the fire grate.

BRIDGES.—Copper bars designed to connect a dynamo to the bus bars in an electric lighting power station.

BRIDGES (OR RIBS).—In a storage battery, wedge shaped vertical projections from bottom of rubber jar on which the plates rest and by which they are supported.

BRIDGING BELL TELEPHONE SYSTEM.—A bridging, or multiple, system of party line telephone working in which the call bells at each station are permanently bridged across the two sides of the line, so that each call rings every bell in the circuit; a code of signals being used to distinguish the various parties on the line.

BRIDGING COILS.—In telephone practice coils connected in bridge, or multiple, as opposed to series connected coils.

BRIDGING CONDENSER.—A fixed condenser shunted across some element of a radio circuit to by-pass h. f. current, as a by-pass condenser.

BRIDGING INDICATOR.—A shunt or parallel indicator in a telephone system, as distinguished from one in series connection.

BRIDGING METHOD OF CONTROL.—A method of making the transformation from series to parallel connection for electric railway motors. This method has an advantage over both the shunting and open circuit methods in that both motors are working all the time and none of the torque is dropped during the transition period. Bridging is used where automatic operation unit switch control is desired and with hand operated unit switch control, where heavy current is handled.

BRIDGING RELAY.—A shunt connected relay in a telegraph or telephone circuit.

BRIDLE CHAIN.—In submarine cable laying, a chain attached to a buoy, and so connected with the buoy rope that the rope may be readily picked up when the buoy is set free.

BRIDLE WIRES.—1. Wires for making line wire connections into a cable box.
2. Wires which bring a telegraph station into connection with the line.
3. Wires for preserving the continuity of the circuit around "anti-hum" devices set in a telegraph wire.

BRIGG'S STANDARD PIPE THREAD.—Standard in U. S. for wrought pipe. Angle of thread 60° slightly rounded on top and bottom. Taper 1-32 in. per in.

BRIGHT DEPOSIT.—In silver plating, a process of securing a bright instead of dull deposit by adding to the plating bath a small quantity of bisulphide of carbon.

BRIGHT DIPPING.—Dipping a metal into acid to give it a bright surface in preparation for electroplating.

BRIGHT DIPPING LIQUID.—The acid used for brightening metals in bright dipping.

BRIGHT EMITTER. — A vacuum tube which has a tungsten or thoriated filament and which glows brightly, hence the name. A British term.

BRIGHT RED HEAT.—In tempering, a stage of temperature when the black scales on the surface of iron are thrown into relief against the red background, and which corresponds roughly with a temperature of 1800° F.

BRIMSTONE.—The common name for artificially prepared sulphur; so called from its burning qualities.

BRITANNIA JOINT.—A method of connecting lengths of telephone or telegraph wires, in which the two ends, after being carefully scraped, are laid side by side for a distance of about two inches, an inch or so at the end of each being previously turned up at right angles, then wound tightly together with several turns of binding wire, and the whole carefully soldered.

BRITISH ASSOCIATION BRIDGE. — A form of Wheatstone bridge used by the British Association for determining the B. A. ohm.

BRITISH ASSOCIATION STANDARD SCREW THREAD.—Used for very small screws. Angle between the sides of the thread is 47½°.

BRITISH ASSOCIATION UNIT.—A value of the ohm as determined by the British Association, and as expressed by standard resistance coils of German silver; the B. A. ohm.

BRITISH STANDARD FINE SCREW THREAD.—Identical in form with the Whitworth thread but having more threads per inch.

BRITISH STANDARD PIPE THREAD.—The sides of the thread form an angle of 55° with each other. Taper is ¾ in. per foot. The top and bottom of the threads are rounded to a radius equal to .1373 x the pitch of the thread.

BRITISH THERMAL UNIT (B.t.u.).—The 1/180 part of the heat required to raise the temperature of one pound of water from 32° to 212° F. It should be noted that this definition, adopted for the British thermal unit, corresponds to the unit used in the Marks and Davis steam tables, which is now the recognized standard.

BROADCASTING.—The transmission of information, entertainment, etc., by radio.

BROADCASTING STATION.—The essential elements of a radio transmitting station consist of:
1. Source of energy. Such as a storage battery, d.c. or a.c. supply, steam engine, or any other source from which energy might be obtained.
2. Oscillator, or high frequency alternator. The device for converting the available energy into the form of high frequency currents.
3. Controlling device. Such as key, which makes and breaks a circuit, or modulator which varies the amplitudes of the high frequency current in accordance with sound waves which it is desired to send out.
4. Antenna. The device for radiating the energy due to the high frequency current into space in the form of electro-magnetic waves.

BROADSIDE DIRECTIONAL ANTENNA.—An antenna array practically at right angles to the line along which its elements are arrayed.

BROAD TUNING.—In radio, tuning in which the set responds not only to the desired frequencies but also to a range of higher and lower frequencies giving interference.

BROMIDE.—In chemistry, a compound of bromine with a more positive radical; a salt of hydrobromic acid.

BROMINE.—In chemistry, one of the elements, related in its chemical qualities to chlorine and iodine. It is a deep reddish brown liquid of a very disagreeable odor, emitting a brownish vapor at the ordinary temperature.

BRONCHOSCOPE.—An instrument for the direct inspection of the interior of the bronchus.

BRONZE.—1. A varying alloy of copper and tin, with occasionally zinc or lead added. The copper varies from 80% to 90% and the tin from 10% to 20%. The greater proportion of tin makes a harder metal but decreases the tensile strength.

2. An alloy, similar in composition to that of tools found in the Pyramids of Ghizeh.

BRONZE WELDING.—Since bronze has a low percentage of zinc, it can be welded without difficulty either by the metallic or carbon arc process, providing an electrode having a low percentage of tin and zinc be used.

BRONZING LIQUID.—A recipe for this material is as follows: mix together one oz. sulphate of copper, one oz. sweet spirits of niter, one pint of water. In three or four days it will be ready for use.

BROWN & SHARPE WIRE GAUGE (B & S or A.w.g.).—A wire gauge in common with a number of other gauges which has the property in that its sizes represent approximately the successive steps in the process of wire drawing. Its numbers are retrogressive, a larger number denoting a smaller wire, corresponding to the operations of drawing. Its sizes are not so arbitrary and the differences between successive diameters are nearer regular than those of other gauges, since it is based upon a simple mathematical law. The gauge is formed by the specification of two diameters and the law that a given number of intermediate diameters are formed by geometrical progression.

BRUSH.—A device for drawing off from the commutator the electric current generated by the armature of a dynamo. Brushes are made in a variety of forms and of different materials; sometimes of metal strips laid together, bundles of wire, carbon blocks, or small carbon wheels.

BRUSH AND SPRAY DISCHARGE.—A discharge of high tension electricity resembling a spray of fine sparks, or a luminous brush, sometimes emitted from an electric conductor.

BRUSH CONTACT ANGLE.—The angle which commutator brushes make with the commutating plane. The several kinds of brush, together with the varied conditions of operation require different contact angles ranging from zero to 90°

BRUSH CONTACT PRESSURE.—The relation between contact pressure, contact resistance, and friction of brushes varies greatly for different kinds of brush. Copper brushes will carry from 150 to 200 amperes per sq. in. of contact surface; and carbon brushes from 40 to 70 amperes per sq. in. The usual contact pressure is 1.25 to 1.5 lbs. per sq. in. for copper brushes, and 1.5 to 2 lbs. per sq. in. for carbon brushes. The rim velocities of commutators vary from 1,500 to 2,500 feet per minute, the velocity usually increasing with the size of the machine.

BRUSH CONTACT SURFACE. — 1. That part of the surface of a commutator upon which the brushes rest.

2. That portion of a commutator brush which makes contact with the commutator surface.

BRUSH DIMENSIONS.—The length of a brush is the maximum dimension in the direction in which the brush feeds to the commutator or collector ring. The thickness of a brush is the dimension at right angles to the length in the direction of rotation. The width of a brush is the dimension at right angles to the length and to the direction of rotation.

BRUSH DISCHARGE.—The faintly luminous discharge which takes place from a positive charged pointed conductor.

BRUSH ELECTRODE.—In electro-therapeutics, an electrode resembling a brush, for the medical application of electricity.

BRUSH HOLDER AND BRUSH TROUBLES.—The following troubles, mostly mechanical, are the ones usually encountered: a, grounded brush holder; b, brushes stuck in brush holder; c, brushes worn too short or glazed; d, weak brush springs.

BRUSH HOLDER CABLE.—A conducting cable directly connected to the brushes of a dynamo or motor commutator.

BRUSH HOLDERS.—Devices employed to hold the brushes against the commutator with the proper pressure. They differ considerably in various types of machine, hence, no general rules can be given with respect to their construction or use. It is desirable that brush holders be capable of individual adjustment, so that each may be set at its own point of minimum sparking. The various types are classed as: a, arm or lever; b, spring arm; c, box; d, reaction.

BRUSH HOLDERS.—Adjustable clutches for holding the commutator brushes of a dynamo, feeding them forward to preserve the contact as they wear away, and permitting them to be lifted from contact when necessary.

BRUSH LOSS.—The loss in watts due to the friction of the brush contacts against the surface of a commutator.

BRUSH POSITION INFLUENCE ON SPEED.—A shunt motor supplied with current at constant pressure runs at minimum speed when the brushes are in the neutral plane, and the effect of giving the brushes either positive or negative lead is to increase the speed, especially with little or no load.

BRUSH PRESSURE.—1. The pressure with which the brushes bear upon the commutator of a dynamo or motor.

2. The electric pressure or voltage delivered at the brushes.

BRUSH ROCKER.—A rocker or "yoke" upon which the brush holders of a dynamo or motor are fixed so that the position of the brushes upon the commutator may be adjusted. Brush adjustment is necessary, therefore, in order to avoid sparking, to shift the brushes bodily upon the commutator from time to time, without in any way altering the adjustments of the brush holder springs or breaking the working circuit.

BRUSH SHIFTING COMMUTATOR A. C. MOTOR.—A type designed to obtain adjustable speed by the method of shifting the brushes. It operates with three phase current and has shunt characteristics; that is, its change of speed is only moderate as compared with the change in load. It is sometimes known as the Schrage motor; its inventor being K. H. Schrage of Sweden. It is built to supply the demand for an a.c. motor having shunt characteristics which will also provide adjustable speed features without unduly complicating the machine. Such a motor may be used for a wide field of applications where its characteristics are desirable or necessary and where alternating current is the only available power supply.

BRUSH SURFACE.—That portion of a brush that makes contact with the surface of the commutator.

BRUSHES IN BAD CONDITION.—In dynamos and motors, if the contact faces of the brushes be fused or covered with carbonized oil, dirt, etc., there will be bad contact which is accompanied by heating and sparking. Simple examination will generally reveal whether this be the case. To remedy, remove the brushes, one at a time if the machine be running, clean, file if necessary, trim and readjust.

BRUSHES NOT PROPERLY ADJUSTED.—Improper adjustment of dynamo brushes results in the whole of the voltage of the armature not being used and probably insufficient voltage to excite the machine. If in doubt as to the correct position, the brushes should be rotated by means of the rocker into various points on the commutator, sufficient time being given the machine to excite before moving them into a new position. Bad adjustment may be detected in rotating or shifting the rocker, by the indication that the sparking will vary with each movement.

B. t. u.—Abbreviation for the British thermal unit, being the 1/180 part of the heat required to raise the temperature of one pound of water from 32° to 212° F.

BUCKING.—In electric railway operating, a sudden and violent stopping of a car as the result of the opposition of one motor against another.

BUCKING COIL.—A coil so connected as to oppose other coils. In one method of storage battery charge control, a bucking coil is so connected as to oppose the main shunt field coil of the charging dynamo.

BUCKLING.—The distortion or warping of a storage cell plate due to over discharge on either the whole or some portion of the plate. Occasionally buckling may occur with too rapid charge and discharge.

BUFFERS AND AIR CUSHIONS.—Safety devices required at the bottom of an elevator shaft. For low speeds a spring alone is used, but for high speeds a combination of oil dash pot and spring is used. An air cushion consists of a hoistway practically air tight at the lower end for a certain percentage of the total height.

BUFFING.—1. The process of making ready metal surfaces for electroplating, by polishing off with rapidly revolving wheels covered with rouge.

2. The polishing of articles which have been plated in order to give them the proper finish.

BUFFING LATHE.—A machine used in polishing by buff wheels; known also as a polishing bob.

BUG.—1. A special type of telegraph key which produces dots by a movement to one side, and dashes by a movement to the other side.

2. A slang name for any form of trouble encountered in the working of electrical apparatus.

BUILDING IRON.—In electrotyping, a tool shaped something like a poker, used when heated to apply melted wax to the mould in order to build it up before it is put in the plating bath.

BUILDING KNIFE.—A tool resembling a knife, used in electrotyping to remove superfluous wax from the matrix.

BUILDING PROCESS.—In electrotyping, a process of building up the blank places in the mould to make corresponding depressions in the plate, by the application of melted wax by means of the building iron.

BUILDING-UP.—The active accumulation of voltage which a dynamo undergoes from initial to maximum as the result of mutual reaction and reinforcing of the currents generated in the armature and field magnet coils; **the reaction of a dynamo.**

BUILDING UP, ELECTRICAL.—In starting a dynamo, the gradual voltage increase to maximum. Sometimes called pick-up. A shunt dynamo will build up slowly if the main switch be closed first, because the resistance of the main line is so much less than that of the field that the small initial voltage due to the residual magnetism causes a much larger current in the armature than in the shunt field. If this be too large, the cross and back magnetizing force of the armature weakens the field more than the initial field current strengthens it, and so the machine cannot build up.

BUILT-IN UNDERGROUND CONDUCTOR.—An electric conductor permanently and solidly built into a conduit with an insulating substance instead of lying detached and free.

BUILT UP ARMATURE CORE.—A method of construction for large cores to avoid waste of material. Ring sections stamped from sheet metal are fastened to a central support or spider, which consists of an iron hub with radiating spokes and a rim with provision for fastening the rings. The rim of the spider is provided with dovetail notches into which fit similarly shaped internal projections on the core segments. Each layer of core sections is placed on the spider so as to break joints and the core thus formed is firmly held in place by end clamps as shown. The manner of fastening the rings to the spider is an important point, for it must be done without reducing the effective cross section of the core in order not to choke the magnetic flux.

BULB.—The glass globe in which the filament of an incandescent electric lamp is placed.

BULLET PROBE.—A surgical instrument having parallel metallic conductors separated by an insulator. Contact with a metallic substance such as a bullet, closes the circuit, rings an electric bell, deflects a galvanometer needle, or causes an audible signal in a telephonic receiver.

BUNCHED CABLE.—A cable enclosing two or more conductors.

BUNCHED STRAND.—Sometimes applied to a collection of straight or twisted wires which are grouped together with little regard to their geometrical arrangement.

BUNSEN BURNER.—A form of gas burner used for stoves, furnaces, and laboratory purposes, where a hot, non-luminous flame is required. It was invented by R. W. Bunsen. Its essential feature consists in drawing in a sufficient supply of air to promote complete combustion and mixing it with the gas beforehand. This is effected by means of a nozzle within a short tube, the jet of gas, rushing from this nozzle toward the burner at the far end of the tube, sucks in the air through openings in the side of the tube, and the gas and air mingle on their way to the burner.

BUNSEN CELL.—A two fluid primary cell having zinc and carbon electrodes. The negative plate is carbon, the positive plate amalgamated zinc. The excitant is a dilute solution of sulphuric acid. The top part of the carbon is sometimes impregnated with paraffin (to keep the acid from creeping up). The voltage of the Bunsen cell increases after setting up for about an hour, and the full effect is not attained until the acid soaks through the porous cell. Carbons are not affected and last any length of time. The zinc is slowly consumed through the mercury coating.

BUNSEN PHOTOMETER.—A device employing a screen of somewhat opaque paper made translucent, except a central spot (or as to a central spot alone) by being saturated with spermaceti, paraffin, or other suitable material; the screen is mounted upon a graduated scale, at one end of which the standard light is fixed, and at the other the light to be compared. By moving the screen along the scale until the spot becomes invisible, the relative illuminating powers of the two lights may be determined as the square of their distances from the screen; also called the grease spot, or translucent disc photometer.

BUNSEN SCREEN.—The movable disc of somewhat opaque paper, made translucent except for a central spot (or with a translucent center only), used in the Bunsen photometer.

BUOY, ELECTRIC.—A float which displays electric light signals.

BURETTE.—A glass tube usually graduated to fractions of a centimeter, used for accurately measuring out small amounts of a liquid.

BURGLAR ALARM, ELECTRIC.—A device for making an electrical contact and sounding an alarm when a door, window, or any other point connected with the alarm is disturbed. An important requirement is that if the system be tampered with as by cutting a wire, the alarm will sound.

BURGLAR ALARM MAT.—A mat furnished with electric contacts which ring an alarm when it is stepped upon.

BURIED CABLE.—A cable laid directly in the ground without being enclosed in a conduit.

BURIED TRANSFORMER.—A transformer enclosed in a water tight case and buried underground.

BURN OUT.—The damaging of any portion of an electric machine by the accidental passage through it of a high voltage current.

BURNETTIZE.—A method of protecting wood from decay by saturating it with a solution of zinc chloride.

BURNING AT COMMUTATOR.—Injurious sparking and flashing at the contacts of the brushes with the commutator of a dynamo or motor due to faulty adjustments, defective conditions, short circuits, overload, etc.

BURNING RAYS.—Infra red rays.

BURNISHING.—Polishing metal articles before and after electroplating, by tools of steel, agate, or similar hard materials.

BURNT DEPOSIT.—A dark colored sediment that is deposited during the process of electroplating when too strong a current is applied to the bath: also called, black deposit.

BUS BAR CONNECTORS.—Connections for joining the ends of dynamo bus bars.

BUS BARS.—Heavy copper bars connected with all of the dynamos in a central station in order to receive the entire electrical output, and carry it to the distributing conductors of the system; omnibus bars.

BUS FIELD EXCITATION.—A method of exciting a dynamo by applying a current taken directly from th. bus bars.

BUSHED POLES.—Poles of a dynamo field frame having extended pole shoes or pieces.

BUSHING.—1. An insulating sleeve of fibre or rubber composition.

2. A pipe fitting used to connect the male end of a pipe to a fitting of larger size. It consists of a hollow plug with male and female threads to suit the different diameters. A bushing may be regarded as either a reducing or an enlarging fitting.

BUSHING OF SOCKET.—A small insulating cylinder inserted at the base of an incandescent lamp socket, affording insulation and protection to the conducting wires.

BUSY JACK.—A jack in the switchboard of a central telephone exchange, so connected that by inserting into it the plug of any line the calling operator may be notified that the subscriber wanted is busy.

BUSY TEST.—In a multiple telephone switchboard, a method of notifying the operators at the different boards that any particular line is already busy, by causing a "click" to sound when any operator touches the tip of her answering plug to the test ring of that line.

BUSY TEST LAMP.—In telephony, a visual signal on the operator's switchboard consisting of a small incandescent lamp, used to indicate when a line is busy.

BUTT JOINT.—1. A method of joining lengths of wire by setting them end to end and welding or soldering them together.

2. An "end-on" joint in belting to secure even running for belt driven machines.

BUTT PROP.—A pole having a U shaped iron fork attached to one end used to support a telegraph pole while being raised Also called dead man.

BUTT WELD.—A welded joint in which the two edges to be united are simply abutted together, after previous bumping up, or upsetting, as distinguished from a lap or scarf weld.

BUTTNER VALVE.—An electrolytic rectifier of the Nodon type employing a cathode of magnesium-aluminum alloy, and probably iron or lead as an anode, with an electrolyte of ammonium borate. Buttner claims that the borate is superior to the phosphate in that it does not attack iron, and will keep in good working condition for longer periods.

BUTTON REPEATER.—In telegraphy, a method of making the necessary connections for repeating a message by the turn of a button. Button repeaters are now obsolete, and have been replaced by the automatic type.

BUZZER.—An electric call signal which makes a buzzing noise caused by the rapid vibrations of a contact breaker. It operates on the same principle as the electric bell and can be adjusted to emit a musical and pleasing hum instead of the ordinary ringing.

BUZZER OSCILLATOR.—A radio frequency oscillator whose operation is due to interruption by a buzzer.

B.w.g.—Abbreviation for Birmingham wire gauge, a British standard gauge.

BY-PASS CONDENSER.—One usually of the fixed type placed in parallel with some element of a radio circuit so as to provide a low impedance alternating current path around the element

BY PASS VALVE.—In a multi-stage expansion engine a valve piped to the second stage cylinder so that in starting, if the high pressure crank be on a dead center, opening the by pass valve will cause the second stage piston to start the engine.

C

C.—Symbol for
1. Capacity.
2. Centigrade.
3. Coulomb.
4. Roman numeral 100.

CABINET.—In wiring, an enclosure designed either for surface or flush mounting, and provided with a frame, matt or trim in which swinging doors are hung.

CABINET PROJECTION.—A system of drawing in which the lines of an object are drawn parallel with three axes, one of which is horizontal, a second vertical, and the third, inclined 45° to the horizontal. The vertical and horizontal axes lie in the plane of the paper, and the inclined axes lie in a plane intended to appear to the eye as being at right angles to the plane of the paper which gives an appearance of perspective.

CABINET SEAT CONTACT.—A contact beneath the seat in a telephone cabinet, which is closed by a person's weight upon the seat.

CABLE.—1. A stranded conductor (single conductor cable).

2. A combination of conductors insulated from one another (multiple-conductor cable). The component conductors of the second kind of cable may be either solid or stranded, and this kind of cable may or may not have a common insulating covering. The first kind of cable is a single conductor, while the second kind is a group of several conductors. The term "cable" is applied by some manufacturers to a solid wire heavily insulated and lead-covered; this usage arises from the manner of the insulation, but such a conductor is not included under this definition of "cable." The term "cable" is a general one, and, in practice, it is usually applied only to the larger sizes. A small cable is called "a stranded wire" or a "cord." Cables may be bare or insulated, and the latter may be armored with lead, or with steel wires or bands.

CABLE BUOY.—A buoy designed to float the end of a submarine cable during process of laying or repairing.

CABLE CASING.—The outside coating or sheath of a cable.

CABLE CELL.—A primary cell produced in a defective cable by a broken strand of the conducting core and the metallic sheath acting together as electrodes.

CABLE CLIP.—A clip for suspending an overhead cable from a messenger wire; a cable hanger.

CABLE CLOSING MACHINE.—A machine for applying the outer covering to a cable.

CABLE CODE.—1. An alphabet for cable signaling.

2. A cipher for abbreviating cable messages.

CABLE CONDUIT DRAINAGE.—Water will gradually accumulate in a conduit unless good drainage be provided. If drainage be not provided, and water accumulate in the duct, the water may freeze in winter in territories subject to low temperatures and damage the cable to such an extent that a complete failure of the cable will result. In addition to loss of service the replacing of the cable may be expensive because of the difficulty of thawing the pipe in order to remove the damaged cable and place the new one.

CABLE CORE.—The inner conducting wire or strand of wires of a cable, as opposed to the insulation and sheathing.

CABLE CROSS CONNECTING BOARD.—A distributing board in a telephone exchange at the point where the outside cables are admitted into a building, designed to aid in making subscribers' connections with the switchboard cables.

CABLE CURRENTS.—Stray currents that may arise in a submarine cable line. They may consist of earth currents, or, in case of a break, currents which flow from the fractured end of the cable core to the metal sheath and so through the station apparatus.

CABLEGRAM.—A message by cable; a cable despatch.

CABLE GRAPNEL.—A grappling iron for the purpose of grasping a submarine cable and bringing it to the surface for inspection or repair.

CABLE GRIP.—A clamp secured to the end of an underground cable so that it may be readily drawn through a conduit.

CABLE HANGER.—A clip designed to hold an overhead cable to relieve the strain. It is suspended from a steel sustaining rope called the messenger wire.

CABLE HEAD.—A sealed iron box within which are arranged terminals of overhead wires so that they may be assembled into a cable.

CABLE HOUSE.—A small house built on the sea shore to shelter the land end of a submarine cable.

CABLE JACKS.—In line construction, a pair of supports for raising the axle of a cable reel so that the drum may freely rotate in paying out the cable.

CABLE JOINT.—An insulated connection for uniting lengths of cable.

CABLE JOINT TEST.—In cable jointing, after wiping the sleeve, test joint to 15 lbs. air pressure with a tire pump and gauge. Apply soapy water to test for leaks.

CABLE JOINTS.—There are numerous types of joint met with in practice. These various joints may be classified

1. With respect to voltage: a, 100 to 240; b, 2,300 to 3,000; c, 7,800 to 13,800; d, 27,000; e, 45,000; f, 132,000.
2. With respect to insulation: a, cotton tape; b, rubber; c, cambric; d, paper.
3. With respect to conductors; a, single; b, duplex; c, three conductor; d, four conductor, etc.

CABLE JOINTING.—Bringing together in proper electrical contact the ends of two cables. The process includes the following operations: a, training; b, cutting cable ends; c, ringing; d, removing sheath; e, belling; f, removing insulation and shaping; g, rounding; h, placing connections; i, sweating; j, penciling; k, boiling out; l, insulating; m, assembling the conducell; n, wiping the sleeve; o, testing joint; p, filling joint with compound. Full instructions on cable jointing are given in Audel's New Electric Library, Vol. VII.

CABLE JUNCTION BOX.—A device for securing a perfectly insulated cable joint.

CABLE PILLAR.—In high pressure electric transmission lines, a pole of steel construction used instead of the ordinary wooden pole for carrying the feeder cables; a feeder pillar.

CABLE PROTECTOR.—1. A contrivance for preventing injury to the insulation of a cable by discharging the electric charges induced in the metal armor by the varying voltage in the core.

2. A fuse provided in the cable head terminal of overhead wires.

CABLE RACK.—A rack set behind a telephone switchboard to support the cable containing the wires leading to that switchboard.

CABLE RESISTOR.—A float for relieving the strain upon a submarine cable in the process of paying out.

CABLE ROAD.—A street railway line in which power is derived from an endless cable actuated by a central stationary engine and running over pulleys between the rails or in a conduit beneath them: the cars are provided with a gripping lever to connect with the running cable. The cable road was the forerunner of electric traction. The underground trolley is now the prevailing type in cities.

CABLE SENDING KEY.—A key for sending through a submarine cable the electric impulses necessary for the transmission of a message

CABLE SERVING.—A hemp or jute coating wrapped about the core of a cable to relieve it from the weight of the external armor.

CABLE SHEATH.—A lead alloy protective covering on cables of various types.

CABLE SHIP.—A specially designed vessel equipped with appliances for laying or repairing a submarine cable.

CABLE SPEAKING SET.—The instruments employed in cable signaling.

CABLE SPINNING JENNY.—A contrivance for adjusting an overhead cable to the messenger wire; a cable winder.

CABLE STOP.—In electric elevators, a device to stop the winding machine and prevent the slacking of the cables upon the drum in case the car be obstructed in any manner in its descent.

CABLE TANK.—A strong compartment on a cable ship, or elsewhere, for accommodating the coils of a submarine cable, either preparatory to laying, or for purposes of testing; a cable well.

CABLE TERMINAL.—An impervious cover applied to the exposed end of a telephone cable to protect it from moisture.

CABLE TERMINAL POLE.—In overhead cable construction, the last pole on a line carrying the cable head.

CABLE TRANSFORMER.—A transformer in which the conductors are enclosed in a metallic sheath, like a cable.

CABLEWAY.—A rectilinear hoisting and conveying apparatus supported by a cable.

CABLE WELL.—A compartment in a cable ship in which the submarine cable is wound before laying; a cable tank.

CABLE WORMING.—Hemp or similar material, forming a core about which to wind the conductors of a cable.

CADMIUM.—A white metal with bluish tinge belonging to the same chemical family as zinc, which it closely resembles. Cadmium and mercury, in electrolytes of the sulphates of cadmium and mercury, form the elements of the Weston standard cell.

CADMIUM CELL.—A standard primary cell known as the Weston cadmium cell. Cadmium and mercury form the elements of this cell in electrolytes of the sulphates of cadmium and mercury. By the constancy of this cell and its freedom from temperature coefficient, it has largely superseded the Clark cell as a working standard.

CADMIUM PLATE.—A small plate of the metal cadmium attached to a wire for testing the voltage of a cell in a storage battery.

CADMIUM TEST.—A storage battery test made with a rod of cadmium (about the shape of a lead pencil). It is dipped in the electrolyte but not allowed to come in contact with plates. The test consists in taking voltage readings between the cadmium and the positive or negative plates of the cell. During charge the cadmium reads negative to the negative plates until the cell is about full, when the reading should be zero; the charge should be continued until the cadmium reads .2 volt positive to the negative while charging at the normal rate.

CADMIUM TEST VOLT METER.—A volt meter used for testing the voltage of storage batteries on charge or discharge.

CAESIUM.—A white metal spontaneously inflammable in air; it decomposes water. Atmoic weight 133. Caesium belongs to the same group of elements as potassium, which it closely resembles chemically. This was the first metal discovered by spectrum analysis. It occurs in many mineral waters and was first discovered by Bunsen in the waters of Durkheim. Its spectrum is characterized by two bright blue lines and from this circumstance it derives its name. Caesium is used in photocells and shows maximum response to yellow light.

CAGE ANTENNA.—One consisting of a number of evenly spaced parallel conductors held in position along its length by circular spacers.

CAGE LIGHTING PROTECTOR.—A wire lightning arrester built like a cage around the protected object.

CALAMINE.—An ore of zinc. It is zinc carbonate consisting of 64.8 zinc oxide and 35.2% carbon dioxide. It is found in many parts of Great Britain and the United States.

CALCIUM.—A rare white metal, rather harder than lead, having a specific gravity of 1.85 and melting at 189° F.

CALCIUM CARBIDE.—A compound of carbon and calcium which mixed with water produces acetylene. It is manufactured in an electric furnace known as a carbide furnace.

CALCIUM LIGHT.—A very intense white light produced by the incandescence of a ball of lime in the flame of combined oxygen and hydrogen gases; lime light.

CALCULAGRAPH.—An instrument employed in long distance telephoning for recording the length of time a subscriber has use of the line.

CALCULUS.—A method of calculating which consists in the investigation of the infinitesimal changes of quantities when the relations between the quantities are known. There are two divisions of the subject: a, differential calculus; b, integral calculus.

CAL-ELECTRIC GENERATOR.—A current generator operating on the principle of producing currents in the core of the secondary coil of a transformer by changes in temperature.

CAL-ELECTRICITY.—An excess current produced in the secondary of a transformer due to thermal action.

CALIBRATE.—To ascertain by special measurement, or by comparison with a standard, variations in the readings of a galvanometer or other instrument for electrical measurement.

CALIBRATING A WATT METER.—This test consists in comparing the deflections on the watt meter at five or six approximately equidistant points over its scale with the corresponding products of volts and amperes used to obtain them. The changes in the watt meter deflections are effected by merely varying the voltage, the value of the current being maintained constant at a value which represents the full current capacity of the meter. Take average of readings on standard meter and average of readings on meter tested. Divide first average by the second average which will give the constant by which readings on the tested meter should be multiplied to obtain the correct reading.

CALIPERS.—Instruments to measure internal and external diameters or calibres of cylindrical pieces; they usually consist of two curved pieces of steel, hinged together with a tight joint at one end, the distance between the points representing the measurement taken. For precision measurements, micrometer calipers are used. There are two general types of calipers: a, outside; b, inside.

CALL LAMP.—A miniature incandescent lamp in a telephone switchboard which lights when a call comes through its circuit and signals the operator; an indicator lamp.

CALL LETTERS.—Radio transmitting station identification letters.

CALL WIRE SYSTEM.—A special switchboard in a telephone station for the purpose of distributing the call wires among the different operators.

CALLAN CELL.—A primary cell consisting of a round outer cast iron cell and an inner porous jar containing a zinc cylinder in dilute sulphuric acid. The solution in the iron compartment is two parts sulphuric acid, two parts nitric acid and one part water.

CALLAND CELL.—A primary cell used in French telegraphic work. It has a negative electrode of copper and a positive electrode of amalgamated zinc in an electrolyte of zinc sulphate, with crystals of copper sulphate as a depolarizer. It is sometimes called the blue-stone gravity cell.

CALLING CIRCUIT.—In a telephone system, the circuit which includes the calling apparatus and rings the call bell of a subscriber.

CALLING DROPS.—Drop shutters used in the switchboard of small telephone exchanges to indicate to the operator which subscriber is calling.

CALLING JACK.—In a multiple telephone switchboard, a spring jack into which the operator inserts a plug to call a subscriber.

CALLING ON ARM.—In railroad interlocking, the lower of two arms called the "calling on" arm being assigned to movements into either one of the two sidings whether these be occupied or not, and also to the main track only in case that track is already occupied, and the top arm is hence restrained against operation by an indicator for such train movements.

CALLING MAGNETO.—In telephony, a magneto generator and polarized call bell mounted together to form a calling apparatus.

CALLING PLUG.—A connecting plug for insertion into the spring jack or socket of a telephone switchboard to effect a connection with, and to call up the subscriber wanted.

CALORESCENCE.—The conversion of invisible rays of heat into light rays by converging them to a focus upon a suitable substance which may thereby be heated to incandescence.

CALORIC.—Heat was at one time regarded as an elastic fluid, and the name caloric was used to denote this substance.

CALORIE.—The French heat unit. There are several units used, known as:

1. The small calorie, being the amount of heat required to raise the temperature of one gram of water one degree Centigrade. Called gram-calorie.

2. The large calorie, being the amount of heat required to raise the temperature of one kilo-gram of water one degree Centigrade. Called the kilogram-calorie.

3. The mean calorie, being the 1/100 part of the heat required to raise the temperature of 1 gram of water from 0 degree to 100 degrees Centigrade.

The mean calorie is practically the same as the 17½-degree calorie, that is the heat required to raise 1 gram of water from 17 degrees to 18 degrees Centigrade. The 15 degree calorie is also used extensively. Because of the variation of the heat capacity of water, this is slightly larger than the mean or 17½ degree calorie. The present tendency is toward the mean calorie (and mean B.t.u.) as the standard heat unit. In countries which have adopted the metric system, engineers employ the kilogram calorie (or large calorie) as the unit in heat measurements. 1 kilogram-calorie=1000 gram calories=3.968 B.t.u. (1 B.t.u.=.252 kilogram calorie).

CALORIFIC.—In physics, a term meaning heating; heat producing.

CALORIFIC VALUE.—The measure of the amount of heat obtainable from a given weight of fuel. It is usually found by direct experiment, the fuel being completely burnt and the heat evolved measured by some form of calorimeter.

CALORIMETER.—An instrument used for measuring the heating power of coal. It consists of a strong steel vessel immersed in water, proper precaution being taken to prevent radiation. One gram of the coal to be tested is placed in a platinum tray within the steel vessel, oxygen gas is introduced under pressure of 20 to 25 atmospheres and the coal ignited by an electric spark. The heat generated causes a rise in the temperature of the water, from which may be calculated the heating power of the coal.

CALORIMETER, ELECTRIC.—An instrument for measuring the heat generated by an electrical current in a conductor. It consists of a vessel containing water and provided with a thermometer. The electric current passes for a measured time through a wire immersed in the liquid. The quantity of heat is determined from the increase of temperature, and the weight of the water heated. The heating power of a current is as the square of the current only when the resistance remains the same.

CALORIMETER METHOD.—In this method of measuring the radio frequency power delivered by a transmitter, a non-inductive resistor carrying the radio frequency power is cooled by water or other liquid surrounding and passing over it. The power dissipated is then calculated from the temperature rise, rate of flow measured in mass per unit time, and specific heat of the cooling fluid. This method is especially desirable for powers above two kilowatts.

CALORIMETRIC PHOTOMETER.—An instrument which measures the intensity of light by absorbing it in a thermoelectric battery, and then calculating the electric energy thus generated.

CALORIMOTOR.—A voltaic battery consisting of one or more pairs of very large plates for producing heat effects.

CALORY.—A common way of spelling calorie.

CALUMET.—A low grade rubber composition.

CAM.—A revolving disc, usually of a spiral eccentric, or heart shape, fixed on a shaft or such other form as to impart to a lever, rod or block in contact with it, such variable velocity or motion as may be required.

CAM GOVERNOR.—A controlling device used in connection with Otto cycle gas engines; a stepped or differential cam is used, giving three or four grades of valve lift; the action of the governor balls slides the roller on to one or another of these cams, according to the centrifugal force of the balls.

CAMBER.—The depth of the curve given to the surface of a wing of an airplane

CAMBRIC TUBING.—An insulating tube. Also called spaghetti tubing.

CAN.—In radio, a slang word for shield.

CANAL RAYS.—1. In a vacuum tube, positively charged particles which pass from the anode through a perforated cathode and seen as fine pencils of light. They produce phosphorescence on the walls of the tube.

2. Those observed back of the cathode in a Crookes tube; they are analogous to the alpha rays, but of much lower velocity. Also called positive rays.

CANCELLATION.—The process of shortening calculations by rejecting equal factors from numerator and denominator, that is, from dividend and divisor.

CANDLE.—A unit of illumination; as, one candle power.

CANDLE BALANCE.—A balanced lever or scale used in photometric research to measure the rate of consumption of a burning candle by the indicated loss in its weight.

CANDLE, ELECTRIC.—An early form of arc lamp called, from its inventor, the **Jablochkoff candle.**

CANDLE FOOT.—A unit of illumination, being the light given by a British standard candle at the distance of one foot. It is equal to 10.764 candle meters.

CANDLE HOUR.—The energy expended by a luminous body of one candle power during a period of one hour; a unit of quantity of light.

CANDLE LUMEN.—A term sometimes employed for the lumen.

CANDLE METER.—A unit of illumination adopted outside of Great Britain, being the light given by a standard candle at the distance of one meter.

CANDLE POWER.—A measure of strength of a light source to produce illumination in a given direction.

CANDLE POWER DISTRIBUTION CURVE.—The intensity of luminous radiation expressed in candle power, measured at various angles about a light source and graphically represented.

CANOPY.—1. A metal cover set at the point where an electric light fixture or pendant enters a wall or ceiling, to conceal the connections.

2. An overhead frame in a telephone exchange, provided with plugs and drops.

CANOPY SWITCH.—A switch placed under the canopy or hood of a trolley car for the purpose of shutting off the current from the motor and controller without pulling the trolley pole off the wire.

CANT HOOK.—1. A lever for rolling and setting telegraph poles, provided with a heavy hinged hook near the end.

2. A lever and suspended hook adapted for turning timbers in the yard, on the skid or on the saw mill carriage.

3. A sling with hooks for raising and tilting casks to empty them.

CANVAS STRAP.—A piece of canvas used by electroplaters and polishers to put a finish on those parts inaccessible by the brush or bob; the workman takes an end of the strap in either hand, the work being held by an assistant or between his own knees.

CAOUTCHOUC.—The resinous milky juice of various tropical trees of the dogbane, nettle and spurge families, which coagulates when exposed to the air; India rubber; gum elastic.

CAP SCREW.—A screw bolt intended to be used without a nut, so called because first used to secure the cylinder heads of small steam engines instead of studs.

CAP WIRE.—An overhead wire supported on the tip of a pole instead of on a cross arm.

CAPACITANCE.—The reaction due to capacity.

CAPACITY.—1. The property of a system of conductors and dielectrics which permits the storage of electric charges.

2. The quantity of electricity which a condenser is able to store or condense. A condenser is said to have a capacity of one farad if one coulomb (that is, one ampere flowing one second) when stored on the plates of the condenser will cause a pressure of one volt across its terminals. The farad being a very large unit, the capacities ordinarily encountered in practice are expressed in millionths of a farad, that is, in microfarads—a capacity equal to about three miles of an Atlantic cable.

CAPACITY ALTIMETER.—An instrument for determining the altitude of an air craft, whose operation is based on changes in electrostatic capacity between two conductors and the earth.

CAPACITY BALANCE OF DUPLEX SYSTEM.—In duplex telegraphy, a balance of capacity as distinguished from a balance of resistance.

CAPACITY COUPLING.—In radio, a method of coupling in which a condenser is connected in common to two circuits.

CAPACITY CURRENT.—1. The current arising from the electric capacity of a cable.

2. The current required to charge a telegraphic cable before a message can be sent.

CAPACITY EFFECT.—In an a. c. circuit, an effect exactly opposite to that of inductance, that is, it assists the current to rise to its maximum value sooner than it would otherwise.

In wiring all circuits have a certain capacity because each conductor acts like the plate of a condenser, and the insulating medium acts as the dielectric. The capacity depends upon the insulation.

For a given grade of insulation, the capacity is proportional to the surface of the conductors, and inversely to the distance between them.

CAPACITY GROUND.—In radio, a name sometimes given to a counterpoise.

CAPACITY OF CABLE.—The charge which must be given to a cable to raise it to unit electrical pressure.

CAPACITY OF CONDENSER.—The quantity of electricity with which either plate must be charged in order to raise its electrical pressure from zero to unity. A condenser has a capacity of one farad when one coulomb is required to raise its pressure from zero to one volt. The farad being a very large unit, the microfarad is generally used. Condensers from 1/10 to 6 microfarads are the ordinary sizes.

CAPACITY OF ELEVATORS.—For passenger elevators, the capacities vary from about 1,000 lbs. in residences to 5,000 lbs. in department stores, and from 2,000 to 3,000 lbs. in office buildings. The capacity determines the car size which should be of sufficient floor area to provide not over 75 lbs. per sq. ft. This is standard practice in the U. S.

CAPACITY OF HOISTING ENGINES.—The horse power required to raise a load at a given speed is equal to

$$\frac{\text{gross weight in lbs.} \times \text{speed in feet per min.}}{33{,}000}$$

To this there should be added from 25 to 50 per cent for friction, contingencies, etc. The gross weight includes the weight of the cage, load and rope. In a shaft with two cages balancing each thus, the net load is taken.

CAPACITY OF STORAGE BATTERY.—The amount of energy which a storage cell is capable of accumulating; it is generally calculated in ampere hours; that is, the product of the number of amperes which the cell can discharge into the number of hours through which it can maintain that discharge.

CAPACITY OF WIRES.—The "safe carrying" capacity of wires.

CAPACITY PRESSURE.—The voltage applied to a condenser to overcome the condenser pressure. The capacity pressure, since it must overcome the condenser pressure, is equal and opposite to the condenser pressure, that is, the phase difference is 180°. The condenser pressure being 90° ahead of the current, the impressed pressure is 90° behind the current.

CAPACITY REACTANCE.—The reaction due to capacity. In circuits containing both capacity and inductance, capacity reactance is given a negative sign because it reduces the spurious resistance due to inductance.

CAPACITY RESISTANCE.—The resistance offered by a body possessing electric capacity, to alternating currents. Usually called the ohmic value of capacity.

CAPILLARITY.—The peculiar action of a liquid by which its surface at the line of contact with a solid is raised or lowered. This action is best exhibited by the use of tubes of very fine bore, called capillary tubes.

CAPILLARY ATTRACTION.—In physics, a manifestation of the surface tension observed in all liquids. In fine tubes and bores the surface tension is sufficient to balance a small column of liquid, maintaining it at a level above the outside. This is very noticeable in small glass tubes, sponges or any porous substance such as loaf sugar.

CAPILLARY CONTACT KEY.—A contact key in which a wire makes contact with mercury to close the circuit.

CAPILLARY DEPRESSION.—1. Where a liquid like mercury does not wet the tube, the behavior is different, as the level is maintained below that of the surface outside the tube; this is known as capillary depression.

2. The amount by which the column of mercury in the barometric column is depressed by the repulsion between the mercury and the glass.

CAPILLARY ELECTROMETER.—A form of electrometer which, when a current is passed through it, indicates difference of pressure by the fall of a column of mercury in a capillary tube which joins on one side a tube filled with mercury and on the other a tube containing dilute sulphuric acid.

CAPILLARY TUBE.—A glass tube with a fine hair-like bore, employed to exhibit the phenomenon of capillary attraction.

CAPSIZING THERMOMETER.—A registering thermometer used for ascertaining the temperature of the sea depths.

CAR.—The cage of an electric lift or elevator. An automobile, railway coach, etc.

CAR HEATING.—Electric heaters for railway cars are made of coils of wire wound on porcelain spools placed in suitable containers and fastened under the seats. The wire offers a resistance to the current and as the current is forced through the wire, it heats the wire and raises the temperature of the surrounding air. The amount of power consumed by electric heaters naturally varies with the climatic conditions, but for cars ranging from 24 to 34 feet in length, the power consumption for average and severe weather conditions varies from 5 to 7 kw. respectively, so that the electric heater loads on both street railway and interurban systems compose a very large part of the total energy consumed. It is well known that on many well equipped electric railway systems, the amount of power consumed in heating and lighting the cars during very cold weather exceeds 20 per cent. of the power supplied to propel them.

CAR LIGHTING.—Electric cars are lighted usually by the electric current which supplies the power, whether it be overhead, trolley or third rail. The lamps are usually connected in series, the number depending on the working voltage and resistance of the lamps. Compensating resistances are often installed to prevent all the lights going out should one fail, as in some cases five lamps are connected in series. These compensating resistances are equivalent to the resistance of the lamp and are thrown in circuit by relays when a lamp fails.

CAR RETARDER.—A stationary, electrically controlled track device for reducing the speed of railway cars in yards by means of friction between brake shoes and the sides of the wheels.

CARBIDE FURNACE.—An electric furnace in which calcium and carbon are united at high temperature to form calcium carbide.

CARBIDE OF IRON.—A highly crystalline form of cast iron. It is extremely hard and brittle and contains nearly all its carbon in the combined state. Hence, called a carbide of iron.

CARBON.—1. One of the non-metallic elements; it exists almost pure in three forms, of which two are crystalline, viz.: 1, diamond; 2, graphite, and 3, non-crystalline, charcoal.

2. The carbon pencil employed in an arc lamp as an electrode.

3. A prepared carbon for use in arc lamps. It is composed of carbon dust, powdered coke or gas carbon mixed with molasses, coal tar pitch or other carbonaceous cementing material, then moulded and baked.

4. An electrode used in arc welding.

CARBON ARC.—An arc occurring between carbon points; as, in an arc lamp.

CARBON BLOCK LIGHTNING ARRESTER.—A device for protecting electrical apparatus from lightning. It consists of carbon blocks separated by an insulating material which compel the discharge to pass to the ground instead of through the apparatus.

CARBON BRUSHES.—Commutator brushes made of strips of prepared carbon, sometimes coated with copper to increase conductivity. Carbon brushes are largely used because they are the only form of brush that will give good commutation with fixed lead. Very soft carbon leaves a layer of graphitic matter on the commutator, and at high voltages, this may cause sparking; such grade of carbon should only be used on low voltage machines. When carbon brushes are used, it is desirable that the current be small, because, on account of the low conductivity of the carbon, more contact area is necessary than with copper for equal current transmission. For fixed lead and fluctuating currents, carbon brushes should be used. Carbon brushes will carry from 40 to 70 amperes per sq. in. The usual contact pressure is 1.25 to 1.5 lbs. per sq. in. The drop in voltage for carbon brushes is about .8 to 1 volt at each contact, or 1.6 to 2 volts for the two, positive and negative, contacts of a machine. The watt loss is equal to 1.6 to 2 volts for carbon multiplied by the total current carried.

CARBON CLUTCH.—A device for gripping the upper or positive carbon of an arc lamp so that it may be fed forward as it wears away.

CARBON CONTACT PICKUP.—A device used on a phonograph. Its action is based on the variable resistance between carbon contacts due to variable pressure.

CARBON DIOXIDE.—A colorless compound gas heavier than air, neither combustible nor a supporter of combustion. It is evolved by the combustion of fuels containing carbon, one atom of that element combining with two of oxygen from the air, to form this gas.

CARBON DISULPHIDE.—A colorless highly refracting liquid having an offensive odor because of impurities. It is prepared by pouring vapor of sulphur over strongly heated carbon.

CARBON ELECTRODES.—1. The carbon points of an electric arc lamp.

2. Carbon employed as the negative plate in a primary cell.

CARBON FILAMENT.—An incandescent lamp filament composed of a thread or fiber which has been reduced to carbon by the carbonizing process.

CARBON-MERCURY COHERER.—In radio, a form of detector in which a globule of mercury is held in light contact with electrodes of carbon. This type is known as the **auto-coherer** having the advantage over the filing coherer in the fact that it automatically restores itself to a sensitive condition without the use of a tapper.

CARBON MICROPHONE.—A device for changing sound waves into electric current variations consisting of a diaphragm set in vibration by sound waves and causing by its motion loosely packed carbon granules to be pressed together more or less, thus producing a variable resistance for controlling a current.

CARBON PILE.—A form of rheostat consisting of carbon discs provided with a pressure regulator, so that the discs may be held loosely or pressed tightly together, thus interposing more or less resistance respectively in the circuit. The telephone transmitter is an example.

CARBON POINT LIGHTNING ARRESTER.—A lightning arrester provided with carbon points between which the lightning stroke is discharged.

CARBON RHEOSTAT.—A rheostat employing carbon plates or grains to effect the resistance.

CARBON ROD MICROPHONE.—An early form of microphone in which the loose contact of one or more carbon rods against a sounding board or diaphragm served to intensify sound. The original type of telephone transmitter was constructed upon this principle.

CARBON STEEL.—A term applied to such steels as contain carbon alone (together with slight impurities such as phosphorus, silicon, sulphur, etc.), as distinguished from the numerous alloy steels, which may also be mixed with chromium, manganese, molybdenum, nickel, tungsten, and the like, for special purposes.

CARBON TRANSMITTER.—A telephone transmitter employing carbon grains held between conducting plates for the purpose of transmitting the vibrations of the diaphragm.

CARBONATE OF COPPER.—A similar salt to the carbonate of zinc, prepared for electroplaters by precipitation, by means of adding a solution of copper sulphate (blue vitriol) to a heated solution of sodium carbonate.

CARBONATE OF LIME.—The chief constituent of incrustation in boilers.

CARBONATE OF MAGNESIA.—Carbonate held in solution in some feed waters, and on deposition, producing incrustation in boiler tubes.

CARBONATE OF ZINC.—The precipitated carbonate is a double carbonate and hydrate and is prepared by mixing solutions of zinc sulphate and sodium carbonate, when it is thrown down as a white precipitate. Used for several purposes, notably by electro-platers in brassing solutions.

CARBONIZE.—1. To subject a substance to intense heat in a closed vessel thereby reducing it to carbon.

2. To effect the destructive distillation of organic matters, as of coal in gas manufacture.

CARBONIZED CLOTH DISCS.—Discs cut out of cloth and carbonized for the purpose of offering a resistance varying with the pressure.

CARBORUNDUM.—A silicide of carbon used as an abrasive, harder than emery (which it resembles). Used also as an infusible coating for furnaces, grindstones, etc. First manufactured by Acheson, at Niagara.

CARBURETER.—A device wherein gasoline vapor and air are mixed in proper proportion to form the fuel charge for a gas engine. As distinguished from a vaporizer, a carbureter has in addition to a mixing chamber, a receiving chamber for the gasoline and means for maintaining therein a constant level of the fuel.

CARBURETER HEATING SYSTEMS.—There are several systems of conditioning the mixture supplied by a carbureter to a gas engine. Heat is supplied for proper vaporization of the liquid fuel by: a, heating the air; b, heating the mixture; c, heating the air and mixture, etc.

CARCASS OF DYNAMO.—The framework upon which a dynamo rests.

CARCEL.—The French unit of illumination, equal to 9½ British candles; it is the light given by a carcel lamp burning 42 grams of colza oil per hour with a flame 40 millimeters high.

CARCEL LAMP.—The lamp burning colza oil used in France to establish the standard of light; it is named for its inventor, B. G. Carcel.

CARCEL STANDARD.—The carcel lamp used in France as the standard of light. 1 International candle=1.11 Hefner candle=.104 Carcel unit.

CARCEL STANDARD GAS JET.—A gas burner designed to give a definite illumination measured in carcels; it is used in comparing the power of electric lights.

CARDAN JOINT.—The universal or Hooke's joint used in machinery to permit flexibility of motion in a shaft.

CARDAN SUSPENSION.—A method of suspending the needle of a mariner's compass upon delicate hinges called gimbals.

CARDEW VOLT METER.—A type of volt meter which indicates electric pressure by the passage of the current through a slender wire of platinum silver which thereupon expands and moves the index needle upon the scale.

CARHART-CLARK CELL.—A primary cell which is a modified form of the Clark standard cell. It has the same elements as the Clark, but the solution of zinc sulphate is saturated at 0° C. Its pressure is 1.440 volt and its temperature coefficient about half that of the Clark cell.

CARNOT'S CYCLE.—The ideal or perfect engine cycle, or series of heat changes, devised by the French scientist Carnot (1824). Carnot's work failed to attract attention until ten years after its publication, when it was brought into prominence by Clapeyron, who cleared up most of what remained obscure in Carnot's reasoning, and exhibited it in a more elegant form by representing the various transformations geometrically by means of indicator diagrams. The cycle which Carnot supposed his working substance to traverse when geometrically represented consists of a four sided figure, ABCD, bounded on two opposite sides, AD and BC, by isothermal lines, and on the remaining pair by adiabatic lines. The principle upon which the cycle is based is that the amount of work done by a heat engine is independent of the nature of the medium employed, being dependent upon its temperature alone.

CARRIER CURRENT.—In radio a current associated with a carrier wave.

CARRIER CURRENT TELEPHONE.—A method of long distance transmission used when it is necessary to employ one of the long lines, or toll line, to carry more than one conversation in both directions simultaneously without interference with one another. It is accomplished by superimposing on the same pair of wires a number of alternating currents, each of different frequency and each controlled to carry a particular telephone conversation. In one channel of a carrier current telephone circuit the transmitting station consists of: A vacuum tube oscillator circuit, which generates the high frequency carrier current; a vacuum tube modulator circuit, which impresses the voice currents on the carrier current; a transmitter. The receiving station consists of: A vacuum tube demodulator circuit, which separates the voice currents from the carrier current wave and a receiver which reproduces the speech.

CARRIER FREQUENCY.—In radio, the frequency of a carrier wave.

CARRIER FREQUENCY TELEPHONY.—A method of radio communication in which the radio waves are directed along wires as a path instead of through space.

CARRIER WAVE.—One which is modulated by a signal and which enables the signal to be transmitted through a specific physical system.

CARRIERS OF REPLENISHER.—The conducting plates of a replenisher which preserve the charges for accumulation.

CARRYING CAPACITY.—The maximum current strength that a conductor can safely transmit.

CARTRIDGE FUSE.—A compact form of safety fuse resembling a cartridge shell; also called, enclosed fuse. There are two types: 1, non-renewable, and 2, renewable. A cartridge fuse consists of one or more strips of fusible metal enclosed in a fiber tube, filled with a powdered insulating substance. This substance serves to absorb the heat liberated when the fuse is blown and condenses the vapor of the molten metal, breaking the continuity of the electric circuit. The ends of the fuses are soldered or riveted to metal contacts which also serve to seal the tube, thus holding in the filling compound.

CASCADE AMPLIFICATION. — In radio several amplification stages in which the output of the first stage forms the input for the second stage, etc. Should be called series amplification.

CASCADE CHARGING.—The charging of Leyden jars or condensers by arranging them in series with the inner coating of one connected with the outer coating of the next throughout the series.

CASCADE CONNECTION.—A name sometimes given to the method of coupling up primary cells in a battery usually known as the series connection.

CASCADE CONVERTER.—A type consisting of the combination of an induction motor having a wound armature and a dynamo, the armatures being placed on the same shaft. The windings are joined in cascade, that is, in series with those of the armature of the induction motor. The line supplies three phase currents at high voltage direct to the field of the induction motor and drives it, generating in it currents at a lower voltage depending on the ratio of the windings. Part of the current thus generated in the armature passes into the armature of the dynamo and is converted by the commutator into direct current as in a rotary converter, but is also increased by the current induced in the winding of the dynamo armature.

CASCADE CONVERTER FEATURES.—The cost is said to be less than a motor generator set, and it is claimed to be self-synchronizing and to require no special starting gear, also to be 25 per cent more efficient than a motor generator. A cascade converter is about equally expensive as the synchronous converter with its necessary bank of transformers, but is about one per cent less efficient. It is claimed to be more desirable for frequencies above 40 on account of the improved commutation at the low frequency used in the dynamo member. For lower frequencies the synchronous converter is preferable.

CASCADE MOTOR GENERATOR SET.—A set employed to deliver constant pressure direct current when supplied with high voltage alternating current. It consists of two machine structures with revolving parts mounted upon the same shaft. The input machine which acts as a frequency converter resembles an induction motor with a coil wound secondary, the output machine resembles a synchronous converter receiving energy from the secondary winding of the input induction motor at a frequency much reduced from that impressed upon the primary winding.

CASE HARDENING.—Hardening the surface of iron or low steel by tempering in a cyanide solution, so called from the skin or case formed upon the surface of the metal.

CASE WIRING.—A method of interior wiring in which the wires are run along the walls and ceilings under suitable casing.

CASINGS.—Grooved courses for interior electric wiring.

CAST IRON.—A carbide of iron, containing from 3 to 5% of carbon, both combined and as graphite, and about 2½% of silicon. This variety of iron, the production of the blast furnace, is valuable on account of the ease with which it can be melted and cast into moulds.

CAST IRON CONDUIT.—For underground conduits, cast iron pipe is used similar to ordinary wrought iron pipe, except that it is thicker.

CAST IRON WELDING.—Gray cast iron used for making castings is welded with cast iron welding rods or sticks, using a flux. The melting points of cast iron are below the fusion temperatures of the iron oxides, and it is necessary to use flux to dissolve them in making cast iron welds. Many cast iron repair welding jobs can be done to advantage with bronze welding rods. The preheat required is less, and the welding rod temperature is from 1,625° to 1,650° F. Many jobs can be done with very little or no preheating. Flux is used when making bronze welds. The strength of good bronze welds is equal to or greater than the base cast iron.

CAST RAIL BOND.—A method of uniting the rails of an electric road at the joints, by casting iron around the lower part of each joint.

CAST STEEL.—Steel, usually open hearth, which is cast into sand moulds like cast iron. The moulds require to be carefully made, and patterns should have more draw than for iron; furthermore, the castings should be removed from the sand as soon as possible and carefully annealed to prevent cracking or damage from internal stresses; the resultant casting is much stronger than cast iron. The same as crucible steel.

CASTING FAULTS.—The chief defects in castings are blow holes, cold shuts, scabs, or places where the metal has not filled the whole of the space in the mould, this being due to insufficient iron, too low a temperature at pouring, or portions of sand becoming detached from the mould and blocking the passage. Insufficient venting of the mould will produce the same effects.

CASTNER CELL.—A mercury type electrolytic cell. In this cell advantage is taken of the property possessed by mercury of forming an alloy with sodium, fluid at the ordinary temperature, this alloy being known chemically as an amalgam. When the amalgam is heated with water it is decomposed, and a solution of sodium hydrate is formed, while the mercury is restored to its original condition of purity. Hence, if a layer of mercury be employed as cathode on the floor of a cell in which a solution of sodium chloride is being decomposed by the current, the sodium liberated at the surface of the mercury will at once enter into union with it, and will be kept safe from further chemical or electrolytic changes. The layer of mercury, in fact, acts as a reservoir for the sodium atoms, or ions, brought to its surface, and stores up these until they are wanted.

CASTOR AND POLLUX LIGHT.—A name occasionally given to the peculiar electric discharge sometimes observed at the tips of a ship's masts and spars and known as St. Elmo's fire.

CATALYSIS.—In chemistry, a process by which reaction occurs in the presence of certain agents which were formerly believed to exert an influence by mere contact. It is now believed that such reactions are attended with the formation of an intermediate compound or compounds, so that by alternate composition and decomposition the agent is apparently left unchanged, as, the catalysis of making ether from alcohol by means of sulphuric acid. Also called, catalytic action.

CATAPHORESIS.—In electro-therapeutics, a method of introducing drugs into the system through the skin by the electrode of a battery. Ionic medication.

CATAPHORETIC DEMEDICATION. — A process of removing injurious matter from the human body by cataphoresis.

CATAPHORETIC ELECTRODE.—An electrode for the purpose of infusing into the human body medicine in solution by the process of cataphoresis.

CATAPHORETIC MEDICATION.—A process of introducing medicine into the human body by cataphoresis.

CATENARY.—1. The curve assumed by a perfectly flexible cord when its ends are fastened at two points, the weight of a unit length being constant.

2. A system of overhead trolley construction employing a slack messenger wire with hangers at frequent intervals so as to maintain the trolley wire practically free from sag.

CATENARY SYSTEM.—This system derives its name from the curve formed by a flexible cable suspended between two supports and in its simple form consists of a steel messenger cable supported on insulators and thus forming a catenary curve. The catenary system of line construction, although developed for high voltage roads, possesses so many desirable characteristics from the operating standpoint that it has wide application for all types of electric traction.

CATHION.—The ion which carries the positive charge in the direction of the current and delivers it at the cathode.

CATHODE. — 1. The electrode through which a direct current leaves a liquid, gas or other discrete part of an electrical circuit.

2. In electrolysis, the electrode at which electric current leaves the electrolyte.

3. In a vacuum tube, the filament or electron emitting element.

4. The positive terminal of a battery.

CATHODE DARK SPACE.—The dark space is the non-luminous region which envelops and follows the outline of the cathode in a discharge tube at moderately low pressures.

CATHODE PICTURES.—Pictures taken by the Roentgen or X-ray machine; radiographs.

CATHODE RAY CURRENT.—1. In a vacuum or rarefied gas, a current of negatively charged particles, usually electrons.

2. A current in a vacuum or in a rarefied gas comprising the movement of negatively charged particles, usually electrons.

CATHODE RAY OSCILLOGRAPH.—This type of apparatus for measuring wave form was devised by Braun, and consists of a cathode ray tube having a fluorescent screen at one end, a small diaphragm with a hole in it at its middle, and two coils of a few turns each, placed outside it at right angles to one another. These coils carry currents proportional to the pressure and current respectively of the circuit under observation. The ray then moves so as to produce an energy diagram on the fluorescent screen. The instrument is much used in radio, as it is capable of showing the characteristics of currents of very high frequency.

CATHODE RAY SPECTRUM.—A spectrum consisting of parallel bands of phosphorescence separated by comparatively dark spaces, produced when cathode rays from an induction coil are influenced by a magnetic field.

CATHODE RAY TUBE.—1. A high vacuum tube having a filament, plate, deflecting plates, shield and a fluorescent screen. The filament is coated with active oxides and arranged to emit the number of electrons required for the cathode rays, at a dull red heat. This type tube is used for the study of vacuum tube characteristics, etc.

2. A discharge tube with a thin window at the end opposite the cathode to allow the cathode rays to pass outside. Also called **Lenard tube.**

CATHODE RAYS.—1. Streams of electrons emitted from the cathode of a vacuum tube normal to its surface, under the influence of an applied voltage. By suitable means they can be brought outside of the tube.

2. In an X-ray tube, the bombardment of the target by cathode rays which produces X rays. A peculiar radiation sent out from the cathode when an electric current is passed through it, producing a golden green phosphorescence upon the glass walls of the tube opposite the cathode.

CATHODE STREAMS.—Cathode rays.

CATHODIC REACTIONS.—The reactions which take place at the cathode of an electro-therapeutic apparatus when it is in contact with the human body.

CATHODOGRAM, OR CATHODOGRAPH.—A name sometimes given to an X ray photograph or radiograph.

CATION.—In electrolysis, the positive ion which moves toward the cathode. Also spelled cathion.

CAT'S WHISKER.—The fine wire used in some types of crystal detector to make contact with the crystal.

CAULKING WELD.—In this weld, the deposited metal is used to close a seam or opening so that no leakage occurs under a water, oil or air pressure test of at least 25 lbs. per sq. in. Neither the ultimate strength nor the design of the weld is of particular importance in a purely caulking weld.

CAUSTIC SODA.—Sodium hydrate. An alkali prepared by the reaction between sodium carbonate and slaked lime. It is employed as the electrolyte in the Edison primary cell.

CAUTERIZATION, ELECTRIC.—Cauterizing by the application of a wire heated by electricity.

CAUTERY CABINET.—A cabinet provided with all the appliances requisite for performing electric cauterization.

CAUTERY, ELECTRIC.—In electro-therapeutics, the operation of cauterizing by means of wires or bands of platinum heated to an incandescent glow by the passage of an electric current.

CAUTERY KNIFE ELECTRODE.—An electrode shaped like a knife blade for purposes of electric cauterization.

CAZIN LAMP.—An early form of metallic filament lamp having a filament of secret composition. The lamp was never produced to a great extent. It gives a brilliant white light.

C BATTERY.—A radio battery, whose function is to control the plate current, that is, the current supplied by the B battery, flowing in the plate circuit of the tube, and to control the quality of the output. In other words, the C battery puts a negative charge on the grid of the tube, thereby forcing it to operate with more clarity and less distortion at high B battery voltages. The negative voltage imposed on the grid also reduces the amount of current taken from the B battery to approximately one-half the amount which would otherwise be taken out. C batteries are used in the grid circuits of audio frequency amplifiers and in the first detector and oscillator tubes of some super-heterodyne sets.

C.C.—Abbreviation for cubic centimeter, the unit of volume in the c.g.s. system of measurement.

CEILING BLOCK.—In incandescent electric lighting, an attachment of insulating material fastened to a ceiling containing the feed wire connection from which a pendant cord hangs; a ceiling rosette.

CEILING BOARD.—An appliance for hanging an arc lamp.

CEILING BRACKET.—A bracket designed to carry insulated electric wires upon a ceiling.

CEILING CUT OUT.—A safety fuse fitted within a ceiling block; a rosette cut out.

CEILING FAN.—An electric fan, hung from the ceiling.

CEILING ROSE, OR ROSETTE.—An ornamental ceiling block for suspending an incandescent lamp.

CELL.—A single element of an electric battery, either primary or secondary, usually the former. It generally consists of a jar filled with a liquid or a pasty electrolyte, in which the electrodes are inserted or with which they are connected. The erroneous and almost universal use of the word battery for cell, is very objectionable.

CELL INSULATOR.—In storage battery work, glass or porcelain insulators, sometimes containing oil, upon which each cell rests to prevent leakage along the floor.

CELL SWITCH.—The end cell switch of a storage battery.

CELLULAR COIL.—A name sometimes given to a radio honeycomb coil.

CELLULOID.—A hard, flexible substance formed from a mixture of camphor and pyroxylin, which is the same as gun cotton. The camphor is dissolved in alcohol, the gun cotton added, and the mass incorporated between rollers; it is then warm-pressed into the desired form. The coloring is usually added during the incorporation. It is highly inflammable, but non-explosive.

CELLULOID FILAMENT.—An incandescent lamp filament composed of a celluloid thread reduced to carbon.

CELLULOSE FILAMENT.—An incandescent lamp filament prepared from wool which has been digested into cellulose form and then "squirted" through a die plate into alcohol by which it is set into a tough fiber and afterwards carbonized.

CELLUVERT FIBER.—A preparation used for insulating purposes.

CELSIUS THERMOMETER.—The Centigrade thermometer, so called from its inventor Andre Celsius, a Swedish astronomer. The freezing point is 0° and the boiling point 100°. It is used in France.

CEMENT.—1. In general, any substance which causes bodies to adhere to one another, such as mortar, plaster of paris, glue, etc. Used without qualification, the term denotes Portland cement, also stucco, natural and Roman cements, etc.

2. Marine glue and other adhesive compounds having insulating properties suitable for electric work; electric cement.

CEMENT ARCH CONDUIT.—A form of conduit for underground wires consisting of arched ducts composed of equal parts of Portland cement and sand moulded around wire gauze.

CEMENT COPPER.—Copper extracted from the water which is pumped out of copper mines. The water is pumped into tanks containing scrap iron, forming sulphate of iron and copper deposit. It is therefore almost in a state of chemical purity.

CENTER OF DISTRIBUTION.—In any distribution system, that point from which electrical energy must be supplied to use a minimum weight of conducting material.

CENTER OF GRAVITY.—That point in a body about which all the parts exactly balance one another, so that the body will remain at rest when supported, though acted upon by gravity.

CENTER OF GYRATION.—In mechanics, that point in a body rotating around an axis, at which, if a given force were applied, it would produce the same angular velocity in a given time as it would if the whole mass of the body were collected at that point.

CENTER OF OSCILLATION.—A point in a swinging body, as a pendulum, such that, if the whole mass of the body were concentrated there, the time of the oscillations would continue unchanged.

CENTER OF PERCUSSION.—That point, in a body revolving about an axis, at which it might be struck without causing any pressure on the axis; or that point at which if a blow be struck by the body, the action is the same as if the whole mass of the body were concentrated at that point.

CENTER POLE TROLLEY SYSTEM.—A system of line construction for double track street railways in which the trolley wires for both tracks are supported from the arms of a single row of poles set in the middle of the street.

CENTI.—A prefix often used with a physical unit to designate the one hundredth part of that unit.

CENTIGRADE THERMOMETER.—The Celsius thermometer, used in France and Germany, and in scientific work everywhere. In its scale 0° is the temperature of melting ice, 100° that of boiling water under the pressure of one atmosphere; hence the name Centigrade. Centigrade temperatures are converted into those of Fahrenheit's scale by multiplying the former by nine, dividing the product by five, and adding 32 to the quotient.

CENTIGRAM.—A measure of weight in the metric system; the one hundredth part of a gram.

CENTILITER.—A liquid measure in the metric system; the one hundredth part of a liter.

CENTIMETER.—A measure of length in the metric system, equal to the one hundredth part of the length of a standard metal bar kept in Paris, called the meter; it is equal to .3937 inch.

CENTIMETER GRAM SECOND SYSTEM.—A system of physical units in which the centimeter is adopted as the unit of length, the gram of mass, and the second of time, the universal scale for physical, electric and magnetic constants. It is usually abbreviated to c.g.s. system.

CENTIPEDE CABLE GRAPNEL.—A form of cable grapnel having numerous prongs or grappling hooks.

CENTRAL STATION.—1. The building and machinery or power plant which supplies electric current to a distribution system. The general tendency is toward larger stations, and the interlocking of the systems located in different localities. The reasons for this is because the investment cost per kw. generated decreases as the size of the station increases, also by taking advantage of the interconnection of stations the most efficient means of generation of power may be employed as, by steam, water or gas engine power.

2. In telephony, the exchange through which subscribers are interconnected

CENTRAL STATION LOCATION.—Usually central stations should be so located that the average loss of voltage in overcoming the resistance of the lines is a minimum, and this point is located at the center of gravity of the system. However, the center of gravity is very rarely the best location because other conditions, such as the price of land, difficulty of obtaining water, facilities for delivery of coal and removal of ashes, etc., may more than offset the minimum line losses and copper cost due to locating the station at the center of gravity of the system.

CENTRAL STATION MULTIPLE SWITCHBOARD.—A central telephone exchange switchboard divided into sections; each section provided with springjacks or terminals for every subscriber entering the exchange.

CENTRAL STATION STEAM GENERATION.—In general power-station design, there has been a lay-off in the effort to increase steam pressure to the level of 1,200 to 1,400 lb. with the necessary reheat, and the tendency is to use as high pressures as possible without reheat. Pressures of the order of 1,000 lb. and temperatures of 1,000° F. without reheat are in sight. In the field of boiler design, fusion-welded drums have practically supplanted those of riveted construction. More attention is being given to means and devices to prevent the carryover of solids with the steam from the boiler, and considerable work has been done to determine the mechanism of scale deposition in the boiler, and particularly the part played by carbon dioxide. Steaming-type economizers are being increasingly employed because of the high temperature of the feed-water coming from regenerative feed-heating systems. The latest design of economizers consists of practically continuous welded loops.—A.S.M.E. report.

CENTRAL TELEPHONE EXCHANGE.—1. The main exchange connected with branch exchanges.
2. The central station connected with individual subscribers.

CENTRALLY GROUNDED WIRE.—A wire running along the roadbed in a trolley system, connected to the rail bonds and grounded at fixed intervals.

CENTRIFUGAL CLUTCH.—An automatic device sometimes used with split phase motors which, below a predetermined speed, permits the rotating element of a motor to revolve free of the shaft, and which at that predetermined speed engages the shaft to make it turn with the rotating element and transmit the motor's power through it.—NEMA.

CENTRIFUGAL CURRENT.—In electrotherapeutics, a descending current.

CENTRIFUGAL FORCE.—The force which acts upon a body revolving in a circular path, tending to force it farther from the center of that circle. If the centrifugal force is just sufficient to balance the attraction of the mass around which it revolves, the moving body will continue in a uniform curved path. Should the centrifugal force increase, the body will either take up a larger path at a further distance from the center, or else tend to fly off in a straight line.

CENTRIFUGAL GOVERNOR.—A steam engine governor, in which the centrifugal force acts upon two or more revolving balls or weights. It is attached either to a throttle valve or the valve gearing and governs by varying the cut off or by throttling.

CENTRIFUGAL PUMP.—A pump in which the moving part is a revolving wheel or fan with curved vanes or spokes. The liquid is admitted at the center of the fan, and being carried round by centrifugal force, escapes from the tip of the blades; often used for pumping the circulating water through a condenser.

CENTRIFUGAL STARTING SWITCH.—A centrifugally operated automatic mechanism usually used in connection with split phase induction motors to open or disconnect the starting winding after the rotor has obtained a predetermined speed, and close or reconnect it prior to the time the rotor comes to rest.—NEMA.

CENTRIFUGE.—A centrifugal machine for separating substances of different densities.

CENTRIPETAL CURRENT.—In electrotherapeutics an ascending current.

CENTRIPETAL FORCE.—That force which draws or impels a body toward some point as a center.

CERIUM.—A steel gray metallic element. The alloys of cerium with other metals of the same group or iron are pyrophoric and are used in making the sparking units of cigarette lighters, gas lighters, tracer bullets, shells, etc.

CERUSITE.—Carbonate of lead used for crystal detectors.

C.g.s.—Abbreviation for centimeter, gram, second.

C.g.s. SYSTEM OF UNITS.—An absolute system for measuring physical quantities in which the fundamental units are the centimeter, gram and second. This system is primarily applicable only to mechanical units. It is extended to other fields of physical science by accepting the doctrine of the conservation of energy and by introducing a fourth unit or a property of a material. For example, in the theory of heat, the degree centigrade is taken as an additional unit

CHAIN CABLE GRAPNEL.—A form of grapnel composed of chain links provided with grappling hooks.

CHAIN DRIVE.—A method of transmitting power, consisting of an endless chain which meshes with sprockets on the driving and driven shafts. Roller chains are sometimes run at speeds as high as 2,000 ft. per min. but speeds of 1,000 ft. per min. or less are more satisfactory. Block chains are adapted to slower speeds, 700 ft. per min. or less. Chains of the "silent" type can be run at speeds up to 1,200 or even 1,600 ft. per min. under favorable conditions, although ordinarily a speed of 1,300 ft. per min. should not be exceeded unless special means for lubrication be provided, such as an oil bath gear case or a drip lubricator. Chain drive is desirable for economy in space.

CHAIN LEWIS.—A device for slinging stones, large masses of concrete, etc.; two curved pieces of steel are introduced into a lewis or dovetailed hole in the block, thus)(. The strain on the chain through their upper extremities forces their points outwards and grips the stone to be lifted.

CHAIN LIGHTNING.—A flash of lightning which appears in a long zig-zag or broken line.

CHAIN OILING.—A self-oiling device applied to bearings in pillow blocks, hangers, etc., in which a small endless chain hangs over the shaft and dips down into an oil well beneath the bearing, thus bringing up a little oil as it revolves.

CHAIN OR NESTED WINDING.—A three phase two range winding. The adjacent coils link one another as in a chain, the center of one set of coils being occupied by the sides of coils of the other phases. In shaping, the two sides of each coil are made of different lengths, and bent so that they can lie behind one another. In the case of open slots, the coils may be form wound and afterwards wedged into their places.

CHAMBER OF INCANDESCENT LAMP.—The glass vacuum bulb containing the carbon filament.

CHANDELIER.—A frame with branches to hold candle sockets; also an ornamental arrangement of pipes and fixtures to hold devices for lighting.

CHANGE OF FREQUENCY.—In a.c. wiring there are numerous instances where it is desirable to change from one frequency to another. Synchronous motor generator sets are generally used for such service as the frequency is not disturbed by load changes; it also makes it possible to use the set in the reverse order, that is, taking power from the high frequency mains and delivering energy at low frequency.

CHANGE OVER SWITCH.—A central station switch by means of which a circuit is changed from one dynamo to another; also called changing switch.

CHANGE SPEED GEAR.—In an automobile, a number of pairs of gear wheels, to produce different ratios of driving wheel speeds to engine speeds.

CHANGE SPEED LEVER.—In an automobile, a hand lever by which are thrown into gear, either of the three or four trains of speed gears for forward running or the double train for reversing the motion.

CHARACTERISTIC CURVE.—A diagram in which a curve is employed to represent the relation of certain varying values A curve indicating the characteristic properties of a dynamo electric machine under various phases of operation. A curve indicating the voltage of a machine, as a variable dependent on the excitation.

CHARACTERISTIC CURVE OF DYNAMO.—A curved line representing the varying pressures of the terminals of a dynamo for different loads. The curve is plotted on co-ordinate paper having the voltage values indicated by ordinates and the amperage values by abscissas.

CHARCOAL IRON.—Wrought iron made solely with charcoal as fuel. This gives the best and purest iron, of great value in electrical work for transformer cores, armature discs, etc.

CHARGE.—1. In electrostatics, the amount of electricity present upon any substance which has accumulated electric energy. A static charge is measured in coulombs.

2. In storage battery work, the amount of current absorbed by the battery during the operation of "charging." A storage battery charge is measured in ampere hours.

3. In a gas engine, the amount of mixture taken into the cylinder during the suction stroke.

CHARGE CURRENT.—A current produced in a telegraph wire by the entrance of electricity into the line when the circuit is closed.

CHARGE INDICATIONS.—In storage battery maintenance, the state of the charge is not only indicated by the density of the electrolyte and the voltage of the cell, but also by the color of the plates, which is considered by many authorities as one of the best tests for ascertaining the condition of a battery. The whitish or reddish gray spots on the positive plates are small particles of lead sulphate which have not been reduced to lead peroxide during the process of forming, and represent imperfect sulphation. As a general rule, the first charging should be carried on until these spots completely disappear. After this the positive plates should be of a dark brown or chocolate color at the end of the discharge, and of a wet slate or nearly black color when fully charged. A very small discharge is sufficient, however, to change them from black to the dark brown or chocolate color. During charging, the yellowish gray color of the negatives changes to a pale slate color which grows slightly darker at the completion of the charge. The color of the negatives always remains, however, much lighter than that of the positives.

CHARGED BODY.—Any substance possessing a static charge of electricity.

CHARGING A STORAGE BATTERY.—The operation of sending a flow of current through a storage battery to bring the plates into condition to cause a flow of current on discharge. The charging current should be in proportion to the ampere hour capacity of the cell. Charging voltage should be at least ten per cent higher than the normal voltage of the battery when charged.

CHARLES' LAW AND GAY-LUSSAC LAW.—The volume of a given mass of any gas, at constant pressure, increases for each rise of temperature of 1° C. by a constant fraction (about 1/273) of its volume at 0° C. For example, if the volume of a gas at 0° C. be 1 cu. ft. then at say 23° C., its volume is

$$1+\frac{23}{273}=1.084 \text{ cu. ft.}$$

CHASSIS.—A frame. The framework of a wagon; later this term was applied to the framework of a locomotive; then to the longitudinal and transverse frame members of an automobile. By extension it also designates the whole of the mechanical portion of an automobile. Strictly the word chassis should only apply to the metal framework receiving the engine transmission and controlling mechanism.

CHATTERTON'S COMPOUND.—An insulating preparation for electric conductors. It consists of 1 part, by weight, Stockholm tar, 1 part resin, 3 parts gutta percha.

CHECK LOCKING.—In a railway interlocking signaling system, check locking is locking between towers. The first requisite of a safe method to prevent the simultaneous entrance of trains from opposite directions onto a piece of common track is the interlocking of the two signal levers by which movements to such a track are governed. This is also known as "traffic locking."

CHECK NUT.—A name sometimes used for lock nut.

CHECK VALVE.—An automatic or non-return valve used to control the admission of feed water into a boiler, etc. The pressure within the boiler keeps the valve upon its seat unless overcome by superior pressure caused by the pump or injector, thus permitting feed water to enter while preventing escape of the contents.

CHECKING TRANSFORMER CONNECTIONS.—To check polarities of parallel connected transformers, two of the terminals are connected by a small strip of fuse wire, and then the other two terminals are touched at the same instant with the ends of another wire. If the fuse blow, then the connections must be reversed; if it do not, then they may be made permanent.

CHECKING UP A RECORDING WATT METER.—This may be conveniently done by noting the deflections at short intervals on an ammeter connected in circuit, and also the readings on the dial of the recording watt meter during this period. If this test be continued for an appreciable time, the product of the pressure in volts, the current in amperes, and the time in hours, should equal the number of watt hours recorded on the counters of the dial.

CHEMICAL ACTION.—The action taking place when a single substance or a number of substances react so as to produce a new substance or substances as distinguished from a mechanical mixture.

CHEMICAL AFFINITY.—The force which is exerted between molecules not of the same kind. To affinity is due all the phenomena of combustion, and of chemical combination and decomposition. Also called, chemical attraction.

CHEMICAL CHANGE.—A change which destroys the identity of the bodies undergoing it, as distinguished from physical change.

CHEMICAL COMPOUND.—A union of two or more ingredients, in definite proportions by weight, so combined as to form a distinct substance; as, water is a compound of oxygen and hydrogen.

CHEMICAL CONDENSER.—An electrolytic condenser consisting of two aluminum electrodes placed in an electrolyte. In operation, the aluminum becomes coated with a thin layer of gas of tremendous resistance. The condenser will not allow current to pass through it in either direction. Used to prevent any sudden surge of pressure due to lightning or other causes.

CHEMICAL EFFECT OF THE CURRENT.—If the conductor be a liquid which is a chemical compound of a certain class called electrolyte, the liquid will be decomposed at the places where the current enters and leaves it. Pats van Trostwyk (1789) pointed out that an electric discharge was capable of decomposing water. To show this he used gold wires, which he allowed to dip in water, connecting one of them with the inner, and another with the outer coating of a Leyden jar, and passing the discharge through the water. The gas bubbles collected proved to consist of oxygen and hydrogen gas.

CHEMICAL EQUIVALENT.—The atomic weight of a substance divided by its valency.

CHEMICAL FORMULÆ.—Groups of chemical symbols, each of which indicates the composition of one molecule, employed to show the character of a chemical compound.

CHEMICAL GENERATOR.—A name given to a primary battery, as distinguished from a dynamo or mechanical generator.

CHEMICAL PHOSPHORESCENCE.—A phosphorescent glow consisting essentially of slow oxidation accompanied by the evolution of light; it is characteristic of the light of the firefly.

CHEMICAL PHOTOMETER.—A photometer which measures the intensity of a source of light by the amount of chemical decomposition which the light can produce.

CHEMICAL RECORDER.—The instrument at the receiving end of the line which records the message in a chemical automatic telegraph system. It consists essentially of a strip of chemically prepared paper moving over a cylinder, and a steel needle which decomposes the chemical solution with which the paper is impregnated. The chemically treated tape upon the smooth metal cylinder serves as one electrode and the steel needle acts as the other in causing electrolysis.

CHEMICAL RECORDING METER. — An electric meter depending upon the action of electrolysis for registering the amount of electricity used.

CHEMICAL RECTIFIER.—An electrolytic rectifier.

CHEMICAL SEPARATION.—The disintegration or decomposition of matter as the result of chemical action.

CHEMICAL TELEGRAPHY.—A system of "automatic" telegraphy in which the messages are recorded by electro-chemical action effected by a metal pen in contact with a strip of paper treated with a chemical solution.

CHEMICALLY CLEAN.—Cleaned by chemical means so that no dust or trace of any foreign substance remains on a surface.

CHEMICALLY PURE.—Without the admixture of any foreign substance whatever such as could be detected by chemical tests.

CHEMISM.—A general term for chemical action, force, or effects.

CHEMISTRY.—The science which deals with the changes in composition and constitution which substances undergo.

CHEMISTRY IN ELECTRICITY.—In the electrical industry, the chemist's work is partly inspection—the determination of the purity or uniformity of the materials of construction. The discovery and invention of new and useful combinations of things which are to become insulators or conductors or magnetic materials and new lubricants.

CHILL.—The casting of iron and steel in a metallic mould, which is kept cool by the circulation of water within it. Only certain varieties possess the property of chilling, but when successfully carried out it results in a very hard skin on the casting, the depth of which is sometimes as great as ⅞" to 1". Cast-iron wheels for cars are usually made by this method.

CHIMES, ELECTRIC.—Chimes of bells which are made to ring under the influence of electrostatic charge and discharge to illustrate electrostatic principles.

CHIMNEY BRACKET.—A bracket designed to support an overhead wire or cable by attaching it to the corner of a chimney

CHLORATE.—A salt of chloric acid. All chlorates are soluble in water; on heating they evolve much oxygen and a trace of chlorine, the residue being a chloride. On account of their oxydizing properties chlorates are much used as reagents, and in the compounding of explosives, fireworks, matches, etc. The most important are the chlorates of barium, potassium and sodium.

CHLORIDE.—A compound of an element with chlorine. The chlorides of non-metallic elements are either gaseous or liquid, those of metallic elements are liquids or solids. Some of these latter are decomposed by water, all the remainder save those of silver and some of mercury are soluble in water. A chloride is formed by direct union of the elements; by decomposition of a metal or its oxides or carbonate in hydrochloric acid; or by double decomposition, as with an insoluble chloride, such as that of silver.

CHLORIDE CELL.—A type of cell having elaborately prepared negative plates in which lead grids are cast around small hexagonal slabs or "pastilles" of chloride of lead. These lead plates are placed in a solution of chloride of zinc and alternated with plates of metallic zinc, and then subjected to various processes which finally leaves an extensive area of porous metallic lead in contact with the solution. The positive plates are formed so as to present a large surface of lead peroxide.

CHLORIDE OF COPPER.—A white crystalline solid, insoluble in water but soluble in hydrochloric acid and ammonia. This salt is used in electroplating, etc.

CHLORIDE OF GOLD.—This is formed by the action of aqua regia, or nitro-hydrochloric acid upon gold. The chloride is readily soluble in various liquids, is extremely susceptible to light, and is consequently much used in photography. It is also employed in electro-deposition.

CHLORIDE OF LIME.—Calcic chloride, prepared by passing chlorine gas over slacked lime in a gradual manner to avoid heating it. The chloride is used as a bleaching agent, as a disinfectant; for the formation of brine used in refrigerating systems.

CHLORIDE OF SILVER.—Formed as a precipitate by treating silver nitrate with chloride of sodium. It is extremely sensitive to light and is used to prepare the sensitive paper upon which photographs are printed from the negative. The chloride is also used by electroplaters in silver solutions.

CHLORIDE OF TIN.—In chemistry, a compound of chlorine with tin.

CHLORIDE OF ZINC.—A white solid, usually seen in the form of sticks, prepared in solution by the action of hydrochloric acid on zinc. This solution is generally known to tinsmiths as killed spirits, and is largely used in soldering with lead and tin alloys.

CHLORINE.—A greenish-yellow gas with powerfully irritating smell; very heavy (2.5 times as heavy as air) soluble in water (1 vol. water at the ordinary temperature and pressure dissolves 2.5 vols. of chlorine). This gas was the first to be liquefied, as the operation is easily effected. It unites directly with most elements, forming chlorides.

CHOKE COIL.—A coil of wire with iron or air core wound in such a manner as to acquire self-induction to a high degree when employed on alternating current circuits. A reactance coil.

CHOKE COIL FOR LIGHTNING ARRESTER.—A lightning protection device consisting of a coil of copper wire, the primary object of which is to hold back the lightning disturbance from the apparatus during discharge so as to permit the lightning arrester to function properly. If there be no arrester, the choke coil cannot add any protection. Accordingly, a choke coil should only be considered as an auxiliary to an arrester.

CHOKE COUPLING.—In radio, a method of coupling by using a self-induction or choke coil.

CHOPPER.—A device consisting of a rotating commutator like multi-segment switch for interrupting continuous wave audio frequency signals at either the transmitter or receiver.

CHOPPER MODULATION.—In radio, audio frequency interruption of continuous waves by a chopper.

CHORD.—Distance between the entering edge and trailing edge of an airplane wing measured on a straight line touching front and rear bottom point of a wing.

CHORD WINDING.—A method of winding a drum armature, in which each coil is laid on so as to cover an arc of the armature surface nearly equal to the angular pitch of the poles; also called, short pitch winding.

CHRISTIE BRIDGE.—A testing instrument invented by Christie and improperly credited to Wheatstone. It consists essentially of a system of four conductors, suitably joined, forming the arms of the bridge, two of the junctions being connected to the terminals of a battery, and the other two joined by the bridge wire which contains a galvanometer.

CHROMATE OF LEAD.—A rare mineral found in Siberia, Hungary and the Philippines. It is known better as crocoite and is found in translucent yellow crystals. Chrome yellow is derived from this substance, which is also used in organic analysis and electroplating.

CHROMATIC ABERRATION.—When white light is passed through a spherical lens, both refraction and dispersion occur. This causes a separation of the white light into its various colors and causes images to have colored edges. This defect which is most observable in condensing lenses is due to the unequal refrangibility of the simple colors.

CHROMIC ACID CELL.—A primary cell employing as a depolarizer, chromium tri-oxide dissolved in water forming a mixture popularly known as chromic acid. This cell was formerly known as the potassium bichromate cell from the fact that originally the chromium trioxide was obtained from potassium bichromate. The plates employed are carbon and amalgamated zinc.

CHROMIUM PLATING.—The bath for chromium plating has as its main constituent chromic acid. Its function in the bath is two-fold: to conduct the electric current, and to act as the source of supply of chromium. During the operation of plating, chromic acid must be added from time to time. A solution of chromic acid alone will not yield commercially valuable deposits of metal. It is essential that small quantities of sulphate or its equivalent be added in amounts about 1% as great as that of the chromic acid used. The most convenient way of adding sulphate is through the use of sulphuric acid; chromium sulphate; sodium sulphate or any such material, however, can be substituted. If thick deposits be desired, a current density and temperature combination to give about 13% current efficiency will form a bright, smooth plate with the minimum tendency toward treeing. Bright chromium surfaces are obtained by plating on bright under coatings. The necessity for control is very great in chromium plating.

CHROMOSPHERE.—A layer of the sun's atmosphere, composed of incandescent gases, of rose color and several thousand miles thick, resting on the photosphere. It is visible to direct vision only at the beginning or end of a total eclipse.

CHRONOMETER.—1. A finely made time piece, whose balance wheel is specially adapted to keep accurate time in all variations of temperature. It has an escapement, more refined than that of a watch. For marine use, the chronometer is mounted on gimbals to preserve it from vibration and keep it horizontal.

2. An instrument operated by electricity for measuring time, and adjusted for accuracy under changing conditions; called also electric chronometer.

CHRONOSCOPE. — An electrically controlled instrument for measuring time to the one-thousandth part of a second. It is by the use of a chronoscope that the speed of a projectile is sometimes measured.

CHURCHILL VALVE.—An electrolytic rectifier of the modified Nodon valve type. It differs from the latter in that it has two cathodes of aluminum and an anode of lead or platinum, suspended in the one cell. This permits the complete utilization of both halves of the supply wave with one cell instead of the four required in the Gratz method.

CHURNING.—In marine propulsion, the action of a high pitch ratio propeller merely to rotate the water and throw it off the ends of the blades instead of forcing it directly astern, "churning" the water. This action is usually due (in the case of a heavy working boat with bluff lines) to the attempt to adapt the propeller to the speed of the engine instead of to the lines of the boat.

CINEMATOGRAPH.—An electric machine for throwing a rapid succession of pictures upon a screen, and thus giving the effect of an animated scene; a biograph.

CIPHER CODE.—A telegraphic code employing arbitrary words or phrases in place of actual extended messages for rapid, economical and secret communication.

CIPHER MESSAGE.—A message composed in terms of a cipher code.

CIRCLE.—A plane figure bounded by a curved line, called the circumference, every point of which is equally distant from a point within called the center.

CIRCLE DIAGRAM.—A graphic method by means of which many of the properties of induction motors and of several other types of a.c. motors can be graphically investigated. By aid of this diagram it is possible to calculate horse power output, kva input, amperes per terminal, per cent power factor for different loads, per cent inrush at starting under full voltage, per cent torque at starting, maximum or pull out torque, per cent slip of motor at different loads and actual, r.p.m. of motor at different loads. The circle diagram is also called the Heyland Diagram.

CIRCLE OF REFERENCE.—A circle of given radius employed in plotting out a curve of sines to illustrate periodic motion.

CIRCUIT.—The course followed by an electric current passing from its source through a succession of conductors, and back again to its starting point

CIRCUIT BREAKER.—A switch which is opened automatically when the current or the pressure exceeds or falls below a certain limit, or which can be tripped by hand. It consists of a switch and a solenoid in the main circuit. When the current, flowing through the circuit, exceeds a certain value, the core of the solenoid is drawn in and trips a trigger which allows the switch to fly open under the action of a spring. There are numerous types, classified: 1. With respect to kind of control as: a, maximum circuit breakers; b, minimum circuit breakers; c, reverse current circuit breakers; d, maximum and reverse current circuit breakers; e, no voltage circuit breakers. 2. With respect to method of breaking the arc, as: a, air circuit breakers; b, oil circuit breakers.

CIRCUIT CLOSING RELAY.—A type whose duty is to close the auxiliary circuit at the time when the predetermined abnormal condition is reached in the primary circuit. The closing of the auxiliary circuit energizes the trip coil and opens the breaker. In operation, when the current or pressure in the main circuit reaches the predetermined value at which the protective system should operate, the relay magnet attracts the pivoted contact arm and closes the auxiliary circuit; this permits current to flow from the current source in that circuit and energize the trip coil thus opening the main circuit. D.c. at from 125 to 250 volts is generally used for the auxiliary circuit.

CIRCUIT INDICATOR.—A type of galvanometer for showing the presence of an electric current and roughly indicating its strength.

CIRCUIT LOOP BREAK.—In overhead wire construction, a bracket carrying insulators for including a loop in the circuit.

CIRCUIT LOOP BREAK INSULATOR.—An insulator for making the connections in a circuit loop break.

CIRCUIT OPENING RELAY.—A type whose duty it is to open the auxiliary circuit, usually a.c., and thereby cause the oil switch or circuit breaker to be opened by the use of a trip coil in the secondary of a current transformer, or by a low voltage release coil. The trip coil of the breaker is generally shunted by the relay contacts and when the moving contact of the relay disengages from the stationary contact, the current from the transformer which supplies the relay, flows through the trip coil thus opening the breaker. Used in places where d.c. is not available for energizing the trip coil. Objectionable because of the relatively high impedance and the heavy volt ampere load imposed on the transformers.

CIRCUITAL FLUX.—1. The electric flux of a circuit.
2. A circular flux.

CIRCUITAL GAUSSAGE.—The magnetic intensity of a complete magnetic circuit.

CIRCUITAL MAGNETISM.—The magnetism of an ordinary bar magnet exhibiting poles only at its two ends.

CIRCUITAL VECTOR.—A vector quantity completing a curve or loop.

CIRCUITAL VOLTAGE.—The voltage indicated in a complete electrical circuit.

CIRCULAR INCH.—The area of a circle whose diameter is one inch; as distinguished from one sq. in. and equals .7854 sq. in. The circular ins. in any circle is simply the diameter in ins. squared.

CIRCULAR LOOM.—A flexible tubing of insulating material which is slipped over a wire where additional insulation is required, as in concealed knob and tube wiring where wires pass through studs, etc.

CIRCULAR MEASURE.—This is used for measuring angles:

TABLE

60 seconds ("),	make	1 minute, '	
60 minutes,	"	1 degree, °	
360 degrees,	"	1 circle, C.	

Unit Equivalents

			'	"
		°	1=	60
	S	1=	60=	3,600
C	1	30=	1,800=	108,000
1=	12=	360=	21,600=	1,296,000

Scale—ascending, 60, 60, 30, 12; descending, 12, 30, 60, 60.

The circumference of every circle, whatever, is supposed to be divided into 360 equal parts, called degrees. A degree is 1-360th of the circumference of any circle, small or large. A quadrant is a fourth of a circumference, or an arc of 90 degrees. A degree is divided into 60 parts called minutes expressed by sign ('), and each minute is divided into 60 seconds expressed by ("), so that the circumference of any circle contains 21,600 minutes, or 1,296,000 seconds.

CIRCULAR MIL.—The area of a circle one mil (.001 in.) in diameter. The area of a wire in circular mils is equal to the square of the diameter in mils. Thus a wire 2 mils in diameter (.002 in.) has a cross sectional area of $2\times2=4$ circular mils. Accordingly, to obtain the area of a wire in circular mils, measure its diameter with a micrometer which reads directly in mils or thousands of an inch, and square the reading.

CIRCULAR PITCH.—The pitch of wheel teeth as measured along the circumference of the rolling or pitch circle, upon which one wheel comes into contact with its mate. Also known as circumferential pitch.

CIRCULAR TOUCH.—A magnetizing process by contact in which four metallic bars to be magnetized are arranged in a square and the magnet applied by a circular movement around the square thus formed.

CIRCULATING DECIMAL.—A decimal in which a figure or set of figures is constantly repeated in the same order; a recurring decimal.

CIRCULATING PUMP.—In a power plant, a reciprocating or centrifugal pump maintaining the circulation of cooling water through a surface condenser.

CIRCUMFERENCE.—The curved line that bounds a circle.

CIRCUMFERENTIAL SPEED.—The rapidity of motion imparted to a point on the surface of an armature or wheel circumference by the rotation; also called, tangential speed.

CLACK VALVE.—A pump valve which works on a hinge; generally the hinge and face are made of leather, the valve itself being of metal. So called from the noise it makes when seating itself.

CLAMP SPLICING EAR.—A splicing ear for trolley wires by which the ends of the wires to be joined are forced together by a clamping device and then securely bolted.

CLAMP TERMINALS.—Terminals in the form of screw clamps for uniting the ends of wires.

CLAPPER VALVE.—A form of foot valve used especially on bilge pumps. It consists of a single hinged disc, or two hinged half discs, the hinge being attached to a seat.

CLARIFIER.—A radio device for eliminating static interference. A wave trap.

CLARK CELL.—A primary cell invented by Latimer Clark and adopted as the standard of voltage by the International Congress at Chicago. in 1893. The positive element is mercury and the negative amalgamated zinc. The electrolyte is a saturated solution of zinc and the depolarizer, mercurous sulphate. At 15° C. the pressure is 1.434 international volts. Before the introduction of the Weston cell, the Clark cell was almost universally used as a standard.

CLARK'S COMPOUND.—A compound of mineral pitch, silica and tar used as a protective covering upon the sheath of a submarine cable.

CLASS A AMPLIFIER.—A radio device so operating that the plate output wave form is essentially the same as that of the exciting grid voltage.

CLASS B AMPLIFIER.—In radio one which so operates that the power output is proportional to the square of the grid excitation voltage.

CLASS C AMPLIFIER.—A radio amplifier which operates in such a manner that the output varies as the square of the plate voltage within limits. This is accomplished by operating with a negative grid bias more than sufficient to reduce the plate current to zero with no excitation. An alternating grid excitation voltage is applied such that large amplitudes of plate currents are passed during a fraction of the positive half cycle of the grid excitation voltage variation. The grid voltage usually swings sufficiently positive to allow saturation plate current to flow through the tube. Thus the plate output waves are not free from harmonics and suitable means are usually provided to remove harmonics from the output.

CLAY.—A widely distributed earthy rock, derived from the disintegration of harder rocks, such as feldspars or granites, etc.

CLAY ELECTRODE.—In electro-therapeutics, an electrode made of clay of such a shape as to fit the part of the human body which is to be subjected to medical treatment.

CLEARANCE.—1. The open space occurring between the polar faces of the field magnets of a dynamo or motor and the surface of the armature.

2. In a steam engine when the engine piston is at the end of the stroke, clearance is the volume between the piston and the nearer cylinder head, plus the volume of the steam passage between the cylinder and the valve seat. Clearance is expressed as a percentage of the volume displaced by the piston in one stroke. The term clearance is also used to denote the distance between the cylinder head and the piston when the latter is at either end of the stroke, being called the linear clearance.

CLEARING.—A term used in telephone practice for the process of disconnecting subscribers who have been using the line.

CLEARING OUT DROPS.—Drop shutters in a telephone switchboard in circuit with any two connected subscribers, which fall when the use of the line has ceased.

CLEARING OUT RELAYS.—Telephone relays for operating clearing out drops.

CLEARING SIGNAL.—A signal given in a telephone exchange when a conversation over the line has ceased.

CLEAT, ELECTRIC.—A small block of suitable grooved wood, or other insulating material for securing electric wires to the walls or ceiling of a room.

CLEAT WIRING.—A method of supporting wiring on porcelain insulators or cleats. By the use of cleats both wires of a circuit are held at the correct distance apart by each cleat. Thus a cleat performs the duty of two knobs, that is, for wires No. 14 to No. 10. For larger wires (sizes No. 8 to No. 0) single wire cleats are used.

CLEAVAGE ELECTRICITY.—Electricity resulting from the splitting of mica or other crystalline minerals.

CLICK.—A short, sharp, non-ringing sound, commonly the result of an impact.

CLICK WIRE.—A wire in a telephone switchboard which sounds a click to indicate that the subscriber called for is busy.

CLIMAX.—Trade name for a grade of resistance wire made by the Driver, Harris Co., Harrison, N. J.

CLIMBERS.—Spurs strapped to a lineman's boots to assist him in climbing a telegraph pole; also called climbing irons.

CLINKER.—1. A compact mass formed by combustion or by partial fusion of certain mineral substances, especially in the manufacture of Portland cement. In this an incorporated mixture of lime and clay is burned at a glowing heat, the resultant clinker being subsequently ground to the required fineness of powder.

2. A heavy vitrified slag, formed in burning certain coals, which clings to the bars of the furnace and clogs its air supply.

CLIPPING OF SIGNAL.—A cutting short of telegraphic signals as the result of some fault or disturbance.

CLOCK, ELECTRIC.—A clock operated by electricity. The latest practice employs a small self-starting synchronous motor. The speed of this motor, and consequently of the clock in which it is installed, depends upon the number of alternations of the current per second. These alternations or impulses are regulated by a master clock in the central power station of the public service company. Therefore, all electric clocks in the territory covered by that station must keep exactly the same time, because each impulse starts from the power station reaches every part of the entire area of distribution. Master clocks at the different central stations are regulated and corrected daily by radio signals from the U. S. Naval Radio Station at Arlington, Va., the source of government official time.

CLOCK METER.—A meter for electricity regulated by clockwork.

CLOCK REGISTER.—An instrument attached to a clock for registering the exact time of any event.

CLOCKWISE.—Said of rotating parts of machinery, when they run right handed or as the hands of a clock, from left over to right. The reverse motion is termed counter clockwise.

CLOSE COUPLING.—1. In radio, a secondary induction coil with sliding secondary winding in the position in which the secondary winding is inside the primary winding, or nearly so.

2. Any degree of coupling whose coefficient of coupling is greater than .5. The closer the coupling the greater the coefficient.

CLOSED ANTENNA.—A loop antenna.

CLOSED CIRCUIT.—A circuit permitting a continuous electric current.

CLOSED CIRCUIT ALARM.—An alarm which rings when the circuit is broken

CLOSED CIRCUIT CELL.—A two fluid primary cell intended for constant service In closed circuit cells polarization is prevented by chemical action, so that the current will be constant and steady until the energy of the chemicals is expended.

CLOSED CIRCUIT THERMOSTAT. — A thermostat resting on a closed circuit, which breaks the circuit as the temperature rises.

CLOSED CIRCUIT WORKING.—A method of telegraphic signaling in which the batteries at the terminals of the line are kept constantly in a closed circuit.

CLOSED COIL ARMATURE.—An armature so wound that the coils are connected together; the junction of each adjacent pair being joined to a segment of the commutator so that the whole forms a closed circuit.

CLOSED HEATER.—Apparatus for heating boiler feed water so constructed that the steam does not come in contact with the feed water, but is separated by a metal surface through which the heat must pass. Evidently in such arrangement no oil can enter the boiler, and because of the metal surface, the heater is somewhat less efficient in transmitting heat than the open heater, varying with the condition of the surface of the metal being subject to deposit of oil on the steam side, and scale on the water side. Accordingly, a closed heater should not be used unless the feed water be reasonably free from scale forming substances.

CLOSED IRON CIRCUIT TRANSFORMER.—A transformer having a core which makes a closed magnetic circuit; a non-polar transformer.

CLOSED LOOP PARALLEL CIRCUIT.—A multiple circuit having its conductors in closed loops between which the receptive devices are connected.

CLOSED MAGNETIC CORE.—A magnetic core of iron designed to secure a closed magnetic circuit for its field.

CLOSED SYSTEM OF PARALLEL DISTRIBUTION.—A system of distribution in incandescent lighting having separate circuits connecting groups of receptive devices with the source, as opposed to the tree system.

CLOWN'S HAT CURVE.—A voltage or current curve which undergoes rapid changes in value, suggesting in shape the pointed hat worn by clowns.

CLUB FOOT ELECTRO-MAGNET.—A horse shoe electro-magnet having a magnetizing coil wound upon only one of its poles.

CLUTCH.—1. A device for gripping any object so as not to interfere with its occasional movement, as the carbon clutch in an arc lamp.

2. A mechanical device for engaging or disconnecting two pieces of shafting.

CLUTCH TYPE INDUCTION MOTOR.—An internal resistance a.c. motor.

C.m.—Abbreviation for circular mil.

Cm.—Abbreviation for centimeter, the unit of length in the c.g.s. system of measurement.

COAL.—Vegetable matter compressed and mineralized so that it occurs in stratified fossil deposits. Chemical changes have reduced the oxygen originally contained, consequently increasing the percentage of carbon. The traces of the original vegetable structure are very few. Coals are classified as follows. a, anthracite; b, semi-bituminous; c, bituminous; d, long flaming or cannel; e, lignite or brown coal.

COAL BREAKER.—An apparatus with tooth-rollers used to break the masses of coal into convenient pieces for the market, and sort them through screens or riddles. In the Pennsylvania anthracite region the sizes of coal are:

Lump will not pass mesh of 4 inches.

Steamboat will not pass mesh of 3 inches.

Broken will not pass mesh of 2½ to 2¾ inches.

Egg will not pass mesh of 2¼ inches.

Large Stove will not pass mesh of 1¾ inches.

Small Stove will not pass mesh of 1¼ to 1½ inches.

Chestnut will not pass mesh of ⅞ to 1 inches.

Pea will not pass mesh of ½ to ¾ inches.

Buckwheat will not pass mesh of ⅜ to ½ inches.

Rice will not pass mesh of ¼ inches.

The household sizes are egg and stove.

COAL GAS.—A complex hydrocarbon gas, containing about 90% of hydrogen and marsh gas, and 5% of heavy carbureted hydrogen and acetylene.

COAL OIL.—A colloquial expression in certain districts for petroleum, and also for the illuminating oils derived therefrom.

COAL TAR.—Condensed during gas manufacture from bituminous coal, in the form of a thick black liquid. In the hands of the modern chemist, it is the source of many by-products.

COARSE WINDING.—The few turns of thick insulated wire joined in series with the armature, employed in winding the field magnet of a series wound or compound wound dynamo.

COATED FILAMENT.—A radio tube filament having its surface covered with a layer of oxide for the purpose of improving the emission.

COATING.—In metallurgy, the process of covering metals with a superior metal as gilding, plating, silvering, galvanizing, etc.

COATINGS OF LEYDEN JAR.—The layers of tinfoil spread upon the outer and inner surfaces of a Leyden jar.

COBALT.—A tough, steel gray metal of the iron group. not easily fusible and somewhat magnetic, valued for the blue pigments it forms.

COBALT PLATING.—Depositing a layer of cobalt upon an object by electroplating. The baths employed for cobalt plating are chloride of cobalt, double chloride of cobalt and ammonium, or the double sulphate of cobalt and ammonium. Cobalt plate resembles nickel plate, and articles coated with cobalt are sometimes designated "superior nickel plate."

COCK.—In mechanics, a device for regulating the flow of fluids through a pipe.

COCKPIT.—The opening and space in the body of an airplane or boat where the passengers sit.

CODE.—A system or arbitary arrangement of signals for effecting communication at a distance.

COEFFICIENT.—In mathematics, a number or letter affixed to a quantity, to show how many times the quantity is to be taken. Hence a coefficient is a multiplier or factor, and when it enters into a formula, represents some known value, usually found by experiment.

COEFFICIENT OF ELECTRO-MAGNETIC INERTIA.—The coefficient of self-induction; being the quantity of induction in a circuit per unit current in it.

COEFFICIENT OF EXPANSION.—The ratio between the increase of volume which a substance undergoes when its temperature is raised by one degree C., and its original volume; thus, in the Centigrade scale the coefficient of expansion of air per degree is .003665=1/273; that is, the pressure being constant, the volume of a perfect gas increases 1/273 of its volume at 0° C. for every increase in temperature of 1° C. In Fahrenheit units it increases 1/491.2=.002036 of its volume at 32° F. for every increase of 1° F.

COEFFICIENT OF FRICTION.—The ratio of the force required to slide a body along a horizontal plane surface to the weight of the body. It is equivalent to the tangent of the angle of repose; that is, of the angle of inclination to the horizontal of an inclined plane on which the body will just overcome its tendency to slide.

COEFFICIENT OF HYSTERESIS.—A certain constant measuring the work spent in taking one cubic centimeter of iron through one complete magnetic cycle.

COEFFICIENT OF INDUCTANCE.—The coefficient of self-induction; being the induction in an electric circuit per unit current in it.

COEFFICIENT OF INDUCTION.—The ratio between the magnetic flux density of a magnetic substance and the field intensity; also called, the magnetic permeability.

COEFFICIENT OF MAGNETIC LEAKAGE.—The ratio of the lines of force which pass away through the air and are wasted, to those which are utilized through the armature of a dynamo or motor.

COEFFICIENT OF MAGNETIZATION.—A term sometimes applied to magnetic susceptibility, which is the ratio between the intensity of magnetization acquired by a magnetic substance and the magnetizing force acting upon it.

COEFFICIENT OF MUTUAL INDUCTION.—The number of lines of induction due to unit current in a circuit which passes through in one second.

COEFFICIENT OF SELF-INDUCTION.—The quantity of induction passing through a circuit per unit current in it; also called inductance. It is measured in terms of the henry.

An inductance of one henry exists in a circuit when a current changing at a rate of one ampere per second, induces a pressure of one volt in the circuit. The millihenry, or the one-thousandth part of a henry, is often used as a more convenient unit.

COERCIVE FORCE.—The magnetizing force necessary to remove all the magnetization remaining in a piece of magnetic material after the magnetizing force has been discontinued.

COFFIN AVERAGING INSTRUMENT.—A form of planimeter having only one leg which carries the graduated wheel. At one end of the leg is a pin, arranged to slide in a straight slot; at the other end is the tracing point. When the outline of an indicator card or other figure is traced by the point, the reading gives the average height, thus making it unnecessary to divide area obtained by reading obtained on a planimeter to get the average height.

COHERENCE.—The act of cleaving or sticking together; cohesion.

COHERER.—A device formerly used for detecting the presence of electro-magnetic waves consisting of a glass tube containing metallic fillings making a connection between two electrodes, or sometimes, two minute metal spheres in light contact. Now obsolete.

COHESION.—In physics, the principle or property by which the particles of a substance hold together, opposed to repulsion. In solids, cohesion is greater than repulsion, especially in the case of metals; with liquids, the two forces are about balanced, while in gases, the force of repulsion is far greater than that of attraction.

COIL AERIAL.—An aerial consisting of one or more complete turns of wire.

COIL AND PLUNGER.—An electro-magnet consisting of a hollow coil or spool having a free core which, upon the passage of an electric current through the coil, is drawn into it; a solenoid.

COIL, ELECTRIC.—Successive turns of insulated wire which create a magnetic field when an electric current passes through them.

COIL HEATER, ELECTRIC.—A heating apparatus which produces heat by the resistance offered to the flow of electricity through a coil of wire.

COIL LOADING.—In telephony, a loading in which the normal inductance is altered by the insertion of lumped inductance in the circuit at intervals.

COIL VAPORIZER.—A device for producing vapor from a volatile liquid by passing the latter through a coil, heated externally by a flame, etc. Used in certain types of lamps burning naphtha and the like, and in oil engines.

COILING SPACE OF CABLE TANK.—The space in a cable tank designed to hold the coils of the cable.

COIN BOX TELEPHONE.—A type of telephone consisting of the usual transmitter and receiver and a bell box containing an induction coil, a condenser and a bell. In addition there is a coin collect and return magnet. The coin, when dropped into chute, follows a zig-zag path and finally drops onto a small platform or coin trap. However, before reaching this point, the coin has accomplished two things: 1, struck a gong; and, 2, tripped a small lever which causes a set of contact springs to come together. This in turn causes a lamp to light at the Central Office switchboard, giving notice to the operator that a connection is desired. A 5c piece when dropped into the chute strikes a solid gong once, a 10c piece strikes the same gong twice and a 25c piece strikes a gong of the cathedral type once. The resultant characteristic tones are transmitted to the operator in the Central Office over the telephone wires.

COKE.—The result of distillation of coal.

COKED FILAMENT.—An incandescent lamp filament of carbon which has been electrically heated in a vacuum to such a degree as to reduce it to coke.

COKING.—1. The manufacture of coke from coal.

2. The process of reducing carbon to coke by electricity; as, when a carbon filament is reduced to coke by electric heat in a vacuum.

COKING PROCESS.—The application in a vacuum of an intense electric current to a carbon filament whereby it is reduced to coke.

COLD CATHODE GRID GLOW TUBE.—A form of radio tube consisting of an anode, cathode and grid. In operation, it acts as a relay, that is very small current changes in one circuit control very large current changes in another circuit, the ratio being 20,000 to 30,000

COLD DRAWN.—A term applied in connection with wire or seamless tubes, which are drawn to size through rolls or dies while cold.

COLD ROLLED SHAFTING.—Round shafting rolled to exact size while cold; the passage through the finishing rolls produces a smooth, polished surface resembling the effect of planishing on sheet metals. Turning is unnecessary on these bars and the unbroken "skin" renders it very strong.

COLD SOLDERING.—A process of amalgamation of metallic surfaces by the aid of mercury. A hard amalgam is made of five or six parts of pure silver, three or four parts of tin and 3 to 5% of bismuth. This alloy is melted and cast into ingots, the ingots reduced to fine filings, and those filings mixed when required with enough mercury to form a stiff paste, which hardens in about an hour.

COLD WATER TEST.—The ordinary test of boilers, cylinders, pipes, etc., by water at ordinary temperatures, as distinguished from a test in which warm water or steam is employed. Also called **hydraulic test.**

COLLAR.—An enlarged cylindrical portion of a shaft, or a cylindrical ring or sleeve secured upon the shaft, in either case to serve as an abutment for securing something or preventing longitudinal movement of the shaft itself; as, a set collar.

COLLAR BEARING.—A bearing provided with several rings or collars, to take the thrust of a shaft, or in the case of a vertical shaft, to provide adequate surfaces for lubrication.

COLLAR GAUGE.—A ring or internal gauge for testing the dimensions of external cylindrical pieces; the corresponding gauge for testing cylindrical holes is the plug.

COLLECTING AMMETER.—A central station ammeter which accumulates the currents of the various machines so as to show the total output of the station.

COLLECTING COMBS.—Comb shaped devices for collecting electricity from the plate of a frictional electrical machine.

COLLECTIVE OR INTERCEPTIVE PUSH BUTTON OPERATION SYSTEM.—A specialized form of full automatic push button elevator control in which the car can be started by pressing a button in the car, or at a landing, and it can afterwards be stopped or intercepted by another button, if that button be at a floor (or corresponds to such a floor, in the case of buttons in the car) in between the point from which the car started and the floor to which it was called or dispatched by the first button pushed.

COLLECTOR GEAR FOR CRANES.—A device for conveying current from the mains to the moving crane. For overhead cranes, copper wires about ¼ to ⅜ ins. in diameter are stretched along the gantry, being supported at the ends by globe strain insulators. Trolley wheels or slides, mounted on the end carriage, make contact with these wires.

From the trolley wheels or slides, insulated cables are led to the switches and controllers, and to another set of trolley wires on the cross girders. Contact with these wires is made by sliders or trolley wheels on the crab, from which cables are led to the motors. For locomotive jib cranes overhead or underground collector gear is used similar to that used for tramway cars.

COLLECTORS.—1. Devices such as brushes and collecting rings, for drawing off electric current from the generating machine so that the electricity may be utilized.

2. The pointed combs or connections leading to the prime conductor on a static machine for collecting the electricity.

COLLET.—1. A small metal ring used for various purposes.

2. A ring, collar or flange secured upon an arbor or spindle.

3. The disc or ring which holds the dies in a screwing machine.

4. A small socket for holding a drill or bit.

5. The ring used to retain metallic packing in a stuffing box.

COLLODION.—A solution of pyroxylin (soluble gun-cotton) in ether containing a varying proportion of alcohol. It is strongly adhesive and is used by surgeons as a coating for wounds; but its chief application is as a vehicle for the sensitive film in photography. Collodion was at one time experimented with as a material for incandescent lamp filaments.

COLLOIDS.—Uncrystalline semi-solid jelly or glue-like bodies which diffuse slowly and have no tendency to pass through porous membranes; opposed to crystalloid.

COLOMBIN.—A mixture of barium and calcium sulphate used as a heat resisting insulation between the carbons of a Jablochkoff candle.

COLOPHONY (ROSIN).—It is the kind of rosin that is used as a flux, and consists of a coagulated exudation obtained from cuts in the bark of trees belonging to several species of Pinus, largely grown in America, and on the west coast of France. It comes in lumps but can be granulated by grinding in a coffee grinder or simply by hammering.

COLOR.—A property, depending on the relations of light to the eye, by which one is capable of distinguishing individual and specific differences in the hues and tints of objects. The sensation of color is due to differences in the wave lengths of light, the portion of the rays which is not absorbed by a surface giving it its distinctive color.

COLOR SENSITIVITY.—The sensitivity of a photo emissive cell to different colors that causes the photo cell current to change in wave length of radiant energy.

COLORING.—In electro-plating, the employment of special salts in the dipping baths, intended to produce shades and tints of colors on the plated articles other than those due to simple metals: as, gold, silver, copper or nickel.

COLUMN, ELECTRIC.—An early name for a voltaic pile.

COLZA OIL.—A pale yellow oil expressed from the seeds of the rape plant, having a specific gravity of .912-.920 at 60° F. The oil is used as an illuminant and a lubricant.

COMB.—A collector of electricity used on influence or frictional electric machines, it consists of a bar from which a number of teeth project like the teeth of an ordinary comb.

COMB LIGHTNING ARRESTER.—A multi-gap lightning arrester in which the gaps are formed by metal teeth opposite each other, resembling the teeth of a comb.

COMB OF STORAGE BATTERY.—The perforated lead plate used in storage cells; the grid.

COMBINATION BRACKET.—1. In telegraph or telephone pole line construction, a bracket for more than one insulator.

2. In lighting, a bracket adapted for both gas and electric lamps.

COMBINATION FIXTURES.—Gas fixtures that provide for electric lamps as well as gas.

COMBINATION LINE PROTECTOR.—A combination lightning protector.

COMBINATION THREE PHASE WINDING.—A method of connecting the coils of three phase alternators by combining the star and mesh windings.

COMBINED ARMATURE AND SHUNT FIELD CONTROL.—A method of speed regulation for d.c. motors. This is the easiest way of obtaining a wide range of speeds. Rheostats embodying this method are known as compound speed regulators. Standard regulators can be obtained, giving a wide range of speed variation, and special regulators may be constructed giving practically any desired range.

COMBINED AUTOMATIC AND STRAIGHT AIR BRAKE.—A type that provides for quick and flexible operation of the brakes on a single unit by straight air with the added facility of immediately changing to automatic operation when coupled to cars. This equipment is designed for use on electrically operated vehicles running in single car service or in trains. It is therefore especially adapted for both city and high speed interurban train service as well as for such service as is required of light electric locomotives or motor cars used for handling freight cars, switching, etc.

COMBINED CARBON.—In chemistry, carbon which has entered into true chemical combination with iron to form white pig iron, steel, etc., and is not perceptible to the eye; as distinguished from the graphitic carbon that is mixed rather than combined, and which gives the gray appearance and comparative softness to cast iron.

COMBINED FIBER AND SPRING SUSPENSION.—A method of suspending a magnetic needle by a fiber, or wire thread, combined with a spring, thereby minimizing the effect upon the instrument of any movement of the support upon which the instrument is placed.

COMBINED GALVANIC AND SINUSOIDAL CURRENT.—In electro-therapeutics, the combination of these two valuable currents gives the polarity effect of galvanism with the tonic effect of the rapid sinusoidal current. Many gynecologists employ this particular modality to great advantage in female G.U. pathology, for short seances, to avoid fatigue. Many uses will be found by the practicing physician, in view of its massage and chemical action.

COMBINING WEIGHTS.—In chemistry, the proportions in which elements or compound substances react upon each other; they are either the same as the atomic or molecular weights of the various substances, or a simple multiple or factor of those weights.

COMBUSTION CHAMBER.—In boilers, a chamber made large enough to allow the gases of combustion to combine and expand. The combustion chamber is necessary to furnish time and space for the combustible gases of the fuel to combine properly with the oxygen which comes in with the air through the hot fuel bed.

COMBUSTION PRODUCTS.—In steam engineering, the combustible parts of coal are hydrogen, carbon and sulphur; and the unburnable parts are nitrogen, water; and the incombustible solid matters such as ashes and cinder. In the operation of firing under a boiler the first three elements are totally consumed and form heat; the nitrogen and water in the form of steam, escape to the flue, and the ashes and cinders fall under the grates.

COME ALONG.—A wireman's tool used in drawing out wire to the proper tension. This tool is attached to a block and tackle, or drawn in by hand, and as soon as the proper force has been applied, the wire is held, while the lineman secures it to the insulator.

COMMERCIAL EFFICIENCY.—A factor for efficiency which takes into account, cost of plant, depreciation, maintenance, etc., used to obtain the actual cost of the power. Also called the **net efficiency**.

COMMERCIAL EFFICIENCY OF DYNAMO.—The output divided by the input.

COMMERCIAL EFFICIENCY OF MOTOR.—The commercial efficiency of a motor is the ratio of the output divided by the input: this is equivalent to saying that the efficiency is equal to the brake horse power divided by the electrical horse power.

COMMERCIAL FREQUENCIES.—The frequencies used in lighting and power circuits. Usually 25 cycles on power circuits and 60 cycles on lighting circuits.

COMMON BATTERY SYSTEM.—In telephony, a system of signal transmission in which, by centralizing the transmitter batteries and calling current generators at the exchange, it becomes possible for a subscriber to signal the central office by simply removing the receiver from the hook, and again by replacing it, thereby greatly simplifying the apparatus and methods employed in the old magneto system.

COMMON RELAY OF QUADRUPLEX SYSTEM.—In quadruplex telegraphy the "neutral" relay or that one which operates by a change in the current strength.

COMMON RETURN.—A single return conductor for several circuits.

COMMUNICATIVE RELAYS.—A type used for signaling in a great variety of ways; for indicating the position of switching apparatus or pre-determining the condition of electric circuits.

COMMUTATED CURRENTS.—Said of the alternating currents induced in the armature of a dynamo when they have been converted into direct currents by the action of the commutator.

COMMUTATING PLANE.—In a dynamo or motor an imaginary plane passing through the axis of the armature and the center of contact of the brush.

COMMUTATING POLES. — Small poles placed between the main poles of a commutating machine. The object of these poles is to provide an auxiliary flux or "commutating" field at the point where the armature coils are short circuited by the brush. This flux assists commutation, that is, it helps reverse the current in each coil while short circuited by the brush, and thus reduce sparking.

COMMUTATING RECTIFIER.—A mechanical rectifier.

COMMUTATION.—The act of converting the alternating currents in the armature inductors of a dynamo into direct currents by a device called the commutator. The act of commutation needs special study. If it be incorrectly performed, the imperfection at once manifests itself by sparks which appear at the brushes.

COMMUTATION CONTROL RELAY.—One which causes a motor operated rheostat on a booster synchonous converter equipment to function for commutation control.—NEMA.

COMMUTATOR.—1. In general, a contrivance for reversing the direction of electric currents in any circuit.

2. Specifically, copper bars or segments arranged side by side forming a cylinder; and insulated from each other by sheets of mica. The assembly is mounted upon the shaft near the armature and rotates with it. The inductors of the armature are so connected with the segments of the commutator that the currents collected by the brushes which bear upon the surface of the commutator are direct, although alternating currents are induced in the armature. A mechanical converter.

COMMUTATOR BARS.—The insulated metallic sections which combine to make up the commutator of a dynamo, upon which the brushes rest; commutator segments.

COMMUTATOR CARE.—This part of a dynamo or motor can be kept in perfect condition by observing the following:

1. Never allow carbon or copper dust to accumulate.
2. Never apply kerosene or any other combustible while machine is running, as sparking at the brushes will ignite it.
3. Avoid using so called commutator compounds.
4. Occasionally wipe commutator with a piece of canvas lubricated slightly with vaseline or sperm oil.
5. Never use cotton waste.
6. Use lubricants sparingly and never leave the commutator in a greasy condition.

COMMUTATOR FAULTS.—If the surface of the commutator be rough, worn into grooves, or eccentric, or if there be one or more segments loose or set irregularly, the brushes will be thrown into vibration, and sparking will result. To remedy, use sand paper or file; if in very bad condition return in lathe or commutator truing machine.

COMMUTATOR FLATS.—A lowering in level caused by wear of the metallic segments of a commutator. It is generally caused by sparking set up by periodic springing in the armature mounting.

COMMUTATOR LUG.—A prolongation of a commutator segment at the back for the purpose of securing the leads from the armature.

COMMUTATOR MOTOR.—A motor driven by alternating currents, carrying a commutator upon its armature. There are numerous types of commutator motors, classed as:

1. Series: a, single phase; b, universal.
2. Neutralized series: a, conductively; b, inductively.
3. Shunt: a, simple; b, compensated.
4. Repulsion (sometimes called inductive series): a, straight; b, compensated.
5. Repulsion start induction: a, brush lifting; b. short circuiting.
6. Repulsion-induction.
7. Induction-synchronous.

Of these numerous types some are of importance commercially and some only of interest theoretically.

COMMUTATOR PAD.—In railroad signaling apparatus, a felt pad applied to switch and derail motors to keep the commutator clean.

COMMUTATOR PITCH.—In the connection of armature coils, the distance around the commutator bridged by the ends of the coils measured in terms of the commutator segments. Thus, if the commutator segments were numbered consecutively 1, 2, 3, etc., and the commutator pitch may be 10, it would signify that one end of the coil was connected to segment 1, and the other end to segment 11; the ends of the next coil in order then would be connected to segments 2 and 12, in each case there would be ten segments between the two segments connecting with the coil ends. On some winding tables the segments are indicated by letters instead of numbers.

COMMUTATOR PRESS BUTTON.—A telephone calling device whereby a subscriber may summon the central station by pressing a button, and so reversing a battery.

COMMUTATOR RIPPLE.—The slight variation in voltage of dynamo current due to commutation.

COMMUTATOR SEGMENTS.—The copper bars which are laid together so as to form the cylindrical surface of a dynamo or motor commutator; commutator bars.

COMMUTATOR SMOOTHING STONE.—A kind of stone used for grinding commutators. These stones consist of compounded abrasive material for grinding out scores or roughened and flat surfaces on commutators. Their application is extremely simple. With the machine in full operation the smoothing stone is held against the revolving commutator and moved very slowly from side to side. A coarse texture should first be used when truing the commutator, after which a stone of finer texture should be applied to secure the desired finish. With the surface true and smooth the occasional application of the finer texture stone will keep the commutator in excellent condition.

COMMUTATOR TRUING DEVICE.—A portable device for machines having brush mechanism mounted on a yoke carried by the field frame. It consists of a carriage for the tool holder having a screw feed and a bracket for attaching to the brush yoke. The bracket replaces two brush holder brackets on the brush yoke, and is made to fit the yoke of the particular machine on which it is to be used.

COMPARATOR.—An instrument by means of which an a.c. ammeter or volt meter may be calibrated with the d.c. standard. It is essentially a hot wire instrument which indicates zero when the a.c. and d.c. to be compared are equal.

COMPARTMENT MANHOLE.—A type having compartments to accommodate various sections of cable.

COMPASS.—The magnetic compass consists of a magnetic needle pivoted on a fine point within a suitable case; below the needle is placed a card graduated to degrees and the cardinal points, so that the movements of the needle, which lies N. and S., always indicate the bearing of any object. The mariner's compass consists of a skeleton card mounted upon the needles, two or four parallel magnets being employed. There are two graduated circles, the inner showing the 32 points, halves and quarters, the outer graduated to 360°. The N. and S. diameter of the cards is parallel with the needles, the N. point being indicated by a fleur-de-lis; a black line (the lubber's line) is drawn vertically on the case in line with the vessel's keel, so as to show the direction of her head. The compass is mounted on gimbals, to preserve its horizontal position, the whole being mounted upon a binnacle, containing provision for counteracting deviation. A spirit compass is filled with a mixture of 1, alcohol; 2, water; within which the card floats, and is hermetically sealed.

COMPASS DEVIATION.—An error introduced in compass reading caused by the attraction of neighboring metal bodies.

COMPASS NEEDLE.—A polarized bar which is suspended so as to assume a direction resulting from the earth's magnetism.

COMPASS VARIATION.—An error in compass reading caused by movement of the earth's magnetic pole and by magnetic disturbances in general.

COMPENSATED ALTERNATOR.—An alternator for maintaining a uniform voltage in the circuit under different loads, having field magnets excited both by current from a separate dynamo and by current furnished by the armature.

COMPENSATED CONDENSER.—In duplex telegraphy, a condenser used to equalize the static capacity of the "artificial" line and that of the main line.

COMPENSATED GALVANOMETER.—A differential galvanometer adjusted to measure the strength of the current at some remote part of a d.c. circuit. One of its coils is shunt wound and one series wound with respect to that circuit.

COMPENSATED METER BRIDGE.—A slide meter bridge, so adjusted as to counteract the influence upon it of changes in temperature.

COMPENSATED PENDULUM.—A pendulum fitted with some form of device to counteract the difference in length caused by expansion. In one form, the bob is suspended by a framework of iron and brass rods, the upward expansion of the brass compensating the lower effect of the iron; in another, the bob or weight consists of a tube containing mercury, the upward elongation of the mercury counteracting the lengthening of the pendulum. In colder weather the downward movement of the brass or mercury balances the shortening of the rod.

COMPENSATED REPULSION MOTOR.—A type of a.c. commutator motor consisting of a simple or "straight" repulsion motor in which there are two independent sets of brushes, one set being short circuited while the other set is in series with the compensating winding. The two sets of brushes are known as, the energy or main short circuiting brushes and the compensating brushes. The compensated repulsion motor is a development of the straight repulsion type and was designed with the object of overcoming field distortion so as to increase the power factor of the machine. This type of motor is characterized by high power factor at speeds above synchronism, but at low speed its power factor is less than with the a.c. series motor, while at all speed points its torque per ampere is not as high.

COMPENSATED RESISTANCE COIL.—A resistance coil, so adjusted as to overcome the effects of the differences of temperature.

COMPENSATED VOLT METER.—A station volt meter so connected with the bus bars as to admit of automatic adjustment to any loss of pressure in any of its feeders, thus indicating the actual pressure furnished the main circuit.

COMPENSATED WATT METER.—An indicating watt meter in which the error caused by the absorbing of power in its series and potential windings is corrected by the introduction of a compensating coil connected in series with the potential coil.

COMPENSATING COIL.—1. A coil acting as or forming part of a compensating winding.

2. On d.c. machines the term is sometimes wrongly used as synonymous with the coil on an interpole.

3. On meters, an auxiliary coil used in d.c. energy meters to compensate for solid friction at low loads and on starting and in mercury motor-meters, to compensate for fluid friction at high loads. In the former it forms the low load adjustment, and in the latter the high load adjustment.

COMPENSATING CYLINDER.—An equalizing device, found on some high duty pumping engines, attached in pairs to each piston rod.

COMPENSATING LINE.—In duplex telegraphy, the artificial or false line, as distinguished from the main line.

COMPENSATING MAGNET.—A magnet employed to exert upon any indicating magnetic needle such a force as to overcome the effect of the attraction of the earth upon that needle.

COMPENSATING POLE.—An electro-magnetic bar or coil inserted between the pole pieces of a dynamo to offset the cross magnetization of the armature currents; also called, interpole or commutating pole.

COMPENSATING RESISTANCE.—A second resistance sometimes introduced in connection with a galvanometer shunt, in delicate measurements, to compensate for the reduction of resistance occasioned by the shunt.

COMPENSATING WINDING.—A dynamo winding designed to neutralize the armature crossfield, wound in series with the armature through holes in the tips of the pole pieces of a dynamo.

COMPENSATING WIRE.—In duplex telegraphy, the artificial or false line

COMPENSATOR.—1. A name sometimes given to the auto-transformer which is a single coil transformer, in which the same winding will serve both as a primary and as a secondary.

2. A type of starter for induction motors consisting of an auto-transformer for each phase, with taps, thus providing variable inductances which are inserted in the field magnet circuit.

3. In radio, part of a direction finder.

COMPENSATOR FOR A.C. LAMPS.—A small choking coil in the circuit to reduce the pressure at the lamp terminals.

COMPENSATOR VOLTAGE REGULATOR.—One in which a number of turns of one of the coils are adjustable.

COMPENSATOR SYSTEM.—The distribution of high pressure alternating currents to low pressure receptive devices through choking coils connected with the mains.

COMPLETE COMBUSTION.—Combustion in which all the elements contained in fuel, or in gaseous charges, enter fully into chemical combination with the air.

COMPLETE FAULT.—A defect which causes a complete break or interruption in an electric circuit.

COMPLETE WAVE.—A full alternation of an alternating current, conceived as rising from zero to its greatest value in one direction, returning, and reaching its greatest value in the other.

COMPLEX DISTRIBUTION OF LAMELLAR MAGNETISM.—A distribution of magnetism into complex magnetic shells.

COMPLEX FRACTION.—One whose numerator or denominator is a fraction.

COMPLEX HARMONIC CURRENTS.—Currents produced by the association of higher harmonic currents with the simple harmonic current.

COMPLEX HARMONIC MOTION.—The resultant of the combined action of simple harmonic motions.

COMPLEX HARMONIC PRESSURES. — Electric pressures which result from the existence of higher harmonics in conjunction with the fundamental pressure in alternating currents.

COMPLEX MAGNETIC SHELL.—A magnetic shell with varying magnetic strength in different parts of its faces.

COMPLEX WAVE.—A radio wave consisting of a combination of sine waves of different frequencies.

COMPONENT.—In mechanics, one of the parts of a stress or strain, out of which the whole may be compounded by the principle of the parallelogram of forces.

COMPONENT CURRENTS.—The several currents into which a single current may be supposed to be separated, so that, acting together, they would give the precise effect of a single current.

COMPONENT FORCES. — The separate forces into which any force may be divided.

COMPONENTS OF IMPEDANCE.—The element of actual resistance and the element of apparent or spurious resistance which are present in the opposition offered to the flow of the current.

COMPOSITE BALANCE.—An electric balance provided with both coarse and fine coils of wire for measuring either strong or weak currents.

COMPOSITE CABLE.—A multi-conductor cable having conductors of more than one size.

COMPOSITE GRID.—A form of grid of a storage battery composed of graphite covered lead foil layers between lead plates secured with lead rivets.

COMPOSITE NUMBER.—A number which can be exactly divided by other integers besides itself and one.

COMPOSITE WIRE.—A compound bi-metallic wire used in telegraph and telephone lines to secure both strength and conductivity; it consists of a core of iron or steel covered with a sheathing of copper; now superseded in best practice by hard drawn copper wire.

COMPOSITED CIRCUIT.—1. A two wire telephone circuit, arranged for the superposition on each of its component metallic conductors, of a single independent ground return signaling circuit.
2. A circuit which can be used simultaneously for telephony and direct current telegraphy or signaling, separation between the two being accomplished by frequency discrimination.—A. I. E. E.

COMPOSITELY EXCITED ALTERNATOR. —This type alternator is similar to a compound wound dynamo in that it has two field windings. In addition to the regular field coils which carry the main magnetizing current from the exciter there is a second winding upon two or upon all of the pole pieces, carrying a rectified current from the alternator which strengthens the field to balance the losses in the machine and also, if so desired, the losses on the line.

COMPOSITION OF FORCES.—The operation of finding a single force whose effect is the same as the combined effect of two or more given forces. The required force is called the resultant of the given forces. The given forces are called the components.

COMPOUND.—A mixture composed of two or more elements or parts; produced by the union of several ingredients, parts or things.

COMPOUND BOOSTER.—A compound dynamo used on railway and power circuits where there are great fluctuations in load, the battery acting to prevent excessive drop and to assist the generating machinery in carrying the load, relieving it from the strain of sudden rushes of current. Under ordinary working conditions, the shunt field of the booster creates an electric pressure in the same direction as that of the battery, tending to discharge it.

COMPOUND CABLE.—A cable having a core made up of several wires stranded, or otherwise bound together.

COMPOUND CATENARY.—A track messenger strand supported by insulators which are suspended from a main grounded messenger supported on bridges.

COMPOUND COMPRESSION.—The operation of compressing air, ammonia or other gases in two stages, successive pressure being applied at each stage, the size of the compressor cylinders being correspondingly reduced. This gradual process overcomes much of the loss occasioned by super heating of the cylinders and facilitates the attainment of high pressure.

COMPOUND DYNAMO.—A dynamo having two windings, of which one is in series with the armature and the other shunted across the armature; known as series winding and shunt winding respectively. The purpose of the series winding is to strengthen the magnets by the current supplied from the armature to the circuit, and thus automatically sustain the pressure. If the series winding were not present, the pressure at the terminals would fall as the load increased. This fall of pressure is counteracted by the excitation of the series winding, which increases with the load and causes the pressure to rise. The number of turns and relative current strengths of the series and shunt windings are so adjusted that the pressure at the terminals is maintained practically constant under varying loads.

COMPOUND DYNAMOS IN PARALLEL.—Machines of this type will not run satisfactorily together in parallel unless all the series coils are connected together by an equalizing connection, as in series dynamos.

COMPOUND ENGINE.—A steam engine in which the steam is expanded in two stages, thus reducing the range of temperature in the cylinders, and making the turning effort nearer uniform. The cylinder of the first stage of expansion is termed a high pressure cylinder, the larger or second one, the low pressure cylinder. Sometimes a compound engine has three cylinders; one high pressure exhausting into two low pressure cylinders. This type should not be confounded with a three cylinder triple expansion engine in which the steam passes from the high to the intermediate, thence to the low pressure cylinder. Three cylinder compounds and four cylinder triples are open to serious criticism. The complication and cost of the extra cylinder is not justified without the saving due to an extra expansion stage.

COMPOUND FRACTION.—A fraction of a fraction.

COMPOUND GAUGE.—A pressure gauge registering pressures above and below that of the atmosphere, or pressure and vacuum. A compound gauge is often fitted to the low pressure receivers of compound steam engines, or to the suction connections of pumps.

COMPOUND MAGNET.—A magnet made up of a group of single magnets parallel with one another with their similar poles together. A compound magnet is stronger in proportion to its bulk and weight than a single magnet.

COMPOUND MOTOR.—A d. c. motor in which the magnet coils have both series and shunt windings, hence it is a combined series and shunt motor.

COMPOUND MOTOR CHARACTERISTICS.—This type of motor has, to a certain extent, the merits of the series motor without its disadvantages, and is adapted to a variety of service. If the current flow in the same direction through both of the field windings, then the effect of the series coil strengthens that of the shunt coil; this strengthening is greater, the larger the armature current. Since it is a combination of the shunt and series types, it partakes of the properties of both. The series winding gives it strong torque at starting (though not as strong as in the series motor), while the presence of the shunt winding prevents excessive speed. The speed is practically constant under all loads within the capacity of the machine. Compound motors are used where there is a heavy load to be started as with the series motor and where at the same time the speed limiting charactristics of the shunt wound motor is desired.

COMPOUND OILS.—In lubrication, the advantage of a compound oil is believed to be that certain advantages of single oils are gained and their disadvantages neutralized.

COMPOUND PROPORTION.—An expression of equality between a compound and a simple ratio, or between two compound ratios. The principle of compound proportion is that the product of two or more proportions is a proportion.

COMPOUND QUANTITY.—An expression containing units of two or more denominations of the same kind, as five yards, one foot and four inches.

COMPOUND RADICAL.—A group of atoms of matter which remains undecomposed throughout a series of chemical changes undergone by the molecules of which it forms a part.

COMPOUND RECEIVER.—A telephone receiver consisting of two distinct receivers combined in a single shell, employed by a central station operator to secure a circuit independent of the speaking circuit.

COMPOUND SYNCHRONOUS CONVERTER.—A compound wound converter designed to maintain an approximately constant voltage.

COMPOUND WINDING.—A method of winding a dynamo or motor field magnet with two sets of coils, one of which is connected in series and the other in parallel with the armature and outside circuit.

COMPOUND WOUND MOTOR.—A motor having compound (that is, series and shunt) field magnet windings in order to secure uniform speed under varying loads.

COMPOUNDING OF ROTARY CONVERTERS.—Compounding is desirable where the load is variable, such as is the case with interurban railway systems. The purpose of the compounding is to compensate automatically for the drop due to line, transformer and converter impedance.

COMPRESSED AIR.—Atmospheric air compressed by mechanical means into a state of increased density. The air is often compressed by pumps at a central station whence it is led in pipes to the spot where the power is required. It may also be transported in steel tanks of convenient dimensions. The power stored in the air is given up on expansion within a cylinder, where it drives a piston in the same manner as steam. Compressed air is employed to drive drills, riveting and chipping machines; many varieties of portable tools; hoists and pumps; small scattered engines or auxiliary machines for various purposes.

COMPRESSED AIR CONDENSER. — One whose dielectric is air at a pressure higher than atmospheric: the object being to increase the dielectric strength.

COMPRESSIBILITY OF GASES.—Owing to the perfect freedom of motion among the molecules of a gas, it is possible to compress gases to a very great extent, reducing a given volume very much. The pressure at constant temperature varies in inverse ratio to the volume, according to **Boyle's Law.**

COMPRESSIBILITY OF LIQUIDS. — As with gases, liquids can offer no resistance to change of shape, only to change of volume. Their resistance to change of volume is very great indeed, and can only be ascertained by delicate experiments; a pressure of one atmosphere will compress a volume of water about .0000466 of its bulk, and a volume of alcohol only .0000216. This is so slight that it may be neglected in engineering.

COMPRESSIBILITY OF SOLIDS.—This varies greatly; with metals and many elementary substances it is so small as to be neglected in engineering, but with highly complex substances, especially those of organic origin, it is often very large; as, for instance, with most woods, cork, india rubber, etc.

COMPRESSION.—1. In physics, the reduction in length, area, or volume of a body, which is occasioned by the application of external force or pressure.

2. In a steam engine, the point on the exhaust stroke at which the valve closes the exhaust, causing steam to be compressed from that point to the point of pre-admission. During compression the pressure varies approximately inversely as the volume being represented by an equilateral or rectangular hyperbola referred to its rectilinear asymptotes. On account of the condensate trapped in the cylinder the actual curve traced by an indicator during compression will be higher than the hyperbolic curve near the end of compression, due to re-evaporation caused by the heat of compression.

COMPRESSION CHAMBER ARRESTER.—A lightning arrester in which the essential elements are two electrodes with a small air gap between them, placed between line and ground. The lightning voltage sparks over the gap and a current flows to ground, thus relieving the lightning strain. Arresters of this type are made for the protection of apparatus on secondary lighting and power circuits. The 750 volt arresters are especially suitable for the protection of apparatus on railway signal feeder circuits. All are for outdoor service only.

COMPRESSION CONDENSER.—A seldom used name for a variable condenser.

COMPRESSION KNOCK.—In a gas engine, a knock occurring during compression in a badly carbonized cylinder due to pre-ignition from incandescent carbon.

COMPRESSION SYSTEM.—In refrigeration, a system employing a volatile agent having a low boiling point, such as ammonia, carbon dioxide, methylic ether, sulphurous acid, etc. The volatile agent is drawn into the compressor, and forced by it into a condenser or liquefier, where it meets with cooled surfaces, parts with its latent heat, and becomes liquid under pressure. It is then released through the regulating or expansion valve, into the expansion pipes—coils of piping or the like within an insulated space or refrigerator—there the liquid encounters a low pressure only and volatilizes into gas, absorbing the heat necessary for the transformation from the surrounding air or liquid, chilling or freezing the latter by the abstraction. The expanded gas is exhausted by the suction stroke of the compressor, and the process is repeated continuously. This system is largely used in the so-called "electric" refrigerators, that is, domestic refrigeration units.

COMPRESSOR.—In refrigeration, a machine for compressing the refrigerant to a suitable pressure, so as to obtain the refrigerating effect by subsequent expansion. There are various types of compressor; they may be either vertical or horizontal, and there is much variation in the details of the valves. These differences are due to attempts to reduce clearance and heating. To prevent injury because of the practically zero clearance, a false head is provided with springs to hold it against the cylinder end in order that if the piston overtravel because of a loose bearing it will simply raise the head.

CONCAVE.—Depressed or indented with curved outlines; a surface which is part of the interior of a hollow sphere; opposed to convex.

CONCEALED KNOB AND TUBE WIRING.—A method of running wires under floors and in partitions by supporting them on knobs and tubes. This method of wiring should be discouraged as far as possible, as it is subject to mechanical injury, is liable to interference from rats, mice, etc. As the wires run according to this method are liable to sag against beams, laths, etc., or are likely to be covered by shavings or other inflammable building material, a fire could easily result if the wires become overheated or short circuited.

CONCEALED WIRING.—Rendered inaccessible by the structure or finish of the building. Wires in concealed raceways are considered concealed.

CONCENTRATED LOAD.—In mechanics, a localized load or stress bearing upon one particular point of a beam or similar structure.

CONCENTRATED WINDING.—An armature winding consisting of one coil per phase per pole. Sometimes called monotooth or uni-coil winding. The features are: cheap construction, maximum voltage for a given number of inductors. Concentrated windings have greater armature reaction and inductance than other types, hence the terminal voltage of an alternator with concentrated winding falls off more than with distributed winding when the current output is increased. An alternator, therefore, does not have as good regulation with concentrated winding as with distributed winding nor as great capacity.

CONCENTRATION THROW.—The deflection of a magnetic needle when exposed to a current generated by metal plates subjected to chemical action within a magnetic field.

CONCENTRATOR.—A telegraph device for traffic distribution by means of which a number of telegraph or telephone lines and connections to operating instruments are brought together at one point to facilitate their interconnection at such times as signals or messages are to be transmitted from one to the other.

CONCENTRIC CARBON.—An arc lamp carbon having an inner core of charcoal or of a softer grade of carbon than the outside, also known as cored carbon; it is used in a modification of the "Jablochkoff candle."

CONCENTRIC CONDUCTOR.—A tubular conductor containing an inner conducting core separated from it by insulation.

CONCENTRIC CYLINDRICAL CARBON.—Arc light carbons composed of a carbon rod within a hollow carbon cylinder, and insulated from it by an air space or by interposed insulating material.

CONCENTRIC DIFFUSER.—A device for improving the distribution of light from enclosed arc lights. The concentric diffuser consists of a metal reflector having properly designed corrugations for distributing downward the light thrown by the arc above the horizontal plane. It is attached to the lamp casing in a manner similar to an ordinary reflector or shade and in the place of an outer globe, a screening shade is used for subdividing the light directly under the lamp, and for reflecting a portion of it on to the diffuser.

CONCENTRIC LAY CABLE.—A cable consisting of a heavily insulated core surrounded by one or more layers of helically laid wires.

CONCENTRIC MAINS.—Main conductors consisting of concentric cables.

CONCENTRIC STRAND.—A strand composed of a central core surrounded by one or more layers of helically laid wires or groups of wires.

CONCRETE.—A mixture of Portland cement, sand and some coarse material, such as gravel, broken stone, etc.; much used for foundations, heavy masonry and engineering structures generally.

CONCRETE NUMBER.—A number used to designate objects or quantities.

CONCRETE POLES.—Transmission line poles made of concrete either solid or hollow. The solid type is made in a trough form and is reinforced by steel rods running lengthwise. In the manufacture of hollow concrete poles, the reinforcing steel is held rigidly in the place it was designed to occupy. The complete reinforcing cage is then placed in a horizontal form and held at the desired distance from the surface of the form by concrete buttons which become part of the finished wall of the pole. Concrete is added and the entire form rotated at high speed developing centrifugal force sufficient to compact the concrete into a very dense wall, leaving a hollow opening in the center running through the length of the pole.

CONDENSANCE.—The reactance in an electric circuit due to capacity acting in the opposite direction to the reactance of the inductance.

CONDENSATE.—Water formed by a change of state which occurs when the temperature of steam becomes less than that corresponding to its pressure.

CONDENSATION.—Reduction in bulk of any substance accompanied by increase in density. Specifically applied to the transformation of heated vapor into liquid by contact with a cold body; as, the condensation of exhaust steam from an engine. The liquid thus formed being known as the condensate.

CONDENSER.—1. An accumulator of electrical energy. A Leyden jar is a simple form of condenser.

2. A type largely used consists of layers of tin foil insulated from each other by sheets of paraffined paper, oiled silk, mica, etc., sealed in an air tight case. It is an important apparatus in telegraphy and telephony and radio. Mica condensers should be used in preference to paper condensers, especially for ignition service.

3. In steam engineering, an apparatus in which the exhaust steam is reconverted into water, either by mingling with a spray of cooling water, or by contact with cooled surfaces. The first process is termed jet condensation; the second surface condensation.

4. In radio, a device consisting of two or more conducting surfaces, separated by various dielectrics as air, paper, mica. There are several types of radio condenser as: a, fixed; b, variable; c, by pass; d, transmitting, etc.

CONDENSER AERIAL.—A radio aerial consisting of two condenser plates, one of which may be a wire or set of wires elevated above the ground, and the other, either the ground or another set of wires. The wire or set of wires elevated above the ground is only a part of the whole aerial. A capacity aerial.

CONDENSER CAPACITY.—The quantity of electricity a condenser is capable of containing. Measured in farads or microfarads.

CONDENSER DIELECTRIC.—The insulating material between the plates of a condenser, consisting of air, paper, mica, etc. The condenser should be named according to the dielectric as a paper condenser, mica condenser, etc. For automobile ignition usually paper condensers are furnished simply because they are cheap; however, they will be found very expensive when disabled far from a repair shop. Use only a mica condenser.

CONDENSER IN PARALLEL.—In radio, a hook up for a tuned primary circuit consisting of placing a condenser in parallel with an inductance coil or another condenser in the aerial circuit.

CONDENSER IN SERIES.—In radio, a hook up for a tuned primary circuit consisting of placing a condenser in series with an inductance coil or another condenser in the aerial circuit.

CONDENSER LEAKAGE.—A very slow discharge of a condenser through the dielectric because the latter is not an insulator.

CONDENSER LIGHTNING ARRESTER.—A lightning arrester operating through a condenser placed in the circuit for that purpose.

CONDENSER MICROPHONE.—A device for changing sound waves into electric current variations. Consisting of an air condenser so constructed that the sound waves cause movement of the condenser plates, thereby varying the impedance and capacity and causing current variation in a connected circuit corresponding to the sound wave.

CONDENSER PICK UP.—A phonograph pick up whose operation is based on changes in electrostatic capacity.

CONDENSER PLATES.—Sheets of tin foil. In a condenser there are two sets of plates separated from each other by sheets of an insulating material called the dielectric.

CONDENSER PRESSURE.—Back or reverse pressure set up by a condenser which opposes the capacity pressure. Phase difference 180°. When the current begins to flow into a condenser, that is, when the flow is maximum, the back pressure set up by the condenser (called the condenser pressure) is zero, and when the flow finally becomes zero, the condenser pressure is maximum. The condenser pressure, when the condenser is discharged being zero, the current enters at a maximum velocity and gradually decreases to zero as the condenser pressure rises to maximum, this change taking place in one quarter period. Thus the condenser pressure, which opposes the current, being at a maximum when the current begins its cycle is 90° ahead of the current.

CONDENSER RHEOSTAT.—In duplex or quadruplex telegraphy, a rheostat connected with a condenser in the false or artificial line.

CONDENSER TESTING METHOD.—In electro-therapeutics the application of low voltage condenser discharges of varying duration to test the degree of excitability of the individual muscles. It is less painful than the ordinary faradic and galvanic test. Measured in micro-farads.

CONDENSER TUBES.—Small brass tubes which form the cooling surface in a surface condenser, they are made of solid drawn brass, a composition of 68% of best selected copper and 32% of best Silesian spelter. The Admiralty, however, always specify the tubes to be made of 70% of best selected copper and to have 1% of tin in the composition, and test the tubes to a pressure of 300 lbs. per sq. in. (Seaton). The diameter of the condenser tubes varies from ½ in. in small condensers, when they are very short to 1 in. in very large condensers and long tubes. In the mercantile marine the tubes are, as a rule ¾ in. diam. externally, and 18 B.w.g. thick (.049 in.) and 16 B.w.g. (.065) under some exceptional circumstances. The smaller the tubes, the larger is the surface which can be put in a certain space. (Seaton.) Whitham says the velocity of flow through the tubes should not be less than 400 nor more than 700 ft. per min.

CONDENSER TUNING.—A method of bringing the tuning circuit into resonance by varying the capacity of the condenser. In radio variable condensers with air dielectric are used.

CONDENSING ELECTROSCOPE.—A form of gold leaf electroscope invented by Volta, in which the condensing power of two prepared discs is used to aid in the detection of very feeble electric charges.

CONDENSING ENGINE.—A steam engine in which the exhaust steam is condensed instead of being discharged into the air.

CONDUCELL.—A cell like insulator used in a cable joint. Conducell for a three conductor cable consists of an outer seamless tube, three similarly formed curved inner separating pieces, and two end spacing rings. This assembly forms three separate cells for the conductors, the parts being interlocked among themselves.

CONDUCTANCE.—That quality of a given conductor in virtue of which it facilitates the flow of an electric current; it is the opposite of resistance, and is measured in terms of the mho. Conductance varies directly as the area of the cross section and inversely as the length. Heat decreases the conducting power of elementary substances. Carbon is an exception, being a better conductor at a red or white heat than when cold. At low temperatures the conducting power of metals is improved.

CONDUCTANCE LEAK.—A leak occasioned in a circuit as a result of conduction, as opposed to one produced by induction.

CONDUCTING POWER.—1. The capability of a substance to conduct electricity, considered in comparison with the conducting power of pure copper taken as a standard.

2. The power which a substance has of conducting heat through its mass; thermal conductivity.

3. The susceptibility of a substance to allow the free action of magnetic force through it; sometimes called magnetic transparency.

CONDUCTING SURFACES.—Those surfaces of a steam boiler which are directly arranged for the transmission of heat; as, the heating surface of a boiler which is a conducting surface.

CONDUCTION.—1. The flow of an electric current through a conducting body, such as a metallic wire.

2. The transfer of heat from the hotter to the colder parts of a body. Hence, conduction depends upon the fact of inequality in temperature existing in the several portions of a body. The transfer of heat through solids; as, through boiler plates, is due to conduction.

CONDUCTION CURRENT.—A current comprising the movement of negative electricity (electrons) exclusive of any movement due to the transportation of negative electricity by masses larger than electrons.

CONDUCTION OF HEAT.—The transfer of heat from one substance to another in contact with it. Any body which transmits heat rapidly is called a good conductor of heat; one that passes heat slowly is termed a bad conductor. Homogeneous bodies such as metals are the best conductors; those which are finely fibered such as cotton, wool or wadding; or those finely sub-divided as charcoal dust or pulverized cork, are the worst conductors of heat. A very bad conductor is also known as an insulator.

CONDUCTIVE DISCHARGE.—A discharge of electricity from a charged body, by bringing a conducting substance into contact with it; as distinguished from disruptive discharge.

CONDUCTIVITY.—1. The specific electric conductance of a substance, the relative power of carrying the electric current possessed by different substances, the conducting power of pure copper being taken as the standard. Sir William Thomson has suggested as the unit of conductivity, the mho or ohm written backwards, the reciprocal of the ohm.

2. The relative value of a material, as compared with a standard, in affording a passage for the transmission of an electric current.

CONDUCTOR.—1. An electrical path which offers comparatively little resistance. Conductors may be classed with respect to their conducting power as: a, good; silver, copper, aluminum, zinc, brass, platinum, iron, nickel, tin, lead; b, fair; charcoal and coke, carbon, plumbago, acid solutions, sea water, saline solutions, metallic ores, living vegetable substances, moist earth; c, partial; water, the body, flame, linen, cotton, mahogany, pine, rosewood, lignum vitae, teak and marble.

2. A wire or combination of wires not insulated from one another, suitable for carrying a single electric current. The term "conductor" is not to include a combination of conductors insulated from one another, which would be suitable for carrying several different electric currents. Rolled conductors (such as bus bars) are of course conductors, but are not considered under the terminology here given.

CONDUIT.—For underground wiring there are numerous kinds of conduit, and they may be classified with respect to material, as a, vitrified clay; b, wood; c, fibre; d, metallic.

CONDUIT BENDER.—A tool for bending pipe conduits; properly called hickey.

CONDUIT BOXES OR MANHOLES.—A manhole is a vault or box-like structure built under the street, having a circular opening with a cast iron cover at the street surface, and large enough to conveniently admit a man, so that access may be had to the conduit ducts and the cables. Manholes should be provided about every 300 feet, in order to facilitate the installation of the conductors in the duct.

CONDUIT FITTING.—A box like device provided with projections which have female pipe threads to which the conduit is screwed direct. They are similar to pipe fittings but modified to suit the condition for which they are intended. A conduit fitting differs from an ordinary pipe fitting principally in that it has an opening with a removable cover.

CONDUIT RISER.—The most important unit of permanent conduit installation used in conjunction with easily changed ceiling and wall under plaster extensions of oval raceway or oval cable. It consists of conduit turned up from run in floor fill into a convenient outlet 12 inches up the side wall or column, conduit extended thence up wall into permanent switch outlet located at usual height of 4½ feet from floor and thence extended further up the wall, terminating in a junction or pull box near ceiling.

CONDUIT TROLLEY SYSTEM.—An underground trolley system in which the conductor is run in an underground conduit midway between the rails of the track, the connection with the motor being effected by means of a shoe introduced through a slot. This system is used only in large cities having trolley cars and where poles and overhead wires are not permitted. The construction is extremely high in cost compared with trolley wire installation.

CONDULET.—A conduit fitting.

CONE.—In geometry, a solid figure described by the rotation of a right angle triangle upon one of its sides as an axis, or one which tapers uniformly from a circular base to a point.

CONE SPEAKER.—A radio loud speaker having a cone shaped radiating element.

CONE VALVE.—A hollow valve having a conical, perforated face, through which water is discharged when the valve rises, without impinging directly upon the valve face or seat.

CONED PLUNGER.—A solenoid core made thicker midway between the ends, instead of having the usual cylindrical shape, for the purpose of obtaining a nearer uniform pull in different portions of the coil.

CONIC SECTION.—Any section cut by a plane passing through a cone. Depending upon the inclination or position of the plane with the axis of the cone. The sections cut are: a, triangle; b, circle; c, ellipse; d, parabola; e, hyperbola.

CONICAL CONDUCTOR.—A conductor of conical shape, tapering at the ends, used for obtaining a constant density of the current in a parallel system of electrical distribution.

CONJUGATE.—1. United in pairs; yoked together; coupled.
2. In chemistry, containing two or more radicals supposed to act the part of a single one.

CONJUGATE COILS.—Two coils in such relation to each other, as to possess the attributes of conjugate conductors; they are so placed that the lines of force established by one do not pass through the other coil. With this arrangement, variations of current may take place in one without inducing currents in the other.

CONJUGATE CONDUCTORS.—Two conductors so related to each other that the presence of electric pressures in one produces no effect on the other, and variations of the current in one results in no induced currents in the other.

CONJUGATE FOCI.—In optics, two points so related that object and image may exchange places.

CONNECTING BARS.—In a telephone multiple switchboard, metal bars for connecting the operator's set with the call wire spring jacks.

CONNECTING BOX.—In underground wiring, a metallic box in which junctions are made between feeders and mains, or between mains and supply wires.

CONNECTING JACK.—The terminal of a line entering a telephone exchange; it consists of a socket containing a simple switching device, mounted on the face of a switchboard, into which the connecting plug is to be inserted.

CONNECTING PEG.—A piece of metal for filling an air space in any apparatus, in order to make an electrical connection across that space; a plug.

CONNECTING SCREWS.—Binding posts, or similar devices, for securing conductors at the point of electrical contact.

CONNECTING SIDE.—The side of a telephone switchboard on which the operator makes the connections with the subscribers called for.

CONNECTING SLEEVE.—A device, usually provided with binding screws, for holding in contact the ends of wires brought into electrical connection.

CONNECTION.—A finished electrical contact.

CONNECTION BOARD OF TRANSFORMER.—A board within a transformer, having binding posts, by means of which connections are made between outside circuits and the transforming coils.

CONNECTOR.—1. Any device for holding, in electrical contact, the ends of conducting wires, in such a manner that they may readily be released when it is desired to disconnect them.
2. For a storage battery, a solid or flexible part for connecting positive pole of one cell to negative pole of another, or to terminal.

CONNECTOR SWITCH OR FINAL SELECTOR.—An automatic telephone switch whose duty is to establish a connection with the called line. It is usually operated by the last digit or digits of the call number.

CONOIDAL.—Anything having the form of a conoid. Any solid generated by the revolution of an ellipse, a parabola, or a hyperbola about an axis; sometimes confined to the two last named solids, and then excluding ellipsoids or spheroids. A surface generated by a line that so moves, parallel with a plane, as always to touch a straight line and a curve.

CONSEQUENT POLES.—1. Magnetic poles occurring abnormally at some point along the axis of a magnetized bar which has its regular poles at the ends; secondary or resultant poles.
2. Magnetic poles developed on a dynamo when the direction of the current flowing in the magnetizing coils is such as to produce two similar poles in each pole piece.
3. Poles occurring in a dynamo at points elsewhere than at the pole pieces.

CONSERVATION OF ELECTRICITY.—A term proposed by Lippman for the theory that: every charge of electricity has an opposite and equal charge somewhere in the universe more or less distributed; that is, the sum of positive charges is always equal to the sum of negative charges.

CONSERVATION OF ENERGY.—The doctrine of physics, that energy can be transmitted from one body to another or transformed in its manifestations, but may neither be created nor destroyed. Energy may be dissipated, that is, converted into a form from which it cannot be recovered, as is the case with the great percentage of heat escaping with the exhaust of a locomotive or the circulating water of a steamship, but the total amount of energy in the universe, it is argued, remains constant and invariable.

CONSONANCE.—1. A sounding together; the reinforcing of sound by a body set in vibration by the first sounding body.

2. In a transformer circuit, a relation between the primary and secondary, due to mutual induction, such that the apparent reactance of the primary circuit is zero.

CONSONATOR.—A body which has the capacity for consonance with a sounding body.

CONSTANT.—1. A quantity or magnitude, derived from actual experiment, which is included as a factor in most formulæ for the purpose of bringing theoretical calculations in agreement with experience.

2. The calculated value of certain invariable factors to facilitate computation.

CONSTANT CURRENT.—Either a direct or an alternating current which is maintained at a constant value, that is, unvarying amperage maintained automatically or otherwise. Strictly speaking, an alternating current of constant ammeter reading is not a constant current, but only the equivalent of a constant current with respect to energy output.

CONSTANT CURRENT ARC LAMP.—An arc lamp used in series connection in a constant current circuit.

CONSTANT CURRENT BOOSTER.—A compound dynamo with shunt field in opposition to the series field for installations where it is desired to supply both an approximately constant load and a fluctuating load from the same dynamos, and where the fluctuations in the power circuits must not interfere with the lighting circuits. To prevent this, two sets of bus bars are provided. The power bars are supplied with current from the lighting bars, a non-reversible or so called constant current booster being interposed between the two. Since this permits only a constant current to pass from the lighting bus bars, the load on the dynamo does not vary, although the load on the power buses may vary widely.

CONSTANT CURRENT TRANSFORMER.—A type used for series arc lighting and constant current incandescent lighting systems. The primary coil is fixed but the secondary coil is attached to a pivoted lever and balanced by a weight. Since the induced currents in the secondary are repelled by the primary there is a tendency for the secondary coil to jump out of the primary field, the action being to maintain a constant voltage. In case of a very large current due to a short circuit in the lamp circuit, the secondary current is quickly reduced to normal by the rapid movement of the coil upward.

CONSTANT LEAD.—In valve gears, lead which does not change for different degrees of expansion.

CONSTANT SPEED MOTOR.—1. One in which the speed is either constant or does not materially vary; such as a synchronous motor, induction motor, with small slip or an ordinary direct current shunt motor.

2. A motor in which the speed is practically constant; for example, a synchronous motor, an induction motor with small slip or an ordinary direct current shunt wound, constant voltage motor.—NEMA.

CONSTANT TORQUE RESISTOR.—A resistor for use in the armature or rotor circuit of a motor in which the current remains practically constant throughout the entire speed range.—NEMA.

CONSTITUENT.—In chemistry, one of the parts or ingredients which go to form any particular whole; an elemental portion of a compound.

CONTACT.—Two or more surfaces abutting on each other in such a manner as to close an electric circuit.

CONTACT BLOCK.—The base or jaw projection of a switch to which is attached a lug.

CONTACT BREAKER.—An ignition device which keeps the circuit closed except at the time of the spark. A contact breaker is used to advantage on small engines, run at very high speed, as it allows time for the magnetism or magnetic flux in the core of the coil to attain a density sufficient to produce a good spark.

CONTACT ELECTRIC RAILWAY.—A type of electric railway, employed in industrial works, obtaining current for the motor through contact buttons embedded in the track structure, thus doing away with dangerous conductors.

CONTACT ELECTRICITY.—Very small charges of electricity generated by the contact of two insulated pieces of dissimilar metals.

CONTACT FAULT.—A term applied to faults due to conductors coming into contact with each other; a short circuit.

CONTACT LAMP.—A form of electric lamp which produces a kind of incandescence with an incipient arc, from the loose contact of two carbon electrodes; also called semi-incandescent lamp.

CONTACT MAKER.—1. An ignition mechanical vibrator or trembler. In operation it makes, by mechanical means, several contacts in rapid succession for each ignition. The movable contact point is carried on a spring blade with weighted end or metal nose which engages with a cam. As the cam revolves, it comes into contact with the metal nose. The pressure due to the action of the spring causes the nose to suddenly drop into the depression in the cam. Its momentum carries it past its normal position, and the contact point makes contact with the insulated screw. The metal nose, on account of its weight, will cause the blade to vibrate, bringing the contact points together several times before the cam again engages the nose.

2. In the plain type the circuit is closed and opened once per revolution of the cam. The latter has a projection or nose on its circumference instead of a sharp depression. This engages the contact blade and presses it against the insulated contact, thus closing the circuit.

CONTACT POINTS.—In ignition, the metal points by which contact is made for completing the circuit in igniters, contact makers, vibrators of induction coils, etc.

CONTACT RESISTANCE.—The resistance due to the lack of absolute contact between two connecting surfaces in a circuit.

CONTACT RING OF TELEPHONE SWITCHBOARD.—A test ring in a multiple telephone switchboard which makes a contact with the sleeve of the spring jack plug for the "busy test."

CONTACT RINGS OF ALTERNATOR.—Collecting rings in contact with the armature of an alternator.

CONTACT SCREW.—A screw furnished at its end with a metal contact for closing a circuit.

CONTACT SERIES OF METALS.—The following lists are so arranged that those metals first in each list become positively electrified when touched by any taking rank after them:

According to Volta.

+zinc	iron	gold
lead	copper	graphite
tin	silver	—manganese ore

According to Pfaff.

+zinc	iron	gold
cadmium	bismuth	uranium
tin	antimony	tellurium
lead	copper	platinum
tungsten	silver	—palladium

CONTACT SHOE.—In electric traction, a device which collects current by sliding on a third rail. This rail which is the insulated conductor from the generating station is laid outside the track rails. The third rail system is adapted to heavy duty service because of the ample contact area afforded by the contact shoe.

CONTACTS.—1. Metal pieces set at different points in an electrical circuit for conveniently making and breaking the circuit.

2. Faults arising as a result of contacts occurring between an electrical circuit and some external conducting substances.

3. The creation of a disturbance in a circuit by the accidental touch of another circuit.

4. In ignition, the stationary insulated metal segments forming part of a timer, there being one for each cylinder of the engine. During one revolution of the rotor of the timer, the primary circuit is made and broken once for each cylinder, thus firing the several charges in proper order.

CONTACTOR.—A device for repeatedly establishing and interrupting an electric power circuit.—**NEMA.**

CONTACTORS.—In the multiple-unit system of electric railway control, the devices which serve to operate the various resistances, to make and break the main circuit between trolley and motors, and to change from series to parallel connection. They consist of movable arms tipped with copper for making contact with a corresponding fixed copper tip when actuated by current by the master controller.

CONTAINING CELL.—Any jar for holding solutions employed in electrical work.

CONTINENTAL TELEGRAPH CODE.—The telegraph code used in Europe as distinguished from the American Morse code. Its chief distinction is that the spaces employed in the American code are excluded in the Continental.

CONTINUITY OF CIRCUIT.—The state of a circuit which preserves an unbroken course throughout for the flow of electricity.

CONTINUITY PRESERVING TRANSMITTER.—A transmitter in duplex telegraphy which permits the transfer of the line wire from the battery to the ground without interrupting the circuit.

CONTINUOUS CURRENT.—A current which flows in only one direction as distinguished from alternating current. It has the same meaning as direct current. It is a useless term which should be discontinued because of the loose usage resulting from the disagreement of writers as to its meaning. Distinguish between constant current and continuous current. A continuous current is not a constant current; some writers do not agree on this.

CONTINUOUS DUTY.—A requirement of service which demands operation at substantially constant load for an unlimited period.—NEMA.

CONTINUOUS LOADING.—A series loading in which the added inductance is uniformly distributed along the conductor.

CONTINUOUS SPECTRUM.—A spectrum of light in which the different colors fade into each other by indistinguishable gradations, showing every shade of color from the extreme red at one end to the extreme violet at the other; such spectra are to be obtained from the electric light, lime light and all solids or liquids heated to incandescence.

CONTINUOUS WAVES.—A succession of radio waves of constant frequency and constant amplitude. Undamped waves. Continuous waves are not modulated, as modulation varies the wave amplitude.

CONTINUOUS WINDING.—A term sometimes applied to wave winding.

CONTRACTING MAGNETIC WHIRLS.—Magnetic whirls which tend to contract in the direction of the electro-magnet from which they spring.

CONTRACTION FIT.—In machine shop work, a fit employed when a bore requires to be firmly and permanently fastened to a cylindrical piece, as a shaft. The bore is turned to a smaller diameter than the cylindrical piece, then heated so as to expand the bore; the cylindrical piece is then inserted and the cooling of the bore causes it to contract upon the cylindrical piece with a force varying with the amount allowed for contraction; also called a shrinkage fit.

CONTRACTION OF AREA.—The amount by which the area, at the point where a test piece has broken, is reduced below what it was before any strain or pulling force was applied. The contraction is usually expressed as a percentage, and is an indication of the ductility of the material tested

CONTRACTURE.—A state of rigidity of the muscles of the body sometimes resulting from the shock of an electric current.

CONTROL AND RESET SWITCH.—On electric cars, a device that energizes or cuts off power from the control circuit. It also resets the overload trip by energizing the reset coil.

CONTROL BOX AND SWITCH GROUP.—On electric cars, the main part of the equipment comprises . the resistance switches, the transition switches and where no separate circuit breaking line switch unit is used, the line switches. The difference between a control box and switch group is that the former includes the reverser mounted on one of the end plates, while a separate reverser is used with the latter.

CONTROL BRACES.—Steel struts on the controls of an airplane to which the control wires are attached.

CONTROL CIRCUIT TRANSFORMER.—A voltage transformer utilized to supply a voltage suitable for the operation of shunt coil magnetic devices.—NEMA.

CONTROL ELECTRODE.—In a vacuum tube, an electrode upon which a voltage is impressed to vary the current to one or more other electrodes.

CONTROL GRID.—In a vacuum tube, an element in which variable voltage between it and another element, controls the action of the tube.

CONTROL POWER TRANSFORMER.—One which supplies the a. c. control power for operating the major a. c. devices.—NEMA.

CONTROL RELAY.—One used with an electrically operated device to control the closing or opening coil current of the device so that the main operating current does not pass through the control switch.—NEMA.

CONTROL RESISTOR.—On electric cars, a device that provides relatively low voltages for the control circuits to the operating coils of the switches.

CONTROL WAYSIDE TO LOCOMOTIVE.—A method of automatic train control. The control device between the wayside and the locomotive is composed of two parts: a, receiver; b, inductor. The receiver is fastened to the trucks of the locomotive and the inductor is attached to cross ties at such height that the receiver can pass over but not touch it. In operation when the receiver carried by a locomotive approaches an unwound inductor or a wound inductor on open circuit, a surge of magnetic flux builds up in the secondary coil and produces a negative current in the relay. This negative current is sufficient to allow the relay to open, and once open stays open until restored, due to its being a stick relay.

CONTROLS.—Devices on an airplane used for operating the adjustable surfaces and for regulating the movements of the airplane in flight.

CONTROLLED SPEED AXLE DYNAMO.—In axle systems of car lighting, a method of controlling the speed of the dynamo by belt slippage when the load exceeds a predetermined value.

CONTROLLER.—1. An electric device or group of devices, which serves to govern in some pre-determined manner, the electric power delivered to the apparatus to which it is connected.—NEMA.

2. A speed regulator and reverser for traction motors. Controllers are designed to be used for starting, stopping, reversing and regulating the speed of motors where one or more of these operations have to be frequently repeated. There are numerous types for d.c. and a.c.

CONTROLLER POINTS.—Short radial bars or "points" cast upon the cover plate of a street railway controller for the purpose of indicating to the motorman the position of the handle in relation to the contacts within the casing.

CONTROLLER RESISTANCE.—Resistance introduced in trolley car controllers for governing the movement of the car.

CONTROLLER SWITCH.—The switch which operates the controller of a trolley car.

CONTROLLER FOR CRANES.—The class of controller most commonly used is that known as the drum, or tramway type. In these controllers the wires and cables are brought to a series of fixed contacts, usually arranged in a straight line. A series of corresponding contacts are attached to a revolving drum, the various combinations and connections for hoisting, lowering, etc., being obtained by rotating this drum into different positions.

CONTROLLING FIELD.—In galvanometers, the magnetic field used to bring the needle back to a definite position whenever it is turned.

CONTROLLING MAGNET.—A magnet employed to exert a controlling influence upon any action; as, for example, the automatic controller for the regulation of constant currents.

CONVECTION CURRENTS.—1. The streams of charged particles flowing from the pointed end of a highly electrified insulated conductor, also called convection streams and electric wind.

2. A current in which the electricity is carried by moving masses heavier than electrons.

CONVECTION OF HEAT.—1. The effect produced by an electric current upon the temperature of an unevenly heated wire.

2. The transfer of heat by the motion of the heated matter itself; it can, therefore, take place only in liquids and gases.

CONVECTION STREAMS.—The flowing of charged air particles in streams from a pointed end of a highly electrified conductor; sometimes called electric wind.

CONVECTIVE DISCHARGE.—A discharge of static electricity which takes place through the air in convection streams from a pointed conductor, or through rarefied gas with luminous effects between electrodes; a quiet or silent discharge as distinguished from a disruptive discharge.

CONVERGING MAGNETIC FLUX.—Magnetic flux tending to converge toward a point.

CONVERSE PROPOSITIONS.—Propositions so related that what is given in each is what is to be proved in the other.

CONVERTED CURRENTS.—Those which have been changed from one form of electrical energy to another form, especially from d.c. to a.c. or vice versa. There are several other conversions as a change in: a, voltage; b, frequency; c, phase, etc.

CONVERTER.—A revolving apparatus for converting alternating current into direct current or vice versa; it is usually called a rotary converter and is to be distinguished from the other methods such as by motor generator sets, mercury vapor rectifiers, electrolytic rectifiers, etc. A converter may be considered as any species of apparatus for changing electrical energy from one form into another. According to the standardization rules of the A. I. E. E. converters may be classified as: a. direct current converters; b. synchronous converters; c. motor converters; d. frequency converters; e. rotary phase converters.

CONVOLUTIONS.—The loops in a coil of wire.

COOLING OF TRANSFORMERS.—Various methods are employed, the cooling mediums used being: a, air; b, oil; c, water. The means adopted for getting rid of the heat which is inevitably developed in a transformer by the waste energy is one of the important considerations with respect to its design.

COOLING SURFACE.—In a surface condenser, the area exposed to the steam or other vapor by the tubes, etc., cooled by circulating water. If the vapor be outside the tubes, as in steam engineering practice, the cooling surface is calculated on the external diameter of the tubes; if the vapor be inside them, as in an ammonia condenser, it is calculated on the internal diameter of the pipes.

COOLING SURFACE OF ARMATURE.—That part of an armature from which the heat generated by its rotation may pass off into the air.

COOLING TOWER.—An apparatus intended to dissipate the heat from the condensing water of a power plant, where the supply is limited or the value of land prohibits a cooling pond. Essentially, it consists of a tower or stack, from the top of which the heated circulating water is sprayed over a cellular construction of brushwood, earthenware pipes, wire mats, diaphragms or other baffles, designed to expose the water to the cooling influences of the atmosphere while in a film or fine rain, the process being assisted by the evaporation of part of its bulk. Counter air currents are maintained by side ventilation, natural draught (using the tower as a chimney), or by a fan blast. The cooled water collects in a tank or sump within the foundations, and its decrease by evaporation is made up from the public water mains or a well.

COOLING WATER.—The injection or circulating water for a condenser, with steam or other heat engines or with refrigerating plants. The necessary quantity depends upon the nature of the machinery. With a jet condenser the cooling water is also called **injection water**, and with a surface condenser, the **circulating water**.

COOPER-HEWITT LAMP.—The mercury vapor lamp invented by Peter Cooper-Hewitt. The mercury arc is produced in a glass tube exhausted to a low pressure The heat of the electric current creates a vapor from a supply of mercury at one end of the tube which forms a conducting path for the current, giving out a greenish light.

COOPER - HEWITT MERCURY VAPOR RECTIFIER.—A vacuum tube rectifier which consists essentially of a glass bulb into which are sealed two iron or graphite anodes and one mercury cathode, and a small starting electrode. The bulb is filled with mercury vapor under low pressure. The action of this device depends on the property of ionized mercury vapor to conduct electricity in one direction only.

CO-ORDINATE.—1. A thing of the same rank with another thing; one of two or more persons or things of equal rank or authority.

2. Lines, or other elements of reference, by means of which the position of any point, as of a curve, is defined with respect to certain fixed lines, or planes, called **co-ordinate axes** and **co-ordinate planes.**

COPAL VARNISH.—A superior variety of varnish manufactured from copal, a resin derived from an African tree.

CO-PHASAL.—Corresponding in phase.

CO-PHASAL ALTERNATIONS. — Alternations corresponding in phase.

COPPER.—A brownish red metal, tough, malleable and ductile. It can be cast, welded, forged, rolled and drawn. Next to silver it is the best conductor of electricity and heat known, and hence is the most important conducting material in electric practice. It is used in the shape of wire, cable, ribbon, strap and bars. The conductivity of Matthiessen's pure copper at a temperature of 0° C., is usually taken as a standard; i. e., 100%.

COPPER ALLOY.—An alloy containing 98.55% copper, 1.4% tin and .05% silicon, employed to manufacture a wire known commercially as **phono-electric wire.** Its conductivity is only 40% of that of pure copper, but it is much tougher and has a tensil strength 40-45% greater than hard drawn copper. It is used for trolley wire, and long telephone line spans.

COPPER ARC.—A voltaic arc produced between electrodes of copper.

COPPER BATH.—A bath for electro-plating with copper, consisting of a solution of cyanide or acetate of copper within which one or more plates of pure copper are suspended. The anodes are these copper plates, and the cathodes, the objects to be plated hung opposite to them.

COPPER BATTERY.—A battery used in telegraphy for sending "copper," or positive currents over the line.

COPPER BRUSH.—A type of commutator brush especially adapted to dynamos furnishing large current at low voltage as electro-plating dynamos where brushes having high conductivity are necessary to reduce the size of the commutator

COPPER CONNECTOR.—1. A form of connector for uniting the copper element in a gravity cell to the conductor.

2. A device employed in connecting heavy conducting wires.

COPPER DAMPING.—A method of bringing to rest the moving parts of a galvanometer after deflection, in which the needle is enclosed in a cavity in a block of copper. When the needle moves, it sets up eddy currents in the copper, which retard the swing without affecting the final deflection.

COPPER EFFICIENCY. -- The electrical power available for use as supplied by a copper conductor, compared with the electrical energy originally delivered to the conductor by the generator.

COPPER GAUZE BRUSH.—A commutator brush composed of copper wire gauze, instead of a solid copper strip.

COPPER LOSSES IN TRANSFORMERS.—Losses due to: a, heating of the conductors (the I^2R loss); b, eddy currents in conductors; c, stray losses (eddy currents in tank clamps, etc.); d, no load loss in primary, but because of its smallness is not mentioned; it is, generally classed as an iron loss.

COPPER PIPE.—In steam engineering, copper is generally used for the steam and various other pipes of large engines, its utility consisting in the readiness with which it can be curved to any form, and in the ease with which it accommodates itself by expansion and contraction to variations of temperature without risk of tearing off the flanges. The flanges of copper pipes are brazed on, a hole being bored through the flange to receive the pipe.

COPPER PLATING.—The process of depositing a coating of copper upon a metallic surface by electro-plating. The object to be plated forms the cathode immersed in a solution of copper carbonate or sulphate while the anode consists of a plate of pure copper. A good copper plating bath is made by dissolving in a gallon of water, 10 ozs. potassium cyanide, 5 ozs. copper carbonate, and 2 ozs. potassium carbonate.

COPPER PYRITES.—The commonest ore of copper, a double sulphide of copper and iron, sometimes containing some arsenical sulphide in addition.

COPPER RESISTANCE.—The conductor resistance encountered in a submarine cable.

COPPER RIBBON.—Copper conductors in the form of flat strips or ribbons; strap copper.

COPPER SHELL OF ELECTROTYPE.—The thin layer of copper deposited by the process of electro-plating upon the impression prepared for reproduction in electrotype.

COPPER SMELTING.—This is a long and elaborate process effected in reverberatory furnaces or converters. The pyrites ores are roasted to liberate arsenic, and the temperature is then raised until the metal fuses, producing cuprous sulphide and silicate of iron; this silicate is removed as slag. By repeating the roasting and fusion, all the iron is removed. (The cuprous sulphide is carefully roasted until it consists of two-thirds oxide, the temperature is then raised until it becomes copper and sulphur dioxide.) On remelting, the copper is poled with green wood, to reduce the oxide remaining. Much copper is refined by electrolysis; the blister copper is cast into slabs for anodes, which decompose under the action of an electric current of low voltage and small amperage. The electrolyte is a solution of sulphate of copper, and the pure copper is deposited on a thin cathode plate of pure metal.

COPPER STRIP WINDING.—A form of armature winding in which the conductors are in the form of strips of insulated copper, instead of lengths of copper wire.

COPPER SULPHATE.—A compound of copper, sulphur and oxygen, also known as **blue vitriol** in solution, and **bluestone** in crystals. It is used as a depolarizer in the Daniell cell, and by the action of electrolysis, sulphuric acid is derived from it.

COPPER TAPE.—Thin strips of copper for winding armatures.

COPPER VOLT METER.—An instrument for measuring larger current values than is possible with the silver volt meter. The anodes are of pure copper, the cathode is copper or platinum, and the electrolyte a solution of pure copper sulphate.

COPPER WELDING.—Welding copper to copper or copper to mild steel can be done by either the metallic or carbon arc. It is recommended that a phosphor copper electrode be used in making such welds. Non-ferrous metals as used commercially have been welded with varying degrees of success. Such metals are more or less difficult to weld with the electric arc, due principally to their low melting points.

COPPERAS.—Ferrous sulphate, also known as **green vitriol** and **green copperas**, prepared either by the action of dilute sulphuric acid on iron, or by gently roasting iron pyrites in the air.

COPPERED CARBONS.—Arc light, or other carbons, covered with a layer of copper deposited by electrolysis.

COPPERED PLUMBAGO.—Plumbago in a powdered state dusted with copper, used to prepare non-metallic surfaces for electro-plating; as in electrotyping.

COPYING TELEGRAPHY.—A method of automatic telegraphy whereby a message is received in facsimile of the transmitter's handwriting; also called, pantelegraphy.

CORD.—A small cable, very flexible and substantially insulated to withstand wear. There is no sharp dividing line in respect to size between a cord and a cable, and likewise no sharp dividing line in respect to the character of insulation between a cord and a stranded wire. Rubber is used as the insulating material for many classes of cords.

CORD PEG.—A connecting peg or plug attached to a flexible conducting cord for use in a telephone switchboard.

CORD TYPE P.B.X. SWITCHBOARD.—A private exchange telephone switchboard equipped with cords to make the connections and having lamps and jacks similar to the Central Office switchboards. All the relays, resistances and retard coils of the cord and trunk circuits are mounted on a swinging gate in the rear of the switchboard.

CORDLESS TYPE P.B.X. SWITCHBOARD.—The smallest private branch exchange telephone switchboard made. It has keys instead of cords to make the connections and consists of a small wooden box containing several keys, magnetic drop signals, hand generator which is used to ring the extension bells whenever the regular Central Office generator supply fails, and a telephone set.

CORE.—1. The insulated electrical conductor of a cable, as distinguished from the outer covering or sheathing.

2. The mass of iron forming the interior portion of an electro-magnet, and around which the coils are wound.

3. The metallic body of a dynamo or motor armature upon which the windings are built up.

4. The bundle of iron wires upon which the primary and secondary coils of an induction coil or transformer are wound.

CORE AND SHELL TRANSFORMERS.—The relative advantages of the two types has been the subject of considerable discussion among manufacturers; some companies who formerly built only shell type transformers, now build core types, while with other builders the opposite practice obtains. The manufacturers' choice depends chiefly upon manufacturing convenience rather than operating characteristics.

CORE DISCS.—Thin plates of sheet iron united in such a way as to form circular discs for building up the laminated cores of dynamo or motor armatures.

CORE LOSS OR IRON LOSS.—These terms are often employed to designate the total internal loss of a dynamo due to the combined effect of eddy currents and hysteresis, but as the losses due to the former are governed by laws totally different from those applicable to the latter, special analysis is required to separate them. The very small loss which takes place in the primary winding on no load is generally classed as an iron loss.

CORE PINS OF MAGNET.—Pins for securely fastening the cores of an electromagnet to the yoke.

CORE TRANSFORMER.—One having an iron core, upon which the wire is wound in such a manner that the iron is enveloped within the coils, the outer surface of the coils being exposed to the air.

CORE VALVE.—A plug valve which has a rotary turning motion in a hollow conical seat; occupying about the same relative position to its seat, as the core of a faucet does to the casting itself.

CORE VENTILATION.—Air spaces provided in the core of a dynamo or motor armature to allow circulation for the purpose of keeping the iron cool.

CORE WIRE.—A soft iron wire having practically no residual magnetism.

CORED CARBONS.—Carbons for arc lamps having an inner core of soft carbon.

CORELESS ARMATURE.—A variety of armature lacking the usual iron core.

CORKSCREW RULE.—If the direction of travel of a right handed corkscrew represent the direction of the current in a straight conductor, the direction of rotation of the corkscrew will represent the direction of the magnetic lines of force. This rule is due to Maxwell, but should not be confused with "Maxwell's rule."

CORLISS ENGINE.—A long stroke four valve steam engine having Corliss valves and a variable cut off releasing valve gear. This type engine should be carefully distinguished from the four valve non-releasing engine.

CORN PLASTER FUSE.—A cylindrical form of safety fuse provided in telephone switchboards.

COROLLARY.—A proposition following so obviously from another that it requires little or no demonstration.

CORONA.—During an eclipse, the outer atmosphere of the sun. Its pearly radiance is emitted from the sun in all directions to distances of millions of miles, but so faint is its light that it can be seen only during totality.

CORONA EFFECT OF A.C.—In wiring, the effect produced when two wires, having a great difference of pressure are placed near each other. If the spacing or distance between the wires be small and the difference of pressure in the wires be very great, a continuous passage of energy takes place through the dielectric or atmosphere. The amount of this energy may be an appreciable percentage of the power transmitted. Therefore in laying out high pressure transmission lines, this effect must be considered in the spacing of the wires.

CORONA LOSS.—A loss which occurs when two wires having a very great difference of pressure between them are placed near together as in high tension transmission lines. The corona loss takes place at the critical voltage and increases very rapidly with increasing pressure beyond the critical voltage.

CORPOSANT.—A name given by sailors to the static electric discharges sometimes seen on the tips of ships' masts; an electric brush or glow; generally known among sailors as St. Elmo's fire.

CORRECTING RELAY.—In quadruplex telegraphy, a relay interposed between the receiving relay and the sounder to guard against false signals.

CORROSION.—Chemical action which causes destruction of the surface of a metal, usually by oxidation or rusting, often by the disintegrating influence of stray electric currents or ground return currents in electric systems, known as electrolytic corrosion; the metal may be also eaten away by the action of acids present in water or in the surrounding air. To diminish corrosion of exposed surfaces, paints, oils or other protective coatings are employed.

COSINE.—In trigonometry, the sine of the complement of an angle. It may be represented as the length of the adjacent side or base of a triangle of which the sine is the perpendicular or opposite side, or as the ratio existing between the adjacent side or base and the hypotenuse. Abbreviated as cos or cosin.

COSINE LAW.—The intensity of illumination received obliquely is proportional to the cosine of the angle which the luminous rays make with the normal to the illuminated surface.

COSINUSOID.—A curve made up of cosines.

COSMIC RAYS.—1. Very high frequency rays coming from unknown origin in outer space.

2. Penetrating radiations from outer space. It is supposed that the effects are produced by non-material waves like light or radium gamma rays.

COTANGENT.—In trigonometry, the tangent of the complement of an arc or angle.

COTTER.—A wedge or taper key used to fasten parts of machinery together.

COTTER PIN.—A split key; properly a headless taper split pin, driven into its hole and expanded at the small end so that it cannot jar loose.

COTTON WASTE.—Refuse thread from the operations of spinning and weaving cotton, largely used in cleaning machinery and also for packing axle boxes of railway cars.

COULOMB.—1. A unit quantity of electricity being equivalent to one ampere flowing for one second. One coulomb= 1÷3,600 ampere hour.

2. The quantity of electricity which flows in a circuit where resistance is one ohm, when the pressure is one volt.

COULOMB, CHARLES AUGUSTIN.—Born 1736, died 1806. A French physicist noted for his investigations in magnetism and electricity. In 1777 he obtained a prize for an essay on the construction of magnetic needles and later gained two other prizes for essays on mechanical problems. He is best known as the inventor of the torsion balance, His name has been given to the unit of electric quantity in recognition of his services to electrical science. During the later years of his life he contributed to the work attending the introduction of the metric system by the French Government.

COULOMB METER.—An instrument for measuring electrical quantity by indicating the number of coulombs which pass through a circuit in a given time.

COULOMB VOLT.—A term sometimes applied to the joule, the practical c. g. s. unit of electric energy.

COULOMBS AND AMPERES.—The distinction between coulombs and amperes is important as illustrated by the following example: A flasher sign takes 18 coulombs and the on period is 3 seconds. What is the amperage?

coulombs=amperes×seconds.........(1)

from which

$$\text{amperes} = \frac{\text{coulombs}}{\text{seconds}} \qquad (2)$$

Substituting in equation (2)

$$\text{amperes} = \frac{18}{3} = 6$$

COULOMB'S BALANCE.—An instrument for determining by the torsion of a wire the action of the forces of attraction and repulsion exhibited between two electrified spheres.

COULOMB'S LAW.—The law of electrostatics first stated by Coulomb; that the force exerted between two charges of electricity is directly proportional to their product, and inversely proportional to the square of the distance between them.

COUNTER.—1. A mechanism for registering or counting the revolutions or double strokes of an engine or pump. In an engine counter, water meter, or similar counter, whatever number of counter dials (or wheels) there may be, the right-hand always records 10; the next to the left, 100; the 3rd, 1,000; the 4th, 10,000; the 5th, 100,000; and the 6th, 1,000,000. Hence, one having six dials can register 1,000,000 revolutions. When a counter has completed its full number of recording, all the numbers will show zero, to which must be added an imaginary one, making for seven dials or wheels, ten millions; and the next stroke of the engine will begin a new series with 1, etc.

2. The overhang of a ship's stern.

COUNTER BALANCE.—In engineering, a weight placed opposite a crank arm to balance the revolving weights and a certain proportion of those having a reciprocating action.

COUNTER CLOCKWISE MOTION.—A circular motion the reverse of the movement of the hands of a clock as seen when one reads the time.

COUNTER ELECTROMOTIVE FORCE.—An objectionable and unnecessarily long term for reverse pressure or reverse voltage, although one largely used by professors and would be highbrows.

COUNTER INDUCTIVE EFFECT.—The resistance offered to an electric current by the force due to the effect of induction.

COUNTERPOISE.—A second aerial suspended on supports about one foot above the ground and insulated from the latter. The counterpoise should run parallel with and preferably underneath the main aerial though if necessary it may be offset to one side. Used in places where it is difficult to obtain a good ground.

COUNTER PRESSURE.—A pressure which exerts an equal and opposite force to another; reaction of one pressure against another; back or reverse pressure.

COUNTER VOLTAGE CELL.—1. A cell set in the circuit of a storage battery to oppose, and thus reduce the charging current by the action of electrolysis; also called reverse pressure cell.

2. Extra storage battery cells intended to maintain normal pressure in the battery when it is to be charged at an excessive pressure.

COUPLE.—1. The two electrodes of a voltaic cell.

2. A pair of equal and parallel forces acting in opposite directions, tending to produce a motion of rotation in the body acted on.

COUPLE, MAGNETIC.—The turning moment which tends to rotate a magnetic needle, placed in the earth's field, into the plane of the magnetic meridian; the total force acting on either pole of a needle free to move in any direction is equal to the strength of that pole multiplied by the total intensity of the earth's field at that place.

COUPLER.—In radio, a device by means of which the coupling between circuits can be varied in a receiving set having more than one circuit.

COUPLET.—In a ratio, the antecedent (first term) ÷ the consequent (second term).

COUPLING.—1. The uniting of a number of dynamos or alternators in large generating stations so that as the load fluctuates it can be shifted from one to another as the case requires; or when the load exceeds the capacity of the largest dynamo in the plant, the output of one can be added to that of another.

2. The association of two circuits in such a manner that power may be transmitted from one to the other.

COUPLING CAPACITOR.—In radio, a coupling condenser.

COUPLING COMPOUND DYNAMOS IN SERIES.—The dynamos are connected in series through the series windings and the shunt coils are connected as a single shunt, which may either extend simply across the outer brushes of the machines, so as to form a double short shunt, or may be a shunt to the bus bars of external circuit, so as to form a double long shunt.

COUPLING INDUCTOR.—In radio, a secondary induction coil used to connect two circuits inductively.

COUPLING JOINT.—A flexible section of conducting material for uniting the ends of the wires inside the connecting boxes of underground electric tubes.

COUPLING OF AMPLIFIERS.—In radio, if more than one amplifier be used, some apparatus must be interposed between successive tubes to obtain the maximum power output of the lower tube and if possible, at the same time obtain the maximum voltage charges on the grid of the upper tube. This is generally done by a transformer coupling.

COUPLING SERIES DYNAMOS IN SERIES.—The positive terminal of one dynamo is connected to the negative terminal of the other, and the two outer terminals are connected directly to the two main conductors or bus bars through the ammeter, fuse and switch. If it be desired to regulate the pressure and output of the machines, variable resistances, or hand regulators, may be arranged as shunts to the series coils so as to divert a portion or the whole of the current therefrom.

COUPLING TRANSFORMER.—A radio tuning device used in transmitters and receivers.

C. p.—Abbreviation for candle power.

C. p. s.—Abbreviation for cycles per second.

C. Q. D.—The original radio distress signal which has been changed to S. O. S.

CRACKING.—In chemistry, the process of destructive distillation, or heating out of contact with air, in which most organic bodies undergo a complex decomposition, a number of fresh bodies being formed by a rearrangement of the atoms under the influence of the heat.

CRADLE DYNAMOMETER.—A method of measuring the mechanical energy of a dynamo by suspending it in a cradle and observing the torque produced about the axis of the cradle.

CRADLE SUSPENSION OF CAR MOTOR.—A method of adjusting the motor of a street railway car upon its truck by resting it upon a cradle supported by springs.

CRAMPON.—1. A pair of hooked pieces of iron for raising heavy stones.

2. An iron attached to the shoe for walking on ice or climbing.

CRAMPOON.—Descriptive of a cross, having a square or cramp shaped piece at each end.

CRANE.—A machine for hoisting and lowering heavy weights. It consists of a vertical post or frame, which is rotatable on its axis, and a jib or projecting arm over which the chain or rope passes on its way from the winch at the foot of the post to the load to be lifted. Cranes are arranged to be operated by hand, steam, hydraulic power or electricity; they may also be operated by means of endless ropes or shafting and worm gearing from another source of power.

CRANE, ELECTRIC.—A machine for lifting, lowering and moving a load in a horizontal direction, having an electric drive.

CRANE MOTORS.—Heavy duty motors designed to meet the requirements of crane operation. Such conditions of operation require very rugged construction in order to insure maximum reliability and minimum operating expense. The design should be such that all parts are readily accessible to permit the substitution of spare parts with very little delay in case of accident. In selecting motors, the most important consideration is the maximum starting torque which the motor can exert.

With a. c. motors, this is less than with d. c. motors, requiring a larger motor, particularly on the bridge and trolley motions which require the greatest starting torque.

CRANK.—In mechanics, a lever formed at right angles to a shaft or keyed thereto, by means of which the shaft may be turned or the motion of the shaft be imparted to another mechanism. The crank is the common device for converting reciprocating motion into rotary; as, in the ordinary direct acting engine.

CRANK CASE.—The casing surrounding the moving parts of a small engine, protecting them against dust and damage, and acting as part of the framing in supporting the cylinders.

CRANK PIN.—The cylindrical stud or pin at the extremity of a crank, opposite to the shaft and parallel with it, which affords attachment for the link or connecting rod by which the crank shaft is turned.

CRANK SHAFT.—The main shaft of an engine on which are formed the cranks for converting the reciprocating motion of the piston or pistons, into the rotary motion of the shafting.

CRANKING.—The act of rotating the shaft of a gas engine by means of a handle, in order to start it; turning it over until the explosive charge is ignited by an electric spark.

CRATER OF ARC.—The concave effect produced upon the top of the positive carbon of an arc lamp by the action of the current.

CREEPING.—An evaporation of the electrolyte of primary cells which results in crystals being left on the sides of the jar previously wetted by the solution, the action being very marked when the solution is a saturated one. The space between these crystals and the side of the jar acts as a number of capillary tubes, and draws up more liquid, which itself evaporates and deposits crystals above the former ones. Thus finally the film of crystals passes over the edge of the jar and forms on the outside, making a kind of syphon which draws off the liquid.

CREEPING OF BELT.—The slip of the belting upon the driven pulley so that the speed of the driving pulley is not fully transmitted.

CREEPING OF CURRENT.—1. The polarization occurring in the solution of a primary cell.

2. The spreading of an electric discharge over the surface of an insulator.

CREOSOTE.—An oily liquid with a characteristic smoky smell, obtained by distillation from that portion of wood tar (principally beechwood), which distills between 400° and 425°, or that portion of coal tar which distills between 450° and 510°. Wood creosote is colorless, that from coal tar is greenish. It is used for pickling wood to preserve it and as a disinfectant.

CREOSOTING.—The process of impregnating timber with creosote as a preservative.

CRITH.—A weight of one liter of hydrogen at a temperature of 0° Centigrade and a barometric pressure of 760 millimeters; proposed as the unit of weight for gaseous substances.

CRITICAL ANGLE.—1. The steepest angle that can be assumed by an airplane for a given speed without loss of control.

2. In optics, the angle of incidence beyond which rays of light striking the surface of a medium are no longer refracted into that medium, but are totally reflected from it.

CRITICAL CURRENT.—That strength of an electric current required to bring about some special effect in electric operation.

CRITICAL CURRENT OF DYNAMO.—The current generated by a dynamo such that a slight effect upon its speed may have a great effect upon its voltage. It is represented upon the characteristic curve by a bend, or distinct deflection from the straight line.

CRITICAL CURRENT OF MAGNETIZATION.—The current applied to magnetize an iron core such that a slight increase in its strength will greatly increase the magnetization.

CRITICAL DISTANCE OF LATERAL DISCHARGE.—The distance at which an electric discharge will cross an air gap rather than follow a metallic conductor having given resistance.

CRITICAL FREQUENCY—In an alternating circuit containing both inductance and capacity, the frequency that produces resonance. The formula for inductance reactance is $X_i = 2\pi fL$, and for capacity reactance $X_c = 1 \div 2\pi fC$; accordingly if capacity and inductance in a circuit be equal, that is, if the circuit be resonant

$$2\pi fL = 1 \div 2\pi fC$$

from which

$$f^2 = 1 \div 4\pi^2 LC$$

$$f = 1 \div 2\pi\sqrt{LC}$$

It is very seldom that a circuit is thus balanced unless intentionally brought about; when this condition exists, the effect is very marked, the pressure rising excessively and bringing great strain upon the insulation of the circuit.

CRITICAL PRESSURE.—In physics, the pressure causing the liquefaction of a gas, at or about its critical temperature.

CRITICAL TEMPERATURE.—In physics, the temperature at which a given substance begins to change its state; as, from a solid to a liquid or vice versa. The critical temperature of gases is that above which it is impossible to liquefy them. The volume at this point is termed the critical volume, and this, together with the temperature and the necessary pressure to produce liquefaction, are sometimes termed critical data.

CRITICAL VOLTAGE.—In a. c. wiring, the voltage at which corona becomes manifest. It is not constant for a given line, but is somewhat dependent upon atmospheric conditions. Assuming a line employing conductors just within the critical voltage limitations for the conditions to be met, the corona loss in such a line would be almost negligible during fair weather, but during stormy weather (particularly during snow storms) this corona loss would be many times what it is during fair weather.

CROOKES' DARK SPACE.—A space at the negative electrode of a highly rarefied tube through which an electric discharge is passing. This space appears dark in contrast to the luminous effect of the discharge, and this increases with the exhaustion of the tube; sometimes called **Crookes layer.**

CROOKES' EFFECT.—The radiant effect produced in a vacuum glass tube in which the exhaustion has been carried to a high degree, when electricity is discharged through it between suitable electrodes. It receives its name from Sir William Crookes, who discovered the phenomenon.

CROOKES' RADIOMETER.—An instrument for exhibiting the transformation of radiant energy into mechanical work. It consists of four slender vanes bearing discs of pith resting on a needle and free to turn upon it; the whole enclosed in a glass vessel from which the air has been exhausted. The impact of radiant energy against these discs causes them to revolve as if driven by the movement of air.

CROOKES' TUBES.—Glass vacuum tubes in which exhaustion has been carried to a very high degree, containing platinum wires terminating in metallic plates. By passing into such tubes a current from an induction coil, luminous phenomena are seen, which illustrate the character of radiant gaseous matter.

CROSS.—1. An interference due to contact or similar cause between neighboring telegraph or telephone circuits.

2. Any accidental contact between electric wires or conductors.

CROSS AMPERE TURNS.—Ampere turns on the armature of a dynamo opposed to the magnetization of the magnetic field.

CROSS ARMS.—A support for insulators upon which conductors are strung and attached to a pole. They are commonly made from yellow pine wood, generally $3\frac{1}{4} \times 4\frac{1}{4}$ inches, and are freely coated with good mineral paint as a preservative.

CROSS BAR.—The insulating connecting piece of a switch which is attached to the blades, and to which is attached a handle.

CROSS BONDING.—A connection made between the ground feeder, or conductor, and the rails of an electric railway in order to preserve a return circuit.

CROSS COIL DIRECTION FINDER.—A goniometer.

CROSS COMPOUND.—A type of compound engine in which the high and low pressure cylinders form distinct and separate engines, each upon its own bed, with the flywheel between them, the cranks being usually overhung. This type of engine is very accessible in all its parts and the main bearings are easily kept in line.

CROSS CONNECTING BOARD.—A board in telephone or telegraph exchanges into which the terminals of the line are assembled so that they may be readily connected to any section of the switchboard, as desired; a **distributing board.**

CROSS CURRENT.—A current which when two separately driven alternators are coupled in parallel and one lags behind the other in phase, flows for a brief time from the leading to the lagging alternator.

CROSS FIRE.—The escape of electric current from one telephone or telegraphic line to another as a result of faulty insulation. An intermittent or swinging cross fire is often due to wires which are too slack, being blown occasionally by the wind into contact.

CROSS HEAD.—In steam engineering, the connection between the piston and connecting rod of a reciprocating engine. About 5% of the total power of the engine is lost by friction of the cross head. This may be reduced and also amount of oil, attention, tendency to heat, etc., by a roller cross head such as shown in the author's Engineers and Mechanics Guide No. 4, page 1719.

CROSS MAGNETIZATION.—Lines of magnetic force set up in the windings of a dynamo armature which oppose at right angles the lines of force created between the magnetic poles. In the operation of a dynamo with load, the induced current flowing in the armature winding, converts the armature into an electromagnet setting up a field across or at right angles to the field of the machine. This cross magnetization of the armature tends to distort the field produced by the field magnets, the effect being known as **armature reaction.**

CROSS OVER BLOCK.—A block of insulating material designed to allow an electric wire safely to cross another in interior wiring without risk of making contact

CROSS SYSTEM.—A method of running overhead wires to counteract the tendency to mutual induction between neighboring circuits, by crossing the wires at intervals so that they pass each other in frequently changing relations.

CROSS TALK.—Conversation over one telephone circuit overheard in the telephone of another circuit when their wires run side by side. This fault is due almost entirely to electrostatic induction.

CROSS VALVE.—A valve designed to be placed in the run of a pipe line to open communication with a branch line.

CROSS WIRE SUSPENSION.—A method of suspending an arc lamp from a cross wire by block and pulley.

CROSSED ARM GOVERNOR.—In engineering, a centrifugal governor whose arms are crossed; that is, each point of suspension is on the opposite side of the spindle to the weight. This causes the balls to vibrate in a parabolic path, which gives more sensitive governing.

CROSSED BELT.—One employed to drive a pulley in the opposite direction to its driver. The part of the belt going from the top of one pulley to the bottom of the other is turned half around so that the same belt face shall be in contact with each pulley, and that the two parts shall be edgewise where they pass each other.

CROSSING CLEAT.—A cleat for interior wiring suitably grooved so as to allow electric wires to cross one another without making contact.

CROSSING FROG.—A frog suspended on a trolley wire at the point where one line branches from another, for directing the trolley wheel to the proper line; a trolley frog.

CROSSING WIRES.—A temporary expedient when a defective section is found to exist in a telegraph circuit, for preserving the continuity of the circuit by crossing the wire over to a neighboring line till the fault is remedied.

CROW FOOT.—A zinc electrode, suggesting a crow's foot in shape; used in a gravity cell.

CROW FOOT CELL.—A name sometimes given to a Daniell gravity primary cell because the zinc element is shaped like a crow's foot.

CROWN OF CUPS.—A primitive primary battery devised by Volta, consisting of a series of vessels filled with lime or dilute sulphuric acid, each of which contained a plate of zinc and a plate of copper connected in series, the isolated zinc and copper plates in the first and last cell, respectively, forming the terminals of the battery.

CROWN TELEPHONE RECEIVER.—A type having a cluster of permanent magnets with the similar poles grouped at the pole piece within the coil and the opposite coil connected to the edge of the diaphragm.

CROWN WHEEL.—In mechanics, a wheel with teeth or cogs, set at right angles to its circumference instead of radially, as in spur gearing. Called also a face wheel.

CRUCIBLE.—1. A pot made of clay, plumbago or other refractory material, in which metals or alloys are melted.

2. The lowest part of a blast furnace, below the hearth, within which the molten metal collects. Its floor is known as the sole.

CRUCIBLE, ELECTRIC.—An electric furnace for melting substances which fuse only at very high temperatures; the heat is produced by an electric arc within the furnace.

CRUCIBLE STEEL.—A homogeneous steel, obtained by melting pieces of suitable blister steel in covered crucibles of plumbago and fire clay; the crucibles are arranged in sixes or twelves in a reverberatory furnace. Several crucibles are poured simultaneously by well drilled workmen to secure uniformity. This steel is more homogeneous than shear steel and possesses greater tenacity, with a fine granular structure. By the addition of manganese carbonate, the property of weldability is restored to crucible steel and brittleness is corrected.

CRUSHER.—A term sometimes applied to a motor used to reduce the pressure on a feeder line by absorbing the extra voltage, when that line requires less pressure than that delivered by the main dynamo.

CRUSHING STRAIN.—One occasioned in a material by simple compression; as, by pressure on a column in the direction of its length.

CRUSHING STRENGTH.—The ability of any material to resist strains due to compressive stresses. Generally speaking, a body which exhibits great resistance to crushing is deficient in tensile strength; as cast iron or concrete.

CRYPTOSCOPE.—A name sometimes given to the fluoroscope, which is an opaque box or tube having at one end a screen coated with fluorescent material for the purpose of exhibiting the shadows cast by X-rays.

CRYPTOSCOPIC SCREEN.—A screen coated with fluorescent material employed in the fluoroscope in X-ray work; a fluorescent screen.

CRYSTAL.—1. A body having definite internal structure with the external form of a solid enclosed by a number of symmetrically arranged plane faces, varying in simplicity from a cube to a complex geometrical form.

2. Clear, pellucid and transparent, like ice.

3. Silica or quartz, in a transparent form; so called because the ancient Greeks believed the gem to be a manifestation of ice.

CRYSTAL DETECTOR.—A device formerly extensively used to detect radio waves. It consists of a crystal and an adjustable metallic contact. In operation, it changes the incoming alternating current signals to pulsating direct current.

CRYSTAL RECTIFIER.—A radio device employing a crystal and metallic contact or two crystals resting against each other to rectify the incoming signals, that is, to change the oscillations into pulsating direct current.

CRYSTALLINE DEPOSIT.—In electro-plating, a deposit in the form of metallic crystals due to an excess of electric current through the plating bath.

CRYSTALLIZATION.—1. The formation of substances as symmetrical solids or crystals, which are definite geometrical figures bounded by flat surfaces. To the chemist and mineralogist the form and appearance of the crystal are generally sure indications of its constitution.

2. The arrangement of the molecules of a fluid substance or liquid into crystalline bodies on cooling, or through thickening by evaporation, as with saline solutions.

3. The rearrangement of the molecules of a metal into crystalline structure under alterations of stress or overload, as with a crane chain or a steel rail.

4. The depositing of crystals in a metal by the action of electrolysis.

CRYSTALLIZATION, ELECTRIC. — The transformation of a substance by electrical means into a crystalline form. For instance, silver nitrate in solution may be decomposed by a current and yield crystals of metallic silver.

CRYSTALLIZATION OF IRON.—This is affected by the conditions under which it is cooled. If cooled rapidly against a cold metallic surface it becomes chilled, and the crystals are long and needle-like. If cooled slowly the crystals are large and the grain is coarse. Crystals which are near the surface always arrange themselves at right angles to the surface and are always smaller than those nearer the central portions. The crystals of graphite mingled among these of the iron are also affected by the conditions of cooling, remaining uncombined in metal cooled slowly, but entering into chemical combination when cooled rapidly.

CRYSTALLOIDS.—A class of bodies which, in a state of solution, diffuse easily through organic membranes and are crystalline in structure. Crystalloids are opposed to colloids, from which they may be separated by a process called dialysis.

C. s.—Abbreviation for central station.

CUBE.—A rectangular solid, measuring the same lineally in the three directions of length, breadth and thickness. Its contents are equal to the product of the lineal measurement of each dimension, hence the third power of a number is termed its cube, as it represents the product of three factors, each equal to the stated number. This is written a^3 or a cubed, as it equals a a a or $a \times a \times a$.

CONCATENATION MOTOR CONTROL.—A method of a. c. motor control permitting half-speed or full speed operation on the same current, by connecting motors in tandem, that is, in concatenation.

CUBIC FOOT.—The volume contained within a space one foot long, one foot broad and one foot deep; 12^3 or 1,728 cubic inches, or $1/_{27}$ of a cubic yard. The usual unit of capacity in dealing with fluids or liquids, except for purposes of buying and selling, when either weights or gallons are employed.

CUBIC MEASURE.—This measure is used to find the volume or amount of space within the boundary surfaces of a body. It involves three dimensions, that is:

volume = length × breadth × thickness.

These dimensions may be taken in any denomination, but all must be of the same denomination. For instance, all in ins., or all in feet, not feet and inches. The word "cubic" is used to denote the product of the three dimensions, thus:

ins. (length) × ins. (breadth) × ins. (thickness) = cu. ins.

There are other kinds of cubic measure known collectively as measures of capacity. These are divided into two classes:

a. Liquid.

b. Dry.

Liquid measure also known as wine measure is used in measuring various liquids as water, molasses, liquors, etc.

CUBIC MEASURE TABLE—

1,728 cu. ins.	=1 cu. ft.
27 cu. ft.	=1 cu. yd.
40 cu. ft. of round timber or 50 cu. ft. of hewn timber	=1 ton or load
16 cu. ft.	=1 cord ft.
8 cord ft. or 128 cu. ft.	=1 cord of wood
24¾ cu. ft.	=1 p'ch of stone or masonry

Scale.—Most of the unit equivalents are fractional except 1,728 and 27, and are therefore omitted.

CUBIC YARD.—The customary unit for measuring excavations, embankments, also concrete and masonry. It is a volume equal to that of a six sided figure or cube, each edge of which measures one yard or three feet.

CU. FT.—Abbreviation for cubic foot.

CULL POLES.—Poles for outside wiring that are smaller at the top than the sizes agreed upon, are troubled with dry rot, large knots and bumps, have more than one bend, or have a sweep of over twelve inches. A cull pole of good material, is the best thing for a guy stub, and is frequently used for this purpose. A cedar pole is always preferable to any other, owing to the fact that it is very light in comparison to other timber, and is strong, durable, and very long lived.

CULM.—A name applied to various classes of coal, originally a Devonshire name for an impure form of coal found locally. Elsewhere it means: a, slack coal; b, breeze, as used in brick burning; c, waste coal, mixed with slate or rubbish; d, the dust or refuse of Pennsylvania anthracite, or the same when found in an impure or pulverulent state.

CUMULATIVE COMPOUND WOUND DYNAMO.—A machine having both series and shunt windings wound in the same direction so that the windings assist each other in the magnetizing action of the field poles.

CUP.—1. A term largely applied to many mechanical details which present a resemblance to a drinking cup, either in form or in use.

2. In lubrication, a vessel or small funnel for receiving oil, etc., and conveying it to a machinery part; an oil cup.

CUP BRUSH.—A brush for polishing the inner surfaces of cup shaped objects in preparation for electro-plating.

CUP VALVE.—1. In steam engineering, a cup shaped or conical valve which is guided by a stem to and from its flaring seat.

2. A form of balance valve which opens simultaneously on top and sides.

3. A valve formed by an inverted cup over the end of a pipe or opening.

CUPEL.—In metallurgy, a small shallow dish about an inch in diameter, upon which assaying specimens are exposed, within the muffle, to the heat of the furnace. The cupel must be porous and very absorbent, and is usually made from ashes of the burnt bones of sheep and horses, washed repeatedly, pressed into form by means of a mould and pestle, dried and ignited to expel all moisture.

CUPRITE.—The red oxide of copper; red copper; an important ore of copper occurring massive and in isometric crystals.

CUPROUS OXIDE CELL.—A photo-voltaic active device consisting of a cuprous oxide cathode and an inert anode submerged in an electrolyte.

CUPRUM.—In chemistry, the technical name for copper. Symbol Cu.

CURB KEY.—In telegraphy, a special key designed for curb signaling over a submarine cable.

CURB SENDER.—In submarine telegraphy, an automatic signaling apparatus for insuring sharply distinct messages, by sending curbed signals. The message is punched on a strip of paper and passed through the transmitter by clockwork.

CURB SIGNALING.—A method of signaling through a submarine cable so as to prevent confusion due to induction, in which the original powerful signal is followed by one or more weak reversed currents which have the effect of hastening the main signal through the cable.

CURBED SIGNALS.—Telegraphic signals transmitted by the process of curb signaling.

CURBING.—Applying the process of curb signaling to the transmitting of cable messages.

CURIE.—A unit of measurement of radium emanation being the mass of particles emitted in equilibrium with 1 gram of pure radium.

CURIE THERAPY.—The radium treatment of disease.

CURRENT AND ELECTRON FLOW.—1. The direction in which an electric current flows is assumed to be from a positively electrified body to a negatively electrified body; an assumption based upon the theory that the positive electric state has a higher voltage than the negative state.

2. In a vacuum tube; if the plate be kept positive with respect to the filament and the latter be heated, electrons will flow from the filament to the plate. This direction of flow is contrary to the usual conception of the direction of flow of electricity, from positive to negative. The reason for this is that before the discovery of electrons, experimenters decided to consider that current flowed from positive to negative as a sort of arbitrary rule. This rule has continued in use even though later experiments seemed to prove the contrary to be true. Therefore, current is always considered to flow from positive to negative, although the electrons actually travel in the opposite direction.

CURRENT COLLECTOR.—Any device used in electric traction to take current from an overhead wire or third rail. There are several types such as: trolley, pantograph, contact shoe.

CURRENT DENSITY.—1. The current intensity at any point in a conductor, as related to the area of the cross section at that point. In determining the current density for armature inductors, much depends upon the provision for ventilation and operating conditions. In general, 600 to 700 circular mils per ampere is safe. For short overloads or for operation in hot engine rooms, 1,000 circular mils per ampere may be used.

2. In electroplating, the current strength in relation to the amount of metal deposited.

CURRENT DIRECTION INDICATOR.—A device for indicating whether or not the direction of the current in a circuit is properly preserved.

CURRENT DISTRIBUTION.—The transmission of electricity to different points through a system of distributing conductors.

CURRENT DIVERTER. — An occasional name for the rheostat used in trolley car motors.

CURRENT, ELECTRIC.—1. The flow of electrical energy along a conductor from the higher to the lower of two points having different pressures. The "flow" is simply the effort to equalize the two pressures just as water runs from a higher to a lower level, or pressure; and the current may be maintained by preserving a constant difference of pressure between the two connected points.

2. The amount of such electrical energy flowing per second along a conductor under a constant difference of pressure.

CURRENT EQUALIZER.—A mechanism for regulating the strength of the current in charging a storage battery, and similarly, of the current strength derived from a storage battery.

CURRENT FOR IGNITION.—The required current may be obtained from: a, dry battery; b, storage battery; c, magneto; d, dynamo. When a dry battery is used, do not make the mistake of using 6 cells instead of 4 because the excess voltage will give excess current and cause the battery to run down sooner.

CURRENT FOR THERAPY.—There are various currents for particular applications, such as: static induced, static wave, galvanic, Leduc, faradic, d'Arsonval, Oudin, Tesla, Morton wave, direct vacuum tube and the various modalities.

CURRENT GOVERNOR.—Any regulating device for preserving the strength of an electric current uniform throughout the circuit.

CURRENT INDUCTION TELEGRAPHY.—A method of telegraphy from a moving train, based on the principle of induction between an outside circuit and a circuit running parallel with it on the train.

CURRENT MARGIN.—In a non-polar telegraph simplex system, current margin is the difference between the current flowing through a receiving instrument while operated to that flowing when not operated.

CURRENT METER.—An instrument for measuring the strength of an electric current. For example, an ammeter is a current meter showing by direct reading the number of amperes of current flowing through a circuit.

CURRENT RELAY.—One which functions at a pre-determined value of current. A current relay may be either an overcurrent relay or an undercurrent relay. —NEMA.

CURRENT RESISTANCE METHOD.—In this method of measuring the radio frequency power delivered by a transmitter a known resistance is used, through which the current is measured, a thermo-ammeter and non-inductive resistor being the measuring instruments generally employed. This method lends itself well to the measurement of small amounts of power.

CURRENT REVERSAL IN ARMATURE COILS.—The energy of the current in the section of the winding undergoing commutation is wasted in heating the wire during the interval when it is short circuited, and as it passes on, energy must again be spent in starting a current in it in the reverse direction. There is, then, a lagging of the current in the armature coils due to self-induction.

CURRENT REVERSER.—Any switching instrument for reversing a current.

CURRENT STRENGTH.—1. The amount of electricity that passes any cross section of a circuit in a second of time.

2. In a direct current, the relation of the voltage to the resistance of the circuit.

3. In an alternating current, the relation of the voltage to the impedance of the circuit.

CURRENT TRANSFORMATION.—The process of changing the voltage of a current by its passage through a transformer or a converter.

CURRENT TRANSFORMER.—One designed to have its primary connected in series with one line of an electrical circuit. Its ratio is the ratio of primary (line) current to secondary current. Current transformers are also called instrument transformers.

CURRENTS OF MOTION.—Electric currents said to pass through muscular or nerve tissues in the human body when they are suddenly contracted or relaxed.

CURRENTS OF REST.—Electric currents said to exist in human muscular and nerve tissue when in a state of rest.

CURVE GUY POLES.—Guy poles set at the curves in a trolley line, to which the trolley wire is braced by wire guys in order to preserve the proper relations of the wire in making the curve.

CURVE OF CROSS SYSTEM.—In the cross over system of overhead wiring, in order to nullify the influence of induction, the curve made in the wire at the cross arm where the change is made in the relations of neighboring wires.

CURVE OF EXPANSION.—In engineering, the curve traced by the pencil of an indicator during the expansion of steam or other working fluid, after cut off. It is generally compared with two other curves, isothermal and adiabatic. On a theoretical card, the curve ordinarily taken to represent the expansion of steam is the equilateral or rectangular hyperbola referred to its rectilinear asymptotes.

CURVES, MAGNETIC.—If iron filings be sprinkled on a sheet of paper held in the field of a magnet, the filings, on gently shaking the paper will arrange themselves in magnetic curves indicating the directions of the lines of force of the magnetic field.

CUSHIONING.—The compression of steam behind the piston of a steam engine, occasioned by closing the exhaust before the completion of the stroke. The cushioning serves to absorb the inertia of the moving parts and brings the piston to rest, preparatory for the next stroke.

CUSHIONING. CHAMBER.—A device in a type of mirror galvanometer for bringing the vibrations of the mirror quickly to rest.

CUT GEARS.—A term applied to toothed wheels whose cogs have been formed by a machine, as distinguished from those whose teeth have been moulded or cast. The former, being mechanically accurate, require less clearance, and therefore run with less noise.

CUT IN.—To insert a conducting appliance or medium into an electric circuit; to switch on.

CUT LINES OF FORCE.—A conductor, forming part of an electric circuit, cuts lines of force when it moves across a magnetic field in such manner as to alter the number of magnetic lines of force which are embraced by the circuit.

CUT OFF.—In the steam distribution of a steam engine by its valve, the closure of the steam port to the admission of steam; this occurs when the steam edge of the valve is in "line and line" position with the steam edge of the port. Cut off is usually expressed as a fraction of the stroke, thus ½, 1/3, etc. This is the apparent cut off as distinguished from the real cut off.

CUT OFF FREQUENCY.—In radio, the frequency range limits of a discriminating filter.

CUT OUT.—1. To take out a conducting device or medium from an electric circuit; to switch off.

2. An electrical device to interrupt the flow of current through any particular apparatus or instrument, either automatically or by hand, more generally by short circuiting than by actual breaking of the current.

CUT OUT BLOCK.—A block of porcelain or similar insulating material containing a safety fuse.

CUT OUT BOARD.—A board for the purpose of carrying safety fuses.

CUT OUT BOX.—In wiring, an enclosure designed for surface mounting and having swinging doors or covers secured directly to and telescoping with the walls of the box proper.

CUT OUT CABINET.—An enclosure in a building designed for the accommodation of cut outs.

CUTTING AND HOLDING GRAPNEL.—A grapnel for submarine cable work so constructed that it automatically cuts the cable after gripping it.

CUTTING CABLE ENDS.—In cable jointing, mark the two overlapping cables at the point where they are to be joined, and take the precaution to cut them square with a hack saw. They should be so cut that the ends which are to be joined butt against each other, that is, no space between. To facilitate cutting off cable square, wrap paper guide around the cable.

CUTTING LINES OF FORCE.—An inductor forming part of an electric circuit, cuts lines of force when it moves across a magnetic field in such manner as to alter the number of magnetic lines of force which are embraced by the circuit. It is important to understand the meaning of this term. For instance, an armature coil in which a current is to be induced, must be tilted in its motion across a uniform field, or rotated around any axis in its plane, so as to alter the number of lines of force which pass through it. If a coil be given a simple motion of translation no current will be induced unless the field be variable.

CUTTING OUT DAMAGED ARMATURE COIL.—First disconnect the coil from the commutator, and after cutting off the leads, insulate the exposed parts with tape. Then connect the commutator bars (which were connected with the leads) with a wire of the same size as the wire winding.

CUTTING OUTLETS.—In house wiring after locating the centers for the outlets, the plaster must be cut out so that the outlet box will set in. For this purpose a special tool has been designed; this plaster drill is constructed so that it may be fitted over a gas pipe, the cutters are adjustable so that any size hole may be cut. A bell shaped cup catches any dirt. If a plaster drill be not obtainable, the outlet box should be traced around with a pencil and the plaster chiseled around this mark with a ¼ in. blade screw driver.

CUTTING POCKETS.—In house wiring, the center of each pocket is indicated by the small hole which was bored through the flooring when cutting the ceiling outlets. In opening a pocket, ¼ in. holes are bored to insert a keyhole saw through the joint between two boards at each end of the pocket, and as near the beams as possible, then the board is cut at an angle. Next saw the tongue of the matched board on each side and pry up the boards with a chisel. Having taken up the boards, nail a cleat on the side of each joist so that when the floor is laid back there will be a good support. A base board is next installed to give a secure hold for the screws used in fastening the fixtures. Two holes are then bored diagonally with an 11-16 inch bit, inserting the bit in the small hole bored in the ceiling. The outlet wires are then tied around the knobs, the upper ends being bared and tapped on to the main wire. A piece of loom is slipped on each outlet wire after which it is thrust through the outlet.

CYANIDE.—A salt of hydrocyanic acid, otherwise regarded as a compound of cyanogen with a metallic base; the most important are the cyanides of potassium, silver and mercury. In a crystalline form, cyanide of potassium is known to electro-platers as cyanide powder.

CYANIDE BATH.—In electro-plating, a bath in which potassium cyanide forms an important ingredient.

CYANIDE OF POTASSIUM.—A white crystalline solid, highly poisonous and a powerful reducing agent, formed either by strongly heating potassium ferrocyanide or by neutralizing hydrocyanic acid with caustic potash. This cyanide is much used in photography, electroplating and laboratory processes; a weak solution readily dissolves finely divided gold, and is therefore employed to treat slimes and poor ores, especially those which have already been through the amalgamation process. The gold is subsequently precipitated from the solution by zinc, and the resultant cake is refined by cupellation.

CYCLE.—A complete set of recurrent values as one complete positive alternation and one complete negative alternation of an alternating current. Usually represented by the sine curve.

CYCLE OF MAGNETIZATION.—A complete wave of magnetization in a succession of periods of magnetic change.

CYCLIC MAGNETIC VARIATIONS.—Periodically recurring variations in the earth's magnetic declination, taking place at long intervals of time.

CYCLIC MAGNETIZATION.—The magnetization caused by applying cycles of magnetization to a susceptible substance.

CYCLIC PHASE.—In physics, an expression denoting the orderly and cyclic succession of the various motions in a heat engine; as, pre-admission, admission, expansion, pre-release, release, exhaust, compression, in a steam engine; and suction, compression, explosion, exhaust, in an internal combustion engine.

CYCLOMETER.—An instrument for registering the number of revolutions made, or the distance measured, by a wheel or other rotating body.

CYLINDER.—1. A circular body generated by the rotation of a straight line around an axis and parallel with same; a bored or hollow surface of a cylindrical outline.

2. In engineering, the essential part of a reciprocating engine; consisting of a cylindrically bored chamber with sealed ends, in which work is done by steam upon a piston, in moving it alternately from one end to the other.

CYLINDER JACKET.—In steam engineering, an annular space surrounding the cylinder walls and through which live steam is circulated to lessen or prevent condensation of the steam within the cylinder, and thus reduce the feed water consumption. The diversity of opinion which still exists as to the value of the steam jacket is due to its misapplication, the tests in such cases being misleading except to the better informed. A jacket should only be used with a very short cut off and to obtain the full economy, the clearance should be reduced to a minimum. For maximum effect heads and piston as well as the cylinder should be jacketed and proper provision for drainage made. See Prof. Prosser's tests, and the author's all jacketed engine. Audel's Engineers & Mechanics Guide No. 4, Chap. 52. See also Bryan Donkin's tests Pro. Inst. Mech. Eng., 1892, page 464.

CYLINDER OIL.—A heavy mineral oil, of considerable viscosity and a high flash point, used to lubricate the cylinders and valves of a steam engine. On account of the high temperature organic oils may not be used, and a flash point of 500° or over is necessary, especially when working with superheated steam.

CYLINDRICAL CORE.—A piece of iron shaped like a cylinder to serve as a solenoid core.

CYLINDRICAL GAUGE.—In instruments, a gauge composed of two pieces, a plug gauge or solid cylinder furnished with a handle, and a collar gauge or hollow cylinder into which the plug gauge fits. These gauges are used as templates for boring and turning parts of machines which are required to correspond in dimensions.

CYLINDRICAL SURFACE.—A curved surface generated by a moving straight line called the generatrix which moves always parallel with itself and constantly passes through a fixed curve called the directrix. The generatrix in any one position is called an element of the surface.

CYLINDRICAL VIBRATOR.—A cylindrical weight suspended in such a manner as to exhibit the effect of torsion.

CYMOMETER.—An instrument devised by J. A. Fleming for the measurement of wave lengths and frequency of oscillatory circuits. It is also useful in the measurement of small inductances and capacities. It consists primarily of an air cored wire coil in series with a condenser consisting of inner and outer metal tubes which form the two plates.

CYMOSCOPE.—A device which indicates the presence of electric waves. When held close to a transmitter a small lamp will light.

CYSTOSCOPY, ELECTRIC.—In medical practice, the examination of the human bladder by means of a specially designed incandescent lamp.

D

D.—1. An abridged abbreviation for d.c. (direct current) sometimes used. Objectionable.

2. Dielectric flux density.

D OR DIAM.—Abbreviation for diameter.

DAILY VARIATION.—Slight variations shown by the magnetic needle at certain hours each day: diurnal variation.

DALTON'S LAW.—The pressure exerted on the interior walls of a vessel containing a mixture of gases is equal to the sum of the pressures which would be exerted if each of the gases occupied the vessel alone.

DAMP-PROOF.—Having an insulation saturated with some non-absorbent material such as asphalt compound.

DAMP STEAM.—In steam engineering, a term used in the same sense as wet steam.

DAMPED ALTERNATING CURRENT.—One with amplitude of successive waves progressively decreasing in value.

DAMPED GALVANOMETER.—A galvanometer provided with a device for damping the oscillations of the indicator, so that it comes quickly to rest after being deflected.

DAMPED MAGNETIC NEEDLE.—A magnetic needle so adjusted as to come quickly to rest after being deflected.

DAMPED NEEDLE.—One that quickly comes to rest as in a damped galvanometer.

DAMPED OSCILLATIONS OR WAVES.—A series of waves of progressively diminishing amplitude.

DAMPED VIBRATIONS. — Vibrations checked by opposing to them such a resistance as will quickly cause them to cease.

DAMPED WAVES.—Those in which the amplitude decreases progressively.

DAMPER.—1. A metallic tube which may be pressed over the core of an induction coil to reduce the induction and lessen the currents of the secondary circuit.

2. A resisting device for checking the oscillations of a magnetic needle.

3. Any arrangement, as a dash pot, for preventing sudden action.

4. A valve or door regulating the flow of heated gases through a chimney, or the entrance of air into the ash pit, thus controlling the rate of combustion.

DAMPER REGULATOR.—A device for controlling the rate of combustion in stationary boilers; a piston or weighted lever is connected by suitable mechanism with the dampers in the throat of the chimney, so that the gases may be throttled as steam exceeds or falls short of the required pressure.

DAMPER WINDING. — An amortisseur winding.

DAMPING COIL.—A coil designed to carry occasional electric currents, mounted near a galvanometer for the purpose of bringing the needle quickly to rest after deflection.

DAMPING EFFECT.—The offering of a retarding force to control swinging vibrations, such as the movements of a galvanometer needle, and to bring them quickly to rest. Very often proper damping may be produced by a shunt or a combination of a shunt and series resistance. In specifying a galvanometer, the external critical damping resistance should be stated. If this cannot be done readily, a complete description of the circuit, external to the galvanometer, should be given.

DAMPING MAGNET.—A magnet used to act upon a needle or other moving body to damp its motion.

DAMPING SUSPENSION.—A suspension so acted on by a damping device as to be free from swing.

DAMPING TUBE.—A metal tube pressed over the core of an induction coil to reduce the induction and lessen the currents of the secondary circuit; a **damper.**

DAMPING VESSEL.—A device usually consisting of a cylinder and piston, offering a retarding force for checking any sudden action; a **dash pot.**

DANIELL GRAVITY CELL.—A two fluid primary cell in which gravity is depended upon to keep the two fluids separate instead of a porous pot. It consists of a large glass jar having a zinc element at the top and copper element at the bottom. The two fluids are sulphuric acid and copper sulphate solution. The latter being the heavier of the two, rests at the bottom of the battery jar, while the dilute sulphuric acid remains at the top. The zinc element is shaped like a crow's foot, hence the cell is often called crow foot cell. The voltage of a Daniell cell varies from about 1.07 volt to 1.14 volt, according to the density of the copper sulphate solution and the amount of zinc sulphate present in the dilute sulphuric acid. Daniell cells are used especially for electro-plating, electro-typing and telegraphic work.

DANIELL POROUS CUP CELL.—A two fluid primary cell containing a zinc plate immersed in dilute sulphuric acid, and a copper plate in a saturated solution of copper sulphate; the two solutions being separated by a porous cup. This cell has a constant voltage and shows only slight polarization.

DARAF.—The unit of elastance or the reciprocal of electrostatic capacity.

DARK CURRENT.—In a photo cell, a small current flowing without light; it is due to the impressed voltage.

DARK DISCHARGE.—A name given by Faraday to the non-luminous electric discharge occurring between the negative and positive electrodes in a vacuum tube.

DARK LAMP METHOD OF SYNCHRONIZING.—Assume an alternator A, in operation and another B, to be synchronized and coupled; also a synchronizing lamp across the switch of B. Now, if B be run a little slower or faster than A, the synchronizing lamp will glow for one moment and be dark the next. At the instant when the pressures are equal and the machines in phase, the lamp will become dark, but when the phases are in quadrature, the lamp will glow at its maximum brilliancy. Accordingly, when the flickering becomes very slow and the lamp finally dark, the alternators are synchronized and the switch may be closed.

DARK LIGHT.—Infra red rays.

DARK SPACE.—1. In a tube carrying current through an ionized gas, a region of darkness around the surface of the cathode. **Crookes dark space.**

2. In a tube containing gas undergoing ionization, a non-luminous region between the visible glows of the cathode and anode. **Faraday's dark space.**

d'ARSONVAL CURRENT. — In electrotherapeutics, high frequency current of relatively low voltage and very high amperage. It has marked heating properties. This current is obtained from high voltage coils.

d'ARSONVAL GALVANOMETER.—A very sensitive, aperiodic or dead beat galvanometer in which the indicating coil is suspended in the field of a powerful horse shoe magnet; the invention of A. d'Arsonval. Its operation depends upon the principle that if a flat coil of wire be suspended with its axis perpendicular to a strong magnetic field, it will be deflected whenever a current of electricity passes through it. Its sensitivity depends upon the strength of the field of the permanent magnet, the number of turns in the suspended coil, and the torsion of the wires by which it is suspended. This type galvanometer is used for general laboratory work as it is not much affected by changes in the magnetic field. It may be made with high enough period and sensitivity to be satisfactory as a ballistic instrument, but for extreme sensitivity an instrument of the astatic type is more generally used.

DASH COIL.—1. A multi-unit induction coil, for jump spark ignition of internal combustion engines, with a coil for each cylinder, the whole being enclosed in one case, with dash connections to the timing device upon the engine or cam shaft.

2. In synchronous ignition a single coil used with a multi-cylinder engine in connection with a **distributor.**

DASH POT.—A device used with Corliss and other releasing gears to cause quick closure of the admission valves at cut off and to absorb the momentum of the moving parts, bringing them quietly to rest. A dash pot is simply a cylinder closed at one end and accurately bored to receive a plunger or piston. A rod connects the latter to the steam arm of the admission valve. The steam arm, then, as it is raised by the hook, lifts the piston or plunger which produces a partial vacuum in the dash pot. When the hook releases the steam arm, the pressure of the atmosphere on top the plunger causes it to quickly drop and close the valve. The compression of air remaining below the plunger forms a cushion which prevents shock.

DATA.—1. Necessary details relative to a mathematical problem which are given when the problem is stated.

2. Information, dimensions and particulars collected, either by experience study or research, respecting technical subjects.

DAVY LAMP.—A miner's safety lamp in which the air passages are covered with a cylinder of finely woven copper gauze, to cool the products of combustion to such an extent that surrounding gases will not be ignited by them.

Db.—Abbreviation for **decibel.**

D. b. SWITCH.—Abbreviation for **double break switch.**

D.c.—Abbreviation for **direct current** (some times only D, but objectionable).

D-CABLE.—A two conductor cable; each conductor having the shape of the capital letter D, with insulation between the conductors themselves and between conductors and sheath.

DEAD BEAT.—A term applied to instruments having indicators which prevent tedious swinging back and forth after deflection, by being heavily damped so that they come to rest quickly.

DEAD BEAT DISCHARGE.—An electric discharge which does not oscillate.

DEAD BEAT GALVANOMETER.—A thoroughly damped galvanometer which gives its readings without useless swinging of the needle before coming to rest; an **aperiodic galvanometer.**

DEAD CENTER.—1. The point at which the connecting rod of a steam engine has no power to turn the crank. It occurs when the position of the crank shaft, crank pin and connecting rod, are all in a straight line; that is, at each end of the stroke.

DEAD DIPPING.—Dipping metallic objects after electro-plating into such acids as will give a dull luster to the surface of the metal, as opposed to bright dipping.

DEAD EARTH.—In telegraphy, a fault in the line involving a complete grounding or connection with the earth; a total earth.

DEAD END.—In wiring, the termination of a line wire on an insulator.

DEAD END EFFECT.—In a tapped radio coil, the effect of the portion of the winding not in use which acts as a miniature oscillating circuit tending to reduce the efficiency of the tuning unit as a whole.

DEAD END OF A PIPE.—The closed end of a pipe or system of pipes.

DEAD END SWITCH.—One used to cut out the dead end turns of a coil from the active turns.

DEAD END TURN.—That portion of an armature winding which does not cut lines of force in the magnetic field and therefore does not contribute to the machine's output.

DEAD ENDED WIRE.—A line wire terminated by having its end fastened to an insulator.

DEAD FRONT SWITCHBOARD.—One having no live parts on the front of the panels.—NEMA.

DEAD GROUND.—Dead earth

DEAD LOAD.—One that is put on by imperceptible degrees and that remains steady, such as the weight of a boiler or an engine on its foundation· opposed to live load.

DEAD MAN.—A pole support consisting of a heavy wooden bar terminating in a broad U-shaped iron fork, designed to prop a telegraph pole while being raised; a butt prop.

DEAD PLATE.—That part of the bottom of a furnace which consists of an iron plate on which the fuel is first thrown.

DEAD POINT OF ARMATURE.—A relation of a motor armature to the field such that it cannot start under the action of the driving current

DEAD RESISTANCE.—A resistance free from self-induction.

DEAD SPOT.—In radio, a region in which signals from certain transmitting stations cannot be received, or are received with difficulty.

DEAD WEIGHT.—Weight or load directly applied to an object, as in a dead weight safety valve.

DEAD WIRES.—1. Wires on a dynamo armature that fail to contribute to the voltage during the rotation of the armature in a magnetic field.

2. Wires on a motor armature which do not contribute to the torque when an electric current is sent through them.

DEADMAN'S HANDLE.—In electric traction control, a safety device on the controller handle which unless pressed down by the operator's hand, operates to shut off the current and in some cases to apply the brake.

DECADE PLAN.—A method of combining resistance coils in a Christie or so called Wheatstone bridge. In this arrangement there are 9 or 10 one ohm coils for the units place, 9 or 10 ten ohm coils for the tens place, 9 or 10 one hundred ohm coils for the hundreds place and so on. Each series of coils of the same value is designated a decade.

DECADE RESISTANCE BOX.—A simple form of resistance box provided with two sets of ten coils; one set of one ohm resistance each, and the other of ten ohms resistance each. By inserting two plugs, one in the tens and the other in the units resistances, any combination may easily be made; also called a decimal rheostat.

DECADENT WAVE.—A damped oscillation.

DECALAGE.—In aviation, a difference in angle of incidence between any two distinct aerofoils.

DECALESCENCE.—The sudden absorption of heat occurring at a certain stage during the process of heating a bar of iron or steel; the reverse of recalescence.

DECI.—A Latin prefix often used with a physical unit to designate a quantity one-tenth of that unit.

DECI-AMPERE.—A unit of electric current equal to the tenth part of an ampere.

DECI-AMPERE BALANCE.—An ammeter balance designed to measure the strength of electric currents in deci-amperes.

DECIBEL.—One tenth of a bel, the number of decibels denoting the ratio of two amounts of power being 10 times the logarithm to the base 10 of this ratio. The abbreviation db is commonly used for the term decibel. Let P and P^1 designate two amounts of power and n the number of decibels denoting their ratio then $n=10 \log_{10} (P \div P^1)$.

DECI-LUX.—The tenth part of a lux.

DECIMAL CANDLE.—The bougie-decimale, a French standard of illumination equal to one-twentieth of a violle, or slightly less than the British standard candle.

DECIMAL EQUIVALENT.—A fractional or duodecimal measurement expressed as a decimal; as, .25 is the decimal equivalent of ¼.

DECIMAL FRACTION OR DECIMAL.—A fraction whose denominator is 10 or a power of 10. It is usually written without the denominator, the number of ciphers in the denominator being indicated by the number of places occupied by the numerator preceded if necessary by ciphers, and placed after a point or period called the "decimal point." The trouble with decimals is the way a beginner or careless person makes the decimal points. It should be understood absolutely once and for all that the decimal point is an item of extreme importance. Most errors are due to writing the decimal point carelessly so as to require a microscope to see it—use an "acre of lead" if necessary to make the decimal point plainly visible.

DECIMETER.—A measure of length in the metric system; one-tenth of a meter, equal to 3.937 inches.

DECK CABLE LEAD.—Pulleys or guides, set upon the deck of a cable ship at intervals from the cable tank to the stern of the vessel, to assist the operation of laying the cable.

DECLINATION.—The angle between the magnetic and geographic meridian. Since the earth's magnetic poles do not coincide with the geographic poles, the magnetic needle does not point exactly north and south, but varies more or less in different parts of the earth's surface; this variation is called the declination.

DECLINATOR.—An instrument for determining the declination and inclination of a plane.

DECLINOMETER.—An instrument consisting of a telephone combined with a magnetic compass, designed to measure the declination of the magnetic needle, and note its variations.

DECOHERER.—A radio device, usually electro-magnetic, for causing a coherer to lose the coherence acquired under the action of the electric wave, preparatory to the reception of new signals.

DECOMPOSITION, ELECTRIC.—1. The decomposing of a substance by the action of an electric current; electrolysis.
2. In therapeutics, electro-catalysis.

DECOMPOSITION, ELECTROLYTIC.—The process of decomposing a liquid solution called electrolyte, into its chemical elements by the action of an electric current.

DECOMPOSITION VOLTAGE. — In electrolysis the sum of the single electrode pressures of the system in question. In a mixture of ions, when a definite voltage is impressed between the electrodes, the ion which discharges at the lowest pressure, discharges first.

Acid.	Decomposition Voltages.
Ammonium chloride	1.31
Ammonium bromide	.94
Ammonium iodide	.52

DECREMENT.—The ratio of one oscillation to the succeeding one, of a suspension needle which has been disturbed, the swings gradually decreasing in amplitude on account of damping.

DEDENDUM.—In toothed wheels, the root of the tooth, or that part within the pitch circle. The dedendum circle is the circle within the pitch circle, to which the bottom of each tooth extends.

DE FARIA VALVE.—An aluminum lead rectifier. The cathode is a hollow cylinder of aluminum placed concentrically in a larger cylinder of lead, and the whole immersed in electrolyte of sodium phosphate in an ebonite containing vessel. Cooling is effected by promoting automatic circulation of the electrolyte by providing the lead cylinder with holes near its extremities; the heated electrolyte then rises in the lead cylinder, passes out at the upper holes, is cooled by contact with the walls of the containing vessel, and descends outside the lead cylinder. It is claimed that this cooling action is sufficient to allow of a current density of 8 amp. per sq. dm. of aluminum.

DEFECTIVE CONTACTS.—In a dynamo, defective contacts sometimes interpose sufficient resistance in the path of the exciting current to prevent the machine building or exciting. Each of the contacts should, therefore, be examined, cleaned, and screwed up tight.

DEFINITE TIME.—A qualifying term applied to any relay indicating that there is purposely introduced a delay in action, which delay remains substantially constant regardless of the magnitude of the operating quantities. For quantities slightly above the minimum operating value, the delay may be inverse.—NEMA.

DEFINITE TIME LIMIT RELAY.—A relay consisting of an air dash pot, and an air diaphragm or equivalent retarding device connected to the contact mechanism. In some designs, when the contacts are released, they descend by gravity against the action of the retarding device thereby making contact a definite interval after the occurrence of the abnormal condition.

DEFINITE TIME OVER CURRENT.—A relay protective principle. This principle is generally used in combination with the inverse time principle to give the familiar inverse definite minimum time relay. Protective devices operating on this principle have inverse time characteristics up to a certain value of current, while at all higher values they operate in a certain definite minimum time. Such schemes are necessary where there is no branching of the circuit at the junction of the faulty section to the rest of the system, as in a radial or a tandem system.

DEFLAGRATION, ELECTRIC.—Volatilization of a metal by the action of a powerful electric current.

DEFLAGRATOR.—An early form of primary cell of low internal resistance designed for purposes of electric deflagration.

DEFLECTING FIELD.—In a galvanometer, the current being tested produces a magnetic field which deflects the needle to an amount depending upon the intensity of the field, the deflection being a measure of the current strength.

DEFLECTION.—1. The alteration in form of any material under stress; deformation caused by the imposition of a load either tensile, compressive, torsional or transverse.

2. The distance or angle by which one line departs from another.

DEFLECTION COMPASS.—An instrument used in meteorology to observe the declination of the magnetic needle, and note its variations; frequently made self-registering by periodical photographs. Useful to tell the hourly variations of the magnet and foretell electrical storms; a declinometer.

DEFLECTION METHOD.—A method of electrical measurement in which the amount of deflection of the index needle is taken as the measure of the electric force acting upon or through an instrument, as distinguished from the null or zero method.

DEFLECTION OF MAGNETIC NEEDLE.—1. The declination.

2. The deflection of a magnetic indicator from its plane of normal rest along the earth's meridian into another position, under the influence of an artificial magnetic field.

DEFLECTOR.—A term of general application for a plate or other suitably shaped fitting employed to turn the course of a stream of liquid or gases in a desired direction; deflectors are commonly fitted to furnaces and fire boxes to direct the course of the hot gases, and to protect the door from the flame.

DEGASSIFICATION PROCESS. — In the evacuation of a bulb, a process to dispose of the gases that might be in the glass and in the metal parts. It is accomplished by heating the bulb in a closed hot chamber and the metal parts by means of an "induction furnace." A hard vacuum is secured by this method.

DEGENERATION.—In radio, feed back in opposite phase.

DEGENERATION REACTION.—In electrotherapeutics the absence of response to both galvanic and faradic stimulus in a degenerated nerve and faradic stimulus in the muscles.

DEGREES.—The circumference of every circle is supposed to be divided into 360 equal parts, called degrees; thus, a degree is 1-360th of the circumference of any circle. A degree is divided into 60 parts called minutes, expressed by ('), and each minute is divided into 60 seconds, expressed by ("), so that the circumference of any circle contains 21,600 minutes or 1,296,000 seconds.

DEKA.—A Greek prefix often used with a physical unit to designate a quantity ten times as great.

DEKA-AMPERE.—A unit of electric current equal to ten amperes.

DEKA-AMPERE BALANCE.—An ammeter balance designed to measure the strength of electric currents in units of tens of amperes.

DE LA RIVE'S FLOATING CELL.—A small floating cell having immersed therein a galvanic couple connected through a coil of wire placed above. An exciting solution is poured in the cell, and the latter as it floats in a larger vessel rotates until the coil and magnetic needle are at right angles to each other. A magnet acts in accordance with Ampere's theory, to attract or repel the coil.

DELIQUESCENCE.—The dissolving of a salt or other crystal substance in the moisture absorbed by it from the atmosphere.

DELTA CONNECTION.—The connection of the circuits in a three phase system in which the terminal connections are triangular like the Greek letter delta; triangle or ring connection. Starting with the inductors of one phase opposite the middle of the poles, assume the maximum current to be induced at this moment; then but one half of the same value of current will be induced at the same moment in the other two phases. The delta connection will stand 1.732 as much current as the Y connection, but will give only $1 \div 1.732$ or .577 as much voltage.

DELTA CURRENT.—The current flowing from one line to the other in the delta connection of a three phase system.

DELTA GROUPING.—A method of connectting three phase alternator armature coils. So called on account of its resemblance to the Greek letter, delta. The voltage at the terminals is equal to the voltage in one phase, and the current in each line is equal to the vector sum of the currents in two phases, that is, it is equal to $\sqrt{3}$ multiplied by the current in one phase.

DELTA METAL.—In metallurgy, an alloy of copper and zinc, with a small quantity of iron. It is prepared in various grades, both cast and forged.

DELTA RAYS.—Etheric waves of motion of high penetration given off by radio active substances.

DELTA THREE PHASE SYSTEM.—The ring connection applied to a three phase system, so that the transmission wires are joined to the three corners of a triangle, resembling the Greek letter delta.

DELTA TRANSFORMER CONNECTION.—A connection in which both primaries and secondaries are connected in delta grouping.

DELTA Y CONNECTION.—In this method the primaries are connected in delta grouping and the secondaries in star grouping.

DEMAGNETIZATION.—The process of removing the magnetism from a magnetic substance. A magnet may be demagnetized a. by bringing its poles into contact with like poles; b, by heating to redness; c, by passing it through a series of cycles in a magnetic field which is at first strong, then gradually diminishing in intensity to zero; d, by reversing the directions of the motions by which its magnetism was originally imparted.

DEMAGNETIZING CURRENT.—A current employed to oppose a magnetic field so as to deprive it of its magnetism.

DEMAGNETIZING EFFECT.—In dynamo operation; a weakening effect of the field magnets due to lead that must be given the brushes on account of armature reaction.

DEMAGNETIZING FORCE.—Magnetic lines of force arising in a bar of iron or steel in an opposite direction to the force magnetizing it, and tending to neutralize that force; and, in the case of a permanent magnet, tending to demagnetize the bar.

DEMAND FACTOR.—The maximum connected kilowatts of capacity divided intc the actual kilowatts of demand and expressed in terms of per cent.,

DEMAND INDICATOR.—A form of electric meter designed to measure the maximum demand of a consumer, or the highest amount of electrical energy consumed by him at one time a rebate indicator.

DEMAND METER.—A device which indicates or records the demand or maximum demand. Demand meters measure a quantity which is composed of an electrical factor and a time factor. Accordingly each demand meter must contain an electrical element and a timing element which may be structurally either distinct or combined with each other. These two elements combined with a suitable recording or indicating element make up the demand meter. The electrical element of a demand meter is that portion which is affected by the electrical quantity which it is desired to measure; the magnitude of the effect gives a measure of that electrical quantity. The timing element of a demand meter is the mechanism or that feature of the device through which the demand interval is introduced into the result.

DEMAND METER CLASSIFICATION.—There are several types of demand meters to meet the varied requirements of service, and they may be classified as: a, integrating; b, lagged; c, recording.

DEMAND RATE.—A central station rate is one in which a factor is introduced offering certain economies to a customer who will arrange his draft of energy so as to require a steady non-fluctuating supply over the major part of the working period.

DEMARCATION CURRENT.—In electrotherapeutics, a current obtained from an injured muscular tissue.

DEMODULATION.—In radio the process of detection, of a modulated wave, current or voltage, in order to obtain the signal imparted to it in the modulation process.

DEMODULATOR.—1. A radio detector.
2. In a super-heterodyne receiver, the second detector.

DENOMINATE FRACTION.—A concrete fraction whose integral unit is a denominate number. Thus 3-7 of a day is a denominate fraction, the integral unit being one day; so are ⅝ of a bushel; 2/3 of a mile, etc., denominate fractions.

DENOMINATOR.—That part of a fraction which expresses the number of parts into which the unit or number is divided.

DENSIMETER.—A device used to determine the specific gravity or relative density of a substance. Usually called hydrometer.

DENSITY, ELECTRIC.—The quantity of electricity on a unit of area at any part of a charged body.

DENSITY OF CHARGE.—The amount of electricity at any point of a charged surface; i.e., the number of units of electricity per unit of area; electric density.

DENSITY OF CURRENT.—The amount of electric current which passes in any part of a circuit as compared with the area of cross section of that part of the circuit.

DENSITY OF ELECTRIFICATION.—The amount of electricity at any point on a surface electrified by an electrostatic charge.

DENSITY OF FIELD.—The quantity of electro-magnetic lines of force existing in a unit cross sectional area of the field.

DENSITY OF FLUX.—The number of lines of force per unit area of cross section in a plane at right angles to the lines of force.

DENTAL MALLET, ELECTRIC.—An instrument used by dentists for hammering tooth fillings. It is operated by an electro-magnet, the mechanism being so arranged that it strikes a rapid series of blows.

DENUDER.—That portion of an electrolytic cell of the mercury type in which the alkali metal is separated from the mercury.

DEPHLEGMATOR.—A still head or rectifying apparatus used in distilling spirits and other products with low boiling points.

DEPOLARIZATION.—The process of preserving the activity of a primary cell by preventing polarization. One of the chief aims in the arrangement of the numerous cells which have been devised is to avoid polarization. The following are the methods usually employed: a, chemical; b, electro-chemical; c, mechanical.

DEPOLARIZER.—A substance employed in some types of cell to combine with the hydrogen which would otherwise be set free at the positive electrode and cause polarization.

DEPOLARIZER BAG.—A cylinder of hemp or other fabric used in place of a porous pot in some forms of Leclanche primary cell, and also as a suport for the depolarizing mass in some forms of dry cell where the electrolyte is of a thin gelatinous nature.

DEPOLARIZING FLUID. — A powerful chemical agent employed to depolarize a primary cell.

DEPOLARIZING METHODS.—Polarization may be avoided by a, chemical methods; b, electro-chemical means; c, mechanical methods. In the simplest form of cell having zinc and copper elements in dilute sulphuric acid, no attempt has been made to prevent the evil of polarization, hence it will quickly polarize when the current is closed for any length of time, and may be classified as an open circuit cell. In closed circuit cells polarization is prevented by chemical action, so that the current will be constant and steady till the energy of the chemicals is expended. When polarization is remedied by chemical means, the chemical added is one that has a strong affinity for hydrogen and will combine with it, thus preventing the covering of the negative plate with the hydrogen gas.

DEPOSITING CELL.—In electro-metallurgy a cell in which to make electro-metallurgical deposits.

DEPOSITION.—1. The electrolytic precipitation of a metal; electro-plating.
2. An action whereby matter in solution is precipitated upon a surface, as the process of electro-deposition, in which a coating of precious metal is bestowed upon base or inferior material.

DERIVED CIRCUIT.—A branch of a divided circuit carrying a derived current; a shunt circuit.

DERIVED CURRENT.—A current which passes through a shunt or derived circuit.

DERIVED UNITS.—Units other than those of length mass and time.

DESCRIPTIVE GEOMETRY.—That branch of geometry concerned with the graphic methods of representing all geometrical magnitudes and the solution of problems relating to these magnitudes. It is based on parallel projections to a plane by rays perpendicular to the plane.

DESK LOOP.—A circuit used in a telegraph station for connecting the instruments upon a desk in that office to the instruments of the main line.

DESK SET.—A convenient type of telephone instrument designed to stand upon a desk, so that the subscriber need not leave his desk in order to use the telephone.

DESTRUCTIVE DISTILLATION.—The decomposition of a substance by great heat in a retort, and the collection of the volatile products evolved by the chemical process undergone; as when coal is heated so as to yield gas, naphtha, tar, etc., leaving a residue of coke.

DETECTOR.—In radio, a device which modulates or varies the frequency of radio frequency waves to audio frequency waves. It is sometimes called a rectifier because it serves to change the incoming current from alternating to pulsating.

DETECTOR GALVANOMETER.—Any simple galvanometer sufficiently delicate for ordinary use in detecting the presence of electricity; the lineman's detector.

DETECTOR PEG.—A peg employed in a detector galvanometer.

DETENT.—A stock or checking device as a pin, lever, stud, click, pawl, dog or fence. Used on racks or ratchet wheels to sustain loads and in clocks or watches in connection with a spring.

DETERIORATION OF INCANDESCENT LAMP.—The decrease in candle power of an incandescent lamp due to prolonged use, whereby the filament "ages" with a corresponding waste of electric energy.

DETONATOR.—An explosive capsule containing fulminate of mercury or similar substance, which by electricity or a fuse is caused to detonate high explosives.

DETORSION BAR.—A metal bar employed in a declinometer to remove the torsion of the thread which suspends the magnet.

DETUNING.—In radio, altering the amount of capacity or inductance or both, from their tuned values for the purpose of reducing the volume or loudness of the reception, or eliminating interference.

DETUNING SPADE.—In radio, a metal disc in which eddy currents are formed when moved into the field of a tuning coil. Detuning is accomplished by effect of the eddy currents in increasing the resonance frequency.

DEVELOPED WINDING DIAGRAM.—In armature construction, a method of showing the windings and connections in which the cylindrical surface is shown "developed," or rolled out flat upon the paper, while the ends of the armature are represented as they actually appear. This method was suggested by Fritsche of Berlin.

DEVIATION.—The deflection of the mariner's compass owing to the attraction of the metallic masses of which the ship is composed.

DEVIL CLAWS.—A claw like instrument used in overhead line construction.

DEVIOMETER.—A reed indicator for air craft, to indicate a lateral course with respect to a radio range equisignal zone.

DEW POINT.—The temperature of the atmosphere at which dew would form or condensation would occur.

DEXTRORSAL HELIX.—A dextrorsal solenoid.

DIACRITICAL CURRENT. — A current which, flowing through a solenoid, is sufficient to bring the iron core to one-half its point of magnetic saturation.

DIACRITICAL NUMBER.—The number of ampere turns in a solenoid required to create a magnetic condition in the iron core equal to one-half magnetic saturation.

DIACRITICAL POINT.—The coefficient of magnetic saturation producing in an iron core a condition equal to one-half its maximum magnetization.

DIAGNOMETER.—A radio portable testing set made by Supreme Instrument Corp. It comprises equipment for testing as follows: a, tube tester; b, modulated radiator; c, resonance indicator; d, neutralizer; e, analyzer; f, continuity tester; g, rejuvenator.

DIAGOMETER.—An instrument consisting of a dry pile and magnetic needle for measuring the electro-conductive power of a substance, and thereby detecting adulterations and impurities in the substance.

DIAGONAL.—A line joining two opposite angles of a quadrilateral figure, and dividing it into two parts.

DIAGRAM. — 1. A skeleton geometrical drawing, illustrating the principles of application of a mechanism.

2. A figure traced by the pencil of an indicator.

DIAGRAM FACTOR.—A coefficient which allows for losses in the power end of an engine.

$$\text{diagram factor} = \frac{\text{area of actual card}}{\text{area of theoretical card.}}$$

In practice diagram factors range from a little over .5 to a little over .90.

DIAL.—1. A graduated circular plate upon which anything is indicated by a needle; as, in a volt meter or numbered face plate.

2. A magnetic compass used in underground surveying.

DIAL BRIDGE.—A form of resistance bridge having its coils arranged in dials, the contacts being made by a movable arm instead of by the insertion of plugs.

DIAL TELEGRAPHY.—A method of telegraphy in which a magnetic needle, swinging over a dial marked with the letters of the alphabet, is used for receiving the messages; step by step, or needle telegraphy.

DIAL TELEPHONE.—A telephone system in which the caller makes the connection by means of a small dial, instead of asking "Central" to make the connection.

DIALYSIS.—The process of separating a substance into colloids and crystalloids by taking advantage of the difference of their diffusibility through a membrane.

DIALYZING.—Subjecting a substance to dialysis.

DIAM.—Abbreviation for diameter.

DIAMAGNETIC.—That property of some substances by which they tend to lie at right angles to the lines of force of a magnetic field. Not susceptible to magnetism, as distinguished from paramagnetic substances which are attracted to the magnet. Bismuth is the most strongly diamagnetic body known.

DIAMAGNETIC PERMEABILITY. — The susceptibility to magnetization possessed by diamagnetic bodies.

DIAMAGNETIC POLARITY.—The magnetic property of diamagnetic substances in virtue of which they appear to be repelled from the poles of a magnet.

DIAMAGNETISM.—The property of being apparently repelled from a magnet.

DIAMAGNETOMETER.—An instrument for measuring, or determining diamagnetism.

DIAMAGNETS.—A name formerly given to diamagnetic substances after undergoing magnetic induction, to distinguish them from magnets.

DIAMETER OF A CIRCLE.—A straight line passing through its center and terminating at both ends in the circumference.

DIAMETRAL PITCH.—A method of computing the pitch of machine cut toothed wheels, in terms of a certain number of teeth per inch of diameter of pitch circle. To proportion the speeds of wheels is only a question of the ratio between the diameters, the pitch depending upon the strength of tooth required.

DIAMETRICAL CONNECTION.—A three phase to six phase connection of transformers, made by bringing both ends of each secondary winding to opposite points on the rotary converter winding, utilizing the converter winding to give the six phases. This transformation of phases may also be obtained with transformers having two secondary windings.

DIAMETRICAL OR SIEMENS WINDING.—A two layer lap winding having a pitch of 180°.

DIAMOND WINDING.—One which is made up of similarly shaped overlapping coils which have V-shaped coil ends, so bent that approximately half of each coil end is on one side of the plane of the coil side and the other half of each coil end is on the other side of the plane of the coil side. The diamond winding is the prevailing type.

DIAMOND WINDING CONSTRUCTION.—A single adjustable form may be used for numerous size coils; it can be connected according to nearly any method; connections may be readily changed; coils easily insulated and assembled; coils and winding all alike; repairs easily made. The coil ends are bent so that the plane of the coil side does not bisect the coil end. The sharp bend at the middle is called the knuckle. The coils of practically all two layer overlapping windings are provided with some sort of a knuckle. The function of the knuckle is to permit coil ends to properly cross each other.

DIAPHRAGM.—1. A thin disc of an elastic substance capable of being vibrated by sound or other wave motion; as, the diaphragm of a telephone receiver.

2. The porous partition employed in electric osmose.

3. A variety of porous vessel used in certain forms of voltaic cells.

4. A disc for regulating the light to be measured in a photometer.

DIAPHRAGM CURRENT.—An electric current due to the difference in pressure on the opposite sides of a porous diaphragm through which a liquid is being forced.

DIAPHRAGM PHOTOMETER.—A photometer which measures the intensity of light by its effect upon the opposite faces of a diaphragm or screen.

DIASCOPE.—1. A machine for showing motion pictures in daylight.

2. A flat glass pressed against the skin to expel blood to determine if any change has occurred in the tissue.

DIATHERMAL.—Capacity for transmitting radiant heat; freely permeable by radiant or reflected heat.

DIATHERMY. — 1. In electro-therapeutics, the production of inductive heat within the body by means of a diathermy apparatus is now a generally accepted and highly useful physio-therapeutic agent. There are two divisions of diathermy; a, medical, and b, surgical.

2. In medical diathermy, the ability to generate heat or warmth within the tissues without shock in a definite measurable quantity, to any superficial area and to any required temperature makes diathermy technique of special importance and value to the progressive physician and surgeon.

DICE BOX INSULATOR.—A line insulator resembling a pair of inverted cones united at the vertices.

DIELECTRIC.—1. Any insulating medium which intervenes between two conductors and permits electrostatic attraction and repulsion to take place across it; usually the dielectric is air, sometimes glass or ebonite.

DIELECTRIC ABSORPTION.—In a condenser, a small amount of current which at the completion of a charge, apparently permeates the dielectric and which flows out at completion of discharge. Sometimes called dielectric viscosity.

DIELECTRIC CAPACITY.—The inductivity or specific inductive capacity of a substance, being its ability to convey the influence of an electrified body. If the inductivity of dry air be taken as 1, the dielectric capacity of any other substance is measured by the ratio of the capacity of a condenser when its plates are separated by that substance to the capacity of the same condenser with its plates separated by air.

DIELECTRIC CIRCUIT.—A circuit made up in a greater or lesser degree of dielectric substances, as distinguished from a circuit through conductors.

DIELECTRIC COEFFICIENT OR CONSTANT.—The same as dielectric capacity or specific inductive capacity.

DIELECTRIC CONSTANT.—The specific inductive capacity of a dielectric.

DIELECTRIC CURRENT.—The rate of change of electric displacement produced in a dielectric; the displacement current.

DIELECTRIC DENSITY OF A GAS.—The amount of electric force a gas can sustain between opposite charges of electricity before it gives way and permits a disruptive discharge to take place through it; dielectric strength.

DIELECTRIC DISPLACEMENT.—Tubes of force acting through a dielectric medium which is subject to electrostatic forces.

DIELECTRIC FLUX DENSITY.—Electrostatic flux density.

DIELECTRIC HYSTERESIS.—A loss in the insulating material somewhat similar to the magnetic hysteresis loss in iron. A dielectric is a poorly conducting material used for insulating conductors, through which voltage establishes a molecular strain or an electrostatic field of flux. The total dielectric loss is due to the sum of a direct I^2R, leakage of current through the dielectric and to the dielectric hysteresis loss, which is thought to be a function of the insulation resistance, varying inversely. The hysteresis loss in the dielectric of a cable is constant and independent of load. It increases with voltage, with the length of cable and with frequency.

2. In a condenser, a property of the insulating material between the plates of a condenser which retards the charge and discharge and generates heat, resulting in a loss. The effect is marked in the case of high frequency currents.

DIELECTRIC POWER.—The inductivity, or specific inductive capacity of a substance, being its ability to convey the influence of an electrified body.

DIELECTRIC RESISTANCE.—The resistance offered by a dielectric to the electric force acting upon it.

DIELECTRIC STRAIN.—The deformed condition which occurs in a solid dielectric under the stress of an electric charge upon its surfaces; as when a Leyden jar dilates, or even breaks, under the force of the charge.

DIELECTRIC STRENGTH.—The maximum voltage that the dielectric can withstand without rupture. It is not affected by the area of a homogeneous insulating material, but does increase with increased thickness.

DIELECTRIC TEST.—A test for all motors regardless of horse power rating, and for operation upon circuits not exceeding 250 volts, shall be made by applying 900 volts alternating current.—NEMA.

DIELECTRIC VISCOSITY.—Dielectric absorption.

DIESEL ELECTRIC DRIVE.—A method of electric ship drive which employs Diesel engine driven alternators which supply current for the propelling motor or motors. An operating stand is usually installed in the pilot house from which the captain can reverse and change the speed of the propellers. The system allows of great latitude in its installation and finds ready application in a wide variety of vessels. The Diesel engines used in connection with electric drive are of the relatively high speed type. The prefix "Diesel-electric" is also applied to locomotives, cars, buses, etc., which are equipped with this drive.

DIESEL ENGINE.—A high compression internal combustion engine in which the fuel is ignited by the heat of compression. The Diesel cycle may be completed in either two or four strokes, the latter being the prevailing practice. Briefly the four stroke Diesel cycle is as follows: a, suction stroke; admission of air into the cylinder; b, compression stroke; compression of the charge of air to about 500 lbs. pressure which causes its temperature to rise to about 1,000° F. As this pressure is reached gradually, it does not cause a shock to the engine, such as an explosion to the same pressure would give; c, power stroke; at the beginning of the stroke, oil previously delivered to the injection valve is blown into the cylinder in the form of fine spray by a small quantity of air compressed by a special compressor to 700 or more lbs. pressure. The oil spray meeting the highly heated air in the cylinder ignites and burns, combustion continuing so long as the fuel is being injected, usually for about one tenth of the power stroke. Usually the heat generated by the combustion is not sufficient to prevent the pressure in the cylinder falling while admission is taking place, so that the admission line on the indicator card falls below the constant pressure line; d, exhaust stroke, expulsion of the products of combustion from the cylinder; this completing the cycle.

DIETRINE.—A trade name for a compound prepared for insulating purposes.

DIFFERENCE FREQUENCY.—In radio, a name sometimes given to beat frequency.

DIFFERENCE OF ELECTRIC PRESSURE.—The difference of electrical condition between two points in an electrical field involving work to be done by a unit of electricity in passing from one point to another; the difference of electric level which causes a current to flow from the higher to the lower.

DIFFERENTIAL ARC LAMP.—A form of arc lamp in series, in which the arc is maintained by the use of a series coil of low resistance for striking the arc, and a shunt coil of high resistance for feeding the carbons forward when the length of the arc becomes too great; a derived circuit arc lamp.

DIFFERENTIAL BOOSTER.—A compound wound dynamo with compensating coil. In this type of booster the series coil energized from the main current, tends to discharge the battery and the shunt coil, excited from the battery, tends to charge the cells. These two coils are opposed to one another, and the difference in their respective strengths represents the net strength available for boosting. In order to produce quicker reversal, additional compound coils are sometimes added.

DIFFERENTIAL CALCULUS.—That branch of calculus which treats of the division of a quantity into infinitesimally small parts.

DIFFERENTIAL COILS.—Resistance coils employed in a differential galvanometer, being so arranged that the circuit divides; one part of the current flowing through the unknown resistance and one coil, while the other part flows through the known resistance and the other coil in the opposite direction.

DIFFERENTIAL COMPOUND WOUND DYNAMO.—A machine having the series and shunt windings wound in opposite directions so that they oppose or buck each other.

DIFFERENTIAL CONDENSER.—A variable condenser having one set of rotor plates so arranged that in turning the rotor set, the more the rotor plates mesh with one set of the stator plates, the less with the other set.

DIFFERENTIAL DUPLEX TELEGRAPH SYSTEM.—One which employs a relay wound with two sets of coils, in each of which the current flows in a different direction Therefore, when two currents of equal intensity are passed through the relay at the same time, they neutralize each other, and the relay does not become magnetized. Each station is provided with a differential relay, and there are two complete circuits, one including the line wire, and the other consisting of resistance coils having a resistance equivalent to that of the line and known as the artificial line.

DIFFERENTIAL ELECTRIC BELL.—An electric bell having coils wound differentially.

DIFFERENTIAL GALVANOMETER.—A type of galvanometer in which a magnetic needle is suspended between two coils of equal resistance so wound as to tend to deflect the needle in opposite directions. The needle of a differential galvanometer shows no deflection when two equal currents are sent through the coils in opposite directions, since under these conditions, each coil neutralizes the other's effects. Such instruments may be used in comparing resistances, although the Christie or so called Wheatstone bridge, in most cases, affords a preferable method. Used especially for comparing two currents.

DIFFERENTIAL GALVANOMETER METHOD.—A resistance test known as a nil, or zero method; that is adjusting the circuit to obtain a zero reading on galvanometer. In the two branch test circuit, when the resistance box has been so adjusted that its resistance is the same as the unknown resistance, the current in the two branches will be equal, and the needle of the galvanometer will show no deflection. Adapted to the measurement of non-inductive resistances.

DIFFERENTIAL METHOD.—1. In duplex telegraphy, a method in which the coils of the transmitting and receiving instruments are differentially wound.

2. In quadruplex telegraphy, a method involving a double differential duplex system.

DIFFERENTIAL PROTECTION.—A relay protective principle. In any section of a system the current flowing into the section must equal that flowing out so long as the section has no electrical fault within itself. The device for detecting abnormal conditions is arranged to balance the normal input current or power against the normal output; it operates when any abnormal condition such as a short circuit or ground produces an unbalance. Differential relays are used to disconnect power transformers when internal short circuits occur.

DIFFERENTIAL PULLEY.—This should be called differential pulleys, because there are two pulleys of different radii which rotate as one piece about a fixed axis. An endless chain passes over both pulleys. The rims of the pulleys are shaped so as to hold the chain and prevent its slipping. One of the bights or loops in which the chain hangs passes under and supports the running block. The other loop or bight hangs free and is called the hauling part. It is evident that the velocity of the hauling part is equal to that of the larger differential pulley at the pitch-circle.

DIFFERENTIAL PUMP.—A pump having two pistons of different diameters, used as an intensifier or accumulator in hydraulic engineering, etc. The fluid under pressure is in contact with the larger piston and the increment of pressure on the smaller piston is proportional to the ratio between the two areas.

DIFFERENTIAL QUADRUPLEX TELEGRAPHY.—Quadruplex telegraphy employing the differential system.

DIFFERENTIAL RELAY.—1. A relay having two electro-magnets which, in normal working, oppose and neutralize each other. Should, however, either winding become stronger or weaker than the other, the balance is upset, the magnet energized and the relay comes into operation.

2. One which functions by reason of the difference between two quantities such as current or voltage, etc.—NEMA.

3. Any relay known as ratio balanced, biased and percentage differential.

DIFFERENTIAL SCREW.—A device for obtaining great pressure through the prolonged action of a small power. A screwed spindle, working within a nut in a press frame, is threaded internally for the reception of another screw of the same hand, but of slightly finer pitch, this last screw being attached to the die-head of the press.

DIFFERENTIAL THERMOPILE.—A thermo-electric pile having opposite faces exposed to different sources of heat so that the two heat intensities may be compared.

DIFFERENTIALLY WOUND DYNAMO.—A compound dynamo having its series and shunt windings wound in opposite directions so as to oppose or buck each other.

DIFFERENTIALLY WOUND MOTOR.—A motor with a compound wound field in which the series and shunt coils oppose each other.

DIFFRACTION.—The breaking up of a beam of light into its component colors, due to the interference of the rays when deflected at the edge of an opaque body or through a narrow slit.

DIFFRACTION PHOTOMETER.—A photometer in which a concave lens is introduced to increase the diffraction of the light rays, and thus make it possible to use a shorter bar in testing powerful lights.

DIFFUSING BULB.—An incandescent lamp in which a frosting or coating makes the lamp bulb translucent, so the light appears to come from its entire area, masking the high brilliancy of the filament. The use of several diffusing bulbs in place of a single one of higher power increases the degree of diffusion.

DIFFUSING GLOBE.—An illuminating device consisting of a globe of opalescent glass or roughened glass which is interposed between the incandescent lamp filament and the eye so as to make the entire globe appear luminous, with corresponding softness of shadows. Since globes are larger than lamp bulbs, they usually produce a higher degree of diffusion.

DIFFUSING REFLECTOR.—In illumination, a device for redirecting light in which the redirecting surface is roughened or made of translucent enamel so as to act as a large secondary light source of low brightness. This type of reflection is known as diffuse reflection. With indirect and semi-indirect lighting, a dull white ceiling becomes a very effective diffusing reflector.

DIFFUSION.—A term relating to the flow of an electric current through a conducting substance of varying cross sectional area. There is difference in the density of the current in different parts of the conducting substance due to the varying area and other causes.

DIFFUSION CREEP.—A term signifying the passage of a current through an electrolyte, if there be a sufficient voltage difference when electrodes of an active circuit are immersed in the solution. The current spreads out in every direction.

DIFFUSION OF ELECTRIC CURRENT.—The uneven distribution of electricity in passing through a conducting body of irregular cross section; diffusion creep.

DIFFUSION OF ELECTRO-THERAPEUTIC CURRENT.—In electro-therapeutics, the distribution of the current in different parts of the body between the points at which the electrodes are applied.

DIFFUSION OF GASES.—The diffusion through each other which takes place when two gases are placed in contact. Even if a porous membrane be placed between them this process is only slightly retarded.

DIFFUSION OF LIGHT.—In illumination, the scattering of light rays so that they travel in different cross directions rather than in parallel or radiating lines. Sunlight, in passing through the earth's atmosphere is more or less diffused by the particles of dust and moisture, so that the entire sky appears to be a source of light and the light from the sky entering a window, is spread throughout the room without striations, strong contrasts, or dense shadows.

DIFFUSION OF MAGNETIC FLUX.—The dissipation or spread of magnetic flux in directions outside of its direct path between the magnetic poles; also called diffusion of lines of force.

DIGGING POLE HOLES.—In transmission line construction, when stakes are used to show pole locations, dig hole around the stake as a center. Where no stakes are used, holes should be dug where directed. The holes must be dug large enough to permit the free entrance of the pole without cutting down its normal circumference at the butt, and of sufficient size to permit tamping throughout their entire depth. The sides of the holes must be straight.

DIGGING SPOON.—A shovel shaped like a spoon with a long handle, for digging holes for telegraph poles; a spoon shovel, or Spanish spoon.

DIHEDRAL ANGLE.—The angle formed by the intersection of two planes.

DILATION, ELECTRIC.—The dilation or increase in size occurring in a body when charged with electricity.

DILATOMETER.—An instrument for determining the amount of expansion a liquid undergoes when heated.

DIMMER.—A resistance inserted in a lighting circuit for shunting or by-passing a variable portion of the current, thus "dimming" the lights in the circuit; an arrangement specially serviceable for theatrical purposes.

DIODE.—A two element vacuum tube having a filament and a plate. This is an early type but still used as a detector. Such names as diode, triode, pentode, etc., should be avoided and plain English used instead.

DIODE WORKING.—In telegraphy, the simultaneous transmission of two messages over one line.

DIOPTRIC SHADE.—A shade which by refracting the rays of a source of light cuts off the illumination in certain directions.

DIP.—In electro-plating, acid solutions of various kinds prepared for dipping articles to be plated; also called steeps.

DIP CELL.—A cell in which one of the electrodes is withdrawn from the solution when not in use; also called plunge cell.

DIP CIRCLE.—A vertical graduated circle in which a dipping needle swings in measuring the magnetic inclination.

DIP OF MAGNETIC NEEDLE.—If a magnetic needle be suspended by its middle so as to be free to turn in a vertical plane, one end of it will hang lower than the other at most parts of the earth's surface. In the northern hemisphere, the N end of the needle will dip, in the southern hemisphere the S end will dip. At the magnetic poles, which do not correspond with the geographic poles, the needle would point straight down. This action is also known as the inclination of the needle. There is no dip at the magnetic equator or circle passing around the earth midway in intensity between the earth's magnetic poles.

DIPHASE.—A term sometimes used for two phase. The latter is preferable.

DIPHASER.—A name sometimes given to a two phase alternator.

DIPLEX TELEGRAPH.—A system which permits two messages to be transmitted in the same direction at the same time over a single wire. Its operating principle is that the receiving instrument at the home station, while free to respond to the signals of the key at the distant station, shall not respond to the signals of its associate key.

DIPOLAR.—Having two magnetic poles; bi-polar.

DIPPING.—1. In electro-metallurgy, a method of applying a thin coating of metal to an article by dipping it into the proper solution.

2. A method of cleaning articles for electro-plating by dipping them into cleansing acids. A bath in which rough articles are steeped for a considerable time is known as a "pickle," while a dip acts on smooth surfaces.

DIPPING BASKET OR BOWL.—An openwork basket of stoneware or similar material, for holding articles to be cleansed for electro-plating by the dipping process.

DIPPING COMPASS.—An instrument sometimes called an inclinometer, used to measure the angle of dip or inclination of the magnetic needles.

DIPPING NEEDLE.—A magnetic needle turning in a vertical circle, and exactly balanced on its center of gravity, for measuring the inclination or dip in an inclinometer or inclination compass.

DIRECT CONNECTED MACHINE.—A dynamo or alternator having one shaft in common with the driver, that is, no intermediate gearing such as belt, chain, etc., between engine and machine. One difficulty encountered in the direct connection of engine and machine is the fact that the most desirable rotative speed of the engine is less than that of the machine Accordingly a compromise is made by raising the engine speed and lowering the machine speed.

DIRECT CONTROL SWITCHBOARD.—A type of switchboard which has all the apparatus mounted, either directly or partly upon the panels and the remainder on the panel supporting frame work.

DIRECT CONTROL SWITCHBOARD LIMITATIONS.—In general, it is recommended that no oil circuit breakers having a continuous current capacity of more than 800 amperes be used on direct controlled boards. Furthermore, no direct control a.c. type of board should be employed for stations having a capacity greater than 3,000 kva. Such limitations naturally restrict the direct control board into what may be termed small capacity isolated generating stations or substations.

DIRECT CONTROL THEATRE SWITCHBOARD.—A type (known as tumbler type) suitable for school auditoriums, small motion picture theatres, churches, and in other places where it is possible to provide skilled attendance. The operating possibilities of these boards are such that independent pre-sets can be made in each color group. Each group is under the control of a master switch, which can feed energy to the complete group of circuits in its color group, or to any desired selection of circuits in the group. The circuits can be arranged so that the complete lighting is controlled by a master switch at the board. Each color group taken care of on this type of board is normally provided with its own dimmers.

DIRECT COUPLED AMPLIFIER.—In radio a type of resistance coupling of audio frequency amplification in which the plate of one tube is conductively connected to the control grid of the following tube, a single coupling resistor being included in the plate and grid circuits.

DIRECT COUPLED MACHINE.—1. As distinguished from direct connected the term means that the driver and machine are each a complete unit connected by some device such as friction clutch, jaw clutch, or shaft coupling.

2. A machine having the shaft of its armature coupled directly to the shaft which drives it.

DIRECT COUPLING.—1. In radio, the association of two circuits by having an inductor, condenser, or resistor common to both circuits.

2. Two circuits joined by a metallic connection.

DIRECT CURRENT.—1. A uni-directional current. It may be constant or periodically fluctuating, as rectified alternating current.

2. An electric current flowing in one direction only and sensibly free from pulsation.—B. E. S. A.

DIRECT CURRENT AMPLIFIER.—In radio a type which employs one or more tubes operated on a steady voltage or direct current to obtain amplification.

DIRECT CURRENT CONVERTER.—A machine which converts from a direct current to a direct current.

DIRECT CURRENT ELEVATOR MOTORS.—The type to be used depends upon the source requirement. For freight service, compound wound motors are recommended. For passenger service, either compound wound or shunt wound motors give satisfactory results.

DIRECT CURRENT GENERATOR.—An objectionable term for a dynamo.

DIRECT CURRENT MOTOR.—A machine for converting electrical energy into mechanical energy, with a device called the commutator for converting the a.c. generated by the armature inductors into d.c. for the external circuit. A d.c. motor is constructed in the same manner as a dynamo. There are three general classes of d.c. motor: a, series; b, shunt; c, compound.

DIRECT CURRENT MOTOR AND DYNAMO COMPARED.—Any machine that can be used as a dynamo will, when supplied with electrical power, run as a motor, and conversely, a motor when driven by mechanical power, will supply electrical energy to the circuit connected to it. Dynamos and motors, therefore, are convertible machines, and the differences that are found in practice are largely mechanical; they arise chiefly from the conditions under which the motor must work. One difference between a dynamo and a motor is, that whereas the brushes are advanced in the direction of rotation in a dynamo, to keep them ahead of the neutral line under load, in a motor they are moved the other way because armature reaction is different in a motor from that in a dynamo.

DIRECT CURRENT MOTOR ESSENTIALS—In construction there must be provided: 1, a magnetic field; 2, conductors placed perpendicular to the field; 3, provision for motion of the inductors across the field in a direction perpendicular to both themselves and the field, and 4, provision for current reversal.

DIRECT CURRENT MOTOR PRINCIPLES.—a, A single coil motor has "dead centers"; b, the rotation of the coil in the magnetic field induces a reverse pressure which opposes the flow of current in the coil; c, the amount of current flowing through the coil decreases as the speed increases; d, force of a magnetic field on a coil carrying a current due to the distortion of the field; e, if the current through the coil be reversed (by reversing in external circuit) the direction of rotation is reversed; f, if the polarity of the field be reversed (in practice by reversing the field current through the electro-magnet) the direction of rotation is reversed; g, if the polarity of both the field and coil be reversed, the direction of rotation remains the same; h, a series motor has a strong starting torque; i, series motor with variable load, the strength of the magnet field varies with that of the armature field; j, a shunt motor (sometimes erroneously called "constant speed motor") varies its speed when the load changes; k, shunt motor with variable load. The strength of the magnet field remains constant while that of the armature field varies.

DIRECT CURRENT MOTOR REVERSE PRESSURE.—A motor will take less current when running than when standing still because the motor, on account of its rotation acts as a dynamo, and thus tends to set up in the circuit a reverse pressure which opposes or "bucks" the impressed pressure.

DIRECT CURRENT NEUTRAL GRID.—A well grounded network of neutral conductors formed by connecting together within a given area all of the neutral conductors of a low voltage direct current supply system.

DIRECT CURRENT OVER CURRENT RELAY.—One which functions on a d.c. overload above a given amount. It may also be provided with specified drop out value so as to reclose load limiting resistor shunting contactor, for example, when the overload had disappeared.—NEMA.

DIRECT CURRENT RECLOSING RELAY.—One which controls the reclosing of a d.c. circuit interrupter.—NEMA.

DIRECT CURRENT TRACK RELAYS.—A class of relay forming part of the equipment used in railway signal systems. The relays are usually of the tractive type or motor type.

DIRECT CURRENT VOLTAGE AND CURRENT DIRECTIONAL RELAY.—One used to give indication to close a circuit when the voltage exceeds a certain amount in a given direction, and to give the indication to open this circuit when the current exceeds a certain amount in the reverse direction.—NEMA.

DIRECT DEFLECTION METHOD.—A resistance test based on the fact that the greater the current through a galvanometer the greater the deflection of the needle. A simple method, capable of extended application. The known resistance is put in circuit with the galvanometer and after noting the deflection the key is moved in order to cut out the known resistance and throw into circuit the unknown resistance. The deflection of the galvanometer is again noted and compared with the first deflection. If the deflections be proportional to the current, the unknown resistance will be as many times the known resistance as the deflection with the known resistance is greater than the deflection with the unknown resistance.

DIRECT DRIVE.—A transmission in which the prime mover or driver is connected to a machine without any form of gearing between them.

DIRECT EXCITATION TRANSMISSION.—In radio spark transmission, a system having the spark gap in the antenna circuit.

DIRECT INDUCTIVE COUPLING.—In radio, a method of connecting two circuits by having an inductor condenser, or resistor connected to both circuits.

DIRECT RAYS.—Primary rays.

DIRECT READING GALVANOMETER.—A galvanometer having a scale graduated by volts or amperes instead of degrees, so that the absolute value of the current strength may be read off without computation.

DIRECT READING POTENTIOMETER.—An apparatus for measuring differences of voltage, such that the voltage may be read directly from its scale.

DIRECT SCANNING.—In television a method in which the photo electric cell is placed in direct photo vision with only one small area of the picture at a time. This method is called direct scanning. The direct scanning system requires the broad illumination typical of outdoor scenes. It lends itself to action at a distance from the lens.

DIRECT SELECTOR.—In radio receiver control, one in which the tuning knob is connected direct to the element it operates instead of through gears.

DIRECT SOUNDER.—A sounder for use in a telegraph line circuit, and not in a local circuit.

DIRECT VACUUM TUBE CURRENT.—In electro-therapeutics, a current obtained from a d.c. source by applying to the part to be treated a vacuum electrode connected to one terminal of the source, the other terminal being grounded.

DIRECTION FINDER.—Radio apparatus for determining the direction of travel of radio waves. A radio compass.

DIRECTION OF CURRENT FLOW.—It is arbitrarily assumed that current flows from a positive terminal to a negative terminal; however electrons, as in a vacuum tube actually flow in the opposite direction.

DIRECTION OF LAY.—The lateral direction in which the strands of a cable run over the top of the cable as they recede from an observer looking along the axis of the cable.

DIRECTION OF MAGNETIC FLUX.—The direction which lines of magnetic force are assumed to take in passing out of the positive pole of a magnet and reentering the negative pole.

DIRECTION OF ROTATION OF DYNAMOS.—As a general rule, a dynamo is intended to run in a certain direction; either right handed or left handed according to whether the armature, when looked at from the pulley end, revolves with or against the direction of the hands of a clock. Dynamos are usually designed to run right handed, but the manufacturers will make them left handed if so desired.

DIRECTION OF ROTATION OF D.C. MOTORS.—In either a motor, or a dynamo used as a motor, the direction in which the armature will rotate is easily found by the left hand rule, when the polarity of the field magnets and the direction of currents through the armature are known. A motor may be reversed by reversing either the current through the fields, or the current through the armature. If both currents be reversed the motor will run in the same direction as before.

DIRECTIONAL.—A relay protective principle. Relays working on this principle permit a normal direction of current only. Direction of current in an a.c. system means the vector relationship between voltage and current. Hence, to apply the reverse current principle, voltage must be introduced as the basis of reference.

DIRECTIONAL AERIAL.—One which functions more efficiently in some directions than in others.

DIRECTIONAL RELAY.—1. One which functions in conformance with the direction of power or voltage, or current or phase rotation, etc.—NEMA.

2. The principle types are: power directional, ground directional, current directional, polarity directional and phase rotation relays.

DIRECTRIX.—A line which so determines the motion of a point, or another line, that the point or line will describe a curve or surface respectively.

DIS. OR DIST.—Marking on ignition apparatus being abbreviation for distributor.

DISC.—1. In general, a cylinder whose length is very short in proportion to its diameter.

2. A phonograph record, or blank for making a record.

DISC ARMATURE.—An early armature in the form of a disc on which the coils are wound flat.

DISC ELECTRODES.—Carbon electrodes in the form of discs, at one time used in all night arc lamps.

DISC ELECTROMETER.—An instrument for measuring the attraction between an electrified and a non-electrified disc. It is similar to a balance in form, having at one end a light scale pan and at the other a disc hung above a fixed insulated disc, to which the charge to be measured is imparted.

DISC FAN.—An air propeller, usually driven by an electric motor, shaped somewhat like a ship's screw, and mounted in a cylindrical casing, delivering air parallel with its axis.

DISC REPRODUCTION.—In motion pictures with sound, a method of reproducing the sound on phonograph discs, and synchronizing the phonograph with the projector.

DISC SIGNALS.—A type of railway signal in which the day indications are given by the color, or by the absence or presence of discs.

DISC WOUND TRANSFORMER.—A transformer built up of coils wound separately into discs and piled alternately on top of one another; a series connection of the sections being used for high voltages and parallel connection for low voltages.

DISCHARGE.—1. The effort to overcome differences of voltage which takes place between two charged terminals when a connection is made between them. Discharges may occur in a great variety of ways and assume many forms.

2. To bring about an electric discharge by connecting two charged points.

3. The removal of a charge from the surface of any charged conductor by connecting it with the earth, or another conductor.

4. The removal of a charge by means of a stream of electrified air particles.

DISCHARGE CURRENT OF LIGHTNING ARRESTER.—The current resulting from the surge which flows through the lightning arrester to earth during the time the lightning surge is taking place on circuit.

DISCHARGE KEY.—A key for sending a discharge through a galvanometer.

DISCHARGE THROUGH GASES.—The passage of an electric current through gases with an effect similar to that of electrolysis, being accompanied by the breaking up of gaseous molecules and the interchange of atoms.

DISCHARGE TUBE.—A tube having metal electrodes and exhausted to a low gas pressure.

DISCHARGER.—A device consisting of a jointed brass rod provided with brass knobs and a glass handle, for discharging a Leyden jar; discharging tongs.

DISCHARGING ROD.—A jointed metal extension rod with insulated handles, and having metal balls at each end, employed to discharge a Leyden jar or condenser.

DISCHARGING TOO RAPIDLY.—In storage battery operation, too high a discharge rate tends to break the plates and in the case of pasted plates, a very sudden discharge will dislodge the paste.

DISCONNECT.—1. To take an electroreceptive apparatus out of a circuit.

2. To break an electric circuit.

DISCONNECTING STORAGE CELLS.—The best method of disconnecting cells assembled with pillar straps, for the purpose of replacing broken jars, cleaning or taking out of commission, is to use a ⅝ in. twist drill, in a carpenter's brace, boring down into the top of the pillar about ¼ in.; then pull off the connector sleeve from the pillar. By following this method, all parts may be used again.

DISCONNECTING SWITCH.—1. A knife switch placed in series with the service switch so that the apparatus controlled by the latter may be repaired in safety by disconnecting it from the bus bars or live circuit. Disconnecting switches are not intended to rupture the load current. Since disconnecting switches are not designed for opening under load, no attempt should be made to open them with current in the circuit. Disconnecting switches are opened and closed with a hook on the end of a wooden pole.

2. A switch intended to open a circuit only after the load has been thrown off by some other means.—NEMA.

DISCONNECTION.—1. The breaking of an electric circuit.

2. The cutting of an electro-receptive apparatus out of a circuit.

3. A fault arising in a circuit as the result of a break in the circuit.

4. Disconnections are classified as, a, total, indicating an absolute separation; as, by the opening of a switch; b, partial, as by dirty contact, loose binding screw or badly soldered joint; c, intermittent, as by a broken insulated conductor, the ends being held together by the insulation and any motion or vibration tending to bring them into contact.

DISCONNECTOR.—A device for opening a circuit, or for cutting out an electro-receptive device.

DISCRIMINATING CUT OUT.—A reverse current circuit breaker. This type of circuit breaker is arranged to open a circuit in the event of current flowing in the circuit in a direction reverse to the normal. This is sometimes effected by winding the electro-magnet of the circuit breaker with two coils, one connected as a shunt across the main circuit and the other in series with the main circuit, the two coils being so arranged that when the main current flows in the normal direction their effects assist one another, whereas, when the main current reverses, the effects of the coils are neutralized and the breaker opens.

DISCRIMINATING CUT OUT TROUBLES.—Reverse current circuit breakers are subject to the following faults: Electrical: a, open circuit in shunt winding; b, poor ground connection. Mechanical: a, points badly pitted; b, points not making contact; c, improper spring tension; d, wrong air gap.

DISINTEGRATION THEORY.—A theory, advanced to explain the phenomena of radio activity, that the atoms of radio active substances undergo spontaneous disintegration, in the course of which parts of the atom escape in the emission of radiations.

DISPERSING PAD ELECTRODE.—A pad electrode used in electro-therapeutics for applying strong currents to the human body and diffusing them over a wide area.

DISPERSION PHOTOMETER.—A photometer in which the rays of light to be measured are made to pass through a convex lens, and thus dispersed. In this way, an intense light like that of an arc lamp, may be more readily measured in terms of a standard candle.

DISPLACEMENT CURRENT.—A momentary current which flows into or out of a dielectric during variations in impressed voltage, as in charge and discharge of a condenser, also called dielectric current.

DISRUPTIVE CONDUCTION.—The conduction of electricity associated with a disruptive discharge.

DISRUPTIVE DISCHARGE.—An electrostatic discharge which suddenly bursts across a dielectric medium.

DISRUPTIVE STRENGTH OF DIELECTRIC.—The mechanical stress a dielectric medium can bear before giving way to a disruptive discharge.

DISSIMULATED ELECTRICITY.—A term sometimes applied to a charge of electricity upon the surface of a conductor, when it is attracted by the presence of a neighboring charge of the opposite kind; a bound charge.

DISSOCIATE.—To break up a compound by great heat into the elements of which it is made up.

DISSOCIATION.—In chemistry, the breaking up of a chemical compound into its constituent parts.

DISSOCIATION THEORY.—A theory advanced by Arrhenius in 1887, upon which is largely based the electro-chemical science of today. He held that the electrical conductance of a solution was due entirely to the dissociated parts of the molecules. He ascribed electrical charges to these dissociated parts, and called them ions.

DISSONANCE, ELECTRIC.—The opposite of electric consonance; a condition existing in alternating currents having phases in opposition.

DISSYMMETRICAL ALTERNATIONS. — A wave motion in which the frequencies are unequal in value.

DISTANCE PIECE.—A thimble or sleeve placed over a bolt or rivet to maintain a set distance between the two thicknesses of material which are united by it.

DISTANT BATTERY.—In telegraphy, a battery stationed at the remote end of the line.

DISTANT STATION.—In telegraphy, the remote station or end of the line, as distinguished from the home station.

DISTILLATE.—Any liquid that is a product of distillation. The lighter hydrocarbons obtained from the first distillation of petroleum which have to be redistilled to prepare them for the market; or any similar product of initial distillation which has to undergo further treatment.

DISTILLATION.—An operation by which two or more liquids having different boiling points may be separated. It consists of a still in which the mixed liquids are boiled, and a worm coil in which the resulting vapors are cooled and allowed to run into different receptacles. Beccaria discovered that when a liquid is electrified its rate of evaporation is increased; and it has been shown by Crookes that negative electrification is more efficient in increasing the rate of evaporation than positive.

DISTILLATION, ELECTRIC.—The evaporation of a liquid and the condensation of the vapors to liquid again, aided by the electrification of the liquid to be distilled.

DISTORTION.—In radio any change in the contour or general shape of a wave that occurs in transmission or amplification. There are several kinds of distortion classed as: a, frequency; b, phase; c, amplitude.

DISTORTION OF FIELD.—A distorted condition of the magnetic field of a dynamo, due to the rotation of the armature against the mutual attraction existing between itself and the field magnets.

DISTORTIONAL ELASTICITY.—Elasticity occurring in a body as the result of distortion.

DISTRESS SIGNAL.—In radio, S. O. S.

DISTRIBUTED CAPACITY.—Electrostatic capacity which is present along the entire length of a conductor as distinguished from concentrated capacity such as that in a charged condenser.

DISTRIBUTED CORE TRANSFORMER.—A type which can be considered either as two superposed shell transformers with coils in common, or as a single core type transformer with divided magnetic circuit and having coils on only one leg. It is best considered, however, as a distributed core transformer, and for small sizes it possesses most of the advantages of both types. It can be constructed at less cost than either a core or a shell transformer having the same operating characteristics and temperature limits.

DISTRIBUTED INDUCTANCE.—The inductance of a circuit considered with relation to the entire length of the circuit.

DISTRIBUTED LOAD.—In mechanics, a load spread over the surface or area of a beam, girder or floor, so as to weigh it down equally, that is, a load of a definite number of lbs. per foot of length of the beam.

DISTRIBUTED WINDING.—An armature winding spread out so as to fill several slots per phase per pole. The winding may be partially or fully distributed.

DISTRIBUTING BOARD.—1. In a central telephone exchange, a board or frame by means of which the line wires entering the exchange are distributed to their proper numbers on the switchboard, also permitting easy access for making changes in the connections, and allowing for the introduction of test clips to simplify testing for faults in the lines; a cross connecting board.

2. In a distribution system, an insulated board by which branch circuits are led from electric mains.

DISTRIBUTING BOX.—A box containing all the safety fuses at a distributing point of a system of electrical distribution.

2. An arrangement whereby arc and incandescent lamps may be connected at the same time on one circuit.

3. A device by which a set of series incandescent lamps may be cut into an arc lamp circuit.

DISTRIBUTING BOX OF CONDUIT.—In an electric conduit system, a box in which connections may be made between branch wires and the main cable. The distributing box is often reached through a manhole.

DISTRIBUTING CENTER.—A central point of electric distribution.

DISTRIBUTING MAINS.—The principal conductors in a system of electric distribution.

DISTRIBUTING STATION.—A central station for electric distribution.

DISTRIBUTING SWITCH.—A switch for cutting a number of distributing circuits in or out of a main circuit or electric source.

DISTRIBUTING SWITCHBOARD. — A switchboard to which a number of electrical circuits are connected; a multiple switchboard.

DISTRIBUTION OF CHARGE.—1. In static electricity, when an insulated sphere of conducting material is charged with electricity, the latter passes to the surface of the sphere, and forms there an extremely thin layer. The distribution of the charge then, depends on the extent of the surface and not on the mass.
2. On elongated bodies, the charge collects at the ends and on pointed bodies, the current accumulates at the point to such a high degree of intensity that it passes off into the air.

DISTRIBUTION OF MAGNETISM.—In a magnet the magnetism is strongest in two regions called the poles. In a long shaped magnet the strongest magnetism resides in the ends, while all around the magnet half way between the poles there is no attraction at all.

DISTRIBUTOR.—In synchronous ignition, a combination of two timing devices attached to one common shaft and operated by the engine. A primary timer makes and breaks the primary circuit at the time a spark is required; a similar device working in step, switches the secondary current to the different cylinders in proper sequence.

DISTRICT CALL BOX.—A box supplied with make and break attachments which are set in motion by the pulling of a lever, thus transmitting electric signals to a central office indicating the service wanted and the location of the call.

DIURNAL CURRENTS. — Earth currents which flow between the various points of a telegraphic circuit each day.

DIURNAL LOAD FACTOR.—The ratio of the actual output of an electric plant for twenty-four hours to the output it would have made if working constantly at maximum load for that time.

DIURNAL VARIATION.—Slight variations exhibited by the magnetic needle at certain hours each day; daily variation.

DIVALENT.—In chemistry, a term applied to an element, one atom of which can unite with two atoms of hydrogen; also called, **bivalent.** Divalent elements are known as **dyads.**

DIVERGENT MAGNETIC FLUX.—Magnetic flux that diffuses with lessening strength through a magnetized body.

DIVERGING LENS PHOTOMETER.—A photometer provided with a convex lens for dispersing the rays of an intense light so that a strong light, like that of an arc lamp, may be measured in terms of a standard candle.

DIVERGING MAGNETIC FLUX.—Magnetic flux that diffuses itself with lessening strength as it proceeds over or through a magnetized body.

DIVERSITY FACTOR.—The ratio between the simultaneous demand of a number of individual services for a specified period, and the sum of the individual demands of those services for the same period. This definition is expressed as a fraction or as a percentage and is never greater than one. The diversity factor of a purely lighting load may be as low as 25%. With motor loads the factor is 50% or higher.

DIVERTER.—In electric traction, a name given to a certain type of motor starting-coil, probably because some of the applied voltage is diverted from the motor in forcing the current through the coil against its resistance.

DIVIDED CIRCUIT.—If a circuit be divided into two branches at one point, uniting again at another, the current will also be divided, part flowing through one branch and part through the other. The relative strength of current in the two branches will be proportional to their conductivities.

DIVIDED TOUCH MAGNETIZATION.—A method of magnetizing a steel bar, in which the bar is stroked with the opposite poles of two other bar magnets, beginning at the middle and drawing them apart to the ends; double touch magnetization.

DIVINING ROD.—A forked rod or branch, as of witch hazel, which, when held loosely in the hand is said to bend slightly when passed over ground under which water or minerals are situated.

DIVISION.—The process of finding the value of one of a given number of equal parts into which a quantity is to be divided. When one number is divided by another number, the first one is called the dividend, and the second one, the divisor, the result thus obtained is called the quotient. Symbol $\div$.

DOBROWOLSKI THREE WIRE DYNAMO.—This type of dynamo was designed to operate a three wire system of distribution without a balancer. The armature is provided with insulated slip rings connected to suitable points in the armature winding and (by means of brushes) with choking coils meeting at a common point, to which the neutral wire of the system is connected, the main terminals being connected with the outside wires. The machine is capable of feeding unbalanced loads without serious disturbance of the pressure on either side of the system. There are various modifications of the arrangement. Thus more than two slip rings may be used. The compensator windings, however, should always be arranged so that the magnetizing effect of the neutral current is self-neutralized in the windings, as otherwise saturation occurs causing a very heavy alternating magnetizing component.

DOCTOR.—1. In electro-plating, a device for applying a coating to surfaces that are too large to be wholly immersed in the bath.

2. In western river steamboats, a vertical beam engine with crank and flywheel operating four pumps, and having feed water heaters supported by the frame. Two simple lift pumps draw water from the river and deliver it to the heaters, while the other two or feed pumps, proper, pump from the heaters into the boilers. Each pump has sufficient capacity to supply all the boilers so that one of either kind may be disconnected for inspection or repair.

DOLLY.—In electro-plating, a polishing brush composed of rings of cloth gripped in a wooden holder and fitted to a lathe.

DOMESTIC REFRIGERATION.—Refrigeration on a small scale as accompanied by a self-contained unit with automatic control, fool proof and of suitable size for household use. Erroneously called electric refrigeration. The term electric refrigeration is misleading. Electricity has nothing to do with the refrigerating cycle, but is used to furnish the power to perform the cycle, that is, to drive the compressor. The compression system is almost universally used for domestic refrigeration.

DOOR CONTACT LAMP.—A lamp which is lighted by an electric contact made when a door is swung open or shut.

DOOR SAFETY SWITCHES. — Elevator switches which in combination with door locks, prevent the car operating unless all doors be closed and locked.

DOOR TRIGGER.—A catch which makes or breaks a circuit to give an alarm when a door is opened or closed.

DOPE.—Preparation for treating the cloth surfaces of aircraft to produce tautness and to maintain air and moisture tightness.

DOT AND DASH CODE.—A name sometimes given to the Morse telegraphic alphabet.

DOTTING CONTACT.—An electrical contact obtained between two contact points.

DOUBLE ARMATURE WINDINGS.—Two sets of coils wound upon an armature and connected to alternate bars of the commutator.

DOUBLE BLOCK DUPLEX.—In telegraphy a form of Wheatstone differential duplex sometimes used on cable circuits, in which signaling and reading condensers are included in the system.

DOUBLE BRACKET TROLLEY SUSPENSION.—A method of suspending the trolley wire in a double track railway from double brackets extending on either side of a line of posts erected between the tracks; center post construction.

DOUBLE BREAK SWITCH.—One which breaks a circuit at two contacts along the same wire. Distinguish between double break and double pole switch.

DOUBLE BRONZE WIRE.—A variety of wire conductor of great strength, composed of a core of aluminum bronze sheathed with a copper brass coating.

DOUBLE BUTTON CONTROL.—Held in push button control for slow speed elevators.

DOUBLE CARBON LAMP.—An all night arc lamp provided with two pairs of carbons, fitted to a mechanical device for changing over the current from one pair to the other when the first pair is nearly consumed; a twin carbon lamp.

DOUBLE CIRCUIT DYNAMO.—A dynamo connected with two distinct circuits.

DOUBLE COIL DIRECTION FINDER.—A goniometer.

DOUBLE CONDUCTOR CABLE.—A cable containing two distinct conductors insulated from each other.

DOUBLE CONE INSULATOR.—An insulator through which the line wire passes. It is supported by two inverted truncated cones which, joined at their vertices, form a tube.

DOUBLE CONNECTOR.—A binding screw suitable for connecting the ends of two wires.

DOUBLE CONTACT KEY.—A key for closing two, or either of two, separate circuits.

DOUBLE CONTACT PUSH.—A push operating two contacts, simultaneously opening one and closing the other.

DOUBLE CUP INSULATOR.—A line wire insulator, usually of glass, resembling in shape two inverted cups set one over the other.

DOUBLE CURRENT GENERATOR.—A type of synchronous converter, driven by an engine and constructed to deliver both d.c. and a.c.

DOUBLE CURRENT REPEATER.—A repeater or translator employed in the double current system of telegraphy.

DOUBLE CURRENT TELEGRAPHY.—A system of telegraphy employed upon long lines for increasing the speed of working, and for obtaining greater permanence of adjustment. A polarized relay is always used, and a current called the "spacing" current is sent in a reverse direction to the "marking" current (which completes the local circuit) for restoring the tongue of the relay to the spacing side.

DOUBLE CURRENT TRANSMITTER.—The transmitter employed in the double current system of telegraphy. in which the key at rest sends out a "spacing" current followed by a "marking" current when the key is depressed.

DOUBLE CURVE PULL-OVER.—A trolley hanger designed to hold the trolley wire at a curve. It is provided with two extension lugs for the attachment of strain wires; a **double pullover.**

DOUBLE DECK SWITCHBOARD.—A telephone switchboard having its jacks arranged in two horizontal parallel rows.

DOUBLE FIELD MAGNET.—A dynamo field magnet provided with two pairs of poles; the exciting coils are wound upon what may be regarded as the yokes of the magnets. The direction of the electric current flowing in the magnetizing coils is such that two similar poles are produced in each pole piece.

DOUBLE FILAMENT LAMP.—An incandescent lamp having two filaments usually of different lengths and of different resistance. The short filament is of very low candle power and is not in circuit with the longer filament.

DOUBLE FLUID CELL.—A primary cell containing two different fluids as electrolytes; a **two fluid cell.**

DOUBLE FLUID THEORY.—A theory once advanced that electricity existed in nature as two "imponderable" fluids, one positive and the other negative.

DOUBLE FOCUS X-RAY TUBE.—A vacuum tube containing two anti-cathodes for producing X-rays by means of a.c.

DOUBLE HUMP RESONANCE.—Resonance at two different frequencies in two closely coupled tuned circuits.

DOUBLE IGNITION.—Two independent ignition systems applied to the same engine, that is, two systems having no part in common.

DOUBLE KEY TAPPER.—In single needle telegraphy, a signaling key consisting of two horizontal levers normally resting against a metal strip joined to the zinc pole of the battery, while at the other end another strip connects with the plus pole; a **double tapper.**

DOUBLE LAYER WINDING.—A form of bi-polar direct current armature winding having the conductors placed in the slots in two layers, one side of each coil being placed at the bottom of the slot, the other side at the top in order to make all connections identical.

DOUBLE LIQUID CELL.—A primary cell having two different solutions as electrolytes.

DOUBLE MODULATION.—A two stage modulation in which a carrier wave of one frequency is first modulated by a signal wave and is then made to modulate a second carrier wave of another frequency.

DOUBLE NEEDLE TELEGRAPHY. — A method of needle telegraphy, employing two needles on the dial of the receiving instrument joined to two separate wires, as distinguished from single needle telegraphy.

DOUBLE PARALLEL WINDING.—A form of armature winding in which the coil terminals, instead of being connected to adjacent segments, are connected to alternate segments. When this winding is used, each commutator brush must be thick enough to always touch two segments, otherwise the proper division of current between the two windings would not be preserved.

DOUBLE PLATE RADIO TUBE.—A full wave rectifier. It has one filament and two plates, one plate for each half of the wave. Objectionably called **diode.**

DOUBLE POLE.—A pair of telegraph poles securely braced together and erected side by side; an **H pole.**

DOUBLE POLE BELL.—An electric bell which is rung by the alternate attraction and release of a polarized armature at the poles of an electro-magnet.

DOUBLE POLE CUT OUT.—A cut out which acts at once on both the positive and negative leads in an electrical circuit.

DOUBLE POLE SAFETY FUSE.—A double pole cut out.

DOUBLE POLE SWITCH. — One which opens and closes two wires of a circuit.

DOUBLE PORTED VALVE.—A type of slide valve in which steam is admitted through two steam ports at each end of the cylinder face, thus reducing the travel of the valve. It is equivalent to two plain side valves—a long Valve V[1], superposed upon a short one V, each having equal steam and exhaust laps. Its object is to overcome the difficulty of obtaining sufficient port opening for high speed engines having cylinders of large diameter and short stroke.

DOUBLE PULLOVER.—A form of trolley hanger designed to suspend the trolley wire at a curve, provided with two extension lugs for the attachment of strain wires.

DOUBLE RANGE INSTRUMENTS.—An indicating instrument (volt meter ammeter) having two scales, one for low range readings and the other for high range readings. One terminal is a common connection for both scales, a second terminal is for connection for low range readings, and a third, for high range readings.

DOUBLE REDUCTION GEAR.—A gearing sometimes employed in street car motors, in which the speed of the armature is reduced twice by two pinions and two spur wheels.

DOUBLE REFLECTION TUBE.—An X-ray tube provided with two anti-cathodes for producing the rays by means of a.c.

DOUBLE REFRACTION, ELECTRIC.—The property sometimes acquired by certain transparent crystals of dividing a ray of light into two when the crystal is influenced by an electric field.

DOUBLE SHACKLE.—A form of swinging telegraph insulator carrying two insulators joined by a shackle arrangement, for use at points where a bend occurs in the line.

DOUBLE SHED INSULATOR.—A line wire insulator having a deeply indented rim, producing two flanges or "petticoats" separated by an air space for increasing the path of leakage; a double cup insulator.

DOUBLE SQUIRREL CAGE MOTOR.—A form of induction motor which does not use a centrifugal switch, but depends upon the change of frequency in the armature circuits, as the armature changes speed, to change the operating characteristics between starting and running conditions. This motor is adapted to high starting torque and continuous running at full load, such as is required for crushers, plunger pumps, belt conveyors, and grain elevator legs. Loads having great fly-wheel effect such as slow speed fans, air compressors, and refrigerating machinery also fall in this class.

DOUBLE SQUIRREL CAGE MOTOR CHARACTERISTICS.—The starting torque is approximately 150% of full load torque with full voltage applied, although this value varies between 145 and 180% for the different ratings. The efficiency is practically the same as similar ratings of ordinary squirrel cage motors, averaging about 90% at full load. The power factor is slightly lower than that of the ordinary squirrel cage motor but in general averages well above 85%. The maximum torque or pull out torque is approximately 200% of full load torque.

DOUBLE SQUIRREL CAGE MOTOR WITH CHOKER.—A double squirrel cage motor modified to make use of the variable gap principle. In starting, the current in the inner squirrel cage is choked by means of movable iron rods, placed in each armature slot between the inner and outer bars, the iron rods being pulled down toward the inner bars, choking the current in the inner cage and producing a high starting torque with low current. As the motor accelerates, the iron rods are thrown out of the leakage gaps, by centrifugal force, thus removing the choking effect from the inner squirrel cage when the motor is running.

DOUBLE STYLE PRINTING RECEIVER.—A Morse telegraphic receiver equipped with two points, one to indicate the dots and the other the dashes upon the paper strip.

DOUBLE THROW SWITCH.—One in which the blade can move on either side of the off position to a live contact.

DOUBLE TOUCH MAGNETIZATION.—A method of magnetizing a steel bar. The bar to be magnetized is placed upon two other bar magnets with its N pole resting upon the S pole of one, and its S pole upon the N pole of the other. With two other magnets, one in each hand and holding the two unlike poles together, stroke the bar beginning at the middle and drawing them away from each other toward the ends. The process should be repeated about ten times on each side.

DOUBLE TRANSMISSION.—The transmission of two messages along the same wire at the same time in opposite directions, as in duplex telegraphy.

DOUBLE TRANSMITTER FOR ENGINE TELEGRAPH.—A transmitter employed on a twin screw steamship for signaling from the bridge to both engines at once.

DOUBLE TROLLEY.—In a double overhead system, two trolleys on a single car, one connecting with the positive conductor and the other with the negative, thereby forming a metallic circuit.

DOUBLE TUBE INJECTOR.—A device for forcing water into a steam boiler against the boiler pressure. One of the two tubes or jets is used to lift the water and the second to force it into the boiler. It is desirable for installation where the injector must lift the water a considerable distance.

DOUBLE VIBRATION.—A double alternation, complete cycle of vibration, or to and fro motion, as in the alternating current cycle.

DOUBLE WINDING.—An armature winding consisting of two independent insulated coils, each joined to alternate segments of the commutator, thereby dividing the current between the coils, and reducing the inductance in the circuit.

DOUBLE WORD.—A word of such length as to be accounted for as two words in telegraphic messages.

DOUBLE WOUND WIRE.—An insulated wire having a double covering of insulating winding.

DOUBLET AERIAL.—A two conductor T type aerial.

DOUCHE, ELECTRIC.—A spray or shower of electrified water for medicinal purposes.

DOWEL.—1. A pin of wood or metal inserted in the edge or face of two boards or pieces, so as to secure them together.

2. A small peg to attach planks edgewise, as in a cask head.

3. A plug put in a deck to cover a bolt head.

DOWN LEAD.—The wire connection from the aerial to the receiving set. Usually called lead in.

D.p.—Abbreviation for double pole.

d.p.d.t.—Abbreviation for double pole double throw.

d.p.s.—Abbreviation for double pole snap switch.

d.p.s.t.—Abbreviation for double pole single throw.

D.Q.—A signal in submarine telegraphy to indicate the point of separation between the address and the message itself.

DRAFT TUBE.—In hydro-electric power stations, an air tight suction tube fitted to reaction turbines. Several types of these latter may be placed as much as 30 feet above the tail water, if this pipe be fitted, so that the weight of the column of water within it balances part of the atmospheric pressure, and the difference of pressure during the flow through the turbine is the same as if the turbine were placed at the bottom of the fall.

DRAG.—1. The total resilience overcome by the thrust of an airplane propeller.

2. The act of drawing a grapnel along the sea bottom, for the purpose of hooking a submarine cable.

DRAG OF MAGNETIC FIELD.—The force exerted by a magnetic field upon a conductor carrying an electric current.

DRAG OUT.—In electro-plating, the quantity of solution adhering to the cathode on removal from the plating bath.

DRAWBRIDGE FROG.—A form of trolley frog adapted to the point of connection with a drawbridge wire.

DRAW TONGS.—A device for gripping a wire in overhead line construction in the operation of securing the needed tension.

DRAW VISE.—A form of vise for gripping a wire in overhead line construction

DRAWING-IN-AND-OUT CONDUIT. — A conduit with ducts for underground wires, and conveniently arranged so that wires may be removed or inserted at will.

DREHSTROM.—A German term for a rotating or rotary current.

DRIFT.—An objectionable term for the horizontal component of the force due to the air striking the inclined surfaces of the wings of an airplane and which tends to push the machine backward.

DRIFT METER.—An instrument for measuring the angle between the fore and aft axis of an air craft and its path over the ground. One type consists of a drift bar provided with a suitable angular scale. The instrument is graduated to read correctly when it is level.

DRIFT WIRES.—Horizontal wires leading from the nose of the frame to the wings of an airplane to prevent collapsing toward the rear.

DRIFTING OF NEEDLE.—A condition of a galvanometer needle in which it fails to indicate zero on the scale when not in operation, due to fatigue of the needle suspension or faulty construction.

DRILL ELECTRIC.—A drill driven by an electro-magnetic motor, and having either a rotary motion for metals, or a percussion or reciprocating action for rocks. In the percussion drill the stock acts as the core of a pair of solenoids through which the current is sent alternately.

DRIP LOOP.—In house wiring, a loop extending downward made at the point where a wire enters a building. The lower end of the loop is below the entrance point. Water gathering on the wire will drip from the loop.

DRIP PROOF APPARATUS.—Apparatus so constructed or protected that its successful operation is not interfered with when subjected to falling moisture or dirt.—NEMA.

DRIVE CIRCUIT.—In radio, a master oscillator circuit.

DRIVER.—In radio, a name sometimes given to an oscillator; the latter is preferable.

DRIVING GEAR.—A general term, signifying the gearing, belts, pulleys, clutches, shafting, etc., whereby motion is transmitted to a machine.

DRIVING GEAR OF MAGNETO.—In a magneto generator for telephone work, a gear wheel designed to engage a pinion on the armature shaft by means of which the armature may be made to rotate rapidly.

DRIVING HORNS.—On early armatures, pins or strips projecting from the surface of a smooth core to take the thrust and thus prevent the inductors being displaced or creeping.

DRIVING POINTS.—Certain points upon the cover plate of an electric railway controller which indicate no resistance in series, and hence are the ones on which the car should be driven. They are cast longer than the others so that the motorman cannot mistake them.

DROP.—1. A device to attract the attention of a telephone operator using a switchboard having a drop annunciator, when a subscriber wants a connection. A pivoted drop shutter is connected to the armature of an electro-magnet and held suspended until a current passing through the coil releases it, when it falls to a horizontal position, displaying the number of the line: an annunciator drop.
2. A lessening or fall of voltage in a circuit.

DROP CORD.—Twisted insulated wires extending from a socket, rosette or outlet box to a lamp, electric cooking utensil or other current consuming device. Where the wires enter a socket, rosette, or an outlet box, they should be relieved of any strain by making an Underwriter's knot so that the weight of the socket, shade and lamp will not be on the joint. Square or granny knots are not approved, sockets may be obtained with strain relief devices attached.

DROP CORD, USES OF.—In house wiring, re-enforced cotton cord can be used with a light outer braid. For factories, the heavy type should be used. For cellars the slicked or weather proof type should be used. For bakeries or places where wires are subjected to a great heat or where the cord is attached to heating appliances, regular asbestos heating cord must be used. For auto garages, extra heavy marine deck cable should be used, or the same encased in a specially wound metallic sheath. For show windows B.X. drop cord must be used. Clusters of more than one light must not be attached to drop cords. Drop cords may be extended from their outlets to another position by means of ceiling buttons.

DROP METHOD.—A resistance test suitable for measuring either high or low resistances with precision. In testing, the volt meter is switched into circuit across the known resistance and then across the unknown resistance, readings being taken in each case. The equation is: Unknown resistance = known resistance $\times$ drop across unknown resistance $\div$ drop across known resistance.

DROP OUT VOLTAGE OR CURRENT.—The voltage (or current) at which the contacts of a magnetic contactor open under conditions of normal operating temperature.—NEMA.

DROP TEE.—A short piece of pipe having a lateral outlet, used to connect a line of pipe with a pipe at right angles to the line, and running downward, causing the water or steam exhaust to drop down.

DROP TROLLEY.—A trolley wheel and pole having a spring by which the trolley is set against the wire.

DROPPING WIRES DOWN OUTER WALLS.—In house wiring, first a hole should be bored in the header and a mouse lowered until it reaches the cellar, or hits an obstruction. Usually obstructions are encountered as fire stops are placed at each floor to prevent the enclosed space acting as a flue in case of fire. These stops usually consist of 2$\times$4 strips or brick. To reach them the baseboard must be removed. This is easily pried off with a floor chisel, sometimes it is necessary to set in the nails with a nail set. If walls be of brick, the entire distance from attic to cellar may be fished with a steel fish or snake wire, as the laths are attached to a ⅞ strip which is nailed to the brick.

DROSS.—1. The scum or extraneous matter of metals, thrown off in the process of melting.

2. An incrustation formed on metals by oxidation; rust; crust of metals; waste matter; any worthless matter separated from the better part.

DROWNED TUBES. — Those generating tubes of water tube boilers which discharge into the steam drum below the water level.

DRUM.—1. A spool or reel for carrying coils of wire.

2. In a water tube boiler, a large cylindrical member into which the up flow and down flow tubes are tapped or expanded. It provides space for an ample quantity of water and steam, with sufficient disengaging surface to prevent violent ebullition.

DRUM ARMATURE.—A dynamo or motor armature shaped like a cylinder and having its coils wound longitudinally, or parallel with its axis.

DRUM CONTROLLER.—One which utilizes a drum switch as the main switching element.—NEMA.

DRUM ELEVATOR MACHINE.—A power unit for operating an elevator in which the drive consists of a drum having the driving cables attached. The word drum, as correctly used to distinguish one of the two general classes of elevator machines, means a winding drum as distinguished from what looks like a short drum; that is, a traction drum, the latter being simply a type of pulley or sheave. A drum then, is a form of spool on which the ends of ropes are attached and around which they are wound and unwound in the operation of the car.

DRY BATTERY.—An assembly of dry cells connected as a unit. This term is often ignorantly and very objectionably applied to a single cell.

DRY CABLE.—A term sometimes applied to a conducting cable composed of wires contained within a lead sheath and separated from each other by air and paper; a dry core cable.

DRY CELL (SO CALLED).—A primary cell consisting of two elements, usually zinc and carbon, and a liquid electrolyte. A zinc cup closed at the bottom and open at the top forms the negative electrode; this is lined with several layers of blotting paper or other absorbent material. The positive electrode consists of a carbon rod placed in the center of the cup; the space between is filled with carbon—ground coke and dioxide of manganese mixed with an absorbent material. This filling is moistened with a liquid, generally sal-ammoniac. The top of the cell is closed with pitch to prevent leakage and evaporation. A binding post for holding the wire connections is attached to each electrode and each cell is placed in a paper box to prevent the zincs of adjacent cells coming into contact with each other when finally connected together to form a battery. A new dry cell has a pressure of about 1.5 volts, and this is true whether the dry cell be a very small one like a flash light battery or a large 6 in. dry cell. On momentary short circuit a fresh dry cell should "kick" 25 to 30 amperes if fresh. Don't buy a dry cell without testing it yourself. In testing, don't hold the connection any longer than necessary to read the ammeter. If a dealer objects to cells being tested it is evidenec that they are no good and that the dealer is dishonest.

DRY CONDENSER.—A sealed condenser, rendering it moisture proof.

DRY CORE CABLE.—Air space and paper core cables, consisting of wires contained within a seamless lead sheath, and separated from each other by air and paper.

DRY DISTILLATION.—A variety of destructive distillation without the use of water or any volatile solvent.

DRY GELATINE CELL.—A primary cell having its electrolyte combined with gelatinous material forming a jelly-like mass; a form of dry cell.

DRY ICE.—Solidified carbon dioxide; sometimes called carbice. According to Gilbert: Carbon dioxide, like many other gases, has the capacity of existing in three separate states, namely, gas, liquid and solid. Like many other gases, it may be liquefied by the application of pressure produced by compression, using a gas compressor for the purpose, then subsequently cooled to remove the heat of compression and the latent heat. The liquid may then be converted to the solid state by reducing the pressure below its condensing pressure and allowing same to escape through a control valve into a suitable container where approximately 75 to 80% forms snow and the remainder passes off in the form of low temperature and low pressure gas to be recovered and reconverted to the liquid state. The snow thus formed is compressed into dense cakes which resembles somewhat a cake of closely packed fine snow. As produced for the trade, a cake of dry ice is more dense than water ice and its weight per cubic foot is approximately twice that of water ice, depending upon the pressure used for compressing the snow. Not all commercial dry ice has the same density.

DRY JUNCTION RECTIFIER.—A type designed to avoid electrolyte, gas, or vacuum as employed in the other rectifiers. As made by the Westinghouse Co. the outfit consists chiefly of a suitably designed transformer and copper oxide rectifying elements enclosed in a sheet steel case. The rectifying element consists of copper discs or washers, one side of which has been treated at high temperature to collect a coating of copper oxide. These discs are separated from each other by a lead washer to furnish good contact. The d.c. terminals, fuse and charging rate selector studs are located at one end of the outfit and all parts plainly marked. Trade name Rectox.

DRY MEASURE.—

2 pints (pt.) make 1 quart (qt.)
8 quarts make 1 peck (pk.)
4 pecks make 1 bushel (bu.)*

Unit equivalents

		qt.	pt.
	pk.	1	= 2
bu.	1	= 8	= 16
1	= 4	= 32	= 64

Scale—ascending, 2, 8, 4; descending, 4, 8, 2.

* NOTE.—The standard U. S. bushel is the Winchester bushel, which is, in cylinder form, 18½ ins. in diameter and 8 ins. deep; it contains 2,150.42 cu. ins. A struck bushel contains 2,150.42 cu. in. or 1.2445 cu. ft. A heaped bushel is a cylinder 18½ ins. in diameter and 8 ins. deep, with a heaped cone not less than 6 ins. high. The British Imperial bushel =8 imperial gallons=2218.192 cu. ins. or 1.2837 cu. ft.

DRY PILE.—In physics, a form of the voltaic pile, constructed without the use of a liquid, affording a feeble current, and chiefly useful in the construction of electroscopes of great delicacy.

DRY STEAM.—Steam free from moisture. The term is objectionable as it does not fully classify, that is, saturated and superheated steam are both dry.

DRY TRANSFORMER.—A transformer employing air instead of oil as the cooling agent.

D.t.—Abbreviation for double throw.

DUAL AMPLIFICATION.—In radio, reflex circuit amplification in which one or more vacuum tubes may be made to act both as radio frequency and audio frequency amplifiers.

DUAL ELECTROLYSIS.—The chemical decomposition of both the metal and the liquid in which the metal is dissolved, which takes place during the electrolysis of a metallic salt.

DUAL IGNITION.—An ignition system having two sources of current but the other parts in common.

DUAL OPERATION.—An elevator control system in which push button operation is combined with manual operation in the same car.

DUCT.—One of the channels in an underground conduit in which wires or cables may be run.

DUCT FITTINGS.—In under floor wiring, since the service extension assembly and service fittings frequently occupy positions under desks or in foot space, they are purposely designed to be kick proof. They will stand any reasonable abuse in connection with exposed position. Ribs at two ends of opening prevent desk occupant's feet injuring connection. Attachment plug is sufficiently protected so that the feet will not strike the plug itself, thereby eliminating interruptions to service.

DUDDELL'S OSCILLOGRAPH.—An instrument for measuring wave form; it employs a movable coil in a magnetic field. It consists essentially of a modified moving coil galvanometer combined with a rotating or vibrating mirror, a moving photographic film, or a falling photographic plate. The galvanometer portion of the outfit is usually referred to as the oscillograph.

DULL EMITTER TUBE.—A low temperature oxide coated radio vacuum tube which in operation glows at dull red color.

DULL PICKLING.—In electro-plating, a preliminary dipping of a metallic object to give it a dead surface so that after plating it will show a matt luster; matt dipping.

DUMMY AERIAL.—An Artificial aerial.

DUMMY MOULDING.—A moulding designed merely to furnish symmetry to a room in which other mouldings are provided for electric wires.

DUODECIMALS.—Method of computing in divisions of 12; as fractions of a foot formed by dividing by 12 successively; as 1/12, 1/144, etc.

DUPLEX ARMATURE WINDING.—A winding composed of two simple windings.

DUPLEX BALANCE.—In duplex telegraphy, a balance maintained between the main line and the artificial line, so that the action of the home transmitting instrument does not operate the home relays.

DUPLEX CABLE.—A cable composed of two insulated stranded conductors twisted together. Duplex cables may or may not have a common insulating covering.

DUPLEX CUT OUT.—A safety fuse so adjusted that a new strip can be substituted as soon as one has been melted by an excessive current.

DUPLEX DIPLEX.—A term sometimes applied to quadruplex telegraphy, which is the combination of duplex telegraphy in which two messages are sent simultaneously in opposite directions over the same wire, and diplex telegraphy in which two messages are sent at the same time in the same direction.

DUPLEX DIRECT CONNECTED PUMP.—A direct acting non-rotative steam pump in which equal cylinders, either simple or tandem compound, are arranged side by side; the piston rod of each engine being prolonged as the pump rod of the pump which it drives. The chief characteristic lies in the valve gearing, the steam valve or each pump being driven through an arrangement of levers and linkwork from the crosshead of its neighbor.

DUPLEX INSULATOR.—A double insulator for a line wire.

DUPLEX LOOP.—A pair of wires connecting a branch telegraph office with the duplex apparatus of the main office, so as to make the duplex system available at the branch office.

DUPLEX "POWER" PUMP.—Two pumps driven from a shaft which receives its power either from a large pulley attached to the shaft or from a small pulley geared to the shaft.

DUPLEX REPEATER.—A telegraph repeater in which the respective armature levers of two polar relays at the repeater office connect the positive and negative main battery currents direct to the line wires. The armatures of both polar relays are closed when a distant office closes the key. This results in placing the duplex negative battery in contact with the other line. As the current passes through the coils differentially, the armature of the open line will not be affected by the impulse thereof. When the closed key is opened the positive battery is presented to the line.

DUPLEX TELEGRAPH SYSTEM.—One which permits the sending of two messages simultaneously in opposite directions over a single wire. There are several systems of duplex telegraphy, namely:

a. Differential; b, polar with battery or with dynamo; c, bridge.

DUPLEX TELEPHONY.—The simultaneous telephone transmission of two messages in opposite directions over the same wire.

DUPLEX TRANSMISSION.—In radio, the simultaneous transmission of signals in both directions between two stations.

DUPLEX WIRE.—A conductor made up of two distinct wires running parallel with each other.

DURALUMIN.—A trade name for a hard aluminum alloy.

DUST CORE.—A transformer core made with iron filings or iron dust. Used to facilitate construction.

DUST PROOF APPARATUS.—Apparatus so constructed or protected that the accumulation of dust will not interfere with its successful operation.

DUST PROOF BEARING.—One constructed with caps and guards of impervious material so that dust is excluded from the surfaces in contact; a necessary device with the moving parts of railway rolling stock, automobiles and vehicles generally.

DUST TIGHT APPARATUS.—Apparatus so constructed that the dust will not enter the enclosing case.—NEMA.

DUST TELEPHONE TRANSMITTER.—A very effective form of transmitter in which carbon "dust" or granules held between two conducting plates are used as the variable resistance medium; a multiple contact carbon transmitter.

DUSTY GASES.—A dangerous mixture, the cause of violent explosions in mines, flour mills and grain warehouses. Air filled with coal dust, etc., which in itself is too small in quantity to induce explosion, becomes explosive on the addition of still smaller proportions of combustible gas.

DUTCH METAL.—An alloy composition of eleven parts copper to two of zinc, forming the most malleable of alloys.

DUTCHMAN.—A piece "fitted in" to restore a worn part or to hide a defect.

DUTY.—In mechanics, the work performed by an engine, especially a steam pumping engine, as measured in foot pounds, for a certain quantity of fuel or dry steam consumed.

DUTY OF PUMPS.—This term is used in engineering to express the efficiency of a steam pumping engine as measured by the work done by a certain quantity of fuel or steam. Duty, then, stands for foot pounds or work done, and means the number of pounds of water lifted one foot, or its equivalent, by 100 pounds of coal, or 1,000 pounds of saturated steam. Formerly duty was expressed on the coal basis, but this has fallen into disuse owing to the variations in the quality of the latter. Duty expressed per 1,000 lbs. of steam is equivalent to 100 lbs. of coal when the evaporation is 10 to 1.

DUTY PER MILLION HEAT UNITS.—In pump tests, the foot pounds of work at the water end per million heat units furnished by the boiler. This is the equivalent of 100 pounds of coal where each pound imparts 10,000 heat units to the water in the boiler, or where the evaporation is $10{,}000 \div 965.7 = 10.355$ pounds of water from and at 212° per pound of coal. This unit was reported in 1891 by a committee of the A.S.M.E. (Trans. XII, 530), reaffirmed it in 1915 as the standard unit and defined it as follows: the duty per million heat units is found by dividing the number of foot pounds of work done during the trial by the total number of heat units consumed, and multiplying the quotient by 1,000,000.

DUTY PER 100 LBS. OF COAL.—This unit shows the combined efficiency of a pump and boiler; when expressed on the steam basis, the efficiency of the pump alone is obtained. The latter, therefore, is generally used, as the result sought is to determine how economical the pump is in the use of steam.

D VALVE.—A name given to the common slide valve, as its sectional appearance is not unlike the letter D. It consists of a long rectangular boxlike casting designed to secure the proper distribution of steam to and from the cylinder. The slide valve in its crude form was invented by Matthew Murray of Leeds, England, toward the end of the 18th century. It was improved upon by James Watt, but the simple D slide valve in use today is credited to Murdock, an assistant of Watt. It came into general use with the introduction of the locomotive, although Oliver Eames of Philadelphia appears to have realized its value, in fact, for years before the advent of the locomotive he applied it to engines of his own make.

DYAD.—An atom, radical, or element having a capacity to unite with two atoms of hydrogen; a bivalent or divalent element.

DYAD ATOM.—An atom having the valency, or combining power, of two units, that is, of two atoms of hydrogen.

DYNAMIC BALANCE.—In the manufacture of dynamos, motors, etc., a rotor with good static balance will not necessarily be in good running balance. It is often necessary to rebalance a rotor dynamically. This is particularly evident on high speed rotors. There are several methods employed in the factory whereby machines are given running balance. Small rotors are balanced by the cable suspension method which has proved very satisfactory, especially on high speed machines. The Lawaczeck-Heyman balance machine is also used on machines up to 15 tons, and facilities are being provided whereby larger machines may be balanced by this method. The larger sizes are balanced on the Akimoff machine.

DYNAMIC BRAKES.—In electric traction or electric elevators, a method of braking in which the motor is run as a dynamo with a resistance load, thus introducing a reverse force which tends to stop the car (or elevator).

DYNAMIC CONDENSER.—An objectional name for a synchronous condenser.

DYNAMIC ELECTRICITY.—Electricity in motion; that is, the electric current as distinguished from static electricity.

DYNAMIC HEAD.—In hydraulics, a head usually expressed in pounds per sq. in., representing both the pressure due to the elevation to which the water is pumped, and that due to friction of the water in the pipes.

DYNAMIC INDUCTION.—Magnetic induction produced in a body by a moving magnetic field, or in a moving body by a stationary magnetic field, or in a moving body by a field moving at a different rate.

DYNAMIC RADIO LOUD SPEAKER.—A type working on the moving coil principle. In this arrangement the signal current flows through the moving coil which is placed around the middle pole of a three-pole magnet, and the reaction between the two causes the moving coil to vibrate corresponding to variations of the signal current. The diaphragm being mechanically connected to the moving coil vibrates similarly.

DYNAMICS.—That branch of mechanics which treats of the action of forces producing motion in bodies; the science of moving forces; opposed to statics.

DYNAMO.—A machine for converting mechanical energy into electrical energy.

by means of electro-magnetic induction, the amount of electrical energy thus obtained depending upon the mechanical energy originally supplied. The dynamo in its simplest form consists of: a, an armature, which in revolving induces voltage in the copper inductors wound upon it; b, a field magnet, which provides a field of magnetic lines, to be cut by the armature inductors as they revolve; c, pole pieces; d, commutator or collector; e, collecting brushes that rest on the commutator cylinder and take off the current of electricity generated by the machine. Dynamos are classed with respect to the winding as series, shunt and compound. Dynamos are sometimes objectionably called direct current generators. Why use three words when one will do?

DYNAMO FAILS TO EXCITE.—To remedy this fault, the operator should first see that the brushes are in the proper position and making good contact, and that the external circuit is open if the machine be shunt wound, and closed if series wound. The principal causes which prevent a dynamo building up are: a, brushes not properly adjusted; b, defective contacts; c, incorrect adjustment of regulators; d, speed too low; e, insufficient residual magnetism; f, open circuits; g, short circuits in machine and external circuits; h, wrong connections; i, reversed field magnetism.

DYNAMO POLE CHANGER.—A duplex or quadruplex telegraph transmitter provided with an automatic switch or contact breaker for reversing the direction of the current.

DYNAMOGRAPH.—1. A recording dynamometer. In railroad testing, an apparatus for recording the condition of a railroad track, resistance of train, speed, etc. Also called dynagraph.

2. A telegraph that records a message in typewritten characters at both ends of the line.

DYNAMOMETER.—An instrument used for measuring power. There are three classes: a, traction; b, brake or obsorption, and c, transmission.

DYNAMOMETER AS A WATT METER.—In this adaptation the stationary coils are wound for current, and the movable coils for voltage. The current is conducted to the moving coil through controlling springs. The pointer is assembled a few degrees ahead of the moving coil, so as to give as near uniform scale divisions as is possible. The slight expansion of the scale near the center is an advantage, as it gives better indications at the more important working loads.

DYNAMOMETER, ELECTRIC.—An instrument used to measure volts, amperes or watts; its operation depends on the reaction between two coils when the current to be measured is passed through them. One of the coils is fixed and the other movable. The fixed coil is composed of a number of turns of wire and fastened to a vertical support and is surrounded by a movable coil composed of a few turns or often of only one turn of wire. The movable coil is suspended by a thread and a spiral spring attached to a torsion head, which passes through the center of a dial. The ends of the movable coil dip into mercury cups, which act as pivots and electrical contacts, making connection with one end of the fixed coil and one terminal of the instrument.

DYNAMOMETER OPERATION.—When current is passed through both coils, the movable coil is deflected against one of the stop pins, then the torsion head is turned to oppose the movement until the deflection has been overcome and the coil brought back to its original position. The angle through which the torsion head was turned, being proportional to the square root of the angle of torsion, the current strength in amperes is equal to the square root of the angle of torsion multiplied by a calculated constant, furnished by the maker of the instrument.

DYNAMOTOR.—A combination dynamo and motor having either two armatures or one armature with two windings and one magnetic field. The motor element is used to drive the dynamo with a pressure either higher or lower than that received at the motor terminals.

DYNATRON.—In radio, a type of vacuum tube generally used as an oscillator.

DYNE.—The c.g.s. unit of force. The force capable of imparting in one second a velocity of one centimeter per second to a mass of one gram.

DYSPROSIUM.—Rare earth metallic element. Atomic weight, 162.5. Occurs in Godolimite. A metal discovered by spectral analysis in holmium.

E

E.—Symbol for earth.

Also with various suffixes as follows:

Volt, pressure.

E_a: E_o—Active pressure; ohmic drop.

E_{av} —Average pressure

E_c —Capacity pressure

E_{ef} —Effective pressure

E_i —Inductance pressure

E_{im} —Impressed pressure

E_{max} —Maximum pressure

E_v —Virtual pressure

EAR.—An insulating device for supporting a trolley wire from the suspension span wire: a trolley ear.

EARLY CUT OFF.—In steam engineering, a term relating to the ratio of the expansion of steam in an engine cylinder. Any cut off shorter than one-half the stroke may be properly termed early cut off. On "automatic cut off" engines, early cut off is obtained by changing both the angular advance and throw of the eccentric; the greater the angular advance and shorter the throw, the earlier the cut off. In order not to unduly affect the other events of the stroke, the valve gear is arranged to increase the angular advance simultaneously as the throw is reduced, this being called the method of combined variable angular advance and variable throw. An objection to this method is that for very early cut off there is insufficient port opening for admission because the shorter the travel, the less the port opening, moreover, pre-release begins earlier and compression later.

EARTH.—1. The ground considered as a medium for completing an electric circuit.

2. That portion of the ground used to complete a circuit.

3. A fault in a telegraph line due to the accidental contact of a part of the circuit with the ground or with conductors leading to it.

EARTH BATTERY CURRENT.—A slight electric current produced between the two earth plates at the ends of a telegraph circuit.

EARTH CELL.—A primary cell made up of a voltaic couple sunk into moist earth; the moisture of the earth serving the purpose of the electrolyte.

EARTH CIRCUIT.—1. An electric circuit which is completed by the use of the ground as a part of the circuit; a ground circuit.

2. In ignition, the term "to ground" means: to the metal of the engine; the the word ground was originally applied to the telegraph circuit where the earth is used as the return conductor.

EARTH COIL.—A coil of large diameter, often used as a standard for magnetic measurements by rotating same through an angle of 90° in the earth's field. The amount of the change of flux through the coil is equal to the density of the earth's field revolved at right angles to the plane of the coil, multiplied by the area of the coil.

EARTH CONNECTION.—A connection made between any electrical circuit or instrument and the earth, called also ground connection.

EARTH CURRENTS.—1. Electric currents flowing through the ground, due to natural difference of pressure.

2. Slight currents produced by the two earth plates of a telegraph line.

3. Currents due to different pressures of the earth's surface flowing over electric circuits, especially in submarine cables, where the working of the cable is seriously affected by them.

EARTH DETECTOR.—In radio, a ground detector.

EARTH FIELD.—The magnetic field produced by the earth's magnetic poles.

EARTH FLUX.—The lines of magnetic force existing in the earth's magnetic field.

EARTH MAGNETIC STATE.—That condition of the earth by virtue of which it possesses magnetic attraction. The intensity of the earth's magnetic force at any place is the force with which a magnet pole of unit strength is attracted.

EARTH PLATES.—1. Metal plates embedded in the earth at the terminals of telegraph or other circuits for the purpose of grounding the circuit.

2. In the installation of lightning arresters, a sheet of copper or iron some 10 sq. ft. in area and at least ⅛ in. thick, buried deep enough to lie in damp soil, with a layer of powdered coke placed above and below it.

EARTH PRESSURE.—The electric pressure of the earth considered as a large conducting sphere. This is due to a positive charge residing near its surface, but as a positive charge generates an equal negative charge, the earth's pressure, due to both charges, equals zero.

EARTH RETURN.—The earth considered as the return path of an electric circuit; ground return.

EARTHED NEUTRAL.—In transformer practice, the grounding of the middle or neutral point of the secondary winding of the transformer in order to reduce fire risk in case the primary should become accidentally grounded; usually called **grounded neutral.**

EARTHENWARE CONDUIT.—A conduit for underground or other concealed wiring, made of glazed earthenware or clay. The conduits are made in both single and multiple duct, the single type being about 3½ ins. in diameter or 3½ ins. square, and 18 ins. long. Multiple conduit is made in two, three, four, six and nine sections, ranging from 2 to 3 ft. in length. Single conduit is best suited where there is great crowding of gas, water and other pipes, as the conduit can be divided into several layers so as to cross over or under such pipes. The multi-duct conduit can be laid somewhat cheaper, especially in lines of about two to four ducts; it is best suited to districts free from sub-surface obstructions.

EARTHKIN.—A magnetized sphere of steel or magnetite having a distribution of magnetism similar to that of the earth; a terella.

EBULLITION.—The rapid production of vapor in the mass of a liquid, usually called **boiling.**

EBURIN.—An insulating compound used especially for strain insulators.

ECCENTRIC.—A disc having its axis of revolution out of its center of figure, used for obtaining a reciprocating or alternate motion from a circular one, especially in the valve gear of steam engines. The motion derived is that of a crank having the same throw; it is a crank pin which is so large that it embraces its shaft and dispenses with arms.

ECCENTRIC CIRCLE.—1. A term applied to the mechanical movement which constitutes the eccentric strap and connections; largely used to obtain reciprocal from rotary motion in steam engines, pumps, etc.

2. In the Bilgram diagram for design of valve gears, a circle whose diameter is equal to the travel of the valve and which depends upon the location of the center of the lap circle.

ECCENTRIC POLE FACE.—A type designed to obtain a sinusoidal distribution of the magnetic flux in the air gap. In the case of rotating magnets, the pole face is turned to a smaller radius than the bore of the magnet wheel. In this way a gradually increasing gap is obtained, the width at the extreme edge of the pole tip being generally twice the minimum value. When this is the case, the mean gap length, for the purpose of saturation curve calculations, may be taken as 4/3 the minimum value.

ECCENTRICITY.—The distance from the center of a figure or revolving body to the axis about which it turns. In the eccentric used in engineering, this distance is equal to one-half the throw. The mistake of considering the throw as equal to the eccentricity should be avoided.

ECCENTRICITY OF ARMATURE.—The displacement of the armature of a machine from its correct position, which is concentric with the bore of the stator.

ECONOMIZER.—1. An essential part of a hot air engine, the object of which is to store up the heat rejected by the air when it falls in temperature and subsequently to raise the temperature of the air by restoring the same heat, so that the only heat which the furnace has to supply is the latent heat of expansion, together with the amount of sensible heat which may be lost through the imperfection of the economizer.

2. An arrangement of tubes placed in the uptake or flues of a boiler serving as a feed water heater, thus effecting economy by extracting further heat from the furnace gases after they have passed through the boiler itself and before they are discharged by the chimney. In connection with stationary boilers, the tubes of the economizer are vertical, they are kept clean by ring scrapers continually traveling up and down them, a small engine being provided for driving the scraper mechanism.

EDDY CURRENTS.—1. Induced electric currents occurring when a solid metallic mass is rotated in a magnetic field. They consume a large amount of energy and often occasion harmful rise in temperature. The pole pieces, field magnet cores and armature of dynamos and motors are specially subject to these currents; also called Foucault currents from the name of their discoverer.

2. The torque tending to turn the armature of an induction motor due to the induction of eddy currents which produce unlike poles at the center of the whirls. If the squirrel cage armature be replaced by a copper cylinder, these current whirls exist even though not directed by squirrel cage inductors due

to field variation met with by an element of the cylinder in traversing the field (See Audel's New Electric Library, Vol. IV, Page 1811).

EDDY CURRENT CRANE BRAKE.—A wheel, generally of copper or other metal of low electrical resistance, which is arranged to rotate between the poles of an electro-magnet. The wheel is driven by the descending load, and eddy currents are generated in it, which give rise to a retarding torque. The eddy currents and the consequent torque are regulated by varying the strength of the magnet by means of a regulating switch and resistance.

EDDY CURRENT LOSS.—The iron core of a transformer acts as a closed conductor in which small pressures of different value are induced in different parts by the alternating field, giving rise to eddy currents. Energy is thus consumed by these currents which is wasted in heating the iron, thus reducing the efficiency of the transformer. This loss is reduced by laminating the core.

EDDY CURRENTS IN TRANSFORMER CORE.—These are due to small pressure differences, induced in different parts of the core by the alternating field. Energy is thus consumed by these currents which is wasted in heating the iron, thus reducing the efficiency of the transformer. This loss is reduced to a minimum by laminating the core.

EDDY CURRENTS OF A. C.—In wiring, eddy currents may be induced in the conductor itself, or in the lead sheathing, or in the steel armor wires by the rapidly changing alternating magnetic flux. Foucault currents are produced at the expense of energy supplied the conductor, and they are dissipated in the form of heat. This lôss would be much greater in single conductor cables carrying a. c. than in two conductor or three conductor cables, in which the outer resultant magnetic field should be very small. Placing a single conductor a. c. cable in an iron conduit would very greatly increase the energy loss, and for that reason it is seldom done. This loss will be greater in solid conductors than in stranded conductors of equal section, and it will increase with thickness of lead sheath and with the diameter of the armor wires.

EDDY DISPLACEMENT CURRENTS.—Eddy currents assumed to be present in a dielectric subjected to displacement currents.

EDGE EFFECT.—In a condenser, especially one with very little margin of dielectric beyond the plates, the effect on capacity due to curving of the lines of the electrostatic field at the edges of the plates.

EDGE STRIP WINDING.—A winding for field magnets made of copper ribbon, formed to shape of core so that it can be edge wound. With this arrangement, the space occupied by insulation is reduced to a minimum, and although the cooling surface is small, each turn of the winding has one edge on the outer surface, being ample for adequate cooling.

EDGEWISE INSTRUMENT.—A form of electrical measuring instrument designed to economize space upon the switchboard, having instead of a flat dial, a dial with a vertical scale in the form of an arc along the curved edge of the instrument case, which is mounted in such a way as to project from the face of the board.

EDISON, THOMAS ALVA.—Born 1847, died 1931. An American inventor famous for his experiments in applied electricity. He began life with newspaper work which he soon abandoned for telegraphy, making many original inventions in duplex systems of operation. To Edison's inventions the following also owe their existence: Central station lighting; isolated power and lighting; electrical fixtures; telephone system; motion pictures and motion picture theatres, radio manufacturing broadcasting. From 1869 to 1910 Edison had patented 1,328 inventions. Only after completing more than 50,000 experiments did Edison produce the storage battery. When completed and on the market, Edison was not satisfied and stopped its sale. He began new experiments and in 1909 produced the new type of cell. The modern Edison phonograph made its debut in 1888, in what was then called the improved form to distinguish it from the original style he invented in 1877. He succeeded just before his death in producing rubber for commercial use from plants and weeds, especially utilizing goldenrod. On his 82nd birthday, Edison received the Congressional Medal in commemoration of his achievements in illuminating the path of progress through the development and application of his inventions. The late Mr. Coolidge, then President, sent him a message in which he called him "Noble, kindly servant of the United States and benefactor of mankind."

EDISON CELL.—A single fluid cell with a solid depolarizer and well adapted for use in closed circuits. The positive element is zinc, and the negative element black oxide of copper. The exciting fluid is a solution of caustic potash. The black oxide of copper plates are suspended from the cover of the jar by a light framework of copper, one end of which forms the positive pole of the battery. A zinc plate is suspended on each side of the copper oxide element and kept from coming in contact with the latter by means of vulcanite buttons. The cell has a low voltage, about .7 of a volt, but as the internal resistance is also very low, quite a large current can be drawn from the cell.

EDISON CHEMICAL METER.—An electro-chemical type of ampere hour meter once largely used, but now superseded by the recording watt meter. The Edison meter consists of one or more pairs of cells connected in shunt to the circuit. Each cell is made up of a glass jar containing two zinc plates held at a fixed distance apart by hard rubber spacers and immersed in a solution of zinc suiphate. After a certain period, the ampere hours of current that have been consumed are measured by the gain in weight of the negative plate due to electrolytic deposits.

EDISON EFFECT.—About 1884 Edison discovered that if inside an exhausted incandescent electric lamp of the ordinary type, containing a filament whose two ends were connected to two wires insulated from each other, there was introduced a third, insulated from the filament connections and maintained at a voltage positive with respect to the filament, then a current would flow across the vacuum inside the tube from the third wire to the filament as long as the filament was incandescent, but that the current ceased as soon as the filament became cold. This phenomenon is generally called the "Edison effect."

EDISON-LALANDE CELL.—A form of primary cell having a low resistance and little polarization. It consists of an amalgamated zinc plate and a compressed cake of copper oxide placed in a very strong solution of caustic potash.

EDISON STORAGE BATTERY.—A bimetallic cell developed by Edison with special reference to the needs of electric automobiles. The active material of the positive plate is peroxide of nickel and that of the negative plate is finely divided iron, the material being held in flat stamped shallow steel boxes which are inserted into rectangular openings punched into a thin plated steel grid. The electrolyte is a 20 per cent. solution of caustic soda.

EDISON THREE WIRE SYSTEM.—A system of electrical distribution employing two dynamos joined in series and connected at their free terminals to the positive and negative mains, respectively, between which a neutral or balance wire, usually smaller than the mains, is introduced and joined to the junction of the dynamos. The object of this system is to reduce the amount of copper required.

EDISON TUBING.—A built-in underground system of laying electric conductors in the Edison three wire system of electric distribution.

EDISWAN.—A trade name for incandescent lamps and other electric apparatus largely used in Great Britain, which embody inventions of Edison and Swan.

E. E.—Abbreviation for electrical engineer, a degree conferred by technical schools upon graduates who have satisfactorily completed the course in electrical engineering.

E.E.I.—Abbreviation for Edison Electrical Institute, formerly the National Electric Light Association.

EEL, ELECTRIC.—An eel capable of giving violent electric shocks. There are several species of so called electric fishes. The Gymnotus or electric eel is common in all streams which flow into the Orinoco and is generally procured from Surinam. In the Surinam eel the electric apparatus extends the whole length of the body. It consists of four batteries, two on each side. These batteries consist of laminæ, composed of polygonal cells to the number of 800 or 1,000 or more, supplied with four large bundles of nerve fibres; the under surface of the fish is —, the upper +. It is able to give a very severe shock

EFFECTIVE.—A word commonly used erroneously for virtual, even among the best writers. S. P. Thompson says: "I adhere to the term virtual, as it was in use before the term efficace which was recommended in 1889 by the Paris Congress to denote the square root of mean square value. The corresponding English adjective is efficacious, but some engineers mistranslate it with the word effective. I adhere to the term virtual mainly because effective is required in its usual meaning in kinematics to represent the resolved part of a force which acts obliquely to the line of motion, the effective force being the whole force multiplied by the cosine of the angle at which it acts with respect to the direction of motion."

EFFECTIVE HEATING SURFACE.—The part of the shell or tubes of a steam boiler which has water on one side and fire or hot gases on the other.

EFFECTIVE HORSE POWER.—The brake horse power of any prime mover. Thus, in a locomotive, the effective horse power given is:

$$\frac{\text{pull on tender draw link} \times \text{speed}}{33{,}000}$$

The pull is taken in pounds and the speed in feet per minute.

EFFECTIVE PRESSURE.—1. The value at a given instant of a resultant pressure which is the difference between a forward pressure and a back pressure. Effective pressure should not be confused with mean effective pressure.

2. In a steam engine, the forward pressure minus the back pressure at a given instant, that is at a given point of the stroke. Do not confuse this with mean effective pressure.

EFFECTIVE STARTING CURRENT.—The value of the starting current of a motor as indicated on the ammeter.

EFFECTIVE VOLTS.—1. That pressure which is available for driving electricity around a circuit, or for doing work. Distinguish between virtual and effective volts and amperes. An effective current is that indicated by an ammeter when the current is in phase with the pressure. In practice, the current is hardly ever in phase with the pressure, usually lagging, though sometimes leading in phase.

2. In a motor, the forward pressure (impressed voltage) is bucked by a reverse voltage induced in the moving armature inductors which causes the effective volts (or amperes) to decrease as the speed of the motor increases.

EFFICIENCY.—1. The ratio of the net power output of an apparatus to its gross power input.

2. In a storage battery, the efficiency may be regarded as the ratio of the energy output to the energy intake in a normal cycle.

3. In an incandescent lamp, it is the ratio of its mean spherical candle power to the watts consumed.

4. In a dynamo, the electric energy delivered by the machine, divided by the total electric energy produced.

EFFICIENCY OF CONVERSION.—The ratio between the energy delivered by a dynamo in the form of electric currents, to the mechanical energy absorbed by the machine.

EFFICIENCY OF DISTRIBUTION.—The ratio of the electrical energy distributed to consumers from an electric source, to the energy generated at the source.

EFFICIENCY OF ELECTRIC LAMP.—Frequently described as the ratio of the power absorbed to the light emitted; that is, proportional to the watts per candle power; but properly speaking, it is the ratio of the light emitted to the power absorbed.

EFFICIENCY OF ELECTRIC MOTOR.—The ratio of the mechanical energy developed by a motor to the electrical energy consumed in driving it. The output divided by the input.

EFFICIENCY OF PRIMARY CELL.—The ratio of the electric energy given out at the poles of a primary cell to the energy expended in performing electrolysis within it.

EFFICIENCY OF RADIATION.—The ratio between the luminous rays and the total radiation emitted by a radiating body.

EFFICIENCY OF STORAGE CELL.—The ratio of the output divided by the input of a secondary cell; the quantity efficiency being the relation of the ampere hours given out to the ampere hours put in; the energy efficiency being the relation of the watt hours given out to the watt hours put in.

EFFICIENCY OF TRANSFORMER.—1. The ratio of the useful power output to the total power input.—NEMA.

2. The ratio of the electric power delivered at the secondary terminals to the electric power absorbed at the primary terminals. Accordingly, the output must equal the input minus the losses. If the iron and copper losses at a given load be known, their values and consequently the efficiency at other loads may be readily calculated.

EFFLORESCENCE.—1. The gradual decomposition of crystalline salts from loss of water, resulting in a whitish powder.

2. The deposit which is the result of this change, especially upon the surface of vessels containing a solution of salts.

EFFLUVIUM, ELECTRIC.—A stream of minute particles formerly supposed to be given off from a magnet or electrified body. During the early history of the science all electrical phenomena were attributed to this imaginary "effluvium."

EFFLUX.—The rate of outflow of a liquid from an opening in the vessel containing it.

EFFUSION.—In chemistry the escape or flow of a gas through a thin sheet or membrane into a vacuum.

EGG, ELECTRIC.—A vacuum tube or chamber resembling an egg in shape, for the purpose of exhibiting luminescence upon the passage of an electric current through it.

EGG INSULATOR.—An egg shaped strain insulator.

E. H. P.—Abbreviation for electrical horse power.

EICHMEYER COIL.—A form wound coil, designed by Eichmeyer in 1888, and which gives a very short over all length of winding.

EIGHT BEND.—In steam fitting, a bent pipe whose length equals one-eighth of the circumference of the circle to whose radius the curve of the bend is struck. It changes the direction of the line 22½°. The same angular change may be obtained by means of a 22½° elbow.

EINTHOVEN'S STRING GALVANOMETER.—An electro-cardiograph.

EJECTOR.—A device consisting of a series of conical nozzles whereby a jet of steam or compressed air propels a stream of liquid or fluid. The principle is the same as that of the injector, but the ejector always delivers into a space with but little pressure upon it, hence the differences in the design. Ejectors are fitted as emergency bilge pumps aboard ships, most warships having one in each compartment; and they are employed on locomotives fitted with vacuum brakes to produce the required vacuum.

ELASTIC LIMIT.—The extent to which a body may be deformed or strained and still retain the power of completely recovering its original shape when the stress is removed. When the elastic limit is exceeded, the body acquires a permanent alteration of form or "set."

ELASTICITY, ELECTRIC.—The property of a dielectric in virtue of which the passage of a displacement current due to the electric stress is arrested; it is equal to the electric stress divided by the electric strain.

ELBOW.—A pipe fitting, consisting of a short bend through various angles. When it is necessary to change the direction of a pipe line to any of several standard and special angles, elbows are used. For gas, water and steam the standard angles are 45° and 90° and the special angles are 22½° and 60°. Cast iron drainage fitting elbows are regularly made with angles of 5⅝°, 11¼°, 22½°, 45°, 60°, 90°. Elbow angles measure the degree that the direction is changed. These figures should be carefully noted to avoid confusion. The angle is not the angle between the two arms, but the angle between the axis of one arm and the projected axis of the other arm.

ELBOW CONNECTOR.—A device for joining two conductors in an elbow connection.

ELECTREPETER.—An instrument for changing the direction of an electric current; a pole changer.

ELECTRIC BRAKING.—In electric traction track brakes are used to a limited extent with car equipments, in which case the controllers must be arranged to make the necessary connections. The energy for track brakes may be taken direct from the trolley or from the motors acting as dynamos driven by the stored energy in the car after the power is cut off. For braking, all the motors are in parallel and connected to the brake magnets through resistance which is varied as the car speed is reduced.

ELECTRIC CIRCUIT.—The path (whether metallic or non-metallic) of an electric current.

ELECTRIC COOKING APPLIANCES.—In devices such as percolators, waffle irons, toasters, etc., heat is produced by electricity by forcing it through resistance wires, raising the temperature of the latter, and applying the heat thus generated to the articles to be heated. The resistance wire forming the heating unit is more or less a bad conductor of electricity, and when current is taken through it, by making it form a portion of an electric circuit, it becomes hot owing to the resistance it sets up to the current. In order to meet the varied conditions of service there are numerous forms of resistor or heating unit. Usually two or three heating values are obtainable by means of a control switch.

ELECTRIC CURRENT.—An electric current through a surface is the differential movement of positive and negative electricity through the surface.

ELECTRIC DEGREE.—1/360 part of a cycle. In a two pole elementary alternator the cycle is completed in one revolution; for a four pole machine, in one-half revolution, etc. Hence, 360 electric degrees are taken to represent the armature motion of an inductor from one pole past the adjacent pole of opposite polarity and to the next pole of like polarity, that is N-S-N.

ELECTRIC DOLLAR.—An electric equivalent for the dollar, being a ridiculous suggestion to use electricity instead of gold as America's standard of value in all monetary transactions, public and private. 40 kilowatt hours are supposed to be equivalent to $1.00.

ELECTRIC DRIVE FOR AUXILIARIES.—Most central stations produce a.c. power and this is being quite generally used for driving the auxiliaries. A.c. motors are simple and dependable and adjustable speed is obtained by using a wound rotor and pole changing induction motor, or brush shifting a.c. commutator motors, which are available in both shunt and series types. Electric drive is particularly well adapted to remote or automatic control, and many central station designers are taking advantage of these features for the auxiliaries.

ELECTRIC EYE.—A photo electric cell. In noctovision if an object is illuminated by infra-red rays (invisible light) it can be clearly seen by the "electric eye" but is invisible to the human eye, and television transmission can take place in the same manner as though visible light were used.

ELECTRIC EYE FOR PRESSURE CONTROL.—A small hole is cut in the steam gauge dial at the pressure for which regulation is desired. A similar hole is cut on the other side of the dial but not quite opposite the first one. The regular gauge hand is replaced by a long hand with metal flags large enough to cover the holes.

As steam pressure increases, the right hand flag moves down in front of the hole, thus interrupting the beam of light to the photo-electric cell. This causes the relay to energize the coil of the relay valve on the gas line and open the valve. Gas under pressure enters the cylinder from the main and moves the piston, which in turn partly closes the butterfly valve in the line to the burners.

As the fuel supply decreases, steam pressure drops. When the pressure reaches a predetermined low limit, the flag on the left covers its corresponding hole in the steam gauge and its photo-electric relay opens the butterfly valve in the gas line. More fuel enters the burners and pressure again increases. This device is said to regulate pressure within a limit of three pounds. The butterfly is so adjusted that gas cannot be turned completely off, and a by-pass is provided around the valve for use in case it is desired to cut the regulator out of service.

ELECTRIC FURNACE, DIRECT RESISTANCE TYPE.—One in which the reaction mixture is inserted between the electrodes and by its own resistance the passage of the current brings the charge up to the requisite temperature. Graphite and carborundum furnaces are examples of this type of furnace.

ELECTRIC GRADIENT.—The rapidity of increase or decrease of voltage.

ELECTRIC HORNS.—An automobile signal alarm. There are two types: a, vibrating, and b, motor. In the vibrating type an electric vibrator is connected with a diaphragm, the transmitted vibrations of which set in motion sound waves. In the motor type the motor drives a toothed wheel which sets a diaphragm in vibration.

ELECTRIC LOCKING.—Modern interlocking for train protection. It includes all the safeguards in the form of electric locking that are necessary to insure the safe passage of trains at such speed as the physical condition of the track wi allow. Approach, route or sectional route, and section locking provide this. Most of the electric locking relays receive their energy from the bus mains. Relays of 1,000 ohm resistance are connected in series with 9,000 ohm resistors to the 110 volt wires. Although the power requirement per unit is not of material consequence, the total energy taken is a considerable portion of that required for the entire interlocking.

ELECTRIC LOCOMOTIVE.—A type of locomotive used especially in passenger and heavy duty traction consisting of an assembly of current collector, transformer, the main or propelling motors, motors to drive air brake and electric control devices. There are many varieties of electric locomotive. They are designed for overhead or third rail operation. Some are designed for gas electric drive.

ELECTRIC LOCOMOTIVE AIR BRAKE EQUIPMENT.—This consists of double air compressor units, an automatic governor which controls the operation of the compressors between predetermined maximum and minimum pressures, reservoirs with sufficient storage capacity, double end brake valves with an independent and automatic position, a distributing valve and the brake cylinders. Severe service demands double air compressor units to provide sufficient air for braking and other purposes. The control of the compressors is so arranged through a governor synchronizing system that each unit will carry its share of the load, both when operating as a single cab locomotive or with two cabs in multiple.

ELECTRIC MACHINE.—An induction machine for generating electricity for experimental purposes, on the principle of electrostatic induction. The ordinary "static" or electric machine is nothing but a continuously acting electrophorus.

ELECTRIC, METER.—An instrument depending for its action on the chemical or the electro-magnetic properties of an electric current, for the purpose of measuring electric supply delivered to a consumer in a distribution system.

ELECTRIC PROTECTIVE RELAY.—An intermediate device, equipped with contacts to open or close an auxiliary circuit, by means of which one circuit is indirectly controlled by a change in conditions in the same or other circuits.—NEMA.

ELECTRIC RAILWAY SYSTEM.—Any system of electric car propulsion including besides the track and rolling stock, suitable apparatus: a, to produce the current, and b, to transmit and distribute e electric motors on the cars is transformed into mechanical give motion to the car. There systems due to the varied con- service. Numerous power sys- are employed as a, d.c. transmission and distribution; b, a.c. transmission, d.c. distribution; c, a.c. transmission and distribution. For city traction 600 volt d.c. is largely used. A.c. transmission voltages depend on the length of transmission.

ELECTRIC REFRIGERATION.—A misleading name for a method of mechanical refrigeration for domestic use, comprising a small self-contained refrigeration plant having electric motor drive and automatic temperature control devices.

ELECTRIC REMOTE CONTROL SWITCHBOARD.—One with electrically operated circuit breakers mounted apart from the board and operated by means of control switches on the board.—NEMA.

ELECTRIC SCREEN.—A screen of wire gauze. When placed around a delicate electrical instrument, it will protect it from external electrostatic induction. This is due to the fact that a charge on the outside of a conductor always distributes itself in such a way that there is no electric force within the conductor.

ELECTRIC SET.—An objectionable term for a radio receiver designed to be operated entirely from a house lighting circuit, as distinguished from a battery set. Since a battery is just as much a source of electricity as a dynamo or alternator, the term electric set is ridiculous and should be discontinued.

ELECTRIC SHIP DRIVE.—Method of propelling a ship by electric motor driven propellers from current generated on shipboard. There are two general classes of plant: a, steam-electric; b, Diesel electric. The object of the electric drive is to overcome the inherent defects or limitations of the turbine and internal combustion engine; that is, its function is similar to the so-called transmission of an automobile in that it gives flexibility of control and permits the turbine or engine to run at its most economical speed. In both the turbine electric and Diesel electric forms of drive the prime movers operate in but one direction of rotation, reversal of the propellers being accomplished by switching of the electrical circuits. In the case of the turbine this eliminates the necessity for a separate turbine for astern operation, which in turn reduces the design to its simplest elements. With the Diesel engine all reversing elements are discarded and starting air is not required during maneuvering operations.

ELECTRIC VALVE.—A name sometimes used for rectifier.

ELECTRIC WIND MILL.—A rotating device consisting of radial conductors with tangential points, and pivoted to an insulated standard. It operates by the reaction due to the escape of the electric charge from the points.

ELECTRICAL CENTER OF DISTRIBUTION.—The electrical center of a lighting system depends upon the distances between the lamps and the fuse block; also the relative sizes of the lamps. It may be defined as the sum of the lamp feet for each section divided by the number of 16 candle power lamps in the circuit.

ELECTRICAL HORSE POWER.—746 watts. It is obtained as follows: One watt is equivalent to one joule per second or 60 joules per minute. One joule in turn is equivalent to .7374 ft. lbs., hence 60 joules equal:

$$60 \times .7374 = 44.244 \text{ ft. lbs.}$$

Since one horse power=33,000 ft. lbs. per minute, the electrical equivalent of one horse power is

$$33{,}000 \div 44.244 = 746 \text{ watts.}$$

or,

$$\frac{746}{1{,}000} = .746 \text{ kilowatt (kw.)}$$

Again, one kilowatt or 1,000 watts is equivalent to

$$1{,}000 \div 746 = 1.34 \text{ horse power}$$

ELECTRICALLY OPERATED TRIP FREE BREAKER.—An electrically operated oil circuit breaker free to trip on overcurrent (or other abnormal condition provided for) and will not reclose after tripping out, even though the closing contact of the control switch is held closed. However, the breaker can be held closed under the condition described by the emergency operating lever at the breaker.—NEMA.

ELECTRICALLY OPERATED VALVE.—A solenoid or motor operated valve either in a vacuum, air, oil or water line.—NEMA.

ELECTRICIAN.—A person who is versed in the knowledge and practice of electricity.

ELECTRICITY.—The name given to an invisible agent known only by its effects and manifestations, as shown in electrical phenomena. Electricity, no matter how produced, is believed to be one and the same thing. The terms frictional electricity, magneto electricity, etc., though convenient for distinguishing their origin, have no longer the significance formerly attributed to them as representing different kinds of electric force. The most recent theory advanced to explain the nature of electricity is the electron theory, the electron being the smallest quantity of negative electricity that may move by itself between atoms of matter. One reason for thinking of electrons only as charges of electricity is that, for instance, in a vacuum tube, no matter how long the electron flow continues from the filament to the plate, and no matter how great the flow, the plate never gains the slightest bit of weight. Before the electron theory was so widely accepted, the convention was adopted which says the electric current flowed from positive to negative as a sort of arbitrary rule. This rule has continued in use even though later experiments seemed to prove the contrary to be true. Therefore, current is always considered to flow from positive to negative, although the electrons actually travel in the opposite direction.

ELECTRICITY OF OPPOSITE SIGN.—In electro-statics, electric charges in which positive and negative electrification are opposed to each other. Bodies so charged attract each other.

ELECTRICITY OF SAME SIGN.—In electro-statics, electric charges which are all positive or all negative, as distinguished from electricity of opposite sign. Bodies so charged repel each other.

ELECTRIFICATION.—1. The act of charging with electricity.
2. The state of being charged with electricity.

ELECTRIFICATION BY INDUCTION.—An insulated conductor having a + or — static charge, acts on bodies in a neutral state placed near it in a manner analogous to that of the action of a magnet on soft iron; that is, it decomposes the neutral electricity, attracting the opposite and repelling the like kind of electricity. The action thus exerted is said to take place by influence or induction. Experiments indicate that when a conductor is brought near a charged body, the end away from the inducing charge is electrified with the same kind of electricity as that on the inducing body, while the end toward the inducing body receives electricity of opposite sign.

ELECTRINE.—1. Pertaining to or resembling amber.
2. Made of the alloy electrum.

ELECTRO-ACOUSTIC TRANSDUCER. — A device which is operated by power from an electrical system and supplies power to an acoustic system or vice versa.

ELECTRO-ANALYSIS.—The electro-deposition of an element or compound for the purpose of determining its quantity in the solution electrolyzed.

ELECTRO-ANESTHESIA.—In electro-therapeutics the state of the skin in not being able to perceive the sensations due to application of electricity.

ELECTRO-BALLISTICS.—Electricity in its application to the determining of the velocity and force of flying projectiles.

ELECTRO-BIOLOGY. — That branch of electricity which treats of the electric phenomena developed in living beings, either mankind or animals.

ELECTRO - BIOSCOPY. — Employment of electricity as a means of determining whether or not life is extinct.

ELECTRO-BRASSING.—Depositing a coating of brass in electro-plating; **brassing.**

ELECTRO-CALORIMETRY.—The operation of measuring the heat developed by an electric current in a conductor or circuit.

ELECTRO-CAPILLARY DETECTOR. — In radio, a device based upon the principle that the capillary attractions at the point of contact between mercury and dilute sulphuric acid undergo modifications upon the passage of an electric current.

ELECTRO-CAPILLARY PHENOMENA. — Capillary forces caused to act by the action of an electric current through a capillary tube; this principle is utilized in the construction of the capillary electrometer.

ELECTRO-CAPILLARITY. — The influence of electricity upon capillarity.

ELECTRO-CARDIOGRAM.—A registration of current variation in action of the heart muscle.

ELECTRO-CARDIOGRAPH. — An instrument for recording the electrical changes caused by action of the heart muscle.

ELECTRO-CATALYSIS.—In electro-therapeutics, chemical decomposition produced by the action of electricity.

ELECTRO-CAUTERY. — Galvano cautery. The apparatus for cauterizing tissue consists of a wire in a holder. The wire may be heated to a red or white heat by the electric current.

ELECTRO-CHEMICAL DECOMPOSITION. —The breaking up of a molecule of matter into its separate ions or atoms by the action of electrolysis.

ELECTRO-CHEMICAL EQUIVALENT. — In an electro-chemical reaction, the weight of an element compound or ion involved during the passage of a certain amount of electricity such as a coulomb, Faraday or ampere hour. The electro-chemical equivalent of hydrogen is .000010352, and that of any other element may be obtained by multiplying this number by the chemical equivalent of that element.

ELECTRO-CHEMICAL FILTRATION. — A term sometimes applied to electric osmose.

ELECTRO-CHEMICAL METER.—An electric meter which measures the current by the amount of chemical change it causes in a metallic solution; an electrolytic meter.

ELECTRO-CHEMICAL SERIES OF METALS.—An arrangement of metals in a series in such a manner that the most electro-positive is at one end and the most electro-negative at the other. The order of the metals varies with the electrolyte in which the metals are tested, as follows:

Sulphuric Acid

Zinc	Iron	Copper
Cadmium	Nickel	Silver
Tin	Bismuth	Gold
Lead	Antimony	Platinum

Hydrochloric Acid

Zinc	Lead	Bismuth
Cadmium	Iron	Nickel
Tin	Copper	Silver
		Antimony

Caustic Potash

Zinc	Antimony	Iron
Tin	Lead	Copper
Cadmium	Bismuth	Nickel
		Silver

ELECTRO-CHEMISTRY.—That branch of the science of electricity which treats of the influence of electricity in producing chemical changes. All electro-chemical operations are performed either by the analytical property of electrical energy when passed through an electrolyte, or by the heat which is produced when a current of electricity is passed through a conductor which is not an electrolyte.

ELECTRO-CHROMIC RINGS.—When a solution of lead is subjected to the passage of an electric current, a film of lead peroxide forms upon the anode, and if the anode be a plate of polished metal placed horizontally in the liquid beneath a platinum wire, as a cathode, the deposit forms rings of rainbow colors. These rings are known as **Nobili's rings** or **metallochromes.**

ELECTRO-COAGULATION.—Hardening of diseased tissues by passing high frequency currents through them.

ELECTRO-CONTACT MINE.—A submarine mine, employed in naval warfare, which is designed to explode at the contact of a passing ship which completes the circuit of an electric battery on the shore.

ELECTRO-COPPERING. — Depositing copper by electro-plating.

ELECTRO-CRYSTALLIZATION.—Crystallization occurring during electrolysis.

ELECTRO-CYSTOSCOPE. — An instrument provided with a minute electric light for examining the interior of the bladder.

ELECTRO-DEPOSITION.—The process of depositing a substance upon an electrode by electrolysis. Electro-deposition includes electro-plating, electro-forming, electro-refining and electro-winning.

ELECTRO-DEPOSITS. — Metallic deposits made through the agency of electricity, as in the reduction of metal from ores, the casting of types, and electro-plating.

ELECTRODES.—1. In electrolysis, the terminal plates in the bath; the plate by which the current enters the solution is called the **anode** and that by which the current leaves is called the **cathode.**

2. In a primary cell, the plates immersed in the exciting fluid or electrolyte.

3. In arc lighting, the carbons which form the terminals for the arc.

4. In electro-therapeutics, terminals for the curative applications of electricity.

ELECTRO-DIAGNOSIS.—Determination of the nature of a disease through observation of changes in electrical irritability.

ELECTRO - DIAPASON.—A tuning fork which is kept in vibration by electricity.

ELECTRO-DYNAMIC ATTRACTION.—The attraction which electric currents exert upon each other.

ELECTRO-DYNAMIC CAPACITY.—A term sometimes applied to self-induction.

ELECTRO-DYNAMIC REPULSION. — The tendency of two electric currents flowing in opposite directions to repel each other.

ELECTRO-DYNAMIC ROTATION.—A rotation produced in a liquid when an electric current is passed through it, while at the same time it is influenced by the induction of a current moving at right angles to it.

ELECTRO-DYNAMOMETER.—1. An instrument for measuring amperes, volts or watts by the reaction between two coils when the current to be measured is passed through them. One of the coils is fixed and the other movable. In operation, when a current is passed through both coils, the movable coil is deflected against a stop pin, then a screw is turned in a direction to oppose the action of the current until the deflection has been overcome and the coil brought back to its original position. The angle through which the pointer of the torsion screw was turned is directly proportional to the square root of the angle of the torsion. To determine the current strength in amperes, the square root of the angle of torsion is multiplied by a calculated constant furnished by the makers of the instrument.

2. For measuring volts, both coils are wound with a large number of turns of fine wire making the instrument sensitive to small currents. Then by connecting a high resistance in series with the instrument, it can be connected across the terminals of a circuit whose voltage is to be measured.

3. For measuring watts, one coil is wound so as to carry the main current, and the other made with many turns of fine wire of high resistance suitable for connecting across the circuit. With this arrangement, the force between the two coils will be proportional to the product of amperes by volts, hence, the instrument will measure watts.

ELECTRO - ENAMEL.— An impregnating preparation for electric conductors. It is claimed to be an acid and moisture proof varnish with good heat conducting and cementing qualities.

ELECTRO-ENDOSOMOSIS.—The migration of liquids through a diaphragm.

ELECTRO - ENGRAVING.—1. An etching process in which a metal plate which has been covered with a ground and etched is subjected to the action of an electro-bath in order to cut deeper the lines of the design.

2. The name for an engraving made by this process.

ELECTRO-ETCHING.—A term sometimes applied to electro-engraving.

ELECTRO-FILTRATION.—The same as electro-chemical filtration or electric osmose.

ELECTRO-FORMING.—The production or reproduction of articles by electro-deposition.

ELECTROGEN.—A device for preventing corrosion and pitting within boilers in connection with surface condensers. A large ball of zinc is suspended in the water space of the boiler, to which are soldered copper wires, these being led to any part of the boiler where pitting has commenced. It is necessary to scrape the steel absolutely bright to ensure good metallic contact, and the wires should be secured by bright studs, nuts and washers; the temperature being generally too high for solder. Galvanic action set up in the boiler now attacks the zinc instead of the steel, as the former metal is electro-positive to the latter.

ELECTRO-GENESIS.—The state of tetanoid spasm that occurs in muscles highly stimulated by electricity after the current is withdrawn.

ELECTRO-GILDING.—Depositing a very thin coating of gold by electro-plating.

ELECTROGRAM.—In meteorology, a diagram showing the electric conditions of the atmosphere.

ELECTROGRAPH.—A tracing, curve or record made by any recording electrical instrument.

ELECTROGRAVURE.—A reproduction made by a special electrolytic process. A cast of the original to be copied is made in some porous material, and is then placed in a suitable electrolyte so that its surface is kept wet without being immersed. A metal disc laid upon the surface becomes the anode. The path from the cathode lying through the face of the cast, the metal disc becomes corroded at the points of contact, and this goes on until the disc bears an accurate reproduction of the object from which the cast was made.

ELECTRO-KINETICS.—That branch of electricity dealing with electric currents or electricity in motion, as distinguished from electro-statics, which treats of the proporties of simple electrified bodies or electricity at rest.

ELECTROLIER.—A fixture for supporting a cluster of incandescent electric lamps.

ELECTRO-LINES.—Prof. Fleming's name for electron lines of force.

ELECTRO-LITHOTRITY.—In surgery, the operation for the destruction of calculi in the bladder by electrolysis.

ELECTROLYSIS.—1. The decomposition of a chemical compound in solution, called the electrolyte, into its constituent elements, called ions, by the passage of an electric current through it. There are two kinds of ions, viz.: the electro-positive ions called cations and the electro-negative ions called anions; the former appear at the cathode and the latter at the anode. The number of ions liberated in a given time is proportional to the current strength. The current may be regarded as being carried through the electrolyte by the ions; since an ion is capable of carrying a fixed charge only of + or — electricity, any increase in the current strength necessitates an increase in the number of ions.

2. In electro-therapeutics, decomposition of a salt or other chemical compound or of certain tissues of the body by means of electricity.

ELECTROLYTE.—1. Any substance which undergoes chemical decomposition by the direct action of an electric current passing through it.

2. The solid or fluid mass through which the current passes between anode and cathode. The electrolyte must be capable of electrolytic decomposition and, therefore, it must be a chemical compound.

ELECTROLYTE DENSITY.—The following table shows the approximate number of parts of pure water to ten parts electrolyte (1.400 spec. gravity), to prepare electrolyte of different densities.

READINGS AT 70° F.

Density	Parts by weight	Parts by volume
1.260	4.7	6½
1.275	4.	6.
1.280	4.	5½
1.300	3.	4¼

ELECTROLYTE MIXING.—For a storage battery, mix one part of chemically pure concentrated sulphuric acid with several parts of water. The proportion of water differs with several types of cell, from three to eight parts, as specified in the directions accompanying the cells. In mixing the water and acid, the hydrometer should be used to test the specific gravity of both the acid and the solution. The most suitable acid should show a specific gravity of about 1.760 or 66° Baume. The mixture should be made by pouring the acid slowly into the water, never the reverse. As cannot be too strongly stated, in mixing, the liquid should be stirred with a clean wooden stick, the acid being added to the water slowly; the acid is corrosive and will painfully burn the flesh.

ELECTROLYTIC ASSAYING.—The application of electrolysis to the testing of metals to determine their purity.

ELECTROLYTIC BATH.—The chemical solution which is acted upon and broken up into its elements by the electric current in electrolysis.

ELECTROLYTIC CELL.—A vessel containing an electrolyte, in which electrolysis is carried on. This type of cell is called a voltameter when the value of the current passing is deduced from the weight of the metal deposited.

ELECTROLYTIC CONDENSER.—A type of condenser for high voltage low frequency and low voltage high frequency a.c. circuits. It resembles a primary cell, and employs one electrode as one plate, the electrolyte as the other plate and the layer of gas formed on the electrode as the dielectric.

ELECTROLYTIC CONDUCTION.—The conduction of electricity through an electrolyte by means of electric charges carried by the ions separated by electrolysis.

ELECTROLYTIC COPPER.—Copper that has been freed from impurities by electrolysis. Crude copper leaving the smelting works with certain percentages of impurities is refined by electrolysis so that electrolytic copper has more than 98 per cent of the conductivity of pure copper, and is, therefore, largely used for copper wires in electric lighting and in electric machines.

ELECTROLYTIC CORROSION.—Corroding, by the action of electrolysis, of metal pipes or other bodies which lie in damp earth in the vicinity of electric currents.

ELECTROLYTIC DECOMPOSITION.—The breaking up of a molecule into its separate ions or atoms by the action of electrolysis.

ELECTROLYTIC DEPILATION.—The removal of hair by the electrolytic destruction of the roots.

ELECTROLYTIC DETECTOR.—A form of radio detector in which a fine platinum wire dips into a cup of nitric or dilute sulphuric acid. The wire is adjusted so as to just touch the acid.

ELECTROLYTIC DIAPHRAGM.—A diaphragm or partition used in an electroplating bath.

ELECTROLYTIC DISSOCIATION.—In electro-chemistry, the breaking up of molecules into ions when certain substances are dissolved in water, which gives to the solution the necessary properties to conduct an electric current.

ELECTROLYTIC DYNAMO.—A machine used for electro-plating.

ELECTROLYTIC HYDROGEN.—Hydrogen that is freed from a compound by electrolysis.

ELECTROLYTIC INSTRUMENT.—Any instrument which depends for its action upon the electro-chemical effects of an electric current upon a solution capable of conducting electricity.

ELECTROLYTIC METER.—A term sometimes applied to the electro-chemical meter.

ELECTROLYTIC OR ALUMINUM ARRESTER.—A lightning arrester whose operation depends on the fact that an insulating film is formed on the surface of aluminum when immersed in certain electrolytes. If, however, the film be exposed to an abnormally high pressure, it may be punctured by many minute holes; thus so reducing its resistance that a large current may pass. When the pressure is again reduced, the holes become resealed and the film again effective. In construction, the aluminum arrester consists essentially of a system of nested aluminum cone shaped trays, supported on porcelain and secured in frames of treated wood, arranged in a steel tank.

ELECTROLYTIC RECTIFIER.—An interupter formed by two electrodes in an electrolyte. The gas which alternately forms and disappears at one electrode interrupts the current. If two metals be placed in an electrolyte and then subjected to a definite difference of pressure, they will (under certain conditions) offer greater resistance to the passage of a current in one direction, than in the other direction. On account of this so-called valve effect, electrolytic rectifiers are sometimes called "valves." Aluminum is extensively used for the cathode and lead or polished steel for the other electrode. Metals of low atomic weight exhibit the valve effect at high differences of pressure, and heavier metals at low differences of pressure. Since this rectifier suppresses one-half of each cycle of the a.c., it is half cycle rectifier giving intermittent, unidirectional current.

ELECTROLYTIC VOLTAMETER.—An instrument for measuring the value of an electric current by the action of electrolysis. It is a convenient means of calibrating direct reading electrical instruments. The measurement depends upon the amount of metal deposited by the current passing through the electrolyte. The principal forms are the silver, copper and water voltameters.

ELECTROLYZING CELL.—A term sometimes applied to an electrolytic cell.

ELECTRO-MAGNET.—A magnet produced by passing an electric current through an insulated wire conductor coiled around a core of soft iron, as in the fields of a dynamo or motor. In such a magnet the magnetism is preserved only while the current is flowing through its coil.

ELECTRO-MAGNETIC ATTRACTION.—The attraction exerted upon each other by unlike poles of electro-magnets.

ELECTRO-MAGNETIC BLOW OUT.—A strong electro-magnet provided in the controller of an electric car to blow out the arcs and sparks arising from the frequent disconnections made in the controller; otherwise the sparking might destroy the contacts and brushes; also called magnetic blow out.

ELECTRO-MAGNETIC COUPLING.—A name sometimes given to inductive coupling. The latter term is preferable.

ELECTRO-MAGNETIC DENTAL MALLET.—An instrument for hammering fillings into teeth, striking blows in quick succession by means of electro-magnetic mechanism.

ELECTRO-MAGNETIC EYE.—A device consisting of a copper wire bent nearly into a circle, having a spark gap between its terminals, for the purpose of examining a field of electro-magnetic radiations.

ELECTRO-MAGNETIC FIELD.—The space which is supposed to be filled with electro-magnetic lines of force.

ELECTRO-MAGNETIC FLUX.—The distribution of the lines of force through an electro-magnetic field.

ELECTRO-MAGNETIC HELIX.—A solenoid or coil of wire through which an electric current is passing while encircling a core of magnetic material; an electro-magnetic solenoid or electro-magnet.

ELECTRO-MAGNETIC IMPULSE.—A pulsation conveyed to the ether from a conductor carrying a pulsatory current.

ELECTRO-MAGNETIC INDUCTION.—The tendency of electric currents to flow in a conductor when it is moved in a magnetic field so as to cut lines of magnetic force. Faraday discovered that if he took a wire, joined the ends and moved it rapidly in front of a magnet, a current would be induced in the wire. This action of the magnet is called electro-magnetic induction. The current is called the induced current and it is upon this principle that all dynamos and alternators are based.

ELECTRO-MAGNETIC INERTIA.—A term sometimes applied to self-induction which is an inductive effect produced in a circuit by the magnetic lines of its own current cutting across other parts of the same circuit. This action produces a reverse pressure which opposes the current and retards it, so that the current behaves as if it possesses inertia.

ELECTRO-MAGNETIC MEDIUM.—A medium exhibiting the phenomena of electromagnetism.

ELECTRO-MAGNETIC METER.—An electricity supply meter depending for its action upon the electro-magnetic properties of an electric current. In this type the entire current may pass through the meter.

ELECTRO-MAGNETIC MICROPHONE.—A radio acoustic device whose operation depends upon the motion of a coil in a magnetic field.

ELECTRO-MAGNETIC MOMENTUM.—The self-induction in a circuit, whereby an effort appears to be made to uphold the current when the circuit is first broken.

ELECTRO-MAGNETIC PERCUSSIVE WELDING.—A form of percussive welding wherein the stored energy in a magnetic field is transformed by the collapse of the field to supply the energy.

ELECTRO-MAGNETIC PICK UP.—A phonograph pick up, the vibrations of the needle being converted into audio frequency currents or voltages.

ELECTRO-MAGNETIC POP GUN.—An electro-magnet having a tubular central portion containing a small free iron core which is forcibly projected when an electric current passes through the coils.

ELECTRO-MAGNETIC PRINCIPLE.—The principle of the action of the electric current discovered by Oersted and developed by Ampere, Arago, Davy and others. It is upon this principle that present day electrical engineering is based.

ELECTRO-MAGNETIC RADIATION.—The projection of electro-magnetic waves into the ether by oscillatory discharges from an induction coil across a spark gap.

ELECTRO - MAGNETIC RECTIFIER.—A type consisting essentially of a double contact rocker which rocks on a pivot (midway between the contacts), in synchronism with the frequency of the a.c., so changing the connections at the instants of reversals of the a.c. that a d.c. is obtained. This speed or frequency is governed by the length, weight, stiffness and other mechanical features of the spring or reed. Therefore, a rectifier having a spring armature will operate properly only when the frequency of the a.c. supply is exactly in tune with the natural frequency of the armature spring or reed.

ELECTRO-MAGNETIC REGULATION. — A method of regulating automobile dynamos, in which the resistance is cut into the shunt field circuit automatically by an electro-magnetic device placed externally to the dynamo. This was formerly extensively used. There are three systems operating on the electro-magnetic principle designed: a, to regulate the current (amperage) so as to obtain constant current or amperage; b, to regulate the voltage so as to obtain constant voltage or pressure; c, to regulate both voltage and current so as to obtain constant current and voltage.

ELECTRO-MAGNETIC REPULSION.—The repulsion exerted by two like electromagnetic poles against each other.

ELECTRO-MAGNETIC RESONATOR. — A nearly complete circle or square of wire containing an adjustable spark gap, employed by Hertz to detect electro-magnetic waves in his experiments which laid the foundation for the science of radio.

ELECTRO-MAGNETIC ROTATION.—An intensified manifestation of electro-dynamic rotation of a liquid when the acid is influenced by an electro-magnet.

ELECTRO-MAGNETIC SEPARATOR. — A machine for the collection of iron ores, in which a powerful electro-magnet is used to separate particles of iron from foreign matter.

ELECTRO-MAGNETIC SHUNT.—In telegraphy, an electro-magnet forming a shunt of high self-induction joined in parallel with the receiving relay. The resistance of the magnetic circuit is reduced by the poles being permanently closed by a soft iron armature. A current is produced in the coils of an electro-magnetic shunt, in the opposite direction to the relay current, on making the circuit in the coils of a receiving relay; on breaking the circuit, a current having the same direction as the current in the relay is produced in the shunt coils.

ELECTRO-MAGNETIC SOLENOID — An electric conductor bent into a long helix of many loops, encircling a central core of magnetic material.

ELECTRO-MAGNETIC STRESS.—A force producing an electro-magnetic strain due to the tension and compression existing in an electro-magnetic field.

ELECTRO-MAGNETIC SYSTEM OF UNITS.—A system of absolute electrical units based on the c.g.s. system and having as its primary electrical unit, the unit magnetic pole.

ELECTRO - MAGNETIC THEORY OF LIGHT.—A theory advanced by Maxwell that waves of very short wave length and high frequency, and not mere mechanical motions of the ether as had been formerly supposed.

ELECTRO-MAGNETIC UNITS.—A system of units based upon the attraction or repulsion between magnetic poles, employed to measure quantity, pressure, etc., in connection with electric currents.

ELECTRO-MAGNETIC VOLT METER.—A type of volt meter in which the electrical pressure is indicated by a magnetic needle moving in an electro-magnetic field.

ELECTRO-MAGNETIC WAVES.—Wave-like vibrations created in the universal ether by electrical disturbances; electric radiation.

ELECTRO-MAGNETISM.—The phenomena which accompany the production of magnetism by electric currents.

ELECTRO-MAGNETIZATION. — The imparting of magnetism to a substance by subjecting it to the influence of an electro-magnet.

ELECTRO - MASSAGE.—Massage of the body combined with the application of electricity.

ELECTRO-MECHANICAL ALARM.—A mechanical alarm whose mechanism is set in motion by electricity.

ELECTRO-MECHANICAL INDICATOR. — An indicator or drop having its mechanism thrown into action by an electric current.

ELECTRO-METALLURGICAL DEPOSIT.—The layer or coating of metal deposited upon a conducting surface in the process of electro-plating.

ELECTRO - METALLURGICAL GALVANIZATION.—A term sometimes employed for the process of depositing a metal over a conducting surface by electrolysis; electro-plating.

ELECTRO-METALLURGY. — That branch of electric science which relates to the electric reduction or treatment of metals. Electro-metallurgical processes effected by the agency of electricity, as electroplating or electro-typing.

ELECTROMETER. — An instrument, of which there are many forms, for measuring differences of electrical pressure.

ELECTROMETER FATIGUE.—The exhaustion of the elastic suspension of an electrometer needle resulting in the failure of the needle to return to zero on the scale after deflection.

ELECTROMETER VOLT METER.—A term sometimes applied to an electrostatic volt meter.

ELECTROMETRIC OR ELECTROMETRICAL.—Relating to the electrometer, or to the measurement of voltage.

ELECTROMETRY.—The art or practice of electrical measurement.

ELECTROMOTIVE FORCE.—An objectionable and unnecessarily long term for pressure or voltage. Abbreviation e.m.f.

ELECTROMOTIVE SERIES. — Electrochemical series.

ELECTRO-MOTOGRAPH. — An apparatus invented by Edison and consisting of a rotating cylinder of chalk moistened with caustic soda against which is pressed by a spring an arm carrying a metallic brush, and connected with a diaphragm producing constant tension: when an electric current passes through the point of contact at the surface of the cylinder, electrolytic action causes a change in the friction. This varying pressure is applied in a type of loud speaking telephone in which the pitch of the sound emitted varies with the friction.

ELECTRON.—1. The smallest charge of negative electricity known. When any substance is heated to incandescence in a vacuum, it throws off into the space surrounding it vast quantities of electrons—invisible small particles of negative electricity. Some substances throw off electrons much more readily than others, and the hotter the substance the greater is the number of electrons emitted. The reason for this is that all matter is largely composed of these particles of negative electricity, which are always in rapid and violent motion. The increase of temperature increases the speed and violence of their motion. There is always an attractive force between electrons and the substance, but when they attain a high speed, some of them overcome the attractive force and are "bumped off" only to return again unless some outside force carries them away.

2. The fundamental unit of negative electricity. Its charge as determined by Milliken is 4.774×10^{-10} negative electrostatic units and its mass 9×10^{-28} grammes at low velocities.

ELECTRON AND CURRENT FLOW.—In a radio tube if the plate be kept positive with respect to the filament the electrons leaving the filament and attracted by the positive plate will flow from the filament to the plate. Again if the plate be kept negative with respect to the filament, the electrons which tend to leave the filament will be held against it by the repulsion due to like negative charges. In the first instance, as stated, electrons flow from a heated substance to a positive plate. This direction of flow is contrary to the usual conception of the direction of flow of electricity, which is considered to be from positive to negative. The reason for this is that before the discovery of electrons, experimenters decided to consider that current flowed from positive to negative as a sort of arbitrary rule. This rule has continued in use even though later experiments seemed to prove the contrary to be true. Therefore, current is always considered to flow from positive to negative, although the electrons actually travel in the opposite direction.

ELECTRON BOMBARDMENT.—In a vacuum tube, the collision of rapidly moving electrons with a cold body such as the plate.

ELECTRON EMISSION.—In a vacuum tube the flow of electrons from the surface of an element as from the filament due to the action of heat or other causes.

ELECTRO-NECROSIC.—Relating to death by electricity as a capital punishment.

ELECTRO-NEGATIVE ION.—In electrolysis, the element which appears at the anode, or positive electrode; the anion.

ELECTRO - NEGATIVE RADICAL. — The electro-negative ion.

ELECTRO-NEGATIVES. — Electro-negative ions.

ELECTRONIC RECTIFIER.—One in which rectification of an a.c. is accompanied by the passage of electrons only at the boundary of a valve metal and a compound of that metal.

ELECTRONICS.—The science of electrons which seeks to explain their nature and behavior in vacuum tubes.

ELECTRO-PATHOLOGY.—In electro-therapeutics, the study of disease by means of electric irritation.

ELECTROPATHY.—The use of electricity in the treatment of disease; electro-therapeutics.

ELECTRO-PHOBIA.—Unreasonable fear of electricity.

ELECTRO-PHONE.—Any instrument for producing or transmitting sound by means of electricity, as a telephone transmitter.

ELECTROPHORE.—A device for obtaining static electricity by inductance; an electrophorus.

ELECTROPHORUS. — An instrument invented by Volta in 1775 for procuring, by the principle of induction, an unlimited number of static charges of electricity from one single charge.

It consists of a round cake of resinous material, cast in a metal dish or "sole" about one foot in diameter, and a round disc of slightly smaller diameter made of metal or of wood covered with tinfoil, and provided with a glass handle. Shellac, or sealing wax, or a mixture of resin shellac and Venice turpentine, may be used to make the cake. In using, the resinous cake is first beaten or rubbed with fur or a woolen cloth, the disc is then placed on the cake, touched with the finger and then lifted by the handle. The disc will now be found to be charged and will yield a spark when touched with the hand.

ELECTRO-PHOTOMETER.—An instrument for comparing sources of light by referring them to the light of an electric spark as a standard.

ELECTRO-PHOTO-MICROGRAPHY. — The art of obtaining photographs of minute objects when enlarged by the microscope with the aid of the electric light.

ELECTRO-PHYSIOLOGY.—The science of electric phenomena in animal and vegetable systems.

ELECTRO-PLATING.—The process of depositing a layer or coating of a rarer metal upon the surface of a baser, or of a metal upon any conducting surface by electrolysis. The full details of the many processes for electro-plating cannot be given on account of their length; the general principle includes a battery or other source of electric current. The battery has its positive plate connected to a rod extending across a trough or tank containing the plating bath. Suspended from the rod are anodes of gold, silver or copper, or whatever metal from which a deposit is desired. The other plates of the battery, or the negative elements, are connected with another rod across the trough, to which are suspended the articles to be plated.

ELECTRO-PLATING BATH.—A vessel containing the solution of the metal to be deposited by electro-plating.

ELECTRO-PNEUMATIC.—Relating to the action of compressed air in combination with electricity.

ELECTRO-PNEUMATIC AIR BRAKE.—An electrically controlled air brake. The operation of this system depends on a triple valve so constructed that the air distribution which causes it to operate may be controlled either pneumatically or electrically. This system was introduced to meet the requirements of changing conditions such as longer trains, heavier cars, higher speed, greater frequency of trains, stops, etc.

ELECTRO - PNEUMATIC AUTOMATIC TRAIN STOP.—A train stop device that is controlled electrically but operated by compressed air. In the rack and pinion type, the piston transmits motion to a rack which rotates a pinion on the stop arm shaft, bringing the stop arm to the lowered or clear position. Upon the removal of energy and the consequent release of air pressure from piston, the rack is moved back by the action of the helical spring under compression, and the pinion on stop arm shaft is rotated in such direction as to bring the stop arm to the engaging position for tripping a train.

ELECTRO-PNEUMATIC BLOCK SYSTEM.—A railway block system provided with semaphores operated by compressed air under the control of valves having electro-magnetic action.

ELECTRO-PNEUMATIC INTERLOCKING.—In train signaling, a system that derives its name from the fact that compressed air is employed to perform the work; that is, the shifting of the switches and signals, and electricity is used to control or direct the performance of the work; that is, the admission and discharge of pressure to and from the cylinders by which the work is performed. The system consists of:

1. A source of compressed air supply of approximately 75 lbs. per sq. in.
2. A source of current supply of approximately 12 volts.
3. An interlocking machine for controlling the operation of switches and signals.
4. Switch operating mechanisms with their controlling and indicating circuits.
5. Signal operating mechanisms with their controlling and indicating circuits and auxiliary devices.

ELECTRO - PNEUMATIC INTERLOCKING MACHINE.—A system of miniature levers conveniently arranged in a common frame and adapted to the operation of a bank of mechanical locking similar in character to that employed in mechanical interlocking machines, but of diminutive design. The machine is electro-pneumatic in name only, since no compressed air is used for any purpose within it.

ELECTRO-PNEUMATIC THERMOSTAT.—A device for opening or closing an electric circuit by the expansion of a gas when heated beyond a given point.

ELECTROPOION.—A trade name for the electrolyte employed in the Fuller cell. It consists of three parts bichromate of potash, one part sulphuric acid and nine parts water.

ELECTRO-POLAR.—Having one end or surface positively electrified and the other negatively electrified.

ELECTRO-POSITIVE.—1. Possessing positive electrification.

2. Relating to those elements in electrolysis that appear at the cathode.

ELECTRO-POSITIVE ION.—In electrolysis, the element which appears at the cathode or negative electrode; the cation.

ELECTRO-POSITIVE RADICAL.—The electro-positive ion.

ELECTRO-PROGNOSIS.—The judgment or opinion concerning the outcome in certain cases of disease as determined by electrical reaction.

ELECTRO-PUNCTURE.—The surgical operation of inserting one or more needles in an affected part of the body and then applying an electric current for the removal of diseased growths.

ELECTRO-PYROMETER. — An instrument for measuring high temperature by the increase in the electric resistance of platinum wire exposed to the heat.

ELECTRO-RADIOMETER.—An instrument for measuring radiant energy. An electroscope.

ELECTRO-RECEPTIVE DEVICES.—Devices of various kinds designed for utilizing the electric current as it passes into or through them; translating devices.

ELECTRO REFINING.—The elimination of impurities from metals and chemicals by electrolysis.

ELECTROSCOPE.—An instrument for detecting whether a body be electrified or not, and indicating also whether the electrification be positive or negative. The earliest electroscope devised consisted of a stiff straw balanced lightly upon a sharp point; a thin strip of brass or wood, or even a goose quill, balanced upon a sewing needle will serve equally well.

ELECTROSCOPIC GAUGE.—A name given to an early variety of gold leaf electroscope.

ELECTROSE.—A trade name for a substance manufactured into high power transmission insulators. It has a brown, smooth polished surface, is very strong, does not absorb moisture, and possesses good insulating properties.

ELECTRO-SEMAPHORE.—A railway signal operated by electricity.

ELECTRO - SILVERING.—Electro - plating with silver.

ELECTRO-SMELTING.—The reduction of metals from their ores by heat derived from electricity.

ELECTROSOL.—The colloidal solution of a metal formed by passing electric sparks through distilled water between poles formed of the metal.

ELECTROSTATIC ADHESION.—The attraction between two materials having unlike charges. Also called Johnsen Rahbek effect.

ELECTROSTATIC ALTIMETER.—An air craft altitude indicator based on capacity variation as the air craft recedes from or approaches the earth.

ELECTROSTATIC ATTRACTION.—Attraction exerted upon each other by bodies carrying unlike electric charges.

ELECTROSTATIC AURORA.—A term sometimes applied to electrostatic corona.

ELECTROSTATIC CAPACITY.—The quantity of electricity with which a condenser must be charged in order to raise its voltage to a given amount, the electrical unit of capacity is the farad.

ELECTROSTATIC CHARGE.—The quantity of electrification of either kind produced by friction or other means upon the surface of a body.

ELECTROSTATIC CIRCUIT.—1. A circuit through which an electrostatic discharge passes.

2. A circuit composed of the paths of electrostatic flux or lines of force.

ELECTROSTATIC CORONA.—The luminous phenomena which occur on the surface of a thin sheet of mica or similar insulator when inserted between two electrodes which have a high difference of voltage.

ELECTROSTATIC COUPLING. — Coupling by means of a condenser. Capacitive coupling.

ELECTROSTATIC CURRENT.—The rate of flow of electrostatic lines of force through an electrostatic circuit.

ELECTROSTATIC DISCHARGE.—A disruptive discharge. A sudden discharge of static electricity which takes place in the form of a flash or spark across an insulating medium, lying between two electrified bodies having different voltages. The stress upon the medium causes it to give way to the passage of the electricity.

ELECTROSTATIC FIELD.—The region occupied by electrostatic lines of force in the vicinity of an electrostatically charged body; electrostatic field of force.

ELECTROSTATIC FLUX.—The lines of force traversing an electrostatic field.

ELECTROSTATIC FLUX DENSITY.—In an electrostatic field the number of lines of force per sq. centimeter of cross section.

ELECTROSTATIC FORCE.—The force between any two electrified bodies which causes them to attract or repel each other.

ELECTROSTATIC INDICATOR.—A term sometimes applied to the electrometer.

ELECTROSTATIC INDUCTION.—The power which a charged body possesses of causing an opposite electrical state in its vicinity under certain conditions.

ELECTROSTATIC INFLUENCE.—A term sometimes applied to electrostatic induction.

ELECTROSTATIC LEAKAGE.—The gradual loss of electrification from a charged body which inevitably takes place because of the impossibility of effecting absolute insulation.

ELECTROSTATIC LINES OF FORCE.—The lines of force traversing an electrostatic field.

ELECTROSTATIC MACHINE.—A machine for collecting static electricity.

ELECTROSTATIC MOTOR. — A motor driven by electrostatic induction acting between two electrostatic fields.

ELECTROSTATIC OPTICAL STRESS.—A stress, due to electrostatic expansions and contractions, producing a strain upon glass or other optical mediums, which can be observed by the aid of a ray of polarized light.

ELECTROSTATIC OR CONDENSER LOUD SPEAKER.—It consists essentially of three elements: a, plate; b, dielectric; c, diaphragm. The dielectric is placed between the plate and diaphragm and the assembly forms a condenser. Any difference in voltage on the two metal elements produces attraction between them, thus compressing the dielectric which in this case is rubber. To keep the speaker normally in this condition, the plate and diaphragm are placed in a battery circuit. The signal current is superimposed on the battery current. The signal current varies the voltage in the circuit which in turn varies the attraction between the plate and condenser; the rubber which is in compression acts as a restoring force to displace the diaphragm outward when the signal current is in such a direction as to reduce the attraction between the plate and diaphragm.

ELECTROSTATIC PERCUSSIVE WELDING.—A method of electric welding which employs a condenser.

ELECTROSTATIC REPULSION. — Repulsions exerted against each other by bodies carrying like electrostatic charges.

ELECTROSTATIC RESISTANCE.—The resistance offered by a charged body to the flow of electrostatic lines of force.

ELECTROSTATIC RETARDATION.—In telegraphy, retardation in transmission due to capacity of the line.

ELECTROSTATIC STRAIN.—The strain experienced by a substance exposed to an electrostatic field of force.

ELECTROSTATIC STRESS.—A stress of tension and compression producing an electrostatic strain upon a body in an electrostatic field.

ELECTROSTATIC SYSTEM OF UNITS.—A system of absolute electrical units based on the c.g.s. system and having as its primary electrical unit, the unit of quantity or charge.

ELECTROSTATIC VOLT METER.—A form of instrument designed for measuring high pressures up to 200,000 volts. The instrument consists of fixed and movable vanes with terminals connecting with each. These vanes which act as condensers take charges proportional to the voltage difference between them, resulting in a certain attraction which tends to rotate the movable disc against the restraining force of gravity.

ELECTROSTATIC WATT METER.—A modification of the quadrant electrometer designed to give readings directly as a watt meter.

ELECTROSTATICS.—That branch of the science of electricity which treats of the properties of simple electrified bodies or of electricity supposed to be at rest, as distinguished from electro-kinetics which deals with electricity in motion.

ELECTRO-STEELING.—Electro-plating the copper plates used in engraving with a thin coating of iron.

ELECTRO-STENOLYSIS. — The precipitation of certain metals from solution through which an electric current is passing.

ELECTRO-STEREOTYPE.—A term sometimes applied to the electrotype.

ELECTRO-STRICTION.—A phenomenon in electro-chemistry, in which all liquids whose dielectric constant is increased by pressure, suffer a contraction in a strong electric field.

ELECTRO-SYNTHESIS.—Forming a compound by means of electrical action.

ELECTRO-TAXIS.—The influence of electricity upon the direction of movement of simple living organisms.

ELECTRO-TELLUROGRAPH. — An instrument for studying electrical disturbances in the earth.

ELECTRO-THERAPEUTICAL CURRENTS.—Numerous currents are used in electro-therapy for heating, cutting, cautery, preparation of surfaces, examinations, etc. The currents generally used are: a, direct; b, alternating, low frequency and high frequency; c, low voltage; d, high voltage; e, various combinations. There are three distinct types: a, galvanic current; b, sinusoidal current; c, oscillatory currents; d, faradic.

ELECTRO-THERAPEUTICS. — The science of treating disease by the application of electricity. Electropathy.

ELECTRO-THERAPY.—A term sometimes applied to electro-therapeutics.

ELECTROTHERM.—A flexible sheet of resistance coils covered with felt, used for applying heat to the surface of the body.

ELECTRO-THERMAL CHEMISTRY. — The branch of electro-chemistry embracing the methods in which the electric current increases the temperature of substances so as to produce fusion, chemical action and other effects. Electro-thermal processes include the production of calcium carbide from lime and carbon in the electric furnace; the smelting of metallic compounds by the heat of an electric current, as the reduction of iron ore in an electric furnace; the electric fusion of refractory substances, such as silica and alumina; and the working of various metals by electric heat, as in welding, forging, rolling, casting.

ELECTRO-THERMAL METER.—A term sometimes applied to the hot-wire ammeter or volt meter which operates on the principle that if an electric current be passed through a constant resistance, the heat generated must be equal to the square of the current. The Cardew volt meter is the earliest type of electro-thermal meter.

ELECTRO-THERMANCY.—That branch of the science of electricity which treats of the thermo-electric effects at a junction in a circuit composed of dissimilar conductors.

ELECTRO-THERMIC OR ELECTRO-THERMOTIC.—Relating to heat generated by electricity.

ELECTRO-TINT.—A method of making a design in relief for printing by suitably treating the plate upon which the lines are drawn, and then subjecting it to the action of an electro-bath.

ELECTROTOME.—A name for a variety of automatic contact breaker which has such a rapid movement as to produce sound.

ELECTROTONIC EXCITABILITY.—The excitability of a nerve or muscle by the passage of an electric current through it.

ELECTROTONUS.—The change of condition in a muscle or nerve during the passage of an electric current through it.

ELECTROTYPE PROCESS.—The process of making electrotypes or electros.

ELECTROTYPING.—The reproduction of type, wood cuts, etc., in copper, by the aid of electro-deposition. A mould is first made of the set type in wax; this mould is next coated with black lead to give it a metallic surface, as the wax is an insulator; the mould is then subjected to the process of electro-deposition, resulting in the formation of a film of copper on the prepared surface. The coppel shell is removed from the mould by applying hot water; the shell is then backed up with electrotype metal to render it strong enough for use.

ELECTROVECTION.—A phenomenon observed when a strong electric current is passed through certain liquids when a porous partition is placed between the electrodes. The current carries a part of the liquid through the membrane in the direction of the flow of electricity; electric osmose.

ELECTRO-WINNING.—The electro-deposition of metals or compounds from solutions derived from ores or other materials using insoluble anodes.

ELECTROZONE.—A trade name for a disinfectant solution of ozone generated by the electrolysis of sea water.

ELECTRUM.—1. A name for amber, a substance which may be readily electrified by friction.

2. An alloy of gold and silver made by the ancients.

ELEMENT.—A substance which the chemist cannot, by any of the means under his control, resolve into two or more simpler substances. A mass composed of atoms all of which are of one kind. There are two kinds of elements; the metals, of which there are 73, and the non-metals, 18. The latter comprise the liquid bromine and the solids, boron, carbon, iodine, phosphorus, silicon and sulphur, and the gases of which there are 11 kinds.

ELEMENTARY MATTER.—Matter which cannot be chemically decomposed into simpler forms; the elements.

ELEMENTS OF STORAGE BATTERY.—A pair of prepared metal plates suitable for use as the accumulators of electrical energy in a cell of a secondary or storage battery.

ELEMENTS OF WINDINGS.—The inductors which make up the windings of an armature.

ELEVATOR.—1. On an airplane, a hinged horizontal control surface acting to lift or depress the tail.

2. A car for passengers or freight arranged to move vertically (guided by a pair of rails), together with the hoisting cables, pulleys, power unit, control and safety devices.

ELEVATOR CAR SAFETY OPERATING SWITCH.—An elevator control switch provided with an automatic return or self-centering feature so that if the operator's hands be removed from the lever it will return to the off position.

ELEVATOR CAR SAFETY SWITCH.—An elevator switch used to stop the car in emergency in case of failure of the car operating switch

ELEVATOR MACHINE.—A power unit for operating elevators. It consists essentially of a motor, drum or traction pulley, brake and motor drum drive. The drive may consist of a direct shaft connection between the motor and drum, or one of the numerous types of gearing.

ELEVATOR SPEEDS.—The measure for the speed of a car is the number of feet the car will travel during the period of one minute. The usual American practice for the speed of elevators is as follows:

Passenger Elevators

	ft. per minute
Private residences	100 to 150
Hotels and apartment houses	100 to 350
Department stores	100 to 300
Office buildings	250 to 800

ELIMINATOR.—1. In radio, an apparatus used in place of a battery to permit operating a set from a lighting circuit. It consists of: a, transformer; b, rectifier; c, filter, and d, voltage divider.

2. A device used to tune out nearby powerful stations.

ELLIPSE.—A plane figure enclosed by a curved line, which is such, that the sum of the distances between any point on the circumference and the two foci is invariable. The ellipse may also be defined as a conic section obtained by a plane cutting a cone obliquely to its axis.

ELLIPTICAL ARCH.—A masonry arch built to a semi-ellipse instead of a semi-circle, to avoid excessive rise in the center.

ELLIPTICALLY ROTATING MAGNETIC FIELD.—A rotating magnetic field in which phases of current vary between zero and 90°, so that the diagrammatic representation is a uniformly rotating line varying in length and tracing an ellipse.

ELONGATION.—1. The amplitude of the angle described by a measuring instrument which starts at zero and ends at a maximum value. With galvanometers, elongation shows the value of the current passing in the galvanometer.

2. The amount to which a test piece of plate stretches, between two fixed points, due to a steady and slowly applied force, which pulls and separates it. This elongation is made up of two parts; one due to the general stretch, more or less, over the length; the other, due to contraction of area at or about the point of fracture.

EMANATION PLANT.—An apparatus for collecting radium emanation.

EMBEDDED COILS.—Armature coils wound in grooves or channels sunk beneath the surface of an armature.

EMBEDDED TEMPERATURE DETECTOR.—A testing instrument; either a resistance temperature detector or a thermocouple, regularly installed in an electrical machine. These are placed in armature structures between top and bottom coil sides, for windings with two coil sides per slot and between coil side and core for windings with one coil side per slot. Because of their position, the embedded temperature detectors give a reading nearer to that of the temperature of the copper conductor inside of the insulation, than do thermometers placed externally on the machine.

EMBOSSER.—A type of telegraph receiver which registers a message by embossing or raising the characters of the message upon a paper ribbon; a telegraphic embosser.

EMERGENCY BRAKE.—An automobile brake intended for use only in emergency, hence the name. Ignorant drivers use this brake for service stops.

EMERGENCY BRAKING.—On electric cars, a method used in case of extreme emergency only, when the brakes have failed, a four motor equipment may be stopped by removing the reverse handle to the opposite running position and putting the main handle on the first notch. After braking by this means has been set up, the reverse handle must not be moved until the car has come to a dead stop.

EMERGENCY CABLE.—A light cable of convenient length suitable for temporarily mending an overhead line after an accident while repairs are in progress.

EMERGENCY CAR LIGHTING.—In subway cars and others which may become stalled through the power going off, an independent lighting system to give some illumination to the cars while the power is off. Small storage battery lights are usually installed which are automatically thrown into circuit when the line current fails These are operated by a solenoid in series with the line circuit and hold an armature suspended until such current fails, at which time the armature drops and throws the battery lights and current into circuit.

EMERGENCY STRAIGHT AIR BRAKE.—A modified straight air brake in which the straight air brake system is provided with an emergency valve and an auxiliary reservoir pipe line. The object of this is to avoid the length of time required to apply the brakes owing to the relatively long pipe through which the air must flow from the reservoir to the brake cylinder in the straight air brake system.

EMERY.—This is a dark colored granular variety of corundum, which is the hardest substance found native, next to the diamond. The emery rocks are crushed into powder of varying degrees of fineness, which are used in that state as abrasive or polishing agents, or else consolidated with various binding materials into hones or wheels and discs for grinding purposes.

E.m.f.—Abbreviation for **electro-motive force**. An objectionable term for voltage or electric pressure.

EMISSION CURRENT.—In a vacuum tube, the flow of electrons. Distinguish between primary and secondary emission.

EMISSION THEORY.—1. In optics, a theory which assumes that luminous bodies emit, in all directions, an imponderable substance which consists of molecules of an extreme degree of tenuity. These are propagated in right lines with an almost infinite velocity. Penetrating into the eye, they act on the retina and produce a sensation which is called vision.

2. In a vacuum tube, a negative charge of electricity or electrons is emitted from the heated filament most of which are attracted to the plate which is positive. Those not strongly enough attracted to the plate recede to the filament which has become more positively charged owing to the emission of the negative electrons.

EMPIRE CLOTH.—Cambric treated with oils and used as an insulation fabric.

EMPIRICAL FORMULA.—One based on experience or observation.

ENAMEL.—1. A substance of the nature of glass, but more fusible and more opaque, used for giving a highly polished, ornamental surface; as, enameled metal or enameled brick.

2. An insulation coating for magnet wire. According to one manufacturer, the wire is automatically run from spools or reels through a tank containing the liquid composition. Thence vertically through an oven, where it is baked at temperatures varying according to the size of the wire and the kind of enamel being used. This process is repeated from three to five times, according to the size of wire, each coat being baked separately, thus eliminating either burnt enamel, or pin holes. When properly baked the insulation will bend, stretch, contract or expand, and remain indefinitely as pliable as the copper itself.

ENAMELING.—In engineering, the process of covering the surface of metals with non-metallic coatings similar to varnish. Two principal kinds are employed: vitrified enameling, which consists in covering the surface of cast iron, or other metal, with a coat of vitrifiable material similar to glass; and varnish enameling consisting in covering the metal with some form of varnish at moderate temperature. The latter process is employed for the chassis of motor cars.

ENAMELING PROCESS FOR MAGNET WIRES.—The wire is automatically run from spools or reels through a tank containing the liquid composition. Thence vertically through an oven, where it is baked at temperatures varying according to the size of the wire and the kind of enamel being used. This process is repeated from three to five times, according to the size of wire, each coat being baked separately, thus eliminating either burnt enamel or "pin holes." When properly baked the insulation will bend, stretch, contract or expand, and remain indefinitely as pliable as the copper itself.

ENCLOSED ARC LAMP.—A form of arc lamp in which a small globe encloses the arc so that only a small amount of air is permitted to enter, thereby retarding the consumption of the carbons and increasing the life of the lamp far beyond that of the original simple open arc type.

ENCLOSED FUSE.—In a system of electric wiring, a safety fuse placed within a tube of vulcanized fibre, paper or similar material containing contacts at the ends, and filled with some light porous material. When an enclosed fuse is blown the formation of an arc is prevented either mechanically or by the chemical action which takes place between the filling and the melted fuse. This type of fuse is commonly called from its shape and size a cartridge fuse.

ENCLOSED MACHINE.—One which is so completely enclosed by integral or auxiliary covers as to practically prevent the circulation of air through its interior. Such a machine is not necessarily air tight.—NEMA.

ENCLOSED SELF-VENTILATED MACHINE.—A totally enclosed machine except that openings are provided for the admission and discharge of the cooling air, which is circulated by means integral with the machine. These openings are so arranged that inlet and outlet duct pipes may be connected to them.—NEMA.

END CELL SWITCH.—A form of switch employed in connection with a storage battery in order to control the end cells for regulating the voltage. The requirement of an end cell switch is that in switching from one end cell contact to another, the discharging circuit must not be opened, neither must the moving arm touch one contact before leaving the one adjacent, since the joining of two contacts will short circuit the cells connected thereto. To accomplish this, the spacings of the two arms and contacts are such that when the main arm is squarely on an end cell contact, the advance or auxiliary arm touches no other contact, but in passing from one point to the next, the advance arm reaches the contact toward which it is moving before the main arm leaves its contact. The resistance between the two points prevents short circuiting, and the current to the main circuit is never broken.

END CELL SWITCH REGULATION.—In a storage battery a method of progressively cutting in cells to boost the voltage, that is, make up for the drop in voltage during discharge, thus maintaining the voltage practically constant.

END CELLS.—The cells near the end of a storage battery which are cut in and out of circuit by means of the end cell switches in order to keep the voltage constant at the battery terminals.

END CONNECTORS.—Copper plates used for connecting up the ends of the conducting strips of a bar armature; end windings.

END PLAY.—Movement endwise, or room for such play or movement.

END PLAY DEVICE.—On a rotary converter, a magnetic device used to give a slight reciprocating motion to the armature parallel with the shaft. Current for its operation is obtained from the d.c. side of the converter. A condenser is connected across the make and break to facilitate the opening and closing of the circuit. Small machines having comparatively light armatures are equipped with a mechanical end play device.

END TO END JOINT.—A method of joining two lengths of wire by bringing the ends into close contact and soldering or welding them together; commonly called the "butt-joint."

ENDLESS BELT.—A belt which returns upon itself so as to have neither beginning nor end, passing over two or more pulleys to transmit power.

ENDODYNE.—Autodyne reception.

ENDOSCOPE.—A lamp suitable for illuminating internal cavities of the human body for purposes of medical examination.

ENDOSMOMETER. — An instrument for measuring the action of endosmose.

ENDOSMOSE, ELECTRIC.—The passage of an electrolyzed liquid into another denser liquid through an interposed septum or partition.

ENDOSMOTIC EQUIVALENT.—The ratio between the amount of water that passes through a porous medium to the amount in exchange of a substance in solution.

ENDOTHERMIC.—Relating to absorption of heat.

ENDOTHERMIC COMPOUND.—In chemistry, a compound which is formed from its elements with absorption of heat.

ENDOTHERMIC REACTION.—A chemical reaction accompanied by absorption of heat.

ENERGY COMPONENT.—In an alternating current circuit, the working or active component of the current in phase with the volts, as distinguished from the wattless component which differs in phase from the volts by 90° and contributes nothing to the watts.

ENERGY CURRENT.—In an alternating current circuit, the working or active component of the current in phase with the volts; the energy component, as distinguished from the wattless component.

ENERGY EFFICIENCY.—The efficiency of an electric machine measured in watt hours or kilowatt hours; the watt hour efficiency.

ENERGY, ELECTRIC.—The work done in a circuit or conductor by a current passing through it. When a current flows from one point to another, there is a drop in voltage and work is accomplished. The amount of this work is measured by the quantity of electricity that flows multiplied by the difference of voltage under which it flows; its unit is the joule.

ENERGY METER.—A name sometimes given to the watt meter.

ENERGY OF POSITION.—Potential energy, or the energy possessed by a body in virtue of its position, as distinguished from the energy of motion or kinetic energy; water stored in an elevated reservoir represents potential energy, since its liberalization to a lower level may be utilized to effect work, as in a hydroelectric power plant.

ENERGY OF ROTATION.—The product of the moment of inertia in a rotating body by one-half of the square of its angular velocity.

ENGAGE.—To interlock with another part; as, the teeth of geared wheels with each other, or a rack with its pinion.

ENGAGED TEST.—In a multiple telephone switchboard, the so-called "busy test" employed by the operator to prevent making connection with a line which is already in use at another board. The test is made by applying the tip of the calling plug of the test pair to the thimble of the jack of the subscriber wanted.

if the line be in use, a click will sound in the operator's telephone.

ENGINE.—A prime mover as a steam engine, gas engine, etc. The use of the word motor for gas engine is objectionable. The word motor should never be used except to mean an electric motor, or water motor.

ENGINE ALTIMETER.—An instrument for indicating the altitude corresponding to the pressure produced in the intake manifold of a supercharged engine.

ENGINE COUNTER.—A device which records by wheel combinations the revolutions of an engine or machine where it is necessary or convenient to know the number of rotary turns within a specified time. Whatever number of dials or wheels there may be, the right hand figure represents the units, the second figure the tens, etc. This ingenious mechanism is capable of various applications relating not only to the number of revolutions the engine has made, but telling approximately how many miles a steamer has gone. Also on water works pumps, to prevent a night engineer shutting down for a rest period.

ENGINE TELEGRAPH.—A telegraph system installed upon a steamship for sending signals to the engine room.

ENGINEER, ELECTRICAL. — A person versed in the science of electricity, and skilled in electric practice; usually one who has had special training in an engineering school and obtained the degree E.E. Distinguish between electrical engineer and electrician. Some electricians imagine they are electrical engineers.

ENGLISH CANDLE.—A standard unit of illumination equal to $1.04\times$ international standard.

ENGRAVING, ELECTRIC.—A method of etching metal plates by the action of electrolysis. It consists of covering a metallic plate with wax and tracing thereon the design, so as to expose the metal. The positive terminal of a battery or dynamo is then connected with the metal which is then placed in a bath opposite another plate of metal connected with the other terminal of the battery. The action of electrolysis dissolves the metal on the exposed portions of the waxed plate and deposits it on the other plate.

ENTREFER.—The open space between the face of the pole piece of a dynamo and the surface of the armature; the air gap.

ENTROPY.—1. In thermodynamics, a certain property of a body, expressed as a measurable quantity, which remains constant if no heat enter or leave the body, while it does work or alters its volume but which increases or diminishes should heat enter or leave. Symbol ϕ.

2. With respect to steam, the change in entropy or in the condition of the water or steam is frequently referred to. The change in entropy which results when the required amount of heat is added to raise one pound of water from 32° F. to the boiling point, 212° F., is called the "entropy of the water." The change in entropy during evaporation, that is, the heat of evaporation divided by the absolute temperature of the boiling point is called the "entropy of evaporation." The entropy of the water plus the entropy of evaporation is called the "entropy of steam."

ENTZ BOOSTER SYSTEM.—A shunt dynamo booster in which the field winding is connected at one end to the middle point of the battery. The other end is connected to the upper contact points of two carbon pile resistances. The lower end of one of the carbon piles is connected to the negative side of the battery and the corresponding end of the other carbon pile to the positive side.

EOLOTROPIC OR ÆOLOTROPIC.—A term applied to a substance which has different properties in different directions through its mass.

EPICYCLIC GEAR.—The same as planetary gear, in which one or more pinions are in contact with teeth inside the circumference of a spur wheel.

EPINUS' CONDENSER.—A form of electrostatic machine devised by Epinus (Æpinus) in which the brass discs are separated only by a stratum of air between them, the air being sufficient to insulate the two charges from each other, thus forming an air condenser.

EPOCH.—In simple harmonic motion, the time required by a moving point to reach greatest positive elongation.

EPSTEIN HYSTERESIS TESTER.—A device for measuring hysteresis and eddy current loss in which an a.c. watt meter is used.

EQUALIZER CONNECTION.—When two or more compound wound dynamos are operating in parallel, a connection is established between their series coils by a heavy bus bar known as an equalizer bar or bus, so as to prevent the currents in the series fields differing widely from each other, however their armature currents may differ. If the difference be small, it may be compensated by means of the hand regulator; if large, however, other means must be taken to cause the machines to take up their due proportion of the load. If the series coils of the several dynamos be provided with small adjustable resistances, in the form of German silver or copper ribbon inserted in series with the coils, the distribution of the current in the latter may be altered by varying the resistance attached to the individual coils, and thus the effect of the series coils upon the individual armatures in raising the pressure may be adjusted, and the load thus evenly divided among the machines.

EQUALIZER RINGS.—Rings resembling a series of hoops provided in a parallel wound armature to eliminate the effects of "unbalancing" by which the current divides unequally among the several paths through the armature. By means of leads, these rings connect points of equal pressure in the winding, and so preserve an equalization of current.

EQUALIZING CURRENT.—When compound wound dynamos are operated in parallel, the current carried by the equalizer bar to insure uniform distribution among the series coils of the machines.

EQUALIZING DYNAMO.—In storage battery practice, an extra dynamo, usually called the "booster," connected into the circuit of the battery for regulating the charge, and sometimes the discharge of the battery.

EQUALIZING RESISTANCES. — Resistance coils sometimes employed with a system of feeders to reduce the pressure in the shorter feeders, when the bus bars are maintained at the pressure required by the longest feeders.

EQUATIONS FOR CIRCUITS CONTAINING RESISTANCE AND CAPACITY.—The component of the impressed pressure necessary to overcome resistance, is from Ohm's law:

active pressure = ohmic resistance ×virtual current

that is using symbols

$$E_a = R_o I_v$$

The component of the impressed pressure necessary to overcome the capacity pressure or reactance drop is applying Ohm's law

capacity pressure = capacity reactance ×virtual current.

$$E_c = X_c I_v \qquad (1)$$

In this, the expression for capacity reactance X_c, that is, for the value of capacity in ohms is.

$$X_c = \frac{1}{2\pi f C} \qquad (2)$$

Substituting this value of X_c in equation (1) and writing I for virtual current.

$$E_c = \frac{I}{2\pi f C} \qquad (3)$$

CAUTION—The reader should distinguish between the 1 (one) in (2) and the letter I in (3); which look alike.

EQUATIONS FOR CIRCUITS CONTAINING RESISTANCE AND INDUCTANCE.—The component of the impressed pressure necessary to overcome resistance, is from Ohm's law:

active pressure = ohmic resistance ×virtual current

that is using symbols

$$E_a = R_o I_v$$

The component of the impressed pressure necessary to overcome the induced pressure, is from Ohm's law:

inductance pressure = inductance reactance ×virtual current;

that is,

$$E_i = X_i I_v \qquad (1)$$

Now the reactance X_i, that is the spurious resistance, is obtained from the formula

$$X_i = 2\pi f L \qquad (2)$$

and in order to obtain the volts necessary to overcome this spurious resistance, that is, the "reactance drop" as it is called, the value of X_i in equation (2) must be substituted in equation (1), giving

$$E_i = 2\pi f L I \qquad (3)$$

writing simply I for the virtual pressure.

EQUATIONS FOR CIRCUITS CONTAINING RESISTANCE INDUCTANCE AND CAPACITY.—For a circuit of this kind

impedance = $\sqrt{\text{resistance}^2 + (\text{inductance reactance} - \text{capacity reactance})^2}$

or, using symbols,

$$Z = \sqrt{R^2 + (X_i - X_c)^2}.$$

To derive an impedance equation without ohmic values use the expressions $2\pi f L$ for inductance reactance and $\frac{1}{2\pi f C}$ for capacity reactance, substitute in the above equation and obtain

$$Z = \sqrt{R^2 + (2\pi f L - \frac{1}{2\pi f C})^2}$$

which is the proper form of equation to use in solving problems in which the ohmic values of inductance and capacity must be calculated.

EQUATOR.—1. A great circle surrounding any sphere midway between its poles; or that circle which passes around any spheroid of revolution in a plane through its center and at right angles to its axis.

2. The great circle about the earth's circumference at every point equidistant from the north and south poles, which divides the northern from the southern hemisphere.

EQUATOR OF MAGNET.—A line assumed to encircle a magnet at a point where there is no polarity or attractive power; a line passing through the neutral points. In a bar magnet it lies midway between the poles.

EQUATORIAL REGION OF MAGNET.—The neutral portions of a magnet at its equator.

EQUIDISTANT.—Situated at equal distances from the same point or thing.

EQUILIBRIUM.—The state of a body in which all the forces acting on it balance one another: the condition of absolute poise.

EQUILIBRIUM OF FORCES.—In mechanics a state of rest produced by the mutual counteraction of two or more forces.

EQUI-MOLECULAR SOLUTION.—A solution in which the dissolved substance is present in proportion to its molecular weight.

EQUI-SIGNAL RADIO RANGE OR BEACON.—One which transmits two distinctive signals which may be received with equal intensity only in certain directions.

EQUIVALENT CONDUCTIVITY.—A conductivity equal to the sum of other conductivities in an electric circuit.

EQUIVALENT RESISTANCE.—A resistance equal to the sum of. other resistances in an electric current.

EQUIVALENT SINE WAVE.—One having the same frequency and the same root mean square value as the actual wave.

EQUIVALENT SINUSOIDS. — Sinusoidal curves taken for purposes of investigation to represent irregular alternating current waves, as giving an equivalent effect and representing equal power.

EQUIVOLT.—A term proposed for the mechanical energy of one volt pressure exerted under unit conditions through one equivalent of chemical action in grains.

ERB'S STANDARD ELECTRODES.—Standard sizes of electro-therapeutic electrodes.

ERG.—The unit of work in the c.g.s. system; it is the work done when a force of one dyne acts through a distance of one centimeter. One erg$=10^{-7}$ joules.

ERG TEN.—A unit of work employed in large measurements when a small unit like the erg would be inconvenient; it is equal to 10^{10} ergs or 1000 joules.

ERGOMETER.—An erg meter.

ESCALATOR.—A moving stairway built as on the endless chain principle, having self adjusting steps that rise to a floor level and move up an inclined plane to a higher level, where they pass beneath the floor line and continue on their course to repeat the ascent.

ESCAPEMENT, ELECTRIC.—A clock escapement controlled by electricity.

ETCHING, ELECTRIC.—A process of etching a metal plate by subjecting the portions that are not coated with an insulating material to the action of electrolysis. Wax is used as the coating, upon which the design is traced, leaving portions of the metal exposed. The plate is put in a bath and connected to the positive terminal of an electric source, the negative terminal being placed in the bath; metal is dissolved from the plate by electrolysis; leaving an imprint of the design upon the plate.

ETHER.—A medium of extreme lightness and elasticity that is assumed to pervade all space and to be diffused even within solid bodies. It is the basis of the explanations of many physical phenomena and theories.

ETHER STREAMINGS.—Streamings that are supposed to be set up in the ether about the poles of a magnet.

ETHER THEORY.—A theory of electricity which identifies it with the luminiferous ether, based upon the discovery of Maxwell that light itself is a manifestation of electricity, being motion of the ether in electro-magnetic waves.

ETHER WAVES.—In radio, ether is the hypothetical medium through which radio waves are said to be propagated through space. However, Dr. Albert Einstein discards the theory of the ether usually presented by writers in an attempt to explain radio transmission. Dr. Einstein derides radio's ethereal medium as fiction, calling it a makeshift fabricated to explain something for which scientists have not had the correct explanation. Einstein believes it is an electro-magnetic phenomenon; so did Charles Proteus Steinmetz. Shortly before his death Steinmetz said: "There are no ether waves." He explained that radio and light waves are merely properties of an alternating electro-magnetic field of force which extends through space. Scientists, he contended, need no idea of ether. They can think better in the terms of electro-magnetic waves.

EUDIOMETER.—A graduated glass tube, used in the analysis of gases, for measuring their volume.

EVAPORATION.—The process of slowly causing a change of state from the liquid to the gaseous form by the application of heat, the action taking place only on the surface of the liquid.

EVAPORATION, ELECTRIC.—The evaporation of a liquid and volatilization of a solid, accelerated by the influence of negative electricity.

EVAPORATIVE EFFICIENCY.—The measure of the efficiency of a boiler in evaporating water as compared with the theoretical value of a certain amount of fuel. Commonly expressed as so many pounds of water at 212° F., evaporated into steam at the same temperature (usually expressed as "from and at 212° F."), the unit of fuel consumed being one pound of dry coal.

EVOLUTE CONNECTIONS.—Fork shaped strips used to connect bars at different positions on the armature. Used with evolute winding.

EVOLUTE OR BUTTERFLY WINDING.—This mode of winding was introduced by Siemens for electro-plating dynamos to overcome the objections to hand winding. It takes its name from the method of uniting the inductors by means of spiral end connectors or forked shaped strips. In large machines, especially where the teeth are wide, these connectors may be straight, but in small machines they must be curved as the room available may diminish by as much as half, as the lowest point is reached, and the room occupied by the strip is the width of a horizontal section at various points. This width, in the case of the straight connectors, is constant. In place of the wooden block, used in early machines, for fastening the middle part of the connectors, they may be anchored to an insulated clamping device built up like a commutator and for that reason called a false commutator.

EVOLUTION OR ROOTS OF NUMBERS.—The word evolution means **the operation of extracting a root.** The root here is a factor repeated to produce a power. Thus in the equation $2\times2\times2=8$, 2 is the root from which the power, 8, is produced. Evolution is indicated by the symbol $\sqrt{}$ called the radical sign, which placed over a number means that the root of the number is to be extracted. Thus: $\sqrt{4}$ means that the square root of 4 is to be extracted.

The **index** of the root is a small figure placed over the radical sign which denotes what root is to be taken. Thus $\sqrt[3]{9}$ indicates the cube root of 9; $\sqrt[4]{16}$, the fourth root of 16. **When there is *no index* the radical sign alone always means the *square root*.**

Sometimes the number under the radical sign is to be raised to a power before extracting the root, thus:

$$\sqrt[3]{4^3}=\sqrt[3]{4\times4\times4}=\sqrt[3]{64}=4$$

The power and the root are often combined and expressed as a fractional exponent, thus $8^{2/3}$ which is read the cube root of 8 squared, that is:

$$8^{2/3}=\sqrt[3]{8^2}=\sqrt[3]{64}=4$$

EWING'S THEORY OF MAGNETISM.—A theory of magnetism advanced by Ewing, that molecular magnets are held together, not by friction but by mutual magnetic attraction, their poles pointing in every direction till some outside magnetic force draws them into a common direction.

EXACT DIVISOR.—A number which will exactly divide another without a remainder.

EXCITABILITY, ELECTRIC.—The stimulus to a nerve or muscle occasioned by the application of an electric current.

EXCITANT.—The electric energy which excites activity in an electro-receptive device.

EXCITATION.—1. The electrification of a substance.

2. The magnetization of a magnetizable substance.

3. The magnetizing of the field magnets of dynamos, alternators, etc., by the passage of a current through the winding of the magnets. The exciting

current is obtained either from the machine itself in self-exciting dynamos, or from an outside source in separately excited dynamos.

4. In electro-therapeutics, the stimulation of muscular or nerve tissue in the human body.

EXCITER.—1. In radio, a name given to that portion of the oscillator or transmitting apparatus at which the sparks are produced that set up the electric waves which are radiated into space.

2. In a directional antenna system, the section of the array connected to the source of power.

3. Buzzer action on an oscillatory circuit.

EXCITER DYNAMO.—The dynamo which generates the field current for a separately excited alternator. The fields of alternators require a separate source of direct current for their excitation, and this current should be preferably automatically controlled.

EXCITING CURRENT.—The current applied to the windings of the field magnets of a dynamo or other machine in order to produce magnetization.

EXCITING CURRENT OF TRANSFORMERS.—The current which flows in the primary winding when the transformer is excited and the secondary winding is open circuited. Exciting current is usually measured when the primary winding is excited at rated voltage (sine wave or equivalent) and frequency.—NEMA.

EXHAUST.—The passing of steam or other working fluid from a cylinder to the atmosphere, condenser, or receiver of the next successive cylinder, after it has pushed the piston to the end of its stroke in one direction.

EXHAUST LAP.—Also known as inside lap; extension of the exhaust edges of a slide valve in a steam engine to promote cushioning by closing the exhaust early. The term inside lap is misleading, because on an inside admission piston valve, the inside lap is the admission lap, the exhaust lap being the outside lap. Increasing the amount of exhaust lap causes pre-release to occur later, and compression earlier.

EXHAUST LINE.—On a steam indicator card, a back pressure line showing the steam pressure between the commencement of pre-release and the beginning of compression. Sometimes exhaust during pre-release is called the pre-release line.

EXHAUSTION, ELECTRIC.—An effect of physical exhaustion sometimes suffered by persons long exposed to powerful arc lights.

EXHAUSTION OF PRIMARY CELL.—The condition of a primary cell which has lost its power to generate a current until electrolytes or electrodes are renewed.

EXOSMOSE.—The passage of liquids through membranes in a reverse direction from that of endosmose, that is, of a denser liquid into one less dense.

EXOTHERMIC COMPOUND.—In chemistry, a compound which is formed from its elements with the giving out of heat.

EXOTHERMIC REACTION.—A chemical reaction accompanied by the liberation of heat.

EXPANDED POLES.—Transmission line poles made from an I-beam by cutting and expanding the web, making what is termed an "expanded steel truss pole."

EXPANSION.—1. The act or process of increasing in bulk; dilatation of any substance through its particles becoming more widely separated from one another by the influence of heat. With gases, the property of expansion is characteristic, that is, any gas admitted into a closed chamber will immediately dilate until it has completely filled the chamber, sometimes becoming extremely rarefied in the process.

2. That portion of the cycle of a heat engine in which the fluid gives off the initial energy stored in it, while being gradually expanded down to the point at which it is rejected from the engine.

EXPANSION, ELECTRIC.—The increase in bulk which occurs in a body upon receipt of an electric charge. It has been observed that a Leyden jar curiously increases in volume as it receives a charge, the electricity producing the effect of expanding the glass.

EXPANSION JOINT.—A device usd in connecting up long lines of piping, etc., to permit linear expansion or contraction as the temperature rises or falls. The usual pattern consists of a sleeve secured to one length of pipe, which works within a stuffing box attached to the next length.

EXPANSION LINE.—On a steam engine indicator card, a forward pressure line extending from cut-off to pre-release. In all engines in which any pretension is made to economy, steam is used expansively. The expansion curve always varies from the theoretical or adiabatic curve due to leakage, condensation, reevaporation and other conditions of operation. A gas in expanding varies in pressure inversely as its volume; and steam follows this law with sufficient accuracy to make its application to the indicator diagram and to engine practice of value. The expansion line falls below the theoretical at the first stages of expansion, and at a later stage, usually above it, crossing it at some point in the stroke. The steam in the clearance space will affect the expansion as it is filled with steam during admission, and all this steam expands with the steam that filled the cylinder volume before cut off, without the clearance volume being changed during expansion.

EXPANSION OF STEAM.—In the operation of a steam engine, the admission of steam to the cylinder is cut off at some point usually earlier than ½ stroke and expanded to the point of pre-release near the end of the stroke. During expansion its pressure varies approximately inversely as the volume being represented by the equilateral or rectangular hyperbola referred to its rectilinear asymptotes. The actual curve traced by the indicator is lower than the hyperbolic curve near the point of cut off on account of initial condensation and higher just before the point of pre-release on account of re-evaporation.

EXPLODER.—A small magneto for the purpose of furnishing current in the electric exploding of blasts.

EXPLORATION OF MAGNETIC FIELD.—The use of an exploring needle in determining the characteristics of a magnetic field.

EXPLORER, ELECTRIC.—An instrument acting on the principle of induction, designed to indicate the location of foreign metallic matter within the human body.

EXPLORING COIL.—A coil wound round a magnetic circuit for the purpose of measuring any change in flux through the magnetic circuit by means of the quantity of electricity sent through an external circuit of known resistance. This quantity can be measured either by a ballistic galvanometer or by a flux meter.

EXPLORING NEEDLE. — 1. An electric probe for surgical use.

2. A magnetic needle for investigating an electro-magnetic field.

EXPLOSION.—A bursting with violence and loud noise, due to a chemical action which causes the sudden formation of a great volume of expanded gas.

EXPLOSIVE.—A chemical substance, solid or liquid, one of the constituents of which is instantaneously converted into gas on ignition or detonation, exerting enormous pressure.

EXPLOSIVE MIXTURE.—1. A finely subdivided substance suspended in the atmosphere, which deflagrates and undergoes chemical change with intense rapidity, accompanied by great heat and the evolution of gaseous products occupying a much greater volume than the original mixture. Coal dust in a mine and the fine floury dust in a mill give occasional instances of the tremendous energy latent in such mixtures.

2. Under control, fine sprays of liquid hydro-carbons, or solutions of gaseous ones in ordinary air, furnish, by explosion, the energy to drive gasoline or gas engines.

EXPULSION FUSE.—One designed to be blown in a confined space such as an explosion chamber. A fuse blown under such a condition has the property of quickly opening the circuit and projecting the arc from the open end of the chamber. The line current is opened at approximately the zero point of the current wave, as in an oil break switch. The arc is ruptured under pressure and no surging takes place so that synchronous apparatus is not apt to be thrown out of step as is often the result with open fuses. Expulsion fuses are made for voltages from 2,500 up to 110,000 and their design differs necessarily with the voltage and make. One type, in general, consists of a reinforced fibre tube, one end of which is closed by a hollow metal receptacle, termed the expansion chamber. The fuse wire or ribbon is enclosed within an asbestos tube in order to protect the insulating tube from injury. It is secured to a plug in the bottom of the expansion chamber and from this is passed through the expansion chamber and tube connected to a terminal block at the upper end of the tube.

EXTENSION CALL BELL.—1. A call bell situated at some point remote from the apparatus or instrument to which it belongs, so placed that it may summon a person from another part of the building.

2. A call bell provided with a relay which causes it to ring indefinitely after the main current is cut off.

EXTENSION PUSH BUTTON.—An extra push button situated at some point remote from the principal push button.

EXTENSOMETER. — An apparatus for measuring the expansion or contraction of metal bars affected by the temperature or by strain.

EXTERNAL CHARACTERISTICS OF COMPOUND DYNAMO.—As the compound dynamo is a combination of the series and shunt machines, the characteristics of both may be obtained from it. The external characteristic is of considerable importance where more than one dynamo is to be connected to the same circuit, or when close regulation is necessary.

EXTERNAL CHARACTERISTICS OF SERIES MACHINE.—In a series machine all the current flowing magnetizes the field, the volts increase with the current and if fully developed the curve is somewhat like the magnetization curve, being always below it, due to the loss of pressure in overcoming internal resistance and armature reactions.

EXTERNAL CHARACTERISTICS OF SHUNT DYNAMO.—The shunt dynamo has besides an external characteristic, an internal characteristic. The first is developed from the volts read while the load in amperes is being added, the armature revolutions being kept constant. Adding load to a shunt dynamo means simply reducing the resistance of the external circuit. With all shunt machines there is a point of external resistance beyond which if the resistance be further reduced, the volts will drop away abruptly, and finally reach zero at a short circuit. The internal characteristic curve or curve of magnetization is plotted on the same scale as the other curves, from the volts at the field terminals and the amperes flowing in the field winding.

EXTERNAL CIRCUIT.—The portion of an electric circuit which is outside of the source of current.

EXTERNAL CRITICAL DAMPING RESISTANCE.—The external resistance in a galvanometer circuit necessary to produce the critically damped condition. The advantage of the critically damped condition rests chiefly in the fact that it aids in rapid work, since a galvanometer system when critically damped returns more promptly to rest than when in an underdamped or overdamped condition.

EXTERNAL MAGNETIC CIRCUIT.—That portion of a magnetic circuit which exists outside of the substance of the magnet itself.

EXTERNAL RESISTANCE.—The resistance existing in an electric circuit outside of the dynamo or battery source of the current.

EXTERNAL RESISTANCE INDUCTION MOTOR.—An asynchronous motor which has a polyphase winding similar to that of the stator, the rotor windings being connected at one end and brought out to a variable external resistance through slip rings. Usually called slip ring motor. Adapted to constant speed service where the starting duty is light and infrequent.

EXTRA BEST BEST IRON WIRE.—The highest grade of iron wire for electrical purposes, being superior in conductivity and uniformity to the other two grades known as best best and best.

EXTRA CURRENTS.—A current of brief duration caused by electro magnetic induction, arising when a circuit is suddenly opened or closed; a self-induced current.

EXTRA HIGH FREQUENCY ALTERNATORS.—A type designed for frequencies up to 10,000 or 15,000 cycles. Typical of the type is a 15,000 cycle Westinghouse machine having 200 polar projections with a pole pitch of only .25 inch, and a peripheral speed of 25,000 feet per minute. The armature core was built up of steel ribbon 2 ins. wide and 3 mils thick. The armature has 400 slots with one wire per slot, and a bore of about 25 ins. The air gap is only .03125 inch. On constant excitation the voltage drops from 150 volts at no-load to 123 volts with an output of 8 amperes.

EXTRA POLAR REGION.—In electrotherapeutics, the area of the body remote from the electrodes.

EXTRACTION OF METALS.—The process of separating metals from their ores by electrolysis.

F

F OR FAHR.—Abbreviation for Fahrenheit.

f.—Abbreviation for frequency.

FACE.—1. The principal surface of a solid.

2 That portion of the curved outline of a tooth in a cog wheel, which lies beyond the pitch circle.

3. The working surface of a slide valve, that is, the surface of a valve which comes into contact with its seat.

4. The dial of a registering instrument of any description.

FACSIMILE TELEGRAPHY.—An automatic system of telegraphy for transmitting a precise copy of handwriting, or of a picture or diagram; pantelegraphy.

FACSIMILE TRANSMISSION.—In radio the electrical transmission of a graphic record having a limited number of shade values.

FACTOR.—One of two or more quantities which, when multiplied together produce a given quantity.

FACTOR OF SAFETY.—A co-efficient which gives the ratio between the breaking load and the working load.

FACTOR OF SAFETY OF STEAM BOILERS.—The number which expresses the ratio of the strength of the boiler to the working strain. The maximum pressure to be allowed on a shell or drum of a boiler shall be determined from the minimum thickness of the shell plates, the lowest tensile strength stamped on the plates by the manufacturer, the efficiency of the longitudinal joint or of the ligament between the tube holes, whichever is least, the inside diameter of the outside course, and a factor of safety not less than five. According to Kent the lowest factor of safety to be used for boilers the shells or drums of which are exposed to the products of combustion, and the longitudinal joints of which are lap riveted shall be as follows: 5 for boilers not over 10 years old; 5.5 for boilers over 10 and not over 15 years old; 5.75 for boilers over 15 and not over 20 years old; 6 for boilers over 20 years old. The lowest factor of safety to be used for boilers the longitudinal joints of which are of butt and double strap construction is 4.5. The A.S.M.E. Boiler Code prescribes a factor of safety of 5 based on the strength of the riveted joint. The Marine rules specify as follows: "The working steam pressure allowable on cylindrical shells of boilers constructed of plates inspected as required by these rules, when single riveted shall not produce a strain to exceed one-sixth of the tensile strength of the iron or steel plates of which such boilers are constructed; but where the longitudinal laps of the cylindrical parts of such boilers are double riveted, and the rivet holes for such boilers have been fairly drilled instead of punched, an addition of 20% to the working pressure provided for single riveting shall be allowed."

FADER.—A double potentiometer used in simultaneously cutting in and cutting out motion picture projectors. At the end of each sound film or disc the music overlaps that at the beginning of the next. The fader operates during this period to progressively diminish the sound on the outgoing projector and increase the sound on the incoming projector.

FADING.—In radio transmission, the gradual decrease in volume or amplitude of radio signals.

FADING, SELECTIVE.—In radio, a kind of fading in which the different frequencies in the transmitted band do not fade simultaneously. When this occurs the automatic gain control system is handicapped by the fact that the carrier or control signal is no longer representative of the entire signal band. Selective fading is probably due to the existence of more than one radio path or route by which signals travel from transmitter to receiver. These paths are of different lengths and thus have different times of transmission. Wave interference between the components arriving over the various paths may cause fading when the path lengths change even slightly.

FAHRENHEIT THERMOMETER SCALE.—The thermometer scale in general use in the United States and England. On this scale 32° represents the melting point of ice and 212° the boiling point of water at sea level. It is commonly abbreviated Fahr. or F.

FAIRLEAD.—In radio, a guide or outlet for a trailing airplane aerial.

FALL OF POTENTIAL METHOD.—A resistance test based on Ohm's law. In making the test, the ammeter and volt meter readings are taken at the same time, and the unknown resistance calculated from Ohm's law. This is a simple and convenient method and is ordinarily used in Central Stations.

FALL OF PRESSURE.—A drop or decrease of electrical pressure in a circuit due to resistance in the conductor. In a wire of uniform resistance the fall of pressure follows the rule, that the electrical pressure along a conductor through which a given current flows, falls directly, as the resistance increases, that is, the voltage is inversely proportional to the resistance. Also called drop.

FALSE FACE.—A clamp or jaw of lead, brass or soft white metal, made to fit on a vise to protect polished work from marking; also known as vise clamp.

FALSE MAGNETIC POLES.—Points on the earth's surface which resemble magnetic poles, in distinction from the two true magnetic poles.

FALSE RESISTANCE.—A resistance in a circuit caused by a reverse voltage due to inductance; a spurious resistance as distinguished from a true or ohmic resistance.

FALSE ZERO.—A zero on a galvanometer scale considered to be at the value of the deflection obtained before the action of forces impressed in the measurement.

FAN AERIAL.—One having a horizontal wire to which is joined a number of wires leading down radially to the lead in wire. The object of the arrangement is to offer greater exposure to electric impulses, and obtain more distinct impression of them.

FAN CONNECTOR.—In radio, a lead in fitting for a multi-wire aerial consisting of a small fan shaped piece of sheet metal with holes along the arc for fastening the several lead in wires.

FAN DUTY RESISTOR.—A resistor for use in the armature or rotor circuit of a motor in which the current is approximately proportional to the speed of the motor.—NEMA.

FAN DYNAMOMETER.—A load device for testing horse power of engines. It consists of a large centrifugal fan arranged to be easily attached to the engine shaft. The power required to turn the fan increases with the speed, and at all times bears a definite relation to the speed. Hence, knowing the speed, it is possible to determine the horse power being developed. The speed is shown by means of a speedometer, driven from the fan shaft, but registering revolutions per minute instead of miles per hour. Fan dynamometers are not suitable for research and very accurate work. They can be used for approximately determining the horse power of engines of high speed and where engines in quantities are tested and their relative differences observed. The horse power obtained is the brake horse power.

FARAD.—Practical unit of electrostatic capacity in the electro-magnetic system. A condenser is said to have a capacity of one farad if it will absorb one coulomb (that is, one ampere per second), of electricity when subjected to a pressure of one volt. Farad is a contraction of the name of the distinguished English scientist Michael Faraday. This is a unit of large size and for convenience the microfarad or one millionth of a farad is generally used.

FARADAY.—The 96,500 coulombs required for an electro-chemical reaction involving one chemical equivalent.

FARADAY EFFECT.—A discovery made by Faraday that a wave of light polarized in a certain plane can be turned about by the influence of a magnet so that the vibrations occur in a different plane.

FARADAY, MICHAEL.—Born 1791, died 1867. An English scientist, famous for his discoveries in chemistry, electricity and magnetism. He first produced the rotation of the magnetic needle around the electric current (1821), based upon Oersted's discovery of electro-magnetism in 1820; he discovered electro-magnetic induction (1831), a principle upon which is founded the development of dynamo machinery; specific inductive capacity (1838); magnetic polarization of light (1845); diamagnetism (1846). He was a brilliant experimenter, and contributed greatly to the knowledge upon which is based present day practice of electricity.

FARADAY'S CUBE.—An experiment made by Faraday to prove that there is no field of electrical force inside a hollow charged conductor. He built a hollow cube 12 feet each way, covered it with tin foil and gave the whole a high charge of electricity. No electrical field could be detected inside even by delicate electrostatic instruments.

FARADAY'S DARK SPACE.—A dark space which is observed when a negative charge is being discharged from a pointed conductor. This space separates the glow from the surface of the conductor, the electricity traversing it without becoming luminous.

FARADAY'S DISC.—A copper disc rotated between the poles of a magnet, having wires with sliding contacts to conduct the current away from the disc. It first illustrated the induction principle, now essentially applied in dynamos.

FARADAY'S DISCOVERY.—In 1831 Faraday discovered that an electric current is induced in a wire by moving it in a magnetic field, so as to cut magnetic lines of force. The wire in which the current is induced is an inductor—ignorantly called a conductor.

FARADAY'S NET.—A device to show that electrical charges are confined to the outer surface of conductors; it consists of a conical gauze bag fastened to a brass ring on an insulated support and capable of being drawn inside out by a silk thread.

FARADAY'S PRINCIPLE.—1. A statement based on Faraday's experiment, viz: When a conducting circuit is moved in a magnetic field so as to "cut," that is alter the number of lines of force passing through it, a current is induced therein, in a direction at right angles to the direction of the motion and at right angles also to the direction of the lines of force, and to the right of the lines of force, as viewed from the point from which the motion originated.

2. Faraday's principle may be extended as follows to cover all cases of electro-magnetic induction: When a conducting circuit is moved in a magnetic field, so as to alter the number of lines of force passing through it, or when the strength of the field is varied so as to either increase or decrease the number of lines of force passing through the circuit, a current is induced therein which lasts only during the interval of change in the number of lines of force embraced by the circuit.

FARADIC ADAPTER.—In electro-therapeutics, a device, including an induction coil, for adapting the current of an ordinary incandescent lamp circuit to medical uses.

FARADIC BATTERY.—An objectionable name for a variety of induction coil employed in the medical application of electricity; a faradic machine. The word battery should be used only in its true meaning to signify a collection of units connected electrically to form a source of current such as primary or secondary cells connected in series or in parallel, etc. It would require a stretch of the imagination to regard an induction coil as a battery.

FARADIC BRUSH.—An electrode resembling a brush employed in electro-therapeutics.

FARADIC COIL.—A medical induction coil, sometimes objectionably called a faradic battery.

FARADIC CURRENT.—1. In electro-therapeutics descriptive of induced electric currents.

2. An intermittent asymmetric alternating current obtained from the secondary winding of an induction coil.

FARADOMETER.—In electro-therapeutics, an instrument for measuring the strength of faradic currents.

FAST AND LOOSE PULLEYS.—In mechanics, a device installed for supplying belt power to machines. Two uniform pulleys are placed side by side upon the same countershaft, one keyed fast to it, the other revolving freely between stop collars. By sliding the belt sidewise from one pulley to the other, it either revolves idly or else drives the countershaft.

FATHOM.—A measure of length equal to six feet, used chiefly in taking soundings, measuring cordage, etc.

FATIGUE OF MAGNETIC IRON OR STEEL.—The change of magnetic hysteresis loss with time. Aging of magnetic material.

FATIGUED.—A term applied to material, as iron, when it has lost in some degree its power of resistance to fracture, due to the repeated application of forces, more particularly when the forces or strains have varied greatly in amount.

FAULT.—An electrical defect.

FAULT INDICATOR.—A device for testing a line for grounds, crosses, breaks or defective insulation. It consists usually of a magneto generator and bell mounted in a portable box; a magneto testing set.

FAULT RESISTANCE.—A resistance in an electric circuit due to the existence of an electrical defect.

FAULT SEARCHER.—In submarine cable repairing operations, an instrument for indicating the instant that the point at which the fault is located passes aboard ship as the cable is raised.

FAURE AND PLANTE STORAGE BATTERY PLATES.—By comparison, the difference is principally in the method of constructing the plates. The Faure plates are usually lighter and have a higher capacity, but have a tendency to shed the material from the grid, thus making the battery useless.

FAURE PLATE.—A form of storage battery plate having the active material attached by some mechanical means to the grid proper. The active material first used for this purpose was red lead, which was reduced in a short time to lead peroxide when connected as the positive or anode, or to spongy metallic lead when connected as the cathode or negative, thus forming plates of the same chemical compound as in the Plante type. The materials used at the present time by the manufacturers for making this paste are largely a secret with them, but in general they consist of pulverized lead or lead oxide mixed with some liquid to make a paste.

FAURE TYPE STORAGE CELL.—A pasted form of secondary cell which is constructed by attaching the active material by some mechanical means to a grid proper. In general the materials used consist of pulverized lead or lead oxide mixed with some liquid to make a paste.

FEATHER.—A key with parallel sides sunk into a recess on a shaft or spindle. The keyway of the boss which fits upon the shaft is made a sliding fit upon the feather, so that if necessary, the boss or hub, while always being driven by the shaft, may be moved lengthwise, as desired.

FED-IN OR ASSEMBLED WINDING.—A type of armature winding possible with open or only partially closed slots, in which coils previously formed are introduced, only a few inductors at a time if necessary. They are inserted into the slots from the top, the slot being provided with a lining of horn fibre or other suitable material, which is finally closed over and secured in place by means of a wedge, or by some other suitable means.

FEED BACK.—In radio, two circuits so coupled that a portion of the current present in one circuit is returned (fed back) to the other.

FEED BACK COIL.—In a radio regenerative set, an inductance coil placed in the plate circuit and arranged in inductive relation to the grid coil. Also called **tickler coil.**

FEED BACK COUPLING.—In radio, any method of coupling the detector plate circuit to the grid circuit so that part of the output current is returned to the grid circuit.

FEED BACK EFFECT.—In radio, undesired **feed back.**

FEED BACK METHODS.—In radio feed back regeneration, there are three methods of feeding back the plate current to the grid. a, capacity coupling; b, conductive coupling; c, inductive coupling. All of these return part of the amplified energy to the grid circuit.

FEED BACK POINT OF OSCILLATION.—In radio, feed back regeneration; the process, if allowed to continue and if the power feed back be enough to counteract all losses in the circuit, will build itself up until the circuit "oscillates" with disastrous results to the clarity of the signal. The best amount of feed back is just below this point of oscillation.

FEED BACK REGENERATION.—The amplifying properties of the three element radio tube can be employed to obtain what is known as regeneration. Since it is possible to have greater output energy than input energy, part of the output may be returned to the input side, thus resulting in amplification of energy or in regeneration, that is, a small part of the amplified energy may be "fed back" to the grid circuit, and, combining with the incoming signal, further increase the plate output.

FEED CHECK.—The non-return or check valve through which feed water enters a steam boiler. The feed check gives a good indication as to whether the pump is forcing water into the boiler, as indicated: a, by sound or "click" each time the valve seats; b, by its temperature. If the valve be cool this is a good indication that the boiler is receiving water.

FEED WATER.—The water supplied to a boiler to replace that evaporated: as, steam or blown off. Net feed water is the quantity of water necessary to supply a stated evaporation in a given interval of time.

FEED WATER HEATER.—An apparatus for raising the temperature of boiler feed water, either by means of steam heated coils or by direct contact with a jet or spray of steam; exhaust steam being used in either manner. These two types of heater are known as closed heater and open heater respectively.

FEEDER.—A stretch of wiring to which no connection is made except at its two ends. Its object is to prevent a drop of pressure at the point where its remote ends are connected, that is, where it feeds current.

FEEDER EQUALIZER SWITCH.—A switch governing the resistances in a feeder system.

FEEDER FOR TROLLEY WIRE.—An independent conductor running direct from the station to some remote point of the trolley wire in order to maintain the pressure at that point.

FEEDER PANEL.—A section of a switchboard which carries the indicating and control apparatus for a feeder circuit.

FEEDER REGULATOR.—A resistance in the circuit of a feeder to maintain its pressure equal to that of the other feeders in the system.

FEEDER SYSTEM.—In a system of electrical distribution, a method of preventing drop of voltage in long lines by running a number of supplementary conductors from the central station, and connecting them to the main conductor at various points along the line.

FEEDING CENTER.—A center of electric distribution maintained by a feeder.

FEEDING MECHANISM.—A mechanism for feeding forward the carbons of an arc lamp to prevent the length of the arc becoming too great as the carbons wear away.

FEELER.—A shop tool for gauging or "feeling," the accuracy of workmanship between two abutting surfaces. Thin strips of hardened steel of known thickness are employed, and by mounting several different sizes in a handle, like blades in a pocket knife, a great range of tests can be made by combining the blades.

FERRANTI CABLE.—A type of electrical conductor designed to carry high tension currents consisting of concentric tubes of copper separated by an insulation of paper saturated with black mineral wax.

FERRANTI EFFECT.—A phenomena of the increase of voltage difference between mains in an alternating current system observed as the distance increases from the generating station.

FERRIC.—A term signifying of or akin to iron; containing or extracted from iron.

FERRO-MAGNET.—A term sometimes applied to a substance which, like iron, is attracted to a magnet; a substance having paramagnetic properties.

FERRO-MAGNETIC MODULATOR. — A radio device whose operation as a modulator depends on the variable inductance due to iron core coils, or hysteretic energy absorption of iron.

FERRO-MAGNETISM.—The magnetic property possessed by substances such as iron, nickel, cobalt, manganese and chromium of being attracted by a magnet so that they tend to lie in the direction of the magnetic lines of force. This property is usually known as simply magnetism or better, para-magnetism to distinguish it from diamagnetism, a peculiar magnetic property possessed by bismuth and antimony which tends to cause them to lie at right angles to the lines of force. These effects being exhibited by a small bar of the substance free to turn in the magnetic field.

FERRO-MANGANESE ALLOYS. — Alloys which have a power of electrical resistance unaffected by variations of temperature, employed in making wire for resistance coils.

FERRON DETECTOR.—In radio, a type of crystal detector employing iron pyrites.

FERRULE.—A cylindrical ring driven into the end of boiler fire tubes to fasten them tightly in the tube plates.

FIBRE.—1. One of the delicate, thread like or string like portions of which the tissues of plants and animals are in part constituted; as, the fibre or flax or of muscle.

2. Any fine, slender thread, or thread like substance; as, a fibre of spun glass.

FIBRE CONDUIT.—This form of conduit consists of pipes made of wood pulp impregnated with a bituminous preservative and insulating compound. Three types of joint are available for connecting lengths of fibre conduit: a, socket joint; b, tapered sleeve joint; c, screw joint.

FIBRE SUSPENSION.—A delicate method of suspending a needle for sensitive movements, as in a galvanometer, by a filament of silk or fibre of quartz; torsion suspension.

FIBRONE.—A compound for insulating purposes.

FIDELITY.—The degree in which an amplifying system or other circuit delivers from its output an accurate reproduction of the input signal. The opposite of distortion.

FIDUCIAL LINE OR POINT.—A line or point of reference assumed as a fixed basis of comparison.

FIELD.—A term applied to the space occupied by electric or magnetic lines of force. Also called magnetic field.

FIELD BORE.—The space between the pole faces of the field magnets of a dynamo in which the armature rotates.

FIELD BREAK UP SWITCH.—A switch which, when open, separates a field winding into two or more sections, insulated from one another.—NEMA.

FIELD COILS.—The coils of insulated wire wound upon the field magnets of a dynamo, or other rotating machine.

FIELD CONTROL.—The control or regulation, by means of a rheostat, of the current used to excite an electro-magnet, or the regulation of the field current of a motor for varying its speed by means of a rheostat connected into the field circuit.

FIELD CONTROL FOR ELECTRIC MOTORS.—A control which has the field arranged in two parts which are connected in series with a lead brought out from the point where they are joined together. Adapted to commutating pole series motors. In starting, the entire motor current passes through both parts of the field in series, called the full field connection, setting up a very strong field and developing a large torque with a relatively small current. When desired, one portion of the field is cut out, leaving only the short field in the circuit, so that a comparatively weak field results and higher speeds are secured. These arrangements give economy and flexibility, in that less starting current is required, and the motor provides two efficient running connections instead of one.

FIELD DENSITY.—The strength of a magnetic or electro-magnetic field measured by the number of lines of force it contains in a given cross sectional area.

FIELD DISCHARGE SWITCH.—One usually of the knife blade type, but also made in the form of an air break circuit breaker, having auxiliary contacts for short circuiting the field of a generator or motor through a resistance when the switch is opened.—NEMA.

FIELD DISTORTION.—A distortion in the magnetic field of a dynamo caused by the magnetizing action exercised by the current in the armature.

FIELD, EDWARD, "DROP TUBE."—A type of boiler tube which is closed at the lower end and expanded into a tube sheet at the upper end, being placed vertically or nearly so. Within each tube is another tube open at both ends. It is so suspended that a rapid circulation takes place, the steam and heated water rising in the outer tube, and the relatively colder (and heavier) water descending in the inner tube. The upper ends of the inner tubes are flared to promote circulation. The practice of some builders of omitting the inner tube cannot be too strongly condemned. It would require a stretch of the imagination to assume proper circulation with such arrangement, but not difficult to believe that the spheroidal state is reached over a considerable area of the tube which no doubt accounts for the very poor steaming of drop tube boilers minus the inner or circulating tubes.

FIELD, ELECTRIC.—The space traversed by lines of electric force.

FIELD EXCITATION.—The production of an electro-magnetic field in a dynamo or motor by supplying a current for magnetizing the field magnets. This may be done in five ways: a, by permanent magnets; b, by separate excitation; c, by a shunt winding; d, by a series winding; e, by a compound winding. Dynamos are classified according as the excitation is supplied from an outside source, or by the machine itself, into separate or self-exciting dynamos.

FIELD EXCITATION OF ALTERNATORS.—A separate source of direct current is required for their excitation and this current should be preferably automatically controlled. In the case of alternators that are not self-exciting, the dynamo which generates the field current is called the exciter. The excitation of an alternator at its rated overload and .8 power factor would not, in some cases, if controlled by hand, exceed 125 volts, although, in order to make its armature voltage respond quickly to changes in the load and speed, the excitation of its fields may at times be momentarily varied by an automatic regulator between the limits of 70 and 140 volts.

FIELD FRAME.—A ring of cast iron or mild steel of suitable diameter and width, standing upright upon the bed plate of a dynamo, and carrying the electro-magnets bolted or cast solidly upon its inner circumference.

FIELD FREQUENCY.—In an alternating current motor, the number of rotations which the magnetic field makes per second.

FIELD MAGNET COILS.—The coils of insulated wire employed to excite the field magnets of a dynamo or motor; the field coils.

FIELD MAGNET WINDING.—That winding in a dynamo or other machine which is energized by direct current producing a magnetic flux in one direction only. This magnetic flux constitutes the magnetic field.

FIELD MAGNETS.—In a dynamo or other rotating machine, strong magnets terminating in pole pieces between which the armature is rotated, the axis of the armature being at right angles to the general direction of the lines of induction of the field. The object of field magnets is to produce an intense magnetic field within which the armature revolves. The magnets may either be permanent magnets as used in magnetos, or electro-magnets as used on dynamos, motors, etc. Electro-magnets are generally used in place of permanent magnets on account of: a, the greater magnetic effect obtained, and b, the ability to regulate the strength of the magnetic field by suitably adjusting the strength of the magnetizing current flowing through the magnet coils. The field magnet, in addition to furnishing the magnetic field, has to do duty as a framework which often involves considerations other than those respecting maximum economy.

FIELD MAGNETS OF INDUCTION MOTORS.—They are in many respects identical with the armature construction of revolving field alternators. Broadly, the field magnets of induction motors consist of: a, yoke or frame; b, laminæ or core stampings; c, winding.

FIELD OF DYNAMO.—The region between the pole pieces of a dynamo, within which the armature rotates and the lines of force are generated.

FIELD OF FORCE.—The space occupied by electric or magnetic lines of force.

FIELD OF SOLENOID.—The magnetic field existing inside and throughout the length of a solenoid when an electric current passes through its coils. The lines of force of a solenoid in which a current is flowing must be thought of as closed loops linked with the current. The conductor conveying the current passes through all the loops of force, and these are, so to speak, threaded or slung on the current line of flow. The lines of force form continuous closed curves running through the interior of the coil; they issue from one end and enter into the other end of the coil. The field is such that a solenoid has north and south poles, and in fact possesses all the properties of an ordinary permanent magnet, with the important difference that the magnetism is entirely under control.

FIELD POLE.—A structure of magnetic material on which a field coil may be mounted.

FIELD REVERSING RELAY.—A device which reverses the shunt field connections of a machine.—NEMA.

FIELD RHEOSTAT.—An adjustable resistance used to vary the strength of the magnetic field of a shunt wound dynamo or motor.

FIELD SPOOLS.—A name sometimes given to the field coils of a dynamo.

FIELD STRENGTH.—The strength or intensity of the lines of force in a magnetic field.

FIELD TELEGRAPH LINE.—A telegraph line erected for temporary use in directing army maneuvers and similar operations.

FIELD TROUBLES.—The following are the various electrical and mechanical field troubles:

1. Electrical troubles: a, grounds; b, short circuits; c, open circuits.

2. Mechanical troubles: a, wrong field connections; b, reversed coils.

FIELD WINDINGS OF INDUCTION MOTORS.—They are almost always made to produce more than two poles in order that the speed may not be unreasonably high. The field core slots contain a distributed winding of substantially the same character as the armature winding of a revolving field polyphase alternator. The poles are produced by properly connecting the groups of coils and not by windings concentrated at certain points on salient poles or separately projecting masses of iron, as in direct current machines. Three phase windings are usually Y connected. In some cases Y grouping is used for starting and delta grouping for running.

FIG.—Abbreviation for figure.

FIGURE.—1. A character standing for, or representing a number; a numeral; a digit; as 1, 2, 3, etc.

2. A name given to an illustration in a book, numbered in regular order so that any illustration referred to in the text can be easily located. A properly made up book will have the illustrations placed where referred to in the text to avoid the annoyance of turning pages.

FIGURE OF EIGHT WIRE.—A form of trolley wire having a cross section resembling the shape of the numeral 8.

FIGURE OF MERIT.—The value of the electric current required to produce a deflection of one degree or one division upon a galvanometer scale.

FIGURES, ELECTRIC.— The distribution in the form of curious figures which takes place when certain electroscopic powders are sifted over a charged surface, illustrating the distribution of electricity over the surface.

FILAMENT—1. The cathode element of a radio vacuum tube which is heated to throw off electrons. Under operating conditions, the plate of the tube is kept positive with respect to the filament and, therefore, attracts the free electrons to it. Neglecting the effect of the grid, it is evident that there will be a continuous flow of electrons from the filament to the plate so long as the plate is positive with respect to the filament and so long as electrons are fed to the filament as fast as they are emitted from the filament. If this were not done, the filament would soon become positive because of the lack of negative electrons, and the plate would become negative because of the surplus of negative charges. To control the flow of electrons to the plate a grid is inserted into the tube.

FILAMENT ACTIVATION.—The process of bringing a fresh supply of thorium atoms on a thoriated filament by applying a voltage much higher than normal for a few seconds and then continuing with a moderately high voltage for a considerable length of time.

FILAMENT BATTERY.—In radio, the A battery or d.c. electric source used to heat the filament of a vacuum tube. Voltage range according to tube from 1½ to 6 volts. in tubes for receivers, but much higher voltage is employed in transmitting tubes.

FILAMENT CONSTRUCTION.—A radio vacuum tube filament is generally made of tungsten and is fused into the tube, the glass insulating it from the other elements. Late tubes have filaments of tungsten coated with thorium, which is more efficient than the old construction.

FILAMENT CURRENT.—In radio, the current required to heat the filament of a vacuum tube. It varies according to the type tube from a small fraction of an ampere to an ampere.

FILAMENT OF INCANDESCENT LAMP.—The thin wire of infusible conducting material within the bulb of an incandescent lamp. Tungsten is generally used for filaments. In the older forms of lamps, carbon, platinum, tantalum and other materials were used, but they have been superseded because of their shortcomings, such as short life, unsuitability to alternating current and high cost for commercial purposes.

FILAMENT RESISTOR.—A variable resistance unit rheostat connected in series with the filament of a vacuum tube to reduce the voltage to the proper value required by the tube.

FILAMENT SHADOWS.—The blackening of the inner surface of an incandescent lamp bulb by the depositing of carbon from the wasting filament.

FILING JIG.—A device for filing relay fingers which have become burnt or pitted by lightning or other high voltages.

FILINGS.—The particles of metal, such as iron or brass, produced by the action of a file or rasp.

FILINGS COHERER.—In radio a coherer employing nickel and silver filings. Obsolete.

FILM.—A strip of sensitized material for use instead of plates in cameras, motion picture cameras and projectors. It consists of a strip of cellulose composition (film support) upon which is a coating to render it sensitive to light. Several grades are made, having different degrees of sensitivity. The commercial motion picture film is 35 m.m. wide, and for amateurs, 18 and 8 m.m. wide.

FILTER.—A radio device consisting of a combination of resistances, inductances and capacities used to pass currents of predetermined frequencies and exclude those of other frequencies. Filters are classified as: a, high pass; b, low pass; c, band pass; d, band exclusion.

FILTER CONDENSER.—Either a fixed or variable condenser forming part of the filter circuit. In a radio filter, the function of the condenser is to prevent the flow of d.c. retarding the flow of low frequency a.c. and to permit the flow of high frequency a.c.

FILTER DEFECTS.—Some radios employing dynamic speakers utilize the field windings of the speaker as a part of all of the choke in the filter circuits of the power pack. An open choke will result in no output voltages. A similar result will be obtained when the other side of the filter is open. Shorted windings within the choke may cause excessive output voltages with hum. Filter condenser leakages reduce the output voltages, a shorted condenser across the filter system resulting in no output voltages, and an analysis from the rectifier tube socket would reveal excessive rectifier plate current.

FILTER TRANSFORMER.—A radio transformer having its windings tuned to the operating frequency so as to increase the secondary output.

FILTERED RADIATION.—In roentgenograms filters are used to eliminate the soft rays in order to utilize only the most penetrating. The filter is generally composed of glass, aluminum, brass, copper or zinc, and is interposed between the skin and the target of the tube.

FILTERING.—Various mediums are used in the process of filtration: charcoal and bone black when it is desired to retain or remove certain gases, etc., sand or gravel for rough filtration in large quantities, and silica or sponge for fine work.

FINENESS RATIO.—The fore and aft length of an airplane body divided by the greatest width across the wing.

FINITE DECIMAL.—A decimal that has no recurring figures; one that terminates with the written figures.

FIRE ALARM.—An electric signal system consisting of a number of signal boxes from each of which the alarm bell can be sounded. A simple system well adapted to a small loft building with three or four floors or to a one story building with considerable floor area, is installed by placing on each floor or in each room or department a bell to give the alarm, and an annunciator to indicate the location of the station from which the alarm was sent. On the larger systems fire alarm boxes are used.

FIRE ALARM BOX.—A contrivance for turning in a signal in code, to indicate where the alarm came from. It consists of a toothed wheel rotated by a spring which makes electrical contacts in accordance with the number of teeth cut and their spacings. These contacts ring a bell, or sound on a telegraph instrument, or record on a traveling tape. The number of rings or tape indicates the origin of the call. This constitutes the fire alarm telegraph as used in the large cities.

FIRE ALARM TELEGRAPH.—A system of telegraphy for sending fire alarms from signal boxes located at convenient points along the line.

FIRE BALL.—A rare form of lightning in which a ball of fire is seen to run along a surface or float in the air and finally burst; globular lightning.

FIRE EXTINGUISHER, ELECTRIC. — A thermostat which, upon a given increase of temperature, completes an electric circuit by means of which water is turned on in case of fire.

FIRE GLOW.—A name given in early times to the aurora.

FIRE SURFACE.—In steam heating boilers, the fire pot surface or that in direct contact with the flame as distinguished from the more remote heating surface. In steam heating boilers the fire pot is a most vital part of the boiler, especially on account of the inadequate heating surface usually provided and the fact that the fire pot heating surface is more efficient than that further removed from the fire, the larger the fire pot heating surface and its coal capacity, together with proper combustion space and ample water passages, the more satisfactory will be the boiler's performance.

FIRE TUBE BOILER.—A term representing a class of multi-tubular boilers in which the inside of the tube is exposed to the fire and gases from the furnace, as distinguished from water tube boilers.

FIRST DETECTOR.—In a radio super-heterodyne receiver, the tube or frequency changer, in which the signal frequency and oscillator frequency combine in the grid circuit, to form the beat or intermediate frequency.

FISH JOINT.—A splice consisting of one or more pieces of iron or wood bolted to the side or sides of two adjacent rails, where the head of one meets the foot of the other; a fish plate.

FISH PAPER.—A superior sheet fibre insulation for armature windings, etc.

FISH PLATE.—In an electric railway, the metal plate which joins one rail to another.

FISH PLUG.—A threaded plug which is screwed into the end of flexible steel conduit and having an eye for attaching a pull wire in drawing the conduit under floors, in partitions or other difficult places in house wiring.

FISHED WIRES.—In house wiring, wires that have been drawn through ducts, partitions, etc., by the process of fishing.

FISHING.—In house wiring, a method of running wires through walls, partitions, etc., by means of a snake. In fishing in a house constructed with furring strips between the joists and ceilings there will be plenty of room to draw through the loom or cable. Furring strips in old houses having single floors will be found to run parallel with the floor boards. After having cut the outlet a steel wire or snake is inserted into the hole so that it may be pushed into the space made by the furring strip, having inserted the end of the snake, it is gently pushed as far as desired; if the snake encounter an obstruction it may be caught against a piece of plaster or become twisted. With a little practice a snake may be fished over 50 ft. with ease, having reached the outlet, another snake or piece of wire is pushed up into the hole at the outlet and the snake is hooked, and then gently drawn through the outlet; the wires are then attached and pulled through. If a man be at each end considerable labor will be saved.

FISHING BOX.—In a conduit system of wiring, a name sometimes given to a junction box at which splices may be made and wires may be "fished" through.

FIVE ELEMENT (PENTODE) TUBE.—The object of the fifth element is to obtain higher plate current and greater sensitivity. The power type five element tube contains: a filament, plate, control grid, screen grid and filament grid. The filament grid permits retaining much of the amplification and increases the output power. Another type of five element tube contains: a filament, plate, control grid, screen grid and space charge grid, the object of the space charge grid is to reduce the plate resistance and increase the mutual conductance.

FIVE POINT BRANCHING JACK.—A five contact spring jack employed in the switchboard of the branch terminal telephone system.

FIVE WIRE SYSTEM.—A system of electric distribution based upon the principle of the three wire system, having in this case five conductors leading from series connected dynamos.

FIX.—The intersection of two or more radio bearings.

FIXED POSITION OF BRUSHES.—If the brushes of a machine are to remain in a fixed position, this condition will only be realized at the particular load for which the brushes are set. Thus, if the brushes be set for the average load, the reversing field will not be correct for either a weaker or stronger load.

FIXED COILS.—Radio coils not having means for varying the inductance.

FIXED CONDENSER.—A radio condenser of non-variable capacity.

FIXED DISCHARGER.—A type of spark gap designed for service not requiring adjustment during operation, used in radiotelegraphic signal transmission, and in high tension or jump spark (spark plug) ignition.

FIXED RESISTANCE.—A non-variable resistance.

FIXED SPARK MAGNETO.—A magneto for automobile ignition which has no provision for retard or advance of the spark.

FIXTURE, ELECTRIC.—The sockets, holders, arms, etc., required for holding, or supporting incandescent electric lamps.

FIXTURE WIRING.—Chain fixtures must be wired with flexible cord preferably single conductors laced through each link of the fixture chain. One-eighth inch trade size sockets should be used so that loops may be screwed into the socket caps. Brackets or side wall fixtures must be wired with No. 18 fixture (solid) wire or larger. The ends of all pipes and bodies being reamed so that the burrs will not cut into the insulation. Pendants or fixtures that are constructed of tubing must be wired with solid fixture wire.

FLAG SIGNALING.—A method of signaling by means of a small flag which is waved to the left and right to indicate the dots and dashes of the telegraphic code; wigwagging.

FLAKE OF CABLE.—One loop of a horizontally coiled cable.

FLAME.—Visible flame consists of combustible gas heated to an intense heat. If it comes in contact with a supply of air in a chamber where the temperature is sufficiently high, it will burn, but if cooled before coming in contact with the air supply it will escape in an unburned state as gas or smoke. The product of perfect combustion is invisible. The product of the perfect combustion of carbon is invisible carbonic acid. The product of the perfect combustion of hydrogen is invisible water vapor.

FLAMING ARC LAMP.—An arc lamp of high efficiency in which the carbons are impregnated with a combination of metallic salts which cause a long arc to flame with intense brilliancy. The length of the arc may be five times as great as with ordinary carbons. The source of light is no longer solely the incandescence of the carbon points but chiefly the luminous arc between the points, which are placed converging downward, so that almost uniform illumination is obtained in all directions.

FLAPS.—Hinged horizontal control surfaces in the spaces cut out of airplane wings.

FLASH.—During an eclipse, the sudden appearance of the chromosphere a fraction of a second before totality causes the so-called "flash spectrum" when its light is analyzed in the spectroscope.

FLASH BOILER.—A type consisting of a series of coils of steel tubing. Water is supplied by a pump on the engine which delivers the water to the top coil, and in passing through each coil, it must rise to an elevation higher than the first or upper coil. In effect, this forms a series of traps, and the water or steam in order to pass from one coil to that next below, must be forced up to a level above the top coil before it passes down to the next lower coil. This trapping of the water gives the generator a certain amount of reserve capacity and prevents the water passing directly through the generator to the engine, as it would otherwise be likely to do on a hard pull, and hot water or wet steam would be drawn into the engine cylinders. It also prevents the steam rising to the top and water settling to the bottom, as is the natural tendency.

FLASH LIGHT.—1. A type of light house or signal light in which the rays are rendered intermittent by being alternately obscured and revealed.

2. A small portable light for intermittent service. It consists of a metal tube about 6 to 8 ins. in diameter in which is placed a dry battery (about 6 volts) and having at one end an incandescent bulb reflector and "bulls eye" lens. Attached to the tube is an easily operated switch.

FLASH POINT OF OIL.—The temperature at which oil gives off explosive vapors. It is determined by heating the oil with a thermometer immersed in it, and applying a flame as the temperature rises. Sometimes the oil is heated in shallow cups of a specified size, and a taper is passed over the surface to cause ignition; this is termed the open flash test.

FLASH WELDING.—A resistance butt welding process wherein the welding heat is developed by the passage of current in the form of an arc across a short gap between the surfaces to be welded, these surfaces being kept slightly separated until they have flashed off to parallelism and have reached the desired temperature. The electrical circuit is then opened and the upsetting movement takes place.

FLASHER.—A sign flasher.

FLASHING OF DYNAMO.—Flashing or sparking which is liable to take place at the brushes of a commutator. It may arise from bad adjustment or condition of the brushes, bad condition of commutator, overload of dynamo, loose connections, disconnections or short circuits in armature circuit, and similar causes. When sparking occurs at the brushes of a good dynamo, two kinds may generally be distinguished by the experienced eye: a, those sparks due to bad adjustment of the brushes, generally of a bluish color, small when near the neutral points, and increasing in violence and brilliancy as the brushes recede from the correct positions upon the commutator; b, those due to a dirty and neglected state of the commutator and brushes, these being distinguished by a reddish color and a spluttering or hissing. When due to this last-mentioned cause, it is impossible to suppress the sparking until the commutator and brushes have been cleaned. In the former case, the sparks will disappear as soon as the brushes have been rotated into the neutral points.

FLASHING OVER.—In dynamos furnishing high voltage current, the drawing out of a long blue spark from brush to brush on the commutator, when the resistance of the circuit is suddenly changed.

FLAT BOARD.—A telephone switchboard which lies in a horizontal position instead of standing upright.

FLAT CABLE.—A cable made up of conductors laid side by side to permit of resting closely against a wall or ceiling.

FLAT COMMUTATOR SEGMENT.—A commutator bar that has become flattened or pitted by wear or some fault in adjustment.

FLAT IRON, ELECTRIC.—A domestic flat iron designed to be heated by the house lighting current. A typical iron consists of two heating elements of resistance wire wound on cores of strip copper, carefully covered with a thoroughly fireproof insulating material and bent to fit the shape of the iron. A V shaped slot is formed in the head of the central iron and the ends of the coils are wedged lightly into the opening. A sheet of mica is inserted between the central core and the coils, and the coils are then pressed against it and fastened at the iron with a clip. Another sheet of mica and a thin sheet of copper sheath held in place by a clip at the heel constitute the complete heating element of the iron. The coils are detachable and interchangeable. In case of a burn out, only one side need be replaced. By means of a detachable plug the iron can be used in any room wired for electricity, by attachment to any electric lamp socket.

FLAT RACEWAY FITTINGS.—These fittings include a switch box 1½ inches deep, round outlet boxes ¾ inch deep, a sleeve coupling for joining two lengths of raceway or an elbow to raceway, a 45° flat elbow, a 90° vertical elbow, fastenings, and connectors which make it possible to extend flat raceway from any other type of raceway or wiring system.

FLAT RING ARMATURE.—An armature having a core shaped like a broad flat ring.

FLAT TOP ANTENNA.—One consisting of two or more parallel conductors lying in a horizontal plane.

FLAT TUNING.—In radio, broad tuning, that is, tuning having little selectivity.

FLATS.—The points upon the surfaces of commutator segments, which, through wear or faulty adjustment, have become worn away so as to form slight depressions. It is not confined to machines of bad design or construction, but frequently appears on those of the highest class, and may be recognized as a "pitting" or "flattening" of one or more segments. It is always accompanied by sparking at the brushes, and may be due to a periodical jumping of the brushes, caused by a bad state of the commutator, or a bad joint in the driving belt, or to a flaw, or a difference in the composition of the metal of the particular bar upon which it appears. But more frequently it may be traced to a more or less developed fault, such as a disconnection, either partial or complete, in the armature coil. The disconnection may occur either in the coil itself, or at the point where its ends make connection with the lug of the commutator, or at the point where the lug is soldered to the segment of the commutator.

FLEETING KNIFE.—A device on a cable laying machine for guiding the cable over the drum.

FLEMING VALVE.—A radio vacuum tube detector invented by Prof. J. A. Fleming in 1904, having a carbon filament and a plate.

FLEMING'S RULE.—A rule for determining the direction of the induced current in a circuit. It may be expressed as follows: Hold the thumb and the first and the middle fingers of the right hand as nearly as possible at right angles to each other, so as to represent three rectangular axes in space: if the thumb points in the direction of the motion of the conductor, and the forefinger points along the direction of the magnetic lines, then the middle finger will point in the direction of the induced pressure or current.

FLEXIBLE CONDUIT.—A raceway for house wiring consisting of a continuous flexible steel tube composed of convex and concave metal strips, wound spirally upon each other in such a way as to interlock their concave surfaces. It possesses considerable strength and can be obtained in long lengths (50 to 200 feet); elbow fittings are not required as the conduit may be bent to almost any radius. The fissures of the conduit provide some ventilation; this is an advantage in some places and a disadvantage in others.

FLEXIBLE CONDUIT SYSTEM.—An underground conduit system constructed in such a manner as to permit of the introduction of wires at any time.

FLEXIBLE FRAME.—A non-rigid structure for supporting high tension conductors. Flexible frames are heavier structures than latticed poles because they are intended to take care of longer spans. Like the poles, their chief function is to take care primarily of transverse loads with a small margin of safety so that under unusual conditions of service they could also provide a little resistance in the direction of the line.

FLEXIBLE LAMP CORD.—A cord composed of insulated flexible conductors, twisted together.

FLEXIBLE LEAD.—Any electrical conductor that is so stranded as to be readily bent.

FLEXIBLE SHAFTING.—A pliant shaft, much used for driving drills and which may be connected directly to an electric motor; a shaft composed of a number of concentric spiral coils of wire, wound alternately right and left.

FLEXIBLE TWIN LEAD.—A lead composed of two flexible conductors running parallel.

FLEXURE.—In mechanics, a term sometimes applied to the bending of a beam under a load. It is measured either by the deflection of a given point in the beam from a straight line, or by the curvature which it acquires under the action of the load.

FLICKER PHOTOMETER.—A type of photometer in which rotating mirrors or diffusing screens are employed in order to give rapidly alternating impressions from both lamps. By increasing the speed of rotation, the two lights appear to flicker and the flickering is more pronounced the greater the difference of the luminous intensities of the lamps under comparison.

FLIGHT RECORDER.—An instrument for recording certain elements of the performance of air craft.

FLOAT FEED CARBURETER.—A type of carbureter for internal combustion engines, in which a cork or hollow metal float controls the height of the gasoline or other liquid fuel in the receiving or float chamber.

FLOAT SWITCH.—A switch automatically controlled by the rise and fall of water in a tank acting on a float. The movement of the float is transmitted to the handle of the switch by suitable gear.

FLOAT TRAP.—In steam engineering, a trap in which the rise of the level of the water of condensation raises a ball, which operates a valve to discharge accumulated water, but prevents the passage of steam.

FLOAT VALVE.—An automatic valve in which the admission of water into a tank or vessel is controlled by a lever attached to a hollow sphere, which floats on the surface and opens or closes the valve, according to its position, as determined by the level of the water.

FLOATING BATTERY.—A storage battery employed in a parallel system to discharge into or be charged by the system as required.

FLOATING COIL.—In a variable ratio transformer voltage regulator, part of the secondary winding which is insulated from the main portion of the winding, and is sub-divided by taps into a number of equal sections. The subdivisions of the main secondary winding are much larger, each one being equivalent to the whole of the floating coil.

FLOATING THE BATTERY ON THE LINE.—A storage battery is said to float on a line when connected across the circuit at some distance from the power station, so that a heavy load on the line, within the range of the battery influence, causes sufficient line drop to allow the battery to discharge, while with a light load on the line, the drop is small and the impressed voltage at the battery high enough to charge the battery. This usage is confined chiefly to electric railway service, where large voltage changes are permissible.

FLOOD LIGHTING.—The illumination of surfaces, such as building facades, sign boards, etc., to a desired level of illumination intensity.

FLOOR CHISEL.—In wiring, a wide rod chisel used by electricians for cutting through floors. It is usually 18 to 24 inches long, and must not be used for prying up boards, the ripping chisel being employed for that purpose.

FLOOR PUSH.—A press button for ringing an electric bell, so constructed that it may be set into the floor and operated by pressing with the foot.

FLOOR TREAD.—A floor switch on a bell or door release designed to be operated by the foot.

FLOSS SILK.—A soft, smooth, loosely twisted filament silk.

FLOWERS OF SULPHUR.—In steam pipe fitting and wiring, a fine flour made of sulphur; this mixed with sal-ammoniac and iron borings is used for making rust joints.

FLUID DEPOLARIZER.—A liquid added to a primary cell to prevent polarization. The Daniell and Grove types of cells employ fluid depolarizers, the former using a solution of copper sulphate, and the latter nitric acid or bichromate of potash.

FLUID, ELECTRIC.—A term formerly applied to electricity in accordance with the now rejected theory that electricity is actually a material fluid existing in all bodies.

FLUID INSULATOR.—An oil insulator sometimes used on high tension circuits.

FLUID PRESSURE.—In mechanics, pressure is transmitted by fluids in all directions with an equal pressure. The intensity of this pressure at any point within the fluid is proportional to the depth of the point from the surface, and to the density of the fluid.

FLUORESCENCE.—That property by virtue of which certain solids and fluids become luminous under the influence of radiant energy.

FLUORESCENT ROENTGEN RAYS.—Secondary rays whose wave lengths are characteristic of the substance which emits them.

FLUORIMETER.—A name sometimes given to the fluoroscope.

FLUOROSCOPE OR FLUORESCING SCREEN.—A device for observing the shadows of objects cast by Roentgen rays, or of bodies that in different parts transmit the rays in different degrees. It consists of a light tight box, provided with an aperture for the eyes, and an opening at the opposite end for the fluorescing screen. The latter consists of a piece of paper or cardboard coated with platinum-barium cyanide crystals, which fluoresce under the action of X rays. When such a screen is held against the face by means of the handle, and the aperture pressed tightly around the eyes so as to exclude all outside light, and the screen placed near an active X ray tube, the former will fluoresce with a greenish yellow light.

FLUSH BOLT.—A screw bolt whose head is countersunk, so that it will not protrude from the surface.

FLUSH BOX.—In an underground conduit system, a box or opening sunk flush with the street level for the purpose of permitting an examination of the conductors, or the introduction or removal of wires from the conduit.

FLUSH OF CURRENT.—The excessive rush of current which enters an arc lamp at the moment of starting.

FLUSH PUSH.—A push button set flush with the surrounding surface.

FLUSH SWITCH.—A key switch so placed as to be flush with the surface of the wall or woodwork on which it is mounted.

FLUVIOGRAPH, ELECTRIC.—An electrical instrument for measuring and recording automatically the rise and fall of level in a river or other body of water.

FLUX.—1. In melting metals, an addition of some mineral, generally limestone or chalk, to the charge in the furnace, for the purpose of absorbing mineral impurities in the metal and running them off as the slag.

2. In soldering or brazing, a substance applied to the portions to be united, causing the solder to flow easily and adhere to the joint.

3. A general term for electrostatic or magnetic flux.

FLUX DENSITY.—The number of magnetic lines that run through a unit area of cross-section of a magnetized substance.

FLUX HORN.—One of the projecting edges of the pole pieces of a dynamo which extend in the direction of the armature; the leading horn.

FLUX METER.—An instrument for measuring flux density. It consists of an exploring coil and a galvanometer.

FLY OR FLYER, ELECTRIC.—A light, delicately poised wheel with radiations terminating in points bent at right angles in the same direction; when connected with a source of electricity, it spins rapidly on account of the discharge of convection streams from the points resisting the surrounding air; a reaction wheel.

FLY WHEEL ALTERNATOR.—A revolving field alternator of very large size in which the field magnets are mounted on a casting having a central hub and spokes, the assembly resembling a fly wheel. By giving liberal thickness to the rim of the spider, the rotor then answers the purpose of a fly wheel, hence no separate fly wheel is required.

FLY WHEEL MOTOR GENERATOR.—By designing the motor generator set with a fly wheel, energy can be stored in and taken out of this fly wheel in such a way that the motor of the set draws practically a uniform load from the line. Since the energy can be obtained from and put into the wheel by varying its speed, it is necessary to have a motor which can be adjusted in a simple manner within the narrow limits required. An induction motor is therefore required. For small sets this may be of the squirrel cage type requiring no regulating device whatever. For larger sets the phase wound rotor is used.

FLYING BREAK OF ARMATURE CONDUCTOR.—A break in an armature winding that can be seen only during the rotation of the armature.

FLYING CROSS.—A fault liable to occur in the armature of a dynamo or motor, due to a loose wire that causes trouble only when the armature is in rotation. If not located, it will finally burn through the armature insulation.

FLYING SOUNDINGS.—Soundings that may be taken in water not over two hundred fathoms deep while the vessel is moving at the rate of five or six knots an hour.

FOAMING IN BOILERS.—Severe priming or agitation of the water due to dirty or impure water.

FOCAL DISTANCE.—The distance from the optical center of a lens or mirror to the point where the rays converge.

FOCI IN DOUBLE CONCAVE LENSES.—In this type of lenses, there are only virtual foci.

FOCI IN DOUBLE CONVEX LENSES.—In this type of lens there are real and virtual foci.

FOCIMETER.—An instrument for finding the focus of a lens or a combination of lenses; also called focometer.

FOCUS.—1. The point of concentration.

2. A point at which rays of light meet, or seem to meet, after passing through a lens or being reflected from a mirror.

FOCUS RAYS.—A term applied to the Roentgen or X-rays; a peculiar radiation produced in a high vacuum tube whenever cathode rays strike some solid substance, the method employed is to apply a high tension current to a vacuum tube having electrodes sealed in its ends.

FOCUS TUBE.—A device for the production of X-rays, consisting of a glass tube with electrodes sealed in the ends and having the air exhausted as completely as possible, the efficiency of the tube depending on the degree of vacuum.

FOCUSING ARC LAMP.—An arc lamp having both carbons automatically movable at their respective rates of consumption so as to maintain the arc at the focus of a lens or reflector; an important consideration in lighthouse and lantern work.

FOG, ELECTRIC.—A fog which sometimes arises when the atmosphere contains an unusual amount of free electricity.

FOIL BRUSH.—A dynamo or motor commutator brush composed of metallic foil, especially copper foil.

FOILED CONDUCTOR.—A conductor having an outside coating of tin foil.

FOLLOW CURRENT ARRESTER.—A lightning arrester that permits follow current to flow and then puts out the follow current. This method of putting out the follow current may be by means of a magnetic blowout; the change in characteristics of metal vapor preventing the reversal of current; or allowing the heat of an arc to draw it out and break it as in the horn gap type.

FOLLOW CURRENT OF LIGHTNING ARRESTER.—The normal or generated current of the circuit which flows through the path formed by the surge current.

FOLLOWING HORNS. — The projecting edges of the pole-pieces of a dynamo which extend in a direction opposite to the rotation of the armature; the poles toward which the armature turns.

FOOT CANDLE.—A unit of illumination, being the intensity of light of a standard candle at the distance of one foot. It is the illumination received when one lumen of light falls on one square foot of area. A fair idea of the illumination represented by one foot candle can be obtained by holding a piece of paper one foot away in a horizontal direction from an ordinary wax candle, or about five feet away from an ordinary 25 watt (that is, 25 candle) lamp. 1 foot candle =10.76 lux (international) =11.95 meter-Hefners=1.0764 milliphot.

FOOT GRAIN.—A section of wire one foot in length and weighing one grain, taken as a unit in measuring resistance.

FOOT LAMBERT.—In illumination, a unit of brightness; one lumen emitted or reflected per square foot of surface.

FOOT POUND.—A unit of work. It is the work done when a weight of one pound is raised to the height of one foot.

FOOT VALVE.—The lowermost valve in a pump through which the fluid is drawn into the working barrel or pump chamber.

2. An upward opening valve placed at the lower end of a pipe to prevent the liquid escaping.

FORCE.—A pressure exerted upon a body so as to produce a change, or a tendency to change its state of rest or motion.

FORCE FIT.—A shop term for that class of fit where a shaft is turned so much larger than its hole that a screw or hydraulic press, or the application of heat to the female piece is necessary to get the pieces together.

FORCED DRAUGHT.—The acceleration of combustion in steam boilers by forcing air through the bed of fuel on the grate. Sufficient chimney capacity is necessary to draw the gases through the boiler and smoke flue, but the draught is small compared to that required to force the air through the fire, a very short "delivery stack" being sufficient. A fan blower delivers air under pressure into an air tight ash pit. In some marine installations the boiler room is entirely enclosed and provided with air locks for the passage of the attendants. The fans discharge into the boiler room and maintain a static pressure of from ¾ to 3 inches of water according to requirements.

FORCED DRAUGHT OR AIR BLAST TRANSFORMER.—A type in which the case is closed at the bottom and open at the top. A current of air is forced through from bottom to top going through ducts, provided between the coils and between sectionalized portions of the core. The cold air is forced through the interior of the core containing the coils, the air passing vertically by a blower, through the coils and out through the top. The amount of air going through the coils may be controlled independently by providing dampers in the passages. About 100 cu. ft. of air per minute per total kw. loss is ordinarily used for transformers which are not designed to operate above their rated capacity. Air blast transformers require a large volume of air at a comparatively low pressure. This varies from 1 to 1½ ozs. per sq. in. The larger transformers require greater pressure to overcome the resistance of longer air ducts.

FORCED OIL COOLED TRANSFORMER.—In this type the cooling of the core and windings is effected by forced circulation of the oil through the tank by means of piping and an external pump. The oil is cooled by being pumped through piping or radiators or through cooling coil immersed in running water. This method of cooling is usually used only when water cooled transformers are prohibited by lack of suitable water.

FORCED OSCILLATIONS.—In radio, oscillations impressed upon an oscillating circuit not in tune with the natural frequency of the circuit.

FOREBAY.—The end of a mill race, next the wheel, or that part of a race above the flume or chute of a turbine water wheel.

FORESHORTENING. — Apparent decrease in length, owing to objects being viewed obliquely; thus, a wheel, when seen obliquely, instead of appearing round, presents the appearance of an ellipse.

FORESTALL.—In automatic train control, the operation of a specific part of the automatic train control device in response to an acknowledgment by the engineman, which prevents an application of the brakes.

FORKED CIRCUITS.—A number of circuits which diverge from a central point, being one of the methods of wiring employed in telegraphy.

FORKED LIGHTNING.—A form of lightning discharge which seems to split into branches or to follow a zigzag path; zigzag lightning.

FORM FACTOR.—A term introduced by Fleming, which denotes the ratio of the virtual value of an alternating wave to the average value. That is form factor =virtual value÷average value, which for a wave corresponding to the sine curve=.707÷.637=1.11. The form factor of a wave shape is significant for certain purposes, as for example in the determination of hysteresis losses in a transformer, in which case the loss becomes greater as the form factor becomes less and vice versa under constant r.m.s. supply voltages of different wave shapes. A peaked wave has a higher form factor than a flat topped wave.

FORM WOUND COIL.—An armature coil prepared upon a form to the shape of an irregular rectangle so as to exactly fit the place intended for it upon the armature core.

FORMED PLATES.—Lead plates prepared for use in secondary cells.

FORMER.—A template or shape sometimes used for winding armature coils before placing them on the armature core.

FORMER COIL.—An armature coil wound complete upon a former before being placed upon the armature. Evolute and diamond or hair pin loop coils are types of former coils.

FORMING BLOCK.—In a multiple telephone switchboard, a block employed to hold spring jack connections before joining them up with the line conductors, preparatory to fitting them into the switchboard.

FORMING PROCESS.—The preparation of the lead plates of a storage battery in which they are subjected repeatedly to the action of reversed currents while immersed in dilute sulphuric acid, until the anode plate becomes coated with a semi-porous film of brown dioxide of lead and the cathode plate assumes a spongy metallic state.

FORMULA.—1. A prescribed form, principle or rule expressed in mathematical terms, chemical symbols, etc.

2. An arithmetical formula is a general rule of arithmetic expressed by signs.

3. The Latin plural formulæ (æ pronounced like the letter i) should be used instead of the English formulas on account of the disagreeable sound of the last syllable.

FORWARD LEAD OF BRUSHES.—A displacement of the brushes upon the commutator of a dynamo in advance of the normal neutral plane. Forward lead is preferably called positive lead.

FORWARD PITCH.—In armature winding a right hand pitch as viewed from the commutator end.

FOUCAULT CURRENTS.—Stray currents which are liable to be set up in the core of an armature, because the iron of the core cuts the flux in the same manner that the windings do. To prevent these local currents, usually known as eddy currents, the armature is built up of laminations consisting of thin stampings of steel.

When the construction of the armature core and inductors does not fulfil the necessary conditions required for the prevention of eddy currents, such as the laminations not being sufficiently insulated or numerous enough, a great heating of the whole of the armature results, which may even extend to the bearings. There is no remedy for this defect other than the purchase of a new armature, or the entire reconstruction of the old. The fault may be detected by exciting the field magnets and running the machine on open circuit, with the brushes raised off the commutator for some time, when the armature will be found to be excessively heated.

FOUCAULT, JEAN BERNARD LEON.—Born 1819, died 1868. A French scientist and inventor, noted for his optical researches and his investigations in connection with eddy currents in an electromagnetic field.

FOUNDATION FRAME.—One of the component parts of a motor or dynamo, consisting of a bed plate or base upon which the coils are erected, and having arms or standards which carry the main bearings. Preferably called bed plate.

FOUR CYCLE.—In gas engines, the cycle of operations occupying four strokes or two complete revolutions. On the first forward stroke, an explosive mixture of gas and air is brought into the cylinder by suction, and compressed by the return or second stroke. The mixture is ignited by an electric spark just before the completion of this stroke. The resulting explosion produces a high pressure within the cylinder, which causes the impulse during the third or power stroke; on the return or fourth stroke, the products of the combustion are exhausted into the air, completing the cycle. The term four cycle is understood to mean four stroke cycle.

FOUR ELEMENT TUBE; DOUBLE GRID TYPE.—A radio tube having a filament, plate and two grids. The grid nearer the filament may be given a positive voltage or positive charge so that it neutralizes the space charge, allowing greater emission of electrons from the filament so that they may be more easily attracted to the plate. The grid nearer the plate is then used for control of plate current in the ordinary manner.

FOUR ELEMENT TUBE; HEATER TYPE.—A radio tube having a filament, plate, grid and a fourth element or heater for heating the filament. The constantly increasing use of alternating current for lighting homes has resulted in the adaptation of the vacuum tube as an eliminator of the A battery by heating the filament of the tube by alternating current, hence the fourth or heater element.

FOUR POLE SWITCH.—A type of switch designed to control four circuits. Note that the number of points (referring to a single pole switch) is equal to the number of live contacts, not including the pivot contact. That is, one less than the number of external wires.

FOUR WAY SWITCH.—A switch which connects one conductor to any one of four other conductors.

FOUR WIRE SYSTEM.—A system of electric distribution based upon the principle of the three wire system, having in this case four conductors leading from three dynamos.

FOUR WIRE THREE PHASE TRANSFORMER CONNECTION.—When the secondaries of three transformers are star connected, a fourth wire may be run from the neutral point, thus obtaining the four wire system. The voltage between any main wire and the neutral will be 57 per cent of the voltage between any two main wires. For general distribution this system is desirable, requiring less copper and greater flexibility than other systems.

FOUR WIRE TWO PHASE CIRCUIT.—A circuit consisting of four separate wires for the transmission of two phase currents.

FOURNEYRON TURBINE.—A radial outward flow water wheel, consisting of a fixed wheel with guide plates, in which the water acquires a rotary motion before entering the movable wheel, which it causes to rotate by pressure or reaction on curved vanes. The turbine rotates in a horizontal plane with a vertical spindle.

FOURTH CIRCUIT.—In the Cockaday radio, a sensitizing circuit for controlling oscillation of the regenerative detector.

FOURTH DIMENSION.—A term used in measurements; an extension of the conception of the three dimensions, length, breadth and thickness. The calculations relating to the fourth dimension belong exclusively to higher mathematics and are based upon assumptions rather than direct measurements. Thus, it is assumed: a, that space is extended in length, breadth and thickness without limits, also without properties dependent either upon position or direction; b, that this space is affected with such curvature that a right line shall always return into itself at the end of a finite and real distance without losing in any part of its course that symmetry with respect to space on all sides of it, which constitutes the fundamental property of our idea of it

FRACTION.—A quantity less than a unit or whole number. Fractions take their name and value from the number of parts into which the unit is divided. Thus, if the unit be divided into 2 equal parts, one of these parts is called one-half, if divided into 3 equal parts, one of these parts is called one-third, etc. To express a fraction by figures two numbers are required: one to express the number of parts into which the unit is divided (the denominator) and the other to express the number of these parts taken (the numerator).

FRACTIONAL DISTILLATION.—A process of distillation by which a solution containing a mixture of liquids having different boiling points may be separated into its constituents by increasing the heat, step by step, according to the varying degrees of volatilization.

FRACTIONAL ELECTROLYSIS.—Electrolysis of one substance after another by the application of voltage in increasing proportions.

FRACTIONAL HORSE POWER MOTOR.—A motor built on a frame smaller than that having a continuous rating of 1 h.p. open type at 1700-1750 r.p.m.—NEMA.

FRACTIONAL PITCH WINDING. — An armature winding in which the span of the coil is smaller than the pole pitch, also called short chord winding. One of the chief advantages relates to the shorter length of the end connections, which effects a saving in copper, armature resistance, and overall length of the armature.

FRAMING POLES.—In transmission line construction framing poles consists of several operations: a, trimming; b, shaving; c, roofing; d, gaining; e, boring.

FRANKLIN, BENJAMIN.—Born 1706, died 1790. An American scientist, philosopher and statesman. He demonstrated the identity of lightning with electricity by his famous kite experiment (1752), and as a result invented the lightning rod; observing the waste of heat in open fire places he devised the Franklin stove; he constructed a lamp which anticipated the principle of the Argand burner; he improved the printing press, invented double spectacles and made many other inventions that contributed to the advancement of mankind.

FRANKLIN INSTITUTE SYSTEM OF SCREW THREADS.—The Sellers standard scale of screw threads, in which the characteristic is that the angle of the sides is 60°, and ⅛ of the thread is flat at top and bottom; this varies from the Whitworth scale, in which the angle is

55°, and 1-6 of the thread is rounded at top and bottom.

FRANKLIN'S KITE EXPERIMENT.—In 1749 Benjamin Franklin set up a kite during the passing of a storm, and found the wetted string to conduct electricity to the earth, and to yield abundance of sparks. These he drew from a key tied to the string, a silk ribbon being interposed between his hand and the key for safety. Leyden jars could be charged, and all other electrical effects produced, by the sparks furnished from the clouds. The proof of the identity was complete. The kite experiment was repeated by Romas, who drew from a metallic string sparks 9 feet long. In 1753 Richmann, of St. Petersburg, who was experimenting with a similar apparatus, was struck by a sudden discharge and killed.

FRAUNHOFER'S LINES.—A large number of dark lines seen in the spectrum of the light of the sun.

FREE ALTERNATING CURRENT.—An oscillating current.

FREE CHARGE.—The state of electricity upon a charged conductor when isolated from a charge of opposite sign.

FREE ELECTRICITY.—The ordinary state of electricity upon a charged conductor, not in the presence of a charge of the opposite kind. A free charge will flow away to the earth if a conducting path be provided.

FREE MAGNETIC POLE.—A pole in a magnetic substance which seems to exist without reference to an opposite pole.

FREE MAGNETISM.—That part of the magnetism of a magnetized body which does not follow the magnetic circuit through the metal, but finds a path from the surface of the magnet through the air; surface magnetization.

FREE OSCILLATIONS.—In radio, oscillations where frequency is determined by the inductance and capacity in the circuit in which they occur.

FREEZING OF ELECTROLYTE.—In a storage battery the freezing point of electrolyte depends upon its specific gravity. There is little danger of freezing except with a discharged battery. Water freezes at 32° F. Hence, if the battery were to be discharged by some means to the point of where the electrolyte is near the gravity of water, the electrolyte would of course freeze near this point. In order to avoid freezing of the electrolyte, the battery should always be kept in a fully charged condition. If water be added to a battery in freezing weather, and then not stirred in with the solution by charging the battery, it will remain on top of the solution and freeze. If the electrolyte become frozen, the expansion will sometimes break the jar. If it do not, simply place it in a warm place and it will come back to its normal charge. It is best, however, to recharge it first and then pour out the old electrolyte and put in new electrolyte of a specific gravity of 1.300.

FREEZING POINT.—The point at which a liquid tends to become a solid by loss of heat. The freezing point of water is 32° F. when the barometer reads 29.921 ins. This reading (29.921) = standard atmosphere = 14.696 lbs. per sq. in. according to Marks and Davis.

FRENCH STANDARD SCREW THREAD.—The form of the thread is the same as the U. S. standard thread. The International standard thread.

FREQUENCIES IN SERVICE.—In a.c. circuits 25 cycle frequency is used for conversion to d.c., for a.c. railways, and for machines of large size; the 60 cycle frequency is used for general distribution for lighting and power. The frequency of 40 cycles, which once was introduced as a compromise between 25 and 60 has been found not desirable, as it is somewhat low for general distribution, and higher than desirable for conversion to d.c.

FREQUENCY.—The number of cycles of the alternating current per second. In a two pole machine, the frequency is the same as the number of revolutions per second, but in multipolar machines, it is greater in proportion to the number of pairs of poles per phase. Thus, in an 8 pole machine, there will be four cycles per revolution. If the speed be 900 revolutions per minute, the frequency is

$$\frac{8}{2}\times\frac{900}{60}=60\sim$$

The symbol $\sim$ is read "cycles per second."

Rule: Frequency = the revolution of armature per second multiplied by one-half the number of poles per phase. In commercial machines the two standard frequencies are 25 and 60 cycles.

FREQUENCY CARRIER.—In radio transmission, the continuous wave upon which audio frequency waves are superimposed.

FREQUENCY CHANGER.—A frequency changing set.

FREQUENCY CHANGING SET.—A combination of a synchronous motor and an alternator wound to give a desired change in frequency. Sometimes called frequency converter but preferably frequency changer.

FREQUENCY CONVERTER.—A machine (preferably called a frequency changer) which converts alternating current at one frequency into alternating current of another frequency, with or without a change in the number of phases or voltage.

FREQUENCY EFFECT.—In the case of an a.c. transmission line alone; the lower frequencies are the more desirable, in that they tend to reduce the inductance drop and charging current. The inductance drop is proportional to the frequency. The natural period of a line, with distributed inductance and capacity, is approximately given by

$$P = 7900 \div \sqrt{LC}$$

where L is the total inductance in millihenrys, and C the total capacity in micro-farads.

FREQUENCY FORMULA.—The frequency of an alternator obtained at the slip rings will depend on the speed of rotation, the number of poles for which the changer is wound and the frequency of the supply circuit. The formula is:

$$N = \frac{\text{r.p.m.} \times \frac{P}{2}}{60} + \text{line frequency}$$

or excitation frequency.

N=slip ring frequency
P=number of poles
r.p.m.—revolutions per minute.

Example.—Assume 60 cycle excitation and a 6 pole machine at 1,200 r.p.m. then

$$\frac{1{,}200 \times \frac{6}{2}}{60} + 60 = 120 \text{ cycles.}$$

FREQUENCY METER.—An instrument used for determining the frequency, or number of cycles per second of an alternating current. There are several forms of frequency indicator, whose principle of operation differs, and according to which, they may be classed as: a, synchronous motor type; b, resonance type; c, induction type. In the synchronous motor type a small synchronous motor is connected in the circuit of the current whose frequency is to be measured. After determining the revolutions per minute by using a revolution counter, the frequency is easily calculated as follows:

$$\text{frequency} = (\text{revolutions per second} \times \text{number of poles}) \div 2.$$

In the resonance type a pendulum or reed of given length is utilized which responds to periodic forces having the same natural period as itself. In the induction type two volt meter electro-magnets act in opposition on a disc attached to the pointer shaft. One of the magnets is in series with an inductance, and the other with a resistance, so that any change in the frequency will unbalance the forces acting on the shaft and cause the pointer to assume a new position, when the forces are again balanced.

FREQUENCY MULTIPLIER.—1. A form of converter for obtaining harmonic frequencies from an applied frequency.

2. In radio, a frequency changer which multiplies the frequency of an a.c. by a whole number.—I.R.E.

FREQUENCY RELAY.—One which functions at a predetermined value of frequency. A frequency relay may be either an over-frequency relay or an under-frequency relay.—NEMA.

FRESHENING CHARGE.—A charge given to a storage battery which has been standing idle, to keep it fully charged.

FRICTION GEARING.—Any combination of elements used to transmit power or motion by frictional contact. Sometimes used in a restricted sense for friction wheels alone.

FRICTION TAPE. — Cotton tape impregnated with a sticky, moisture repellant compound.

FRICTION WHEELS. — Wheels for the transmission of power by frictional contact; made as spur wheels and pinions, or bevel and miter wheels, the teeth being replaced either by compressed paper fillers, leather or other lining, or plain metallic surfaces.

FRICTIONAL ELECTRIC MACHINE.—A machine for the development of electricity by friction. In construction, a glass cylinder revolves around a horizontal axis which is turned by means of one or two wooden handles. On one side there is a leather cushion covered with amalgam of zinc or tin pressing against it, and a piece of silk extending from this cushion covers the upper part of the cylinder. On the other side there stands a brass cylinder, with a rod extending toward the glass cylinder and provided with sharp points (like a comb). In operation, the rubbing element becomes negatively and the glass positively excited. The comb becomes charged by induction. The machine will develop electricity best if a conductor attached to the rubbing element be connected with the ground, as by a chain.

FRICTIONAL ELECTRICITY.—Electricity generated by friction. The terms frictional-electricity, galvanic-electricity, etc., though convenient for distinguishing their origin, have no longer the significance formerly attributed to them as representing different kinds of the electric force.

FRICTIONAL HEAD.—In hydraulics, increase or decrease of the pressure of fluids in piping due to their friction upon the sides thereof. Thus, in forcing water through pipes, the friction within the mains augments the head to be overcome by the pumps, while the friction of water on the sides of a flume, will, to a certain extent, destroy the head of water available for power. Preferably called dynamic head.

FRICTIONAL LOSS.—In an engine or machine, the energy dissipated in overcoming the friction or internal resistance of the mechanism. According to Prof. Thurston's tests on a 8x14 straight line steam engine, the results were as follows: i.h.p. from 7.41 to 57.54, the friction h.p. varied irregularly between 1.97 and 4.02, the variation being independent of the load. With 50 h.p. on the brake the i.h.p. was only 52.6, the friction being only 2.6 h.p. or about 5%. Tests show that the friction of any engine is practically constant under all loads.

FRINGE HOWL.—In radio receivers, a piercing sound heard when the set is at the point of oscillation.

FRINGE OF MAGNETIC FIELD.—The dissipation of free lines of magnetic flux in regions outside of the magnetic field proper.

FROG GALVANOSCOPE.—The hind legs of a recently killed frog. Galvani observed spasmodic contractions in the legs of freshly killed frogs under the influence of the "return shock" experienced every time a neighboring electric machine was discharged. As directed by Galvani, after the animal has been killed the hind limbs are detached and skinned; the crural nerves and their attachments to the lumbar vertebræ remaining. For some hours after death the limbs retain their contractile power. The frog's limbs thus prepared form an excessively delicate galvanoscope.

FRONT END OF ARMATURE.—The end of a dynamo or other rotating machine upon which the commutator is mounted; the commutator end.

FRONT OF MACHINE.—Usually the end of the machine at which the commutator or collector rings are found.—NEMA.

FRONT STOP OF KEY.—A stop on the front of a telegraph key to restrict its downward movement.

FROST ALARM.—An alarm which rings by an electric mechanism when the temperature falls below freezing.

FRUSTUM.—That which is left of a cone or pyramid after the upper part has been cut off by a plane parallel with the base.

FRYING OF ARC.—The peculiar hissing sound which is produced when the carbons of an arc lamp are too near each other; a hissing or noisy arc.

FULCRUM.—A prop or support; that by which a lever is sustained or about which it turns in lifting or moving a body; in the operation of the lever, three points are to be considered: a, the fulcrum or point about which the bar turns; b, the point where the force is applied, and c, the point where the weight is applied.

FULGURATION.—In electro-therapeutics, the treatment of malignant growths by means of a high tension, high frequency current of relatively low amperage applied with a cooled long spark to the area from which the growth has been removed.

FULGURITE.—A tubular mass of vitrified sand supposed to be produced by lightning entering the ground.

FULL ARC.—A term sometimes applied to an arc lamp of 2,000 nominal candle power.

FULL BATTERY.—In quadruplex telegraphy, the two parts of the battery introduced together to produce the whole power.

FULL CAPACITY TAP.—A tap from a transformer winding on which the unit may be operated at rated kilovolt ampere capacity without exceeding the specified temperature rise.—NEMA.

FULL MAGNETIC CONTROLLER.—One having all of its basic functions performed by electro-magnets.—NEMA.

FULL WAVE RECTIFIER.—A vacuum tube having a filament and two plates. The hook up is such that in operation one plate is positive during the positive half of the cycle and the other plate is positive during the negative half of the cycle. This results in a uni-directional flow during both halves of the cycle.

FULLER BICHROMATE CELL.—In the bichromate primary cells or the chromic acid cells, bichromate of soda, or bichromate of potassium is used for the depolarizer, water and sulphuric acid being added for attacking the zinc. The Fuller cell is of the two fluid type. A pyramidal block of zinc at the end of a metallic rod covered with gutta percha is placed in the bottom of a porous cup containing an ounce of mercury. The cup is then filled with a very dilute solution of sulphuric acid or water and placed in a jar of glass or earthenware containing the bichromate solution and the carbon plate. Is suited to open circuit, or semi-closed circuit work.

FULLER BOARD.—A fibrous material much harder than paper. It is flexible, durable, and is largely used in insulating the coils of electric machines; also known as presspahn.

FUNDAMENTAL FREQUENCY.—The lowest component frequency of a periodic wave or quantity.

FUNDAMENTAL UNITS.—The units of length, mass and time in terms of which all other units can be expressed.

FUNDAMENTAL WAVE LENGTH. — In radio, the wave length that will produce free oscillations in a circuit. This obtains at the frequency at which the inductance and capacity are resonant in the antenna circuit.

FUNNEL ANTENNA.—In radio an arrangement of the aerial wires in a funnel shaped group the better appropriation of passing electric impulses.

FURNACE, ELECTRIC.—A furnace heated by electricity for performing difficult or unusual fusions, especially in metallurgical processes. There are numerous types of electric furnaces classed as: a, resistance; b, resistor; c, charge resistance; d, arc; e, direct arc; f, indirect arc; g, smothered arc; h, induction; i, low frequency; j, high frequency.

FURRING STRIPS.—In house wiring, after locating the outlets a small portion of flooring is removed to find out whether or not there are seven-eighth inch furring strips between the joists and the ceiling plaster. If a house have hot air registers set in the floors, they may be lifted up, instead of taking up flooring. If it be found that there are furring strips, much labor will be saved, as the wires may then be fished from outlet to outlet and little flooring need be removed. All houses, however, are not so built, so in case there be no furring strips it will be necessary to take up the floor and bore a hole in each joist or beam.

FUSE.—A protective device having a strip or wire of fusible metal which when placed in a circuit will melt and break the circuit when subjected to a temperature beyond that due to maximum current that the circuit will safely carry. There are numerous types of fuse. In wiring, all branch lines should be fused at the junction with the main line, and all electrical apparatus, if not protected by some other automatic device, should be protected individually by fuses.

FUSE ALLOY.—An alloy of lead with a small percentage of tin, used for electric safety fuses because it readily melts under the heat of an electric current when the current becomes too strong for the safety of the circuit.

FUSE BLOCK.—A block of porcelain or other insulating material upon which one or more safety fuses are mounted.

FUSE BOARD.—A slab of slate upon which safety fuses are mounted.

FUSE CHARACTERISTICS.—The operation of fuses differs from plain overload circuit breakers in that they are governed by both the time and quantity of the current. Standard fuses will open the circuit at as small an overload as 25% in a certain time, and in a proportionately shorter time at greater overloads. The time element is dependent upon the capacity of the fuse as well as on the amount of overload, the relatively greater amount of metal in the larger sizes of fuses requiring a longer time to reach the maximum temperature.

FUSE CLASSIFICATION.—Fuses may be divided into two general classes:

1. Those designed to protect the circuit and apparatus against both short circuits and definite amounts of overloads.
2. Those designed to protect the system only against short circuits.

To the first class belong link and enclosed fuses of the National Electrical Code that opens on 25% overload. To the second belong the expulsion fuses, which blow at several times the current they are designed to carry continuously. Fuses are especially suitable for protecting motor circuits, because they will carry an overload for a short time, but open if the overload continue.

FUSE LINKS.—Links of fusible material designed for safety fuses.

FUSE PRECAUTIONS.—To avoid trouble the following precautions should be taken in the selection and use of fuses:

1. Use only fuses approved by the Underwriters. If such fuses blow, correct the trouble before installing new fuses.
2. See that the fuse terminals and the

fuse clips are clean, that good contact is made between the fuse terminals and clips, and that the clips are securely fastened to the bases.

3. Use only the renewals intended for a renewable fuse.

4. Do not use ordinary fuse wire or other material for renewals. To do so will cause a severe fire menace.

5. When renewing a renewable fuse, see that the links and contacts are clean, and that the links are securely fastened.

6. Do not omit any part, as each part is necessary to make the fuse 100% safe.

FUSELAGE.—A term sometimes used for an airplane body.

FUSIBLE ALLOY.—An alloy which will melt at a comparatively low temperature, employed for safety fuses in electric circuits and for the filling of safety plugs in boilers. An alloy of one part tin, two of bismuth and one of lead will fuse at 100° C.

FUSIBLE ARRESTER.—A safety fuse.

FUSIBLE PLUG.—A safety device for a steam boiler which acts in case of dangerously low water. It consists of a core of an alloy of tin, lead and bismuth, and a covering of brass or cast iron. A fusible plug is expected to fuse at its melting point; however, fusible plugs are unreliable, blowing out when there is no apparent cause, and sometimes remaining intact when the plates become overheated.

FUSING CURRENT.—The current required to melt a safety fuse.

FUSING OF HOUSE CIRCUITS.—According to Underwriter's Code, for lighting circuits no fuse larger than 10 amperes may be used except with special permission from the local inspector or where all the lights are controlled by one switch; also no lighting circuit should have a load in excess of 660 watts except in factories where all the lights are connected with porcelain sockets and a wire not smaller than a No. 14 is used, but in houses the 660 watt rule must prevail.

FYNN-WEICHSEL MOTOR.—A slip ring induction-synchronous motor; that is, it starts as a slip ring induction motor and after attaining synchronous speed it becomes a self-excited synchronous motor. Moreover, if over loaded it drops out of step and operates as an induction motor, resuming synchronous operation if the excess load be removed. The motor consists of a stator with starting and operating field windings and a rotor field with windings carrying the load and exciting currents. The rotor windings are connected to a commutator and slip rings of the usual construction. Brushes bearing on the commutator suitably interconnect the stator and rotor windings. The motor is a general purpose motor that operates at unity power factor, or in other words, a motor that furnishes its own magnetizing current. The Fynn-Weichsel motor was produced in response to this need and according to the claims of the manufacturer (Wagner) not only accomplishes this, but in addition corrects low power factor due to other motors on the line, that is, furnishes magnetizing current for induction motors as well as for itself.

G

G.—1. A signal in telegraphy for "go ahead."

2. An abbreviation for gram, the unit of mass in the Centimeter Gram Second system.

3. The symbol for the unit of conductance. The mho.

g.—Symbol for acceleration due to gravity.

GAIN.—1. In a radio circuit, the ratio of the output to the input.

2. A broad notch cut into a telegraph pole to accommodate the cross arms; also a steel channel sometimes employed for the same purpose to save cutting the pole.

GAIN PLATE OF VOLTAMETER.—The plate in a metal voltameter at the cathode, and hence the one on which the metal dissolved from the anode is deposited, increasing its weight.

GALENA.—A bluish gray mineral, from which most of the lead of commerce is obtained; native sulphide of lead; used in the form of a powder to glaze pottery.

GALENA DETECTOR.—A radio crystal detector using a natural crystal sulphide of lead called galena.

GALVANIC ADAPTER.—A device for deriving from an electric light circuit continuous currents adapted for use in medical treatment.

GALVANIC ARC.—An occasional and unusual term for voltaic arc.

GALVANIC BATTERY.—A name sometimes given to a primary battery.

GALVANIC CAUTERY.—A method of searing the flesh in medical treatment by the heat of an electric current; an electric cautery.

GALVANIC CELL.—A name sometimes given to a primary or voltaic cell.

GALVANIC COUPLE.—Two dissimilar metals associated together as elements in an electrolytic cell for the generation of electricity, as zinc and carbon electrodes of a primary cell.

GALVANIC CURRENT.—In electro-therapy a smooth or even current, obtained from a copper oxide rectifier which changes the a.c. to d.c. The galvanic current then passes to a choke coil and condenser, known as the filter circuit, where all ripples or pulsations are removed or filtered out. On account of its polar effects galvanic current is indicated in ionization, electrolysis, etc. The positive pole is acid, vaso-constrictor, sedative and hardens tissue. The negative pole is alkaline, vasodilator, irritating and softens tissue. In ionization, a simple rule to use is to consider what part of the solution it is desired to drive into the tissues, and put it on the pole corresponding to its own polarity.

GALVANIC FLUID.—An early name for the electric current, given in honor of Galvani who discovered current electricity in 1786 as the result of his famous experiments with the legs of a frog.

GALVANIC IRRITABILITY.—Contractions of muscular tissue caused by a galvanic current.

GALVANIC MULTIPLIER.—A name formerly given to the galvanometer.

GALVANIC PILE.—A name sometimes given to the apparatus devised by Volta for generating electricity and usually known as the voltaic pile. It consists of a series of pairs of discs of zinc and copper in contact, each pair being separated by a piece of flannel or blotter moistened with brine, and arranged one on top of another. By connecting the top and bottom disc, an electric current will pass.

GALVANIC POLARIZATION.—An occasional term for the polarization of a voltaic cell.

GALVANIC SINUSOIDAL CURRENT.—In electro-therapeutics, this was formerly called the slow sinusoidal. It is an alternating galvanic current with slight polar effects and acts favorably on unstriated muscular tissues. Adjustment 10 to 90 pulsations per minute. C. F. Voyles recommends this modality as a mechanical exercise for atony of the colon and states that for stronger effect the rapid sinusoidal wave or super-imposed wave may be substituted. He states that cases have been reported in which this treatment corrected incompetency of the ileocecal valve. Neiswanger recommends this for treating paralyzed muscles and terms it "practically a perfect imitation of the natural contractions that build muscular strength. It has a marked effect upon cellular metabolism and in building up secretory function, as for example: a prostate with poor secretion."

GALVANIC TASTE.—A peculiar taste noticeable when two wires from a primary cell are touched by the tongue.

GALVANIC WAVE SUSTAINED PEAK CURRENT.—In electro-therapeutics, a form of pulsating current which rises abruptly from zero to a peak. The current is maintained at the maximum for almost one-half phase and decreases to zero as abruptly as it rose from zero. Somewhat similar to the interrupted galvanic, except that it does not rise to the peak so abruptly and again there is no rest period between the waves. Its greatest value lies in intestinal atony with muscular degeneration. A very good wave current with full polarity effect.

GALVANI'S FROG.—To illustrate muscular contractions, the limbs of a frog are prepared (as directed by Galvani) as follows: After the animal has been killed the hind limbs are detached and skinned; the crural nerves and their attachments to the lumbar vertebræ remaining. For some hours after death the limbs retain their contractile power. The frog's limbs thus prepared form an excessively delicate galvanoscope.

GALVANIZED IRON WIRE.—This kind of wire is largely used for telegraph and telephone lines, although it is rapidly being replaced by copper in long lines. Made in sizes 4 to 12 B.w.g.

GALVANIZED SHEET METAL.—This usually means iron or steel coated with zinc by immersion in a molten bath of that metal, without galvanization. Galvanizing sheet metal protects it against corrosion, the zinc becoming covered with a film of zinc carbonate which protects the metal from further chemical action. If the galvanizing be poorly done and the coating do not adhere properly, and if any acid from the pickle or any chloride from the flux remain on the iron, corrosion takes place under the zinc coating. The zinc used for galvanizing should contain at least 98% pure zinc.

GALVANIZING.—The process of coating metals with zinc to prevent corrosion. A bath containing zinc sulphate, which must only be slightly acid, is employed; as the electrolysis proceeds the solution becomes acid by the zinc being deposited out, and in order to keep the strength of the solution constant, it is circulated through a filter bed containing zinc dust. Zinc anodes are not generally used because they are apt to disintegrate; the anodes usually employed are of lead, but iron is sometimes used. In fact, the presence of a trace of iron in the bath improves the deposit.

GALVANO-CAUSTIC LOOP.—An electric cautery instrument consisting of a loop of platinum wire which, when brought to a white heat by an electric current, is drawn through the parts to be surgically treated.

GALVANO-CAUTERY OR CAUSTRY.—The surgical treatment of the human body such that parts are seared by the heat of a platinum wire made white hot by a current of electricity or by an electric needle.

GALVANO-FARADIZATION.—The use of continuous and interrupted currents simultaneously.

GALVANOMETER.—A current indicator. It consists of a magnetic needle suspended within a coil of wire and free to swing over the face of a graduated dial. The movement of the needle shows the direction of the current, and indicates whether it is a strong or weak one. There are numerous types of galvanometer such as: a, astatic; b, tangent; c, sine; d, differential; e, ballistic; f, D'Arsonval.

GALVANOMETER CONSTANT.—The resistance through which the galvanometer will give a deflection of one scale division when the current applied is at a pressure of one volt. Accordingly, the deflection as indicated on the scale must be multiplied by its constant or figure of merit, in order to obtain the correct reading. If the scale readings be not directly proportional to the quantity to be measured, the law of the instrument must also be considered. Also called figure of merit.

GALVANOMETER PERIOD.—The full undamped period, which is the time in seconds elapsing between two successive passages in the same direction through the position of rest. It is customary to take the period of a critically damped galvanometer as equal to its undamped period, for while the critically damped period is theoretically infinite, practically, a critically damped deflection is within about 1.5% of its final position in the undamped periodic time. While the full undamped period is stated for ballistic galvanometers, the quarter period (or the time for the initial deflection away from zero) is of principal interest in ballistic measurements. When critically damped, the time for the quarter period is obtained by dividing the undamped quarter period by 2×3.1416.

GALVANOMETER, POSITION OF INSTABILITY.—The position of the needle beyond which the rotation of the coil will cause it to turn all the way round.

GALVANOMETER SENSITIVITY.—A galvanometer characteristic or the electrical conditions required to secure a standard deflection. A galvanometer should have a sensitivity sufficient to permit reading to a degree of precision commensurate with the requirements of the work to be undertaken. It is not desirable to employ a galvanometer having a sensitivity greater than the work demands because this results in working with a galvanometer which is more difficult to use.

GALVANOMETER SHUNT.—A resistance of known value placed across the terminals of a galvanometer so that only a fractional part of the current goes to the galvanometer. By this means the range of measurement of the instrument may be extended.

GALVANOMETER VOLT METER.—A galvanometer designed to measure differences of voltages.

GALVANO - PLASTIC ADHESION. — Adhesion between two surfaces produced by a galvano-plastic deposit.

GALVANO-PLASTIC BATH.—A name formerly given to the solution employed in the preparation of electrotype plates. It consists of an 8 to 10 per cent solution of sulphuric acid in water, in which copper sulphate is dissolved until saturated at ordinary temperatures; an electro-bath.

GALVANO-PLASTIC MATRIX.—A name formerly given to the mould employed in electrotyping.

GALVANO-PLASTIC SOLDERING.—Soldering by an electrolytic deposit.

GALVANO-PLASTICS.—A general term formerly applied to the deposition of metals by electrolysis, especially in electrotyping.

GALVANOPLASTY.—In a restricted sense, the term applies to the production, by the aid of electrolysis, of copies of various articles true to nature, and of such thickness as to form a resisting body which may be removed from the object serving as a mould. The term is sometimes used broadly for electrotyping.

GALVANOSCOPE.—A simple type of galvanometer which serves merely to show the presence of an electric current without measuring its strength. It is an indicator of currents where the movement of the needle shows the direction of the current, and indicates whether it is a strong or a weak one. When the value of the readings has been determined by experiment or calculation any galvanoscope becomes a galvanometer.

GALVANOTONIC CONTRACTION.—A tonic muscular contraction produced by a continuous current of electricity.

GALVANOTONUS.—The state of muscular contraction produced by excessive electric stimulation.

GALVANOTROPISM.—Movements in growing organisms caused by the passing of an electric current through them.

GAMMA AERIAL.—An inverted L type aerial.

GAMMA RAYS.—One of the three different types of radiation emitted from radio-active substances. Gamma rays have the following characteristics: they are not deviated by a magnetic field; they have far greater power of penetrating matter than the alpha or beta rays, but slight energy; they always accompany beta rays. They are not electrically charged particles like the alpha and beta rays, but are waves of motion analagous to if not identical with X rays. Frequencies lying in and above the highest X ray frequencies.

GANG CONDENSER.—In radio, several variable condensers operated from one control.

GANG SWITCH BOX.—A metal fire proof box containing an assembly of switches.

GANTRY CRANE.—In machinery, an overhead traveling crane carried on trussed beams or girders; as, in the erecting department of a machine shop.

GAP.—The distance between the upper and lower wings of a biplane.

GAP WIRE GAUGE.—A wire gauge in which gaps of various sizes are left in the rim of a metal disc into which wire may be fitted for measurement.

GAS.—That fluid form of matter which is elastic and tends to expand indefinitely. A term used at first by chemists as synonymous with air, but since restricted to fluids supposed to be permanently elastic; as, oxygen, hydrogen, etc., in distinction from vapors, as steam, which become liquid on a reduction of temperature.

GAS CELL.—A voltaic cell in which platinum electrodes in contact with hydrogen and oxygen, take the place of the usual zinc and copper plates.

GAS DRIVEN ELECTRIC BUS.—A type of bus whose power unit consists of a gas engine, dynamo, controller and one or more motors. With this outfit, the operator has no clutch to pedal, and has no gears to shift, but obtains acceleration merely by depressing a pedal; this is of importance to him because it vitally affects the two most costly phases of operating expense, namely, labor costs and accidents.

GAS ELECTRIC RAILWAY CARS.—A system having a power unit on each car designed for light traffic and branch line trains, especially to compete with bus lines. Gas electric cars are extensively used and are handling light traffic runs with mileage up to 400 miles per day. The usual gas electric car equipment has two motors operating in series or parallel from one dynamo, which in turn is driven by an internal combustion engine.

GAS JET PHOTOMETER.—A photometer in which a jet of gas of given height, under certain conditions, serves as a standard of illumination.

GAS PHOTO-CELL.—A photo tube in which a quantity of gas has been introduced to increase its sensitivity. Also called gas photo-tube.

GAS PRODUCER.—A form of furnace charged with coke and other carbonaceous fuel through which air and steam are blown forming a mixture of hydrogen, oxygen, carbon monoxide and certain non-combustible gases, which combination is known as producer gas. This gas is an economical fuel, and after purification can be used to drive gas engines.

GAS RECTIFIER.—A soft radio tube.

GAS TIGHT APPARATUS.—Apparatus so constructed that the specified gas will not enter the enclosing case under specified conditions of pressure.—NEMA.

GAS VOLT METER.—A device for measuring the strength of an electric current by determining the volume of gas evolved by the electrolysis which the current produces in a solution through which it is caused to pass.

GAS WELDING.—A method of uniting metal pieces by means of a torch flame of appropriate temperature with the addition of metal of the same composition. The joint thus obtained is called autogenous. The torch used is an instrument in which the flame is produced and projected on the metallic parts to be welded. The flame produced by the torch is of unusually high temperature. An oxy-acetylene torch is generally used giving a temperature of 6300° F.

GASEOUS STEAM.—Descriptive of highly superheated steam. Steam whether superheated or saturated is gaseous. The word gaseous is probably applied because highly gaseous steam will expand in a steam engine cylinder to a considerable degree before the point of saturation is reached. In one of Prof. Carpenter's tests, steam was exhausted from a compound engine still in the super-heated state.

GASKET.—1. The plaited hemp used for packing a piston; as, of a pump or the stuffing box of an engine.

2. Any ring or washer of packing.

3. A thin sheet used in making joints.

GASOLINE.—A volatile distillate from crude petroleum, largely used as a fuel in internal combustion engines. The boiling point of gasoline ranges from 120° to 250° F., with an average range between 149° and 194° F. Its vapor is 3.05 times as heavy as air, and its calorific value is between 18,000 and 20,000 B.t.u.

GASOLINE OR "GAS" ENGINE.—An internal combustion engine in which is utilized the energy contained in a mixture of air and vapor of gasoline, the gasoline fuel being vaporized and mixed with air in a device called a carbureter before it enters the cylinder, and after compression is ignited by an arc or spark furnished by a low tension or high tension ignition system respectively. There are two general classes of gas engine: a, two cycle, and b, four cycle in which the cycle is performed in two or four strokes respectively.

GASSING.—In a storage battery, the giving off of oxygen gas at positive plates and hydrogen at negatives, which begins when the charge is something more than half completed, depending on the rate.

GASSIOT'S CASCADE.—A peculiar effect produced by placing a goblet, having part of its interior surface lined with tinfoil, into an air pump receiver. A wire is inserted from the top of the receiver and projected into the glass without touching the foil. When a partial vacuum is maintained by the pump and a high tension electric current discharged between the wire and the metal of the air pump, a luminous effect is produced, as if pale blue electricity were overflowing the goblet.

GASTROSCOPE, ELECTRIC.—An apparatus for illuminating the human stomach by an incandescent lamp, and permitting a medical examination by prism reflections.

GATE VALVE.—A type of valve having two inclined seats between which the valve wedges down in closing, the passage through the valve being in an uninterrupted line from one end to the other, while the valve, when opened, is drawn up into a dome or recess, thus leaving a straight passage the full diameter of the pipe.

GAUGE.—1. A measure; a standard of measurement; an instrument to determine dimensions or capacity.

2. An instrument used to measure wire.

3. An instrument used to measure the pressure of gases or liquids.

GAUGE PLATES.—In order to conveniently and quickly measure the size of sheet metal or wire, plates, or as they are called "gauges" may be obtained having numbered slots or holes into which the sheet metal or wire may be fitted. These gauges are usually circular or rectangular in shape.

GAUSS.—The unit of magnetic field strength. It is the intensity of field which acts on a unit pole with a force of one dyne. It is equal to one line of force per square centimeter or 6.45 lines per sq. in. of cross section. Named after Karl Friedrich Gauss, the German mathematician.

GAUSS, KARL FRIEDRICH.—Born 1777, died 1855. A German mathematician; founder of the mathematical theory of electricity, and inventor of the bifilar magnetometer (1835).

GAUSS' THEOREM.—The total normal electric induction over a closed surface is 4π times the charge enclosed by the surface.

GAUZE BRUSH.—A commutator brush made up of a sheet of copper gauze, folded several times, with the wires running in an oblique direction, so as to form a solid flat strip of from ¼ to ½ inch in thickness, increasing with the volume of the current to be collected. They make good contact but are expensive. They may be set either tangentially or radially, the latter preferably, since the point of contact remains the same as the brushes wear away.

GEAR.—A word used collectively for an assembly of parts as toothed wheels, chain and sprockets, links, etc., used to transmit motion.

GEISSLER MURCURIAL PUMP.—A form of air pump used in exhausting incandescent lamp bulbs, which produces the vacuum by the suction of mercury drawn through glass tubes.

GEISSLER TUBES.—Tubes of thin glass blown into a great variety of shapes, generally consisting of two bulbs joined by a slender spiral or twisted tube. They are provided with platinum electrodes which are fused into the glass after a partial vacuum has been formed by an air pump, so that by the passage of an electric discharge through them under different conditions a great variety of luminous phenomena may be observed. The color of the light depends upon the kind of glass and upon the gas enclosed. Geissler tubes are sometimes made in beautiful designs. The incandescent lamp is the most common form of the Geissler tube.

GEM LAMP.—A name sometimes given to the "metalized" or "graphitized" filament incandescent lamp.

GENERAL ELECTRIC OSCILLOGRAPH.—A device for measuring wave form consisting primarily of a high period galvanometer and a suitable optical system for directing beams of light from a lamp to mirrors on the galvanometer vibrating elements and from there to a revolving film or to a visual screen. Suitable mechanisms are also provided for controlling the operation of a shutter which by opening and closing, allows the beams of light to strike the film for a single complete revolution of the film drum.

GENERAL PURPOSE MOTOR.—Any motor of 200 or less h.p. and 450 or more r.p.m. having a continuous time rating, and designed, listed or offered in standard ratings for use without restriction to a particular application.—NEMA.

GENERATOR.—A general name given to a machine for transforming mechanical into electrical energy. An objectionable term. Not specific and when qualified, much too long. Why use three long words, as for instance, alternating current generator, in place of one word, alternator. Even when the abbreviations a.c. or d.c. are used the terms are still objectionable and the author can see no reason why such terms are used.

GENERATOR FIELD CONTROL.—A method of control for elevators which employs an individual machine for each elevator, the voltage applied to the elevator motor being varied by varying the strength and direction of the field.

GENERATOR PANEL.—A section of a switchboard which carries the instruments and apparatus for measuring and electrically controlling the machines. On a well designed switchboard each machine has, as a rule, its own panel.

GENERATOR RELAY.—One which indicates an operating value of generator voltage, insures positive building up of the generator, or indicates presence of generator field.—NEMA.

GENERATRIX.—A line point or figure that generates another figure by its motion.

GENEVA INTERMITTENT MOVEMENT.—In a motion picture projector, a device for producing the intermittent movement necessary in projecting motion pictures. The movement consists essentially of an intermittent sprocket and intermittent gear. The sprocket is a cylinder with teeth at each end, or for very light construction, it may consist of two hubs provided with teeth and properly spaced on a shaft to take the film. The teeth mesh with perforations in the film and thus secure a positive movement. Of the various intermittent movements, the Geneva is extensively used and easily understood.

GEOMANTIC LINES OF FORCE.—The lines of force of the earth's magnetism.

GEOMETRY.—That branch of pure mathematics that treats of space and its relations. In other words, it is the science of the mutual relations of points, lines, angles, surfaces and solids, considered as having no properties except those arising from extension and difference of situation. There are several branches of geometry as: a, plane; b, solid; c, spherical; d, descriptive; e, analytical.

GERMAN CANDLE.—A standard of photometric measurement employed in Germany. It is a paraffin candle burning with a flame of 50 millimeters (1.98 ins.) height.

GERMAN SILVER.—An alloy having comparatively low conductivity, composed of copper, zinc and nickel in varying proportions, used in making resistance coils; sometimes called nickel silver. It consists of an alloy of copper two parts, nickel one part, and zinc one part. The variation of its resistance with change of temperature is very small. Specific resistance of German silver in microhms is 1.609.

GERMANIUM.—A metal of gray white color and fine metallic luster. It melts at 1562° F.

GILBERT.—The unit of magnetic pressure. It is equal to the magnetic pressure of .7958 ampere turn.

GILBERT, WILLIAM.—Born 1540, died 1603. An English physicist, noted for his experiments in magnetism, and for the publication in 1600 of his chief work "De Magnete" which marked an epoch in the science of magnetism, and earned for its author the title of the "founder of the science of magnetism and electricity." His work led to further study by other philosophers who discovered other electric and magnetic truths. Gilbert disposed of a number of false ideas connected with electric and magnetic phenomena. He made valuable investigations on the nature and properties of magnetic poles and showed that many other substances besides amber become electrified by rubbing.

GILDER'S WAX.—A fatty, solid substance which is used by gilders to cover those parts of an object which are not intended to be gilded.

GILDING, ELECTRIC.—Depositing a layer of gold by electro-plating. The electric current passes from a plate of pure gold through a bath of cyanide of gold in which the articles to be plated are suspended.

GILLEY-GRAMME MACHINE. — A school demonstration model of a d.c. machine for illustrating the working principles of dynamos and d.c. motors.

GILT PLUMBAGO. — Powdered graphite which has been electro-gilded to increase its conducting power, so that it may be used to advantage in dusting the surfaces of wax or paper pulp moulds in electrotyping, to render them conductive for the deposition of copper.

GIMBALS.—A method of suspension for securing free motion to a compass or chronometer on shipboard, so that it shall always preserve a horizontal position. Gimbals usually consist of a pair of rings moving on pivots in such a way as to have free motion in two directions at right angles, so as to neutralize the motion of the vessel.

GIN POLE.—A contrivance for raising or moving heavy weights, consisting of a strong pole with four ropes fastened at the top end to guide it, and also a block and fall fastened on the top of the pole. Generally a small cross piece, about 8 or 10 ins. down from the top, is nailed on to hold guide lines and hoisting tackle.

GIRDER ARMATURE.—An early form of Siemens armature having a core resembling the letter H.

GIRDER SECTIONS.—Rolled joists and girders of H or I form or similar sections, for use as girders.

GIRDER STAYS.—In boiler setting, the stays of girder form supporting the crown of a combustion chamber.

GIRTH SEAMS.—The seams which pass around the body of the boiler, commonly known as circumferential seams. According to A.S.M.E. Boiler Code: a, the strength of circumferential joints of boilers, the heads of which are not stayed by tubes or through braces shall be at least 50% of that of the longitudinal joints of the same structure; b, when 50% or more of the load which would act on an unstayed solid head of the same diameter as the shell, is relieved by the effect of tubes or through stays, in consequence of the reduction of the area acted on by the pressure and the holding power of the tubes and stays, the strength of the circumferential joints in the shell shall be at least 35% that of the longitudinal joints.

GLAND.—The sliding bushing which holds the packing in a stuffing box; it is usually adjusted by bolts and nuts. Sometimes called a follower.

GLASS.—A hard, brittle, usually transparent substance made by melting together sand or silica with lime, potash, soda or lead oxide. Different qualities of glass such as flint, crown, plate or bottle are made by varying the proportions.

GLASS FUSE.—A fuse enclosed within a glass tube.

GLASS INSULATOR.—A line wire insulator which is cheaper than porcelain, and owing to its transparency can be more easily examined, but glass is less strong both mechanically and electrically, and more apt to collect a film of moisture, and so for high tension transmission, porcelain is almost exclusively employed.

GLASS PLATE CONDENSER.—A type of radio fixed condenser used in transmitting.

GLASS SCREW INSULATOR.—A glass insulator for overhead wiring, designed to screw down upon wooden pins; the ordinary line wire insulator.

GLAZE.—A gloss or smooth transparent surface applied to porcelain, as in the manufacture of insulators for high tension circuits. It is generally composed of an admixture of alkalies with silica, lime, and often oxide or carbonate of lead.

GLAZED COTTON.—Cotton thread tightly twisted and given a hard glossy finish.

GLIDING ANGLE.—The angle of inclination assumed by an airplane when descending with power shut off.

GLIDOMETER.—An instrument on an airplane which indicates the airplane's position relative to the gliding path furnished by a landing beam.

GLOBE STRAIN INSULATOR.—A form of insulator employed in strain, or pullover wires in a trolley line, consisting of a pair of interlocking rings which are kept insulated from each other by means of an insulating ball or globe in which they are embedded; a spherical strain insulator.

GLOVES.—In electric repair work, special rubber gloves are used to prevent the frequent ano often fatal accidents occurring to linemen from shock while handling electric light wires or other wires in contact with the same, and also the dangers of line work from lightning in stormy weather. Gloves are also useful in handling the acids of batteries.

GLOW DISCHARGE.—1. A variety of convective discharge seen at the tip of a pointed conductor.

2. The glow in a tube due to ionization.

3. The corona or luminous discharge along high tension electric transmission lines.

GLOW LIGHT OSCILLOGRAPH.—This device for measuring wave form consists of two aluminum rods in a partially evacuated tube their ends being about two millimeters apart. When an alternating current of any frequency passes between them a sheath of violet light forms on one of the electrodes, passing over to the other when the current reverses during each cycle. The phenomenon may be observed or photographed by means of a revolving mirror.

GLOWER.—In the Nernst lamp, the pencil of refractory oxides which becomes incandescent upon the passage of the electric current.

GLUCINUM.—A rare metallic element of a white color, resembling magnesium in its properties.

GLUE POT, ELECTRIC.—A glue pot provided with an electrical heating arrangement.

GLUT WELD.—A weld in which the ends of the two parts are tapered down, and the angles filled with wedges of iron, the whole being welded together while checking the length with a trammel, excess material being subsequently cut away. This type of weld is generally used in repair work where it is necessary to maintain unchanged the length of the broken part.

GLYPHOGRAPHY.—An electrotype process by which a copy of an engraved plate is obtained in a relief, so that it may be used in letter press printing.

GNEISS.—A crystalline or igneous rock, consisting, like granite, of quartz, feldspar and mica, but having these materials, especially the mica, arranged in planes, so that it breaks rather easily into coarse slabs or flags.

GNOMON, ELECTRIC.—A name sometimes given to a type of pith ball electroscope.

GO DEVIL.—1. The squib or detonator which is dropped down a drilled well to explode the nitro-glycerin used to "shoot" it.

2. A scraper with self-adjusting spring blades, inserted in a pipe line and carried forward by the fluid pressure, clearing away accumulations in the walls of the pipe.

GOLD.—A conductor of electricity, noted for its beautiful yellow color, ductility, malleability, and freedom from liability to rust or tarnish. Its specific gravity is 19.3 and melting point 2000° F.

GOLD BATH.—A solution of cyanide of gold in which articles are suspended for electro-plating with gold, or electro-gilding.

GOLD LEAF ELECTROSCOPE.—A sensitive electroscope having two narrow strips of gold leaf suspended within a wide mouthed glass jar, which both serves to protect them from draughts of air and to support them from contact with the ground. A piece of varnished glass tube is pushed through the cork, which should be varnished with shellac or with paraffin wax. Through this passes a stiff brass wire, the lower end of which is bent at a right angle to receive the two strips of gold leaf, while the upper end is attached to a flat plate of metal, or may be furnished with a brass knob. When kept dry and free from dust it will indicate minute quantities of electricity.

GOLD PLATING.—Depositing a layer of gold by electro-plating; gilding.

GOLDSCHMIDT ALTERNATOR.—A high frequency alternator of the reflection type which multiplies the original generated frequency in tuned circuits.

GONIOMETER.—In radio, a direction finder for determining the direction of radio waves. It consists of two fixed aerial loops at right angles to each other used with a special oscillation transformer.

GONIOMETRIC RADIO STATIONS.—Two stations located at the ends of a known base line for the purpose of ascertaining the location of a transmitting station.

GOOSE NECK.—That part of a steam loop which traps water entering the condenser from the riser, circulation to the drop leg being due to a slight inclination of the condenser.

GOOSE NECK PULL OFF.—In electric traction, a "goose neck" curve insulator, either single or double, to which the strain wires are attached to keep a trolley wire in place along a curve.

GORDON CELL.—A non-polarizing closed circuit cell used largely for fire, police and railway signal systems. The negative element consists of a perforated tin cylinder containing the depolarizer. The zinc element rests on porcelain lugs in an electrolyte of caustic soda solution.

GOVERNOR.—A device or attachment for controlling and regulating the speed of a prime mover, usually by means of centrifugal force. In a steam engine, the principle of the conical pendulum is generally employed, as the speed of the engine increases the centrifugal force causes the weights to fly out, thus shortening the height of the pendulum; this shortening pull being transmitted to the throttle valve or valve gearing of the engine. A governor of the same type controls the admission of water to water wheels, turbines, etc.

GRAB LOAD.—In crane loading, a load of from 1 to 1½ tons.

GRADIENT, ELECTRIC.—The rate of increase or decrease of a variable magnitude, sometimes used for the curve that represents a variable current.

GRADING A TRANSMISSION LINE.—The line should follow the general contour of the ground over which it passes, avoiding, however, any abrupt dips or rises which would cause excessive pull on tie wires, pins, or other attachments on the pole. In all cases, poles should be made as short as the required clearances and allowable change of grade on each pole will permit.

GRADOMETER.—A variety of clinometer, consisting of a curved glass vial filled with alcohol and a graduated scale. The position of the bubble shows the degree of the gradient.

GRAM CALORIE.—A unit of heat, representing the amount of heat required to raise the temperature of a gram of water 1° C.

GRAM EQUIVALENT.—The quantity of a substance in grams equal numerically to its electro-chemical equivalent.

GRAM MOLECULE.—In chemistry, the amount of a compound having a weight in grams equal in number to the molecular weight of the compound.

GRAM OR GRAMME.—The unit of mass, or amount of matter, in the c.g.s. system; it is the one-thousandth part of the mass of a standard kept in Paris called the kilogram. For practical purposes the gram is equal to the mass of one cubic centimeter of water at 4° C. (39.2° F.), or 15.43235 grains.

GRAMME ARMATURE.—A form of ring armature invented by Gramme, in which the armature core, consisting of a ring of iron wire, is wound uniformly with insulated copper wire, which is, at equal intervals, electrically connected to the segments of the commutator.

GRAMME WINDING.—An early form of winding employed upon a Gramme ring armature invented by Zenobe Theophile Gramme, a French electrician (born 1826, died 1901). The core of the armature being in the form of a ring, the wire is wound through the core as well as upon the outside.

GRANGER TECHNIQUE.—A well known method of radiography.

GRANULAR CARBON.—The carbon grains employed at varying resistance between the electrodes of a telephone transmitter. The best grade is made from very hard and pure anthracite which has been carefully carbonized and afterwards crushed and screened. The grains are dense, jet black, brilliant in luster and extremely hard.

GRANULAR CARBON TRANSMITTER.—A telephone transmitter in which carbon grains are employed as varying resistance between the electrodes; a dust transmitter.

GRANULAR COHERER.—A form of wave detector for radio experimented with in the early development of the science. It consists of a glass tube containing carbon granules between metallic electrodes. Obsolete.

GRANULAR MICROPHONE.—A telephone transmitter employing granular carbon to furnish the varying resistance between the electrodes.

GRANULAR TELEPHONE. — A telephone provided with a dust, or granular carbon transmitter.

GRAPHIC METHOD.—The system or method of solving problems in the equalization or distribution of forces, stresses, loads, etc., by means of accurately drawn figures and diagrams.

GRAPHITE COATING.—A layer of powdered graphite sometimes distributed over an insulating surface in order to render the surface good conductor of electricity, especially in electro-typing when a mould requires a surface of metal for printing purposes.

GRAPHITIZED FILAMENT LAMP.—A term sometimes applied to the metallized filament incandescent lamp, in which the carbon thread has been subjected to excessive heat in a form of electric furnace so that the texture of the filament has more of the characteristics of a metal than of carbon.

GRAPNEL.—An implement having flukes or prongs for grappling purposes; a grappling iron for seizing a submarine cable or other object under water.

GRATE AREA.—In a steam boiler, the amount of surface (expressed in square feet) presented by the grate bars upon which the coal may be piled. This means not only the area of the metal but that of the air spaces as well. The size grate required for a given boiler horse power depends upon a, rate of combustion; b, heating value of the coal; c, grate heating surface ratio; d, factor of evaporation, etc.

GRATINGS.—A plate, usually of glass, ruled with fine lines forming alternate opaque and transparent parallels for producing spectra of light by diffraction.

GRAVITY.—A force which gives to every particle of matter a tendency toward every other particle. This influence is conveyed from one body to another without any perceptible interval of time. The weight of the body is the force it exerts in consequence of its gravity, and is measured by its mechanical effects.

GRAVITY AMMETER.—An ammeter in which the index needle is held at zero by the force of gravity, and is drawn away against that force by the action of the current to be measured. The winding consists of a few turns of heavy wire for an ammeter, and a large number of turns of fine wire when constructed as a volt meter. Since the iron has a certain amount of residual magnetism, the deflection with smaller following large currents is more than would be produced by the same current following a smaller one. The instrument therefore is less reliable than the usual type.

GRAVITY DROP ANNUNCIATOR. — An electric bell indicating device in which one of a number of shutters will drop exposing a number or letter, when released electrically.

GRAVITY VOLT METER.—A variety of volt meter in which the voltage to be measured deflects the index needle against the action of gravity upon a weight.

GRAY IRON.—A quality of iron which is softer and less brittle than white iron. It is to a slight degree malleable and flexible, can be easily drilled and turned in the lathe, and does not resist the file. It has a brilliant fracture, of a gray, or sometimes a bluish gray color; the color is lighter as the grain becomes closer, and its hardness increases at the same time.

GREASE SPOT PHOTOMETER.—A familiar name for Bunsen's photometer which consists essentially of a paper screen with a grease spot in the center, on either side of which are placed the two lights to be compared. When the screen is equally illuminated on both sides the spot becomes invisible.

GREATER CALORIE.—A unit of heat larger than the calorie; it is the amount of heat necessary to raise the temperature of a kilogram of water from 0° to 1° C.

GREATEST COMMON DIVISOR. — The greatest number that will exactly divide each of two or more numbers.

GREEN CANDLE.—A standard candle having a green glass screen for the purpose of measuring the candle power of an arc lamp.

GRENET CELL.—A bichromate primary cell consisting of a glass bottle containing the electrolyte and fitted with a lid from which the elements are supported. There is a zinc plate in the center and a carbon plate on each side. The two carbon plates are connected to the same terminal, thus forming a large positive surface, and the zinc plate to a terminal on the top of the brass rod to which it is attached. This rod slides through a hole in the lid so that the zinc plate can be lifted out of the electrolyte when the cell is not at work, thus preventing wasteful consumption of zinc and of the electrolyte. Bichromate cells give a strong current, the voltage of a single cell being 2 volts.

GRENZ RAYS.—Soft rays similar to violet rays in their biological action upon tissue and their wave length; they are produced by a special vacuum tube with a hot cathode operating from a transformer delivering not more than 8 kv. Also known as infra-roentgen and border line rays.

GRID.—1. A lead plate for a storage cell; it is provided with corrugations or perforations so that it may be capable of holding a large amount of the active material, and thus increase the capacity of the cell.

2. In a radio vacuum tube, a fine wire network placed between the filament and the plate. The object of the grid is to control the flow of electrons from the filament to the plate. If the grid be held at the same pressure as the plate, it will aid the plate in drawing electrons from the filament. If the grid be held at the same pressure as the filament, it will neither aid nor hinder the plate in drawing electrons from the filament. If, however, the grid be kept negative, with respect to the filament, it will tend to drive back the electrons leaving the filament, and since the grid is between the plate and the filament, it will reduce the number of electrons which eventually reach the plate.

GRID BATTERY.—The "C" radio battery. The function of this battery is to control the plate current, that is, the current supplied by the B battery, flowing in the plate circuit of the tube, and to control the quality of the output. In other words the C battery puts a negative charge on the grid of the tube, thereby forcing it to operate with more clarity and less distortion at high B battery voltages. The negative voltage imposed on the grid also reduces the amount of current taken from the B battery to approximately one-half the amount which would otherwise be taken out.

GRID BIAS.—In radio, the difference in voltage between the negative end of the filament of a radio tube and the grid when no signals are coming over. The negative end of the filament being the point of reference, grid bias is said to be: a, negative; b, zero, or c, positive with respect to the negative or zero end of the filament. If the C battery (or other pressure source) impress a voltage on the grid less than the voltage of the negative end of the filament, it is called negative bias; when no voltage is impressed on the grid it is called zero bias and when the grid is at a higher voltage than the negative end of the filament, it is called positive bias.

GRID CIRCUIT.—In radio, the grid-filament circuit.

GRID COIL.—In radio hook ups, an inductance coil or bias resistor forming part of the grid circuit.

GRID CONDENSER.—A small fixed radio condenser inserted between the tuning coil and the grid member of a detector tube. The capacity is generally from .00025 to .0005 microfarad.

GRID CURRENT.—In a radio tube, the current passing to or from the grid through the vacuous space.

GRID DIP OSCILLATOR.—A radio instrument for indicating the resonance frequency of an oscillating circuit.

GRID EMISSION.—In a radio tube, the invisible small particles of negative electricity called electrons which are thrown off the grid when it becomes overheated.

GRID GLOW TUBE.—A three element gas filled cold cathode vacuum tube, which under certain operating conditions; may be used as a relay for a photo cell.

GRID LEAK.—In radio hook ups, a high resistance inserted in the grid circuit of a vacuum tube to permit the electrons forming the grid current to leak off after each charge, thus preventing their accumulating on the grid in such numbers as to stop the flow from the filament. The grid leak determines or affects the grid bias; it is connected across a grid condenser.

GRID PLUGS.—In storage battery practice, plugs of oxide of lead inserted into the perforation of a grid to assist in the forming process.

GRID POTENTIOMETER.—A radio voltage divider used in the grid circuit to control the grid voltage. Used especially in amplifying tube circuits to control sensitivity and volume.

GRID RESISTANCE.—In a radio tube, the space resistance between the grid and filament.

GRID SYSTEM.—The English system of electrical distribution.

GRID VOLTAGE.—In a radio tube, the voltage between the grid and a specified point of the filament.

GRILL WORK.—In engineering, a heavy framework of cross timbering, resting upon the heads of piles, serving as a foundation for a building resting on insecure or treacherous soil.

GRINDER.—In radio, a term sometimes used for static.

GRIP CONTROLLER.—A device applied to motor cycles operated from the grip, or handle, which controls the motor by interrupting the ignition.

GRIP OF BELT.—The hold which a driving belt has upon the pulley.

GRISSON VALVE.—An electrolytic rectifier in which the cathode is a sheet of aluminum, and the anode, a sheet of lead, supported, in the original form, horizontally in a vessel containing the electrolyte, consisting of a solution of sodium carbonate. Cooling is effected by circulating water through metal tubes in the electrolyte itself.

GROTTHUSS' THEORY.—A theory advanced to explain the process of electrolysis which takes place in a primary cell, suggesting that the molecules of the liquid arrange themselves in chains, the particles being alternately charged positively and negatively, and that along these chains the decompositions and recombinations occur.

According to the theory all the molecules arrange themselves in regular order with their unlike "poles" or ends in contact. The new arrangement is due to the fact that each one is "polarized," or has acquired magnetic qualities. In addition to this "polarization," all the molecules are supposed to move in regular order, in lines, from the zinc electrode to the copper, and back again. In course of this "rotation," or traveling around, it is found that the sulphur and oxygen unite with the zinc, causing it to waste, and the hydrogen, thus liberated, unites with the oxygen of the molecule just ahead; that, in turn, giving its oxygen to the molecule in front of it, and so on, until the copper electrode is reached. The hydrogen is given off to unite again with the liquid and perform the same rotation, until all the oxygen has united with and consumed the zinc plate.

GROUND.—The earth regarded as an electric conductor.

GROUND ABSORPTION.—In radio transmission, loss of power due to dissipation in the ground.

GROUND CLAMP.—A type of clamp suitable for fastening to a water pipe and having a terminal to receive the ground wire of a radio set.

GROUND COIL.—A small rheostat used in duplex telegraphy for preserving the balance of the line at the home station.

GROUND CONNECTIONS FOR ARRESTERS.—In all lightning arrester installations, it is important to make proper ground connections, as many lightning arrester troubles can be traced to bad grounds. An approved connection for station arrester is to drive a number of 1 in. galvanized iron pipes or copper welded rods down to permanent moisture surrounding the station, connecting all these pipes together by means of a heavy copper wire or preferably by a copper strap.

GROUND DETECTOR. — An instrument used for detecting (and sometimes measuring) the leakage to earth or the insulation of a line or network and is sometimes called ground or earth indicator, or leakage detector. For systems not permanently earthed anywhere, ground detectors are nearly all based on a measurement of the pressure difference between each pole and earth, two measurements being required for two wire systems, and three for three wire, whether direct current single phase, or polyphase alternating current. In the case of direct current systems, the insulation, both of the network and of the individual lines, can be calculated from the readings, but with alternating current, the disturbance due to capacity effect is usually too great. In any case, however, the main showing the smallest pressure difference to earth must be taken as being the worst insulated. On systems having some point permanently earthed at the station, an ammeter connected in the earth wire will serve as a rough guide. It should indicate no current so long as the insulation is in a satisfactory state, but on the occurrence of an earth it will at once show a deflection. The indications are, however, often misleading and serve more as a warning than anything else.

GROUND EQUALIZER INDUCTORS. — In radio, coils of relatively low inductance placed in the circuit connected to one or more of the grounding points of an antenna or aerial, to distribute the current to the various points in any desired manner.

GROUND IN ARMATURE.—If confined to a single coil it is not in itself liable to do damage. The fault can frequently be repaired without disconnecting any of the wires if its exact position be determined. A ground is generally caused by: a, a weak spot in insulation at end of core, generally due to leaving a weak spot in insulation at this point when winding. Under heat and vibration this spot breaks down and causes a ground; b, laminations coming loose and cutting into wires; c, armature rubbing on pole faces, driving laminations into wires.

GROUND IN COMMUTATOR.—These are caused by:

1. In front end, caused by carbon and copper dust deposit which starts current leaking. This leakage develops heat

which blackens the mica and turns it into a conductor.

2. Behind risers caused by dust deposit or from soldering wires, in which case acid, or even solder may run down behind risers.

3. Sometimes ground develops inside commutator caused by defective mica or defective assembling of commutator.

GROUND INCANDESCENT SWITCH.—A switch which controls a group or cluster of incandescent lamps.

GROUND LINE.—The ordinary level of the surface of the ground, above or below which the height of structures or the depth of excavations is measured.

GROUND NOISE ELIMINATOR.—In film sound recording, a device which makes opaque that portion of the sound track not used at any given instant.

GROUND OR RESIDUAL.—A relay protective principle. In numerous cases it is possible to use the magnitude of the ground current present in a system, as an indication of the presence or absence of abnormal conditions on the system. With systems normally grounded at one point only, the existence of a current to ground is an indication of an abnormal condition. This ground current may be detected directly, or as the difference from zero of the vectorial sum of the line currents at any point (this current is called the "residual current"). Complete protection is never obtained in this way, since these schemes are not sensitive to short circuits between phases.

GROUND PLATE.—A metal plate buried in damp soil forming a path to earth in a grounded electric circuit; an earth plate.

GROUND RETURN.—The earth or ground used to complete an electric circuit.

GROUND SWITCH.—An antenna or aerial switch. In one position the antenna or aerial is connected to the set and in the other position to the ground.

GROUND VOLTAGE.—Zero pressure.

GROUND WIRE.—1. A wire used to connect a circuit conductor, conduit, or other device to an earth plate, water pipe, etc. The ground wire used must not be smaller than No. 10 copper. Larger sizes of wire may be used, and are required for large service installations. The size of wire required for grounding is determined by the ampere capacity of the service wires. This ground wire need not have any insulation, and may be fastened to the building with nails or staples or with cleats or knobs. When the neutral wire is grounded, No. 8 copper wire, rubber covered, single braid, must be used, and it should be encased in conduit from the service switch to the ground clamp.

2. In radio transmitters or receivers, the wire connection between the apparatus and the ground.

GROUND WIRE CONNECTION.—Generally a water pipe is selected for a ground connection in house wiring installations. In the absence of which, efficient connection can be made as by means of embedded plates or pipes driven in the ground. Driven pipes possess many advantages over other methods which have been used, such as buried plates, buried strips, coils of wire, and the various patented ground electrodes commonly advertised.

GROUNDED CIRCUIT.—An electric circuit completed through the ground.

GROUNDED TUNING CONDENSER.—In radio, a method of avoiding hand capacity by grounding the rotor of a variable capacity tuning condenser.

GROUNDING.—In wiring the intentional connection of a circuit to the earth for the purpose of insuring safety from shock. Thus, if any live conductor be efficiently connected to earth, a person touching the conductor cannot receive a shock, since there is no difference of pressure between the earth on which he is standing and the conductor which he is touching. When a circuit is intentionally grounded, the voltage of the grounded point is made permanently that of the earth and the voltage of every other point of the circuit becomes fixed with respect to the ground. When one conductor is grounded it depends upon which conductor a person touches as to whether he receives a shock.

GROUNDING OF COMPENSATORS.—The cases of all compensators should be grounded especially when installed on high voltage circuits, to insure safety to the operator if for any reason the current carrying parts should accidentally come in contact with the case. A good contact is obtained by securing the ground wire under a screw or bolt on the compensator. The ground wire should be run to a water pipe as required by the Code.

GROUP FREQUENCY.—In a damped or undamped system of radio transmission, the number of separate groups of waves per second.

GROUPING OF PHASES.—The method of connecting the separate windings on an a.c. machine. In polyphase alternators the separate windings of the various phases may be grouped in two ways:

1. Star connection.
2. Delta connection.

The star connection is frequently called a Y connection. In a three phase star connected alternator the voltage between any two collector rings is equal to the voltage generated per phase multiplied by $\sqrt{3}$ or 1.732. The line voltage in a three phase delta connected alternator is equal to the voltage generated in each phase.

GROUTING.—In construction work, the pouring of a mixture of cement, sand and water into the voids of stone, brick or concrete work, either to give a solid bearing or to fasten anchor bolts, dowels, etc.

GROVE'S CELL.—A form of primary cell consisting of an outer jar containing a zinc electrode in dilute sulphuric acid, and an inner porous cup with a platinum electrode in strong nitric acid.

GROVE'S GAS BATTERY.—An early form of storage battery devised by Sir W. R. Grove in 1829. Plates of platinum are contained in glass tubes closed at the top, the lower ends being immersed in dilute sulphuric acid. The charging current introduces oxygen into certain of the tubes and hydrogen into others. The platinum in contact with these gases then permits of a current to be derived from the cell equal, under favorable circumstances, to 843 volts per couple.

GROWLER.—An audible electric testing device for armatures. In operation, the a.c. which is used, sets up vibrations at the contact surfaces between armature core and growler poles resulting in a buzzing or growling noise, hence the name "growler." Every armature no matter if it be good or bad, when placed on a growler with current turned on will growl, and this noise is no indication as to the condition of the armature.

GUARD ARM.—In pole line construction, an upright attached to a cross arm to prevent a wire falling in case it become detached from its insulator.

GUARD SUSPENSION WIRE.—A span wire stretched above a trolley wire from the tops of opposite poles in order to support the guard wires.

GUARD WIRE.—A wire stretched parallel with a trolley wire and just above it to prevent other wires falling across and making electrical contact with the live wire; a running guard wire.

GUERICKE'S MACHINE.—The first production of electric light in a practical way is attributed to Otto von Guericke, who made the first electrical machine about the middle of the seventeenth century and with which he produced sparks sufficiently powerful and frequent as to produce a perceptible amount of illumination. The operation of the machine depended on the excitation of a rotating ball of sulphur.

GUIDED WAVES.—In radio, those which follow along the earth's surface.

GUN METAL.—A bronze, ordinarily composed of nine parts of copper and one of tin. The name is also given to certain strong mixtures of cast iron.

GUSSET STAY.—An angular plate or bracket used to reinforce a boiler where it changes from a circular to a square section. The flat ends of cylindrical boilers (especially marine boilers) are stayed to the round portions of triangular plates of iron called gusset stays. These are simply pieces of plate iron secured to the boiler front or back, near the top or bottom, by means of two pieces of angle iron, then carried to the shell plating, and again secured by other pieces of angle bar. Sometimes only one angle iron is used at each end, the plate itself being flanged to form the other side of the T. The tension on a gusset stay is not uniform, but is greater near one edge.

GUTTA PERCHA.—A substance obtained from the gum of a tropical tree found in the East Indies. It has many of the properties of India rubber and is of great value in electrical work for its insulating powers and durability.

GUTTER OF INSULATOR.—A depression in an insulator to lead off rain water.

GUY.—A rod, wire or other appliance for stiffening a telegraph pole, or for steadying a system of overhead wires.

GUY ROD BANDS.—Bands by which a guy rod is attached to a telegraph pole.

GUY STUBS AND ANCHOR LOGS.—Devices for guying a line. Each pole is connected by a suitable cable to a guy post or "stub" or to an anchor log firmly embedded in the ground. Standard rules specify stubs between 18 and 25 ft. with exact limits as to circumference measurements at the top and at a point 6 ft. from the butt, according to the kind of wood used.

GUYS FOR POLES.—A brace consisting of heavy galvanized wires to take any lateral stress to which a pole may be subjected. The guys are attached near the top and secured either to the base of the next pole, to a suitable guy stub or post, or to a guy anchor, which is buried about eight feet in the earth and held down by stones and concrete.

GYMNOTUS ELECTRICUS.—The scientific name for the electric eel.

GYRO COMPASS.—A device for indicating direction. It consists of an electrically rotated wheel which together with the earth's rotation act as two gyroscopes.

GYRO-PILOT.—A device which automatically steers a ship upon a given course.

GYROPLANE.—A combination of an airplane and a helicopter.

GYROSCOPE.—A heavy wheel arranged to revolve at high speed, the axis of which is free to turn in any direction. It is used to illustrate the characteristics of rotating bodies. It is used on ships as a stabilizer to prevent undue rolling of the ship in rough water.

GYRATION.—The act of revolving about an axis; rotation.

GYROSTAT.—An instrument for illustrating the dynamics of rotation.

GYROSTATIC ACTION OF DYNAMO.—The effect produced by the motion of the vessel upon the rotation of the parts of a dynamo operated on shipboard.

GYRO-TRACK RECORDER.—An apparatus for locating and measuring the irregularities in a railroad track.

H

H.—1. Symbol for hydrogen.
2. Symbol adopted by the I.E.C. for the henry.

HÆMATITE.—Ferric oxide. An important ore of iron, occurring in steel blue or black crystals, or blood red when very thin, also in blood red masses, whence the name **bloodstone** by which it is often known. It is found in the Marquette region of Lake Superior in the U. S. Hæmatite is also known as **specular iron.**

HALATION.—In illumination, the halo effect seen around light sources which causes the outlines of the letters in a sign to appear blurred.

HALF COIL WINDING.—An armature winding in which the coils in any phase are situated opposite every other pole, that is, a winding in which there is only one coil per phase per pair of poles. Also called **hemitropic winding.**

HALF DEFLECTION METHOD.—A method of electrical measurement in which the galvanometer deflection is reduced one-half.

HALF HOOP MAGNET.—A semi-circular magnet.

HALF-SET REPEATER.—A telegraph repeater used for connecting together a simplex circuit and a duplexed circuit converting them into the equivalent of a single simplex circuit.

HALF WAVE ANTENNA.—One whose length is equal to half the wave length of the connected transmitter.

HALF WAVE RECTIFIER.—1. In radio, a vacuum tube having a filament and a plate. When alternating current is applied, only one-half of each wave or cycle is rectified, that is, no current flows during each reversal of the a.c.
2. Any device used to rectify or change a.c. into pulsating direct current in which only one-half of each wave is rectified. An example of half wave rectifier is the crystal detector.

HALL EFFECT.—A phenomenon first observed by E. H. Hall in 1879, of a transverse voltage produced when a powerful magnet is caused to act upon a current flowing in a strip of very thin metal.

HALLEYAN LINES.—Lines drawn upon a map passing through points on the earth's surface which have the same magnetic declination; the **isogonic** or **isogonal lines.**

HALPINE-SAVAGE TORPEDO.—A submarine torpedo operated by electricity, and propelled by a current generated within itself.

HAMMER BREAK.—In jump spark ignition a rapid separation of the contact points of a magnetic vibrator, produced with a compound mechanism, consisting of two vibrator blades. One blade, attracted by the action of the coil is set in motion and delivers a 'hammer blow" to the second blade, which contains the movable contact. The action produces a rapid interruption of the primary current.

HAMMER TEST.—A trial of the qualities of sheet metal, such as iron, copper or steel, by the use of the hammer; such as flattening out cold to a thickness of one-half the diameter, and flattening out hot to a thickness of one-third the diameter. In neither test should they show cracks or flaws.

HAMMER VIBRATOR.—A type of vibrator for an induction coil which has besides the spring armature arm, an extra spring arm so arranged that in operation it strikes the armature arm resulting in a very rapid or hammer break.

HAND CAPACITY.—Body capacity which at times renders tuning a radio set difficult.

HAND HOLE.—An opening large enough to readily admit the hand, provided in an underground conduit for the purpose of gaining access to the cable.

HAND REGULATOR.—A hand regulated resistance box, in which the separate resistance coils may be cut in or out by turning a hand wheel or switch.

HAND RULE.—Generally known as Fleming's hand rule.

HAND TELEPHONE.—The ordinary form of telephone receiver, as distinguished from the head gear receiver.

HAND WINDING.—The winding of armature coils by hand as distinguished from machine winding. Armatures with commutators having two, three or more bars per slot are adapted to multi-wire winding, and facilitates hand winding as the winder takes wires from several reels and winds them simultaneously, thus, for each turn he makes, there are two, three or more turns of wire wound, depending upon the number of reels in use. If there be say three commutator bars per slot three wires are wound, that is, one wire for each commutator bar. The number of wires in hand will depend on the number of times the commutator bars exceed the armature slots. Thus, for a 12 slot armature and 36 commutator bars, there will be $36 \div 12 = 3$.

HANGAR.—An airplane or dirigible shed.

HARD AND SOFT BRASS.—The terms hard and soft as applied to brass rod have different meanings to the manufacturer and to the user. To the user, the term hard applied to brass rod means that it is difficult to cut; the term soft means that it is easy to cut. To the manufacturer, the term hard means high tensile strength, stiffness, and high Brinell, scleroscope, and Rockwell hardness numbers, and does not necessarily mean that the rod is difficult to cut.

HARD DRAWN WIRE.—Wire as it comes from the drawing machines without annealing.

HARD IRON.—Cast iron which is dense and close grained. It is obtained by making suitable mixings of various brands with scrap, and is used for wearing parts, the liners of engine cylinders, and cog wheels.

HARD PATCH.—A piece of metal riveted to a boiler shell, used to strengthen a weak place or cover a hole. If bolted or studded it is called a soft patch. It is important that an applicant for an engineer's license know the difference between a hard and a soft patch, because the question is almost always asked.

HARD POROUS CELL.—An unglazed earthenware jar made especially dense by hard baking to better resist the disintegrating action of the primary cell for which it is designed.

HARD RAYS.—Short wave-length rays of great penetrability.

HARD RUBBER.—A name often given to vulcanite or ebonite which is india rubber "vulcanized" by a large admixture of sulphur. It is much used in the manufacture of electrical instruments.

HARD SOLDER.—A fusible alloy, ordinarily composed of copper and zinc, or copper, zinc, and silver. Hard solder in general is sometimes erroneously called spelter. Usually red heat is required to fuse hard solders. A variety that is readily melted is made of 44% copper, 50% zinc, 4% tin, and 2% lead. A hard solder for the richer alloy of copper and zinc may be produced from 53 parts copper and 47 parts zinc. When alloys containing much lead are used the strength of the joint is decreased because lead does not transfuse with brass. The effect of tin is to increase the brittleness of the solder.

HARD STEEL.—A loose and indefinite term, meaning all steel that is not mild, it may be taken as steel containing over ½ of 1 per cent of carbon.

HARD TUBE.—A radio tube exhausted to a vacuum of very high degree. Hard tubes make good amplifiers. The vacuum is higher than that necessary for a detector.

HARD WATER.—A water in which soap will not readily dissolve, thus rendering the formation of lather difficult. Hardness may be temporary or permanent, and is due to the presence of salts, principally of lime, in solution.

HARDENED WIRE.—Wire which has been tempered after manufacture.

HARDENING.—The preliminary process of tempering edge tools; the tool, being heated to a cherry red, is plunged into brine or clear water, the sudden quenching rendering it hard enough to scratch glass. Subsequent reheating, to a point determined by experience and judgment, is necessary to draw the temper, so that the steel shall have those qualities of hardness and toughness necessary for desired duties.

H-ARMATURE.—An early form of Siemens armature having a core resembling the letter H; a girder or shuttle armature.

HARMONIC AMPLIFIER.—A radio amplifying tube which produces strong harmonic frequencies, the tube being so biased as to distort the applied frequency.

HARMONIC ANALYZER.—A separator of complex radio waves into the component sine waves. It measures harmonic distortion.

HARMONIC CURRENT.—An alternating electric current the waves of which follow the law of a simple harmonic or sine curve.

HARMONIC CURVE.—The curve obtained when simple harmonic motion is represented by plotting time as abscissæ, and displacements from zero position as ordinates.

HARMONIC FREQUENCY.—A multiple of a lower or fundamental frequency.

HARMONIC RECEIVER.—In harmonic telegraphy, a receiver consisting of an electro-magnetic reed tuned to vibrate to one note only.

HARMONIC SELECTIVE SIGNALING.—In telephony, a method of signaling which employs devices tuned mechanically or electrically to the frequency of the ringing current, so that each device will not operate when receiving current intended to operate another device.

HARMONIC SUPPRESSOR.—A form of radio filter which suppresses frequencies that are multiples of the desired or fundamental frequency. It consists of a special coil shunted by a condenser and tuned to the frequency of the interfering wave, the main tuning circuit at the same time being adjusted to the desired frequency.

HARMONICS.—In radio, oscillations to which a circuit will respond of which the frequency is an odd or even multiple of the fundamental frequency. Harmonics are usually objectionable; the power that goes into them is wasted.

HARMONICS OF CURRENT.—The separate harmonic currents which go to make up a complex harmonic current.

HARMONICS OF SOUND WAVES.—The separate overtones which combine to make up a sound wave.

HARNESS.—The equipment for adjusting the transmitter and receiver upon the breast and head of a telephone exchange operator.

HARP AERIAL.—A fan aerial.

HARPOON, ELECTRIC.—A type of spear provided with an electric bomb which explodes after the weapon has reached its victim.

HARVEYIZING.—A process, invented by R. A. Harvey, of hardening the surface of a steel plate, in which the steel is given a thick face of great hardness backed by the metal in a gradually decreasing state of hardness through its mass.

H. D.—Abbreviation for half day, especially refers to plants shut down at night.

Hd.—In radio, abbreviation for heterodyne.

HEAD BATH, ELECTRIC.—A convective electric discharge applied in the medical treatment of the head.

HEAD GUY.—A guy fastened to the top of a telegraph pole.

HEAD PHONE SET.—Two small telephone receivers arranged to be attached to a band with provision for adjustment, so that they will be supported by the band while covering the ears.

HEAD RACE.—In hydraulics, the water course leading to the upper part of a water wheel.

HEAT.—That form of energy which consists in the agitation of the molecules of matter by which heat is produced; the state of a substance in which it produces the sensation of heat. Heat is distinguished as sensible and latent.

HEAT COIL.—A protective device for telephone apparatus by means of which "sneak" currents are arrested by cutting an instrument out of circuit when a stray current exceeds a predetermined limit; a thermal arrester.

HEAT CONTROL OF CAR HEATERS.—In order to maintain the temperature at a desirable degree some means must be provided for controlling the heat given off by the heating elements. This may be done by: a, manual control; b, automatic control; obtained respectively by means of: a, snap switch; b, thermostat. In the automatic control the thermostat operates to automatically cut the current off the heating coils the moment a set car temperature is reached, and to cut it in when the temperature falls slightly below that point.

HEAT, ELECTRIC.—The heat produced in a conductor by the passage of an electric current through it.

HEAT LIGHTNING.—Lightning visible in broad flashes near the horizon and unaccompanied by thunder, observed when a storm is at a great distance.

HEAT LOSS FROM BUILDINGS.—Heat escapes from buildings in two ways: a, by conduction through the windows, walls, roof, and floor, and b, by leakage of warm air. The loss is proportional to the difference in temperature between the inside and outside air.

HEAT OF COMPRESSION.—A rise in temperature occurs in reducing the volume of a gas by compression. If a cylinder with a piston be filled with air at atmospheric pressure (14.7 lbs. per sq. in. absolute) represented by volume A, and the piston be moved to reduce the volume, say to 1/3 A, then according to Boyle's law the pressure will be trebled or $=14.7\times3=44.1$ lbs. absolute or $44.1-14.7=29.4$ gauge pressure. In reality, however, a pressure gauge on the cylinder would at this time show a higher pressure than 14.7 gauge pressure because of the increase in temperature produced in compressing the air. Now, in the actual work of compressing air, it should be carefully noted that the extra work which must be expended to overcome the excess pressure due to rise of temperature is lost, because after the compressed air leaves the cylinder it cools, and the pressure drops to what it would have been if compressed at constant temperature.

HEAT RUN.—In testing alternators of large capacity or odd voltage and frequency, they are often given an open circuit heat run. The alternator is run with the armature open circuited at a predetermined voltage which will give, approximately, the full load iron losses. This value is generally 110% normal voltage. The run should be continued until the temperatures are constant, recording armature voltage and field voltage, with the speed held constant.

HEAT UNIT.—Unit quantity of heat; the amount of heat required to raise the temperature of a unit mass of water one degree. The units in general use are the British thermal unit (B.t.u.) and the French unit called the calorie. With repect to the calorie, distinguish between a, mean calorie; b, 15 degree calorie; c, 17½ degree calorie; d, large calorie.

HEATER BIAS.—In a heater radio tube, a difference of pressure between the heater and the filament maintained to reduce the tendency to hum.

HEATER TUBE.—An a.c. tube in which the current for heating the filament is applied to a separate heating element which simply functions as a heater, but does not emit electrons. The object of this type of tube is to avoid applying the a.c. to the filament which is objectionable.

HEATER VOLTAGE.—In radio tubes, the pressure required ranges from 1.1 to 6 volts in most receiving tubes. Transmitting tubes require much higher voltage.

HEATING BY ELECTRICITY.—The method of obtaining heat by passing an electric current through a high resistance conductor called a resistance wire or heating unit. The heat thus produced is used for various domestic and industrial purposes. Although very desirable in some cases, it is more expensive than gas or coal.

HEATING EFFECT OF THE CURRENT.—A conductor along which a current flows becomes heated. The rise of temperature may be small or great according to circumstances, but some heat is always produced. The heat effect is manifested in different degrees in different metals, according to their varying conducting powers. The poorest conductors, such as platinum and iron, suffer much greater changes of temperature by the same charge than the best conductors, such as gold and copper. The charge of electricity which only elevates the temperature of one conductor a small amount, will sometimes render another incandescent, and will vaporize a third.

HEATING ELEMENT.—A length of resistance metal in the form of a strip, or coiled wire through which electric current is passed to give off heat. It becomes hot on account of the resistance it offers to the current. Also called heating unit.

HEATING OF BRUSHES, COMMUTATOR AND ARMATURE.—When heating occurs in these parts, it may be due to any of the following causes: a, excessive current; b, hot bearings; c, short circuits in armature or commutator; d, moisture in armature coils; e, breaks in armature coils; f, eddy currents in armature core or conductor.

HEATING OF ELECTROLYTE.—In mixing sulphuric acid and water for electrolyte of storage battery, the mixture becomes hot. The mixture should be made by pouring the acid slowly into the water, never the reverse. As cannot be too strongly stated, in mixing, the liquid should be stirred with a clean wooden stick, the acid being added to the water slowly; the acid is corrosive and will painfully burn the flesh.

HEATING OF ROTATING MACHINES.—The excessive heating of the parts of dynamos, motors, etc., is probably the most frequent and annoying fault which arises in operation. When the machine heats, it is a common mistake to suppose that any part found to be hot is the seat of the trouble. Hot bearings may cause the armature or commutator to heat, or vice versa. The temperature of a machine should not exceed 80° F. above the surrounding air. Excessive heating may be due to various causes, electrical or mechanical; and may occur in any one or more of the component parts of the machine. In a dynamo, or motor, heating may occur in: a, armature; b, commutator; c, brushes; d, connections, bearings, etc. It may be detected by applying the hand to the different portions of the machine if low tension, or a thermometer if high tension, and also by a smell of over-heated insulation and paint or varnish. When this last indication is noticed, it is advisable to stop the machine at once, otherwise the insulation is liable to be destroyed. No part of a rotating machine should have a temperature of more than 80° F. above that of the surrounding air.

HEAVISIDE-KENNELLY LAYER.—A theory first postulated in 1902 by Oliver Heaviside, English physicist, and A. E. Kennelly, and proved to exist in 1925 by other scientists, is a conducting layer of ionized gas at a level of forty to fifty kilometers (twenty-five to thirty-one miles) above the earth's surface during the day, rising to about ninety kilometers (fifty-six miles) at night. Its existence was pointed to be the behavior of long wave length radio waves.

HEAVISIDE-LORENTZ SYSTEM OF UNITS. An electro-magnetic system of units so devised that, in the magnetic laws and in the corresponding electric laws, the same constants appear. These units are frequently used in electro-magnetic theory, but are seldom used in measurements.

HEDGEHOG TRANSFORMER.—1. A form of transformer devised for reducing the iron loss, having its coils wound upon a core consisting of a bundle of iron wires with their ends spread out like the spines of a hedgehog, so that the lines of force pass partly through the iron and partly through the air.

2. A radio type of audio frequency transformer so called because of its construction.

HEELING ERROR OF COMPASS NEEDLE.—A further deviation, due to the magnetism of the vessel, to which a ship's compass is liable when the ship is rolling.

HEFNER.—The name of the standard light source adopted in the United States and Germany. It is the light given by an amyl-acetate flame adjusted until its tip is 40 mm. above the top of the wick tube. One candle power equals 1.1364 hefner.

HEFNER - ALTENECK AMYL - ACETATE LAMP.—The lamp of the Hefner standard consists essentially of a cylindrical base for holding the amyl-acetate which is drawn up through a German silver tube by means of a specially prepared wick.

HEISING MODULATION.—In this method of modulating currents for radio transmission, sound vibrations are impressed on the microphone which vary the current through a transformer, thus serving to vary the voltage of the grid, which in turn varies the plate circuit current; the same characteristics being maintained. As the field winding of a high frequency alternator is in the plate circuit, it is evident that the antenna current will be modulated in accordance with the variations of the speech or sounds introduced in the microphone.

HELICAL COIL.—A coil of wire elongated like the turns of a screw; a helix.

HELICAL SPRING.—A spring whose coils have a gradually decreasing diameter, either lying flat in one plane like a watch spring, or assuming a conical form. The helical spring coiled on a cylinder is generally known as a spiral spring.

HELICOPTER.—A form of airplane which can be sustained by a propeller with long blades turning on a vertical shaft.

HELIOGRAPH.—An instrument consisting essentially of a movable mirror, employed in signaling, by which beams of sunlight are flashed to a distance in terms of the telegraphic code.

HELION LAMP.—A type of incandescent lamp having a filament composed of a core of carbon which has been treated with a gaseous compound containing silicon. The metal enters the carbon and at the same time forms a surface deposit. The filament is strong, will withstand much higher temperatures than carbon, consumes less watts per candle power, and gives a white light resembling daylight.

HELIOSTAT.—An instrument consisting of a mirror kept in motion by clockwork in such a way as to constantly reflect the rays of the sun in a fixed direction.

HELIOTHERAPY.—Exposure to the sun's rays for remedial purposes.

HELIUM.—A supposed atmospheric gas which forms compounds with nitrogen, hydrogen and carbureted hydrogen. Boiling point about 5° below the absolute zero. Helium has been used as a thermometric substance in measuring the very low temperatures at which hydrogen boils and solidifies; it is also used for inflating dirigibles.

HELIX.—1. A conducting coil or solenoid.
2. The curve formed by a straight line traced on a plane when the plane is wrapped around a cylinder; as, in a screw thread or the convolutions of a coiled conductor; a screw or spiral.

The length of a helix is found as follows to the square of the circumference described by the generating point add the square of the distance advanced in one revolution, and take the square root of their sum multiplied by the number of revolutions of the generating point.

HELM INDICATOR.—An electrical instrument for indicating the position of a ship's rudder.

HELMHOLTZ'S GALVANOMETER.—A tangent galvanometer having two parallel coils symmetrically set on either side of the needle in order to secure uniformity of magnetic field.

HEMISPHERICAL POLE PIECES.—Dynamo field magnet pole pieces so shaped as to allow a spherical space between them for the rotation of the armature.

HEMITROPIC WINDING.—An armature winding in which the coils in any phase are situated opposite every other pole, that is, a winding in which there is only one coil per phase per pair of poles.

HEMLOCK.—A variety of spruce or fir, used largely for telegraph poles, found along the northern border of the United States and in Canada. The wood is rough and splintery. It is used for small scantlings, boarding and general purposes. A larger sized hemlock, of harder and heavier timber, abounds around Puget Sound, where it is known as Alaska fir.

HENLEY'S QUADRANT ELECTROSCOPE.—An electroscope designed by Henley for indicating large charges of electricity; it is a pith ball electroscope approaching an electrometer in its operation.

HENRY.—The practical unit of self-induction, equal to 10^9 absolute units of induction. It receives its name from J. Henry, the American scientist. The self-induction of a circuit is one henry when the induced pressure is one volt, while the inducing current varies at the rate of one ampere per second.

The henry is, therefore, the coefficient by which the time rate of change of the current in the circuit must be multiplied, in order to give the voltage of self-induction in the circuit. The formula for the henry is as follows:

$$\text{henrys} = \frac{\text{magnetic flux} \times \text{turns}}{10^8}$$

However, as in the case of the farad, the theoretical unit is too great for practical computations, which involves that the millinery, or 1/1000 henry, is the accepted unit. In pole-suspended lines the inductance varies as the metallic resistance, the distance between the wires on the cross arm and the number of cycles per second, as indicated by accepted tables.

HENRY, JOSEPH.—Born 1797, died 1878. An American physicist noted for his researches in electromagnetism. He developed the electromagnet, which had been invented by Sturgeon in England, so that it became an instrument of far greater power than before. In 1831, he employed a mile of fine copper wire with an electromagnet, causing the current to attract the armature and strike a bell, thereby establishing the principle employed in modern telegraph practice. He was made a professor at Princeton in 1832, and during his experimenting then, he devised an arrangement of batteries and electromagnets embodying the principle of the telegraph relay which made possible long distance transmission. He was the first to observe magnetic self-induction, and performed important investigations in oscillating electric discharges (1842), and other electrical phenomena. In 1846 he was chosen secretary of the Smithsonian Institute at Washington, an office which he held until his death. As chairman of the U. S. Lighthouse Board he made important tests in marine signals and lights. In meteorology, terrestrial magnetism, and acoustics he carried on important researches. Henry enjoyed an international reputation, and is acknowledged to be one of America's greatest scientists.

HERCULES' STONE.—A name formerly given to the lodestone, or magnetite, the natural magnet.

HERMETICAL SEAL.—The air tight sealing of a glass or other vessel by fusion, as illustrated in the incandescent lamp, so that no air or gas can enter or escape.

HERTZIAN WAVES.—In radio, ether waves so called on account of the early experiments (1888) of Hertz, the German physicist. Dr. Einstein derides radio's ethereal medium as fiction, calling it a makeshift fabricated to explain something for which scientists have not had the correct explanation. Einstein believes it is an electro-magnetic phenomenon; so did Charles Proteus Steinmetz. Shortly before his death Steinmetz said: "There are no ether waves." He explained that radio and light waves are merely properties of an alternating electro-magnetic field of force which extends through space. Scientists, he contended, need no idea of ether. They can think better in the terms of electro-magnetic waves.

HERTZ'S OCILLATOR.—In radio, a device for creating and projecting electromagnetic waves devised by Hertz for his experiments which laid the foundation of radio. It consists of two insulated rods with balls at the gap end to give capacity.

HETEROCHROMATIC PHOTOMETRY.—The comparison and measurement of the illuminating intensity of sources of light that differ in color.

HETERODYNE.—Hetero means other, and dyne force; heterodyne, other force. The term was originally applied by Fessenden, in the sense that when two currents of different frequencies flow in the same circuit, they combine to produce a current of a new frequency called the **beat frequency**. The two currents in producing the new frequency are said to **heterodyne**.

HETERODYNE AND AUTODYNE PRINCIPLES.—These radio principles relate to the formation of a "beat" note by the superimposition on the incoming wave of a second wave of a slightly different frequency, either a little higher or lower than the incoming or fundamental wave. This beat note will pass through the detector and be made audible in the phones in the ordinary manner. The added a.c. wave may be produced by a separate electron tube oscillator, in which case the set is heterodyne, or the detector tube may be made to function as an oscillator also in which case the set is **autodyne**.

HETERODYNE RECEIVER.—A radio receiver which operates on the heterodyne principle.

HETEROPOLAR DYNAMO.—A bipolar or multipolar dynamo in which the armature inductors in rotating, pass north and south magnetic poles alternately.

HETEROPOLAR INDUCTOR ALTERNATOR.—A type in which the polar projections are staggered, and therefore, do not require the staggering of the armature coils.

HETEROSTATIC.—A term applied to an electric measuring instrument, such as an electrostatic volt meter, which employs electrification other than that to be tested, as distinguished from idiostatic.

HETEROSTATIC ELECTROMETER.—An electrometer in which there is present electricity independent of that to be measured.

HEYLAND DIAGRAM.—The circle diagram for induction motors.

h.f.—Abbreviation for **high frequency.**

HICKEY.—A form of hand conduit bender consisting of a long lever having at one end a slot at right angles, which fits over and grips the conduit when pressure is brought on the lever or handle to bend the conduit.

HIGH AMPERAGE DISCHARGE TEST.—In storage battery testing, a suitable current rate is approximately 25 amperes for each positive plate for the usual types of automobile starting and lighting batteries (or twenty-five times the "charge rate.") For example, take a battery which has 13 plates per cell (7 negative and 6 positive plates). The required amperage discharge would be $6\times25=150$ amperes, which would be the approximate discharge rate of the entire battery. Hold the current for about 15 seconds, and then take the individual cell voltage readings.

HIGH COMMUTATOR BARS.—Commutator segments which, owing to some defect, have surfaces higher than the adjoining ones.

HIGH FREQUENCY ALTERNATOR.—A radio type for producing radio frequency currents.

HIGH FREQUENCY AMPLIFICATION.—In radio, amplification of the high frequencies in the aerial circuit before reaching the detector tube. These high frequencies are known as radio frequencies being higher than audio frequencies.

HIGH FREQUENCY AMPLIFIER.—A **radio frequency amplifier.**

HIGH FREQUENCY CHOKE.—A radio choke coil of high self-inductance. In spark transmission, it is connected between the secondary of the supply transformer and the oscillatory circuits, to prevent flow of high frequency currents back into the transformer windings.

HIGH FREQUENCY INSTRUMENT.—One adapted to measuring high frequency currents as for instance a **hot wire meter.**

HIGH FREQUENCY OSCILLATOR. — In radio, a radio frequency oscillator.

HIGH MICA.—This condition obtains after some wear if mica be too hard or brushes too soft and results in heating and burning of the commutator bars due to arcing. In severe cases the solder melts, resulting in open circuits due to leads becoming disconnected. To remedy this condition the mica must be under cut.

HIGH MU TUBE.—In radio, a tube having a high amplification factor. High mu tubes have amplification factors of from 15 to 40 as compared with the average of about 8 for ordinary amplifiers. Used as audio amplifiers and sometimes as detectors.

HIGH PASS FILTER.—In radio a device which passes currents above a critical or cut off frequency, and reduces the amplitude of currents of frequencies below the critical frequency.

HIGH PRESSURE CYLINDER.—The initial cylinder of a compound, triple or quadruple, steam engine in which expansion takes place in several successive stages.

HIGH RESISTANCE CONNECTORS.—Connecting wires of high resistance between the armature winding and the commutator bars. Used to prevent sparking at the brushes.

HIGH SLIP MOTOR.—An induction motor having high armature resistance. This type up to a certain point will have increased starting torque, without change in maximum or pull out torque. However, two motors of the same rated horse power and speed may be designed to vary widely in reactance and other characteristics, depending on the purpose for which they are intended. Hence a high slip motor may have a fairly low starting torque; and a motor with high starting and pull out torques may have a low slip.

HIGH SPEED ALTERNATOR.—A type designed to run at speeds far in excess of desirable engine speeds in order to reduce its size and cost. Since the desired velocity ratio or multiplication of speed is so easily obtained by belt drive, that form of transmission is generally used for high speed alternators, the chief objection being the space required for the belt, but in numerous installations this is not important.

HIGH SPEED CIRCUIT BREAKER.—A circuit breaker which starts to open the main circuit in .01 second or less on excessive rate of rise of current or on d.c. overload above its setting.—NEMA.

HIGH TENSION CURRENT.—A high voltage current. The word high tension refers to pressures of 1000 or more volts.

HIGH TENSION IGNITION.—A method of producing a spark with a device called a spark plug, very high voltage current being used. In the production of the spark two distinct circuits are necessary: 1, a low tension or primary circuit and 2, a high tension or secondary circuit. The current which flows through the low tension circuit is called the primary current and that which it induces in the high tension circuit, the secondary current. In order to obtain the high pressure required to produce a spark, a device known as a secondary induction coil is used which transforms the primary current of low voltage and high amperage into a secondary current of high voltage and low amperage.

HIGH TENSION INSULATOR.—Insulators of extra size and special design, and possessing great insulating properties, employed in high tension electric circuits. These insulators are usually made of brown glaze porcelain securing a long surface leakage path from wire to pin by a series of deep "petticoats" which increase in diameter toward the top. The topmost shell overhanging the lower ones protects them from rain and the danger of the current "flashing over."

HIGH TENSION MAGNETO.—Any magneto which produces a high tension current at its terminals. There are two classes: a, those in which the induction secondary wiring is wound directly on the armature; b, those having a secondary induction coil contained within the magneto.

HIGH TENSION TESTING TRANSFORMER.—A transformer designed for the purpose of making tests up to 10,000 volts; it is usually tested up to 35,000 volts, and so constructed as to avoid any danger of breaking down.

HIGH VACUUM.—1. In steam engineering any vacuum higher than 24 ins., the ordinary standard vacuum for condensing engines.

2. In radio, a tube exhausted to an almost perfect vacuum such as employed in so called hard tubes.

HINGE JAW.—The jaw of a switch to which the blade is pivoted.

HISSING ARC.—An arc lamp which gives off a peculiar hissing sound because the tips of the carbons come too near together; a frying or noisy arc.

"HITCHING UP."—An expression used for inserting a "booster" into an electric system.

HITTORF EFFECT.—The effect produced by Hittorf in his vacuum tube.

HITTORF RAYS.—The forms of radiation observed in a Hittorf tube.

HITTORF'S SOLUTION.—This consists of a solution of iodide in amylic alcohol made with ten per cent of the salt. It is used as a resistance and is placed in a tube having metallic cadmium electrodes.

HITTORF TUBES.—Vacuum tubes designed by Hittorf for his experiments with electrical discharges through highly rarefied gas.

HOBART SYSTEM OF ELECTRIC SHIP DRIVE.—A method of drive having alter-cycle control with induction motors. It consists of four induction motors (wound for 24, 36, 48 and 72 poles) with different connections to obtain various speeds.

HOHO AND LAGRANGE WELDING PROCESS.—The apparatus used usually consists of a lead lined wooden tank, filled with an electrolyte of any conducting liquid solution, either alkaline or acid. The positive pole of a dynamo, giving usually about 200 volts, is connected directly to the inner leaden sheath. The bar of steel or other metal to be heated, is connected to the negative pole and plunged into the bath. Directly the bar touches the liquid, electrolysis is set up and the water splits up into its component parts, the oxygen going to the leaden sheath and the hydrogen clinging to the metal, forming a complete gaseous envelope around it, and thus preventing the metal actually touching the solution. Here again, a high resistance to the flow of current is offered by the hydrogen sheath, and the electric energy is transformed into heat. It is difficult with this process to control the temperature, but some practical applications have been made, one of the most successful being the annealing of wire by passing it rapidly through the solution.

HOIST, ELECTRIC.—A hoist operated by an electric motor, the power being applied to the hoisting drum through a suitable transmission.

HOLD IN PUSH BUTTON OPERATION.—A system of elevator control comprising up and down buttons mounted in the car and also at each landing. Pressure on an up button starts the car up, and it runs only so long as the button is held depressed. When the button is released, the car stops. Hence this system is applicable only to low speed elevators. Provision is made to prevent operation by the landing buttons when the car is in motion as the result of pressure on one of the car buttons. This system is widely used for freight elevators at 100 f.p.m. or less. It is sometimes called double button control.

HOLOPHANE.—A term applied to a type of glass shades and reflectors fitted to electric and other lamps whereby the whole of the light is evenly diffused over a room. The effect is produced by cutting the glass so as to form lenses which refract the light at such angles as to prevent waste.

HOLOPHANE GLOBE.—A glass globe for diffusing light provided with a ribbed surface, the ridges sometimes running vertically on the interior surface, and horizontally on the exterior.

HOLTZ INFLUENCE MACHINE.—An electrostatic induction machine consisting essentially of two parallel plates of glass, one of which is capable of rapid rotation; it is fitted with suitable inducting and collecting devices.

HOME AND DISTANT SIGNALS.—In railway block signals a home signal shows the condition of the block directly in front of a moving train; and a distant signal the condition of the second block in front, or the block in the rear of the home block. An advance signal shows the condition of a block in conjunction with the home signal of that block. It is placed in advance of the home signal.

HOME BATTERY.—In telegraphy, the battery located at the sending or home station.

HOME STATION.—In telegraphy, the sending station.

HOMODYNE RECEPTION.—In radio, a system of reception by the aid of a locally generated voltage of carrier frequency. Sometimes called zero-beat reception.

HOMOPOLAR DYNAMO.—A dynamo in which a conductor moves continuously around one pole of a magnet; a unipolar dynamo, of which Faraday's disc is a type.

HOMOPOLAR INDUCTOR ALTERNATOR.—A machine in which the positive polar projections of the inductors are set opposite the negative polar projections. When the polar projections are set in this manner, the armature coils must be "staggered" or set displaced along the circumference with respect to one another at a distance equal to half the distance from the positive pole to the next positive pole.

HONEYCOMB COIL.—A radio multi-layer inductance coil having a staggered scheme of winding to reduce self-capacity.

HOOD FOR ARC LAMP.—A conical tin hood serving the double purpose of sheltering an arc lamp and reflecting its light downward.

HOOK SWITCH.—In a telephone set, the yoke support upon which the receiver hangs when not in use; it is provided with a switch lever so adjusted that when the receiver is lifted off the hook, a spring brings it into contact with the terminal of the talking circuit.

HOOK UP.—A radio shop term for the general circuit arrangement of radio transmitting or receiving apparatus, as indicated on a wiring diagram.

HORIZONTAL CANDLE POWER.—The illuminating power of a source of light in a horizontal direction.

HORIZONTAL COMPONENT.—The intensity of a force acting in a horizontal direction.

HORIZONTAL FIN.—A horizontal stabilizer.

HORIZONTAL STABILIZER.—On an airplane the horizontal fixed tail plane.

HORN BREAK SWITCH.—One provided with horn shaped extensions to the contacts. The arc formed on breaking the circuit, as it travels toward the extremities of the horn, becomes attenuated and is finally ruptured. An objection to horn break switches is the considerable space required for the horns and arcs, and the line surges caused by the arc. Horn switches were used extensively for high pressure a.c. circuits before the introduction of oil switches. The horn break, however, is of theoretical interest.

HORN GAP ARRESTER.—A lightning arrester consisting essentially of two horn shaped terminals forming an air gap of variable length; one horn being connected to the line to be protected and the other to the ground usually through series resistance.

In operation, the arc due to the line current which follows a discharge, rises between the diverging horn and becoming more and more attenuated, is finally extinguished. Horn arresters should be used to protect the series rectifiers and moving coil transformers used in series lighting. They should also be used at the junction of cable and overhead series circuits.

The horn type arrester was invented by Oelschlaeger for the Allgemeine Electricitaets Gesellschaft, and like the Thomson arc circuit arrester, its operation is based on the fact that a short circuit once started at the base, the heat generated by the arc will cause it to travel upward until it becomes so attenuated that it is ruptured. On circuits of high voltage this rupture sometimes takes a second or two, but seems to act with little disturbance of the line. Sometimes a water resistance is used, a choke coil being inserted in the circuit in series.

HORNS.—Steel struts on the controls of an airplane to which the control wires are attached.

HORNS OF POLE PIECES.—The projecting terminals of the pole pieces of dynamo field magnets; the polar tips.

HOROLOGY, ELECTRIC.—The application of electricity to the regulation and control of the movement of clocks.

HORSE POWER.—33,000 foot pounds per minute. The unit is due to James Watt as being the power of a strong London draught horse to do work during a short interval and used by him to measure the power of his steam engines. One horse power = 33,000 ft. lbs. per minute = 550 ft. lbs. per sec. = 1,980,000 ft. lbs. per hour.

HORSE POWER HOUR.—A unit of work; the amount of work done by one horse power working for one hour; 1,980,000 foot pounds.

HORSE POWER TRANSMITTED BY LEATHER BELTS.—Rule: A single belt one inch wide and traveling 1,000 feet per minute will transmit one horse power; a double belt under the same conditions will transmit two horse power. This rule gives a liberal size belt and can be depended upon for operation under any reasonable conditions.

HORSE SHOE MAGNET.—A magnet bent into the shape of a horseshoe or the letter U, thereby bringing the two poles together so that they act at the same time upon the armature or keeper. A horse shoe magnet is made of hardened steel which retains its magnetism a long time after being magnetized; it will attract and hold pieces of iron and steel. The ends or poles are named north and south. The "armature" or keeper, which is put across the ends, has the peculiar property of keeping the magnetism from becoming weaker.

HOSPITALIER ONDOGRAPH. — A wave form measuring device. The principle on which its action is based, consists in automatically charging a condenser from each 100th wave, and discharging it through a recording galvanometer, each successive charge of the condenser being automatically taken from a point a little farther along the wave.

HOT BEARINGS.—On dynamos and other machines, hot bearings are detected by applying the hand to the different parts of the machine if low tension, or a thermometer if high tension, and also by a smell of overheated insulation, paint, or varnish. The temperature of a bearing should not exceed 80° F., above the surrounding air, and this temperature ought not to be reached under normal conditions of working.

HOT GILDING.—The electro-plating of gold with the aid of heat, a method especially adapted to the gilding of small articles. The use of a hot bath has certain advantages over cold gilding; the deposit is smoother and cleaner and with a deeper color, and generally more durable.

HOT PLATING.—Electro-plating by the use of a hot bath, as in hot gilding.

HOT TUBE IGNITION.—In this method a short tube of metal or porcelain is maintained at a dull red heat by contact with a gas flame; it is attached to the engine cylinder in such a manner that a portion of the explosive charge is forced into it, this being ignited by contact with the hot walls of the tube, ignites the whole charge.

HOT WELL.—In a condensing engine, a receptacle for the hot water drawn from the condenser by the air pump. Usually this water is returned to the boiler, being drawn from the hot well by the feed pump. Under ordinary conditions, the temperature of the hot well varies from 110° to 120° F.; occasionally as much as 130° is maintained.

HOT WELL BY-PASS VALVE.—In a marine condensing steam plant, a valve on a pipe line connecting the feed pump discharge to the hot well. The valve may be adjusted so as to maintain sufficient water in the hot well as to prevent the pump sucking air. If the make up valve be adjusted to admit enough water to equal that lost by leakage, a constant level will be maintained in the hot well. The main idea being to prevent the pump sucking air.

HOT WIRE INSTRUMENTS.—A type of ammeter or volt meter invented by Major Cardew and based on the expansion and contraction of a fine wire carrying either the current to be measured or a fractional part of it. The expansion or contraction of the wire is caused by temperature changes, which in turn are due to the heating effect of the current flowing through the wire. Since the variations in the length of the wire are extremely small, considerable magnification is necessary. Pulleys or levers are sometimes used to multiply the motion. Hot wire instruments are equally accurate with alternating or direct current, but have cramped scales (since the deflection is proportional to the square of the current) and are liable to creep owing to unequal expansion of the parts. There is also the danger that they may be burnt out with even comparatively small overloads. They are not affected by magnetic fields, but consume more current than the other types. The readings are inaccurate near either end of the scale.

HOUSE MAINS.—In a system of parallel incandescent lamp distribution for buildings, conductors connecting the auxiliary service conductors with the street mains.

HOWDEN SYSTEM OF FORCED DRAUGHT.—A system in which the air in the stokehold is at the same pressure as the outside atmosphere but the ash pits are closed and the air handled by the blowers is led through ducts, and after passing over tubes that are heated by the waste gases from the boiler is delivered to the ash pits under pressure. Some air is also admitted above the fires to prevent smoke being formed and to produce nearer perfect combustion, while the fire doors are usually arranged so as to cut off the draught when they are opened.

HOWLER.—A particularly noisy variety of electric buzzer.

HOWLING.—In a radio receiver, a sound usually due to feed back effects.

H. P.—Abbreviation for horse power, or high pressure.

H.p.c.—Abbreviation for high pressure cylinder.

H-POLES.—A pair of telegraph poles braced together by a cross piece thus resembling the letter H.

H.t.—Abbreviation for high tension.

HUBBELL BATTERY.—A storage battery of the alkaline type in which the electrolyte is a solution of potassium hydrate in water. In this is placed a cadmium negative plate and a nickel oxide positive plate.

HUGHES' ELECTRO-MAGNET.—A form of electro-magnet devised by Hughes for his printing telegraph; it is a permanent horseshoe magnet provided with magnetizing coils upon its pole pieces.

HUGHES' INDUCTION BALANCE.—An apparatus for detecting the presence of a hidden metallic or conducting body by the use of induced electric currents.

HUGHES' MICROPHONE.—An early form of the telephone transmitter, consisting of a small pencil of gas carbon loosely held perpendicularly between two carbon blocks fastened to a diaphragm.; the **pencil microphone.**

HUGHES' THEORY OF MAGNETISM.—A theory proposed by Hughes that magnetism is an original property of matter; every molecule of matter being assumed to exist as a natural magnet. In a magnetized substance the poles of these molecular magnets are supposed to be arranged in the same direction, and in an unmagnetized body in opposite directions thus neutralizing each other.

HUM.—A trouble experienced with radio receivers having power units operated with a.c. Hum from the radio frequency stages and detector is due to incorrectly placed wiring, with a.c. and d.c. lines too close together or else to operation of the amplifying tubes in an oscillating condition. In combined power units and amplifiers the location of the parts with reference to each other is important. Audio frequency transformers or coupling chokes should be kept as far as possible from all power transformers, filament transformers and rectifier tubes. Filter chokes should be kept well separated from power transformers. When such a power amplifier is being constructed, it is advisable to alter the positions of coupling transformers and chokes with reference to each other and to the power transformers until the positions for least inductive coupling are found.

HUMIDITY.—The amount of water vapor in the air. This depends upon the temperature of the air. When there is mixed with the air all of the water vapor which it can hold, the air is said to be saturated. The quantity of water vapor actually present in a given volume of air, without regard to its temperature, is called its absolute humidity. Thus if air, at any temperature, contain 4 grains of water vapor per cubic foot, its absolute humidity is expressed as 4 grains per cubic foot. Relative humidity is an expression, in percentage, of the degree of saturation of air at any given temperature. A relative humidity of 50% means that the air, at its given temperature, contains 50% of the water vapor required to saturate it at that temperature.

HUMMING OF TRANSFORMER.—A sound produced in a transformer core, due to the rapid reversal of the magnetic flux. It may be caused partly by the contraction and expansion of the iron itself, and partly by the mutual attraction and repulsion of any loose core plates.

HUNTING.—The state of two parallel connected alternators running out of step, or not synchronously, that is, "see-sawing." When the current wave of an alternator is peaked and two machines are operated in parallel it is very difficult to keep them in step, that is, in synchronism. Any difference in the phase relation which is set up by the alternator will cause a local or synchronizing current to flow between the two machines and at times it becomes so great that they must be disconnected.

Alternators which produce a smooth current wave and are maintained at uniform speed by properly designed governors, operate fairly well in parallel, but are not entirely free from hunting, and other means are provided to overcome the difficulty, such as amortisseur winding.

HUNTING OF MOTOR GENERATOR SETS.—When hunting, motor generator sets are not so liable to flash over as a rotary converter because the motor generator operating on a high frequency circuit can be designed with a few poles and the brushes set far apart which will greatly reduce the chance of flashing over.

HUNTING OF ROTARY CONVERTERS.—There are several methods used to prevent hunting, namely:

1. The employment of a strongly magnetized field relative to that developed by the armature.
2. A heavy fly-wheel effect in the converter.
3. The increasing of the inductance of the armature by sinking the windings thereon in deep slots in the core, the slots being provided with extended heads.
4. The employment of damping devices or amortisseur winding on the pole pieces of the converter.

The damping method is the best method.

HUNTING OF SYNCHRONOUS MOTORS.—Regular increase and decrease from synchronous speed in trying to find the phase difference corresponding to a change in load.

HYBRID COIL.—A single transformer having effectively three windings which, within certain limitations as to the impedances to which it is connected, performs the function of a hybrid set.

HYBRID SET.—Two or more transformers interconnected to form a network having four pairs of accessible terminals to which may be connected four impedances so that the branches containing them may be made conjugate in pairs.

HYDRAULIC CRANE.—A crane driven by a hydraulic ram or piston, the stroke of the ram being multiplied several times by means of a pulley system, thus giving a long rapid lift.

HYDRAULIC JACK.—A jack used for lifting heavy weights, the load on which is moved by a hydraulic plunger instead of a screw. The plunger is actuated by a small pump, whose water supply is contained in the head of the jack. This has been called the seventh mechanical power.

HYDRAULIC LIME.—One possessing the property of hardening under water. Limes containing 8 to 12 per cent of silica, alumina, etc., set slowly in water, those containing 12 to 20 per cent of the same ingredients set in six or eight days, those termed eminently hydraulic, and possessing 30 to 50 per cent of foreign matter harden in 2 to 4 days.

HYDRAULIC TURBINE.—One driven by water pressure or impulse, as distinguished from one actuated by steam or other fluid.

HYDRAULICS.—That branch of the science of engineering which treats of water in motion, and the application of its laws to the industries; as to hydro-electric generation.

HYDRO-AIRPLANE.—An airplane fitted with floats or boats so designed that it can arise from and alight on the water.

HYDROCARBON.—A compound of hydrogen and carbon; the possible number of these compounds is infinite, and the known number very large.

HYDROCHLORIC ACID.—A colorless gas with keen acid smell. It liquefies under a pressure of 40 atmospheres at 10° and solidifies at 115°. The gas is very soluble in water and its solution behaves as a strong acid. It is obtained on a large scale by heating common salt with sulphuric acid. When combined with zinc to form chloride of zinc, the solution is used as a soldering flux, but should not be used in soldering connections of electric circuits—use rosin.

HYDROCYANIC ACID.—Prussic acid, one of the most poisonous substances known. Its salts are called cyanides such as potassium cyanide and mercurous cyanide. Potassium cyanide is largely used in extracting gold and in electro-plating.

HYDRO-DYNAMICS.—That branch of mechanics which treats of the laws of motion and action of water and other liquids.

HYDRO-ELECTRIC BATH. — In electrotherapeutics, a bath having one electrode connected with the metal of the tub and another for application to the patient's body.

HYDRO-ELECTRIC CENTRAL STATIONS.—The economy with which electricity can be transmitted long distances by high tension a.c., has led to the development of a large number of water powers in more or less remote regions. Invariably the turbines, alternators, exciters and controlling switchboard are housed in one large room. The prime movers should be arranged in a single row to simplify the penstock and tail race design, and the exciters (if not directly connected to the main units) and other auxiliary equipment common to the station should preferably be located in the center.

HYDRO-ELECTRIC MACHINE.—An experimental machine for generating electricity by the friction of jets of steam issuing from an insulated boiler through wooden nozzles against a metal comb.

HYDRO-ELECTRO-THERAPEUTICS.—The application of electricity and water for curative purposes; usually applied in the form of a bath furnished with suitable electrodes, one applied to the tub and the other to the body of the bather.

HYDROGEN.—A colorless, odorless, tasteless gas, the lightest body known. Its specific gravity is taken as 1, air being 14.4. It is combustible, burning with an almost invisible flame, if pure, and forming water by union with the oxygen of the air; it is a non-supporter of combustion. Hydrogen liquefies under great pressure and low temperature, solidifying at —431° F.

HYDROGEN FLAME.—The flame of burning hydrogen supplied with oxygen, producing an extreme heat sufficient to melt many refractory substances. It is usually known as oxy-hydrogen flame.

HYDROGEN VOLT METER.—A volt meter depending for its action upon the amount of hydrogen liberated under certain conditions.

HYDROMETER.—An instrument for measuring the specific gravity of liquids. It is usually constructed of glass and consists of: a, a graduated stem, a fine tube of uniform diameter; b, a bulb or enlargement of the tube containing air; c, a small bulb at the bottom, containing shot or mercury which causes the instrument to float in a vertical position. The graduations represent either specific gravities, or the numbers of an arbitrary scale, as in Baume's, Beck's, Twaddel's, etc.

HYDRO-PLATINUM RHEOSTAT.—A rheostat offering water resistance provided with electrodes of platinum.

HYDROSTATIC BALANCE.—A balance for weighing substances in water, for the purpose of ascertaining their specific gravities.

HYDROSTATIC BED.—In hydraulics, a water bed; as, that of a pond.

HYDROSTATIC PARADOX.—The principle that any quantity of fluid however small may balance any weight however great.

HYDROSTATICS.—That branch of physics which treats of the laws governing fluids at rest, as distinguished from hydraulics, which refers to them in motion.

HYDRO-TASIMETER, ELECTRIC. — An electrical instrument for indicating at a distance the height of a water level. Usually a float is placed in the water and connected with an electric circuit. The action of the float sends positive impulses when rising, and negative impulses when falling; an index registers these.

HYGROMETER.—An instrument for measuring the amount of water vapor in the air. Most hygrometers are really instruments for finding the dewpoint, and depend upon cooling some surface in the open air until moisture is deposited upon it.

HYPERBOLA.—The locus of a point which moves so that its distance from a fixed point, called the focus, bears a constant ratio, which is greater than unity, to its distance from a fixed straight line, called the directrix.

HYPERBOLIC LOGARITHMS.—In mathematics, those logarithms devised by John Speidell in 1619, of which the base is 2.7182818; also called Napierian logarithms, from the inventor of logarithmic tables.

HYPOCHLORITES. — Sodium hypochlorite is a compound whose molecule contains two atoms of oxygen less than the chlorate. It is produced at some intermediate stages in the electrolytic process for making chlorate.

HYPOTENUSE.—The side of a right angled triangle opposite the right angle.

HYPSOMETER.—An instrument for measuring the height of mountains, consisting essentially of a sensitive thermometer by which the temperature of the boiling point of water at a given elevation is determined; a thermo-barometer.

HYSTERESIMETER.—A device for measuring hysteresis loss by mechanical torque. It consists of a U shaped magnet which can be rotated around a vertical axis. The sample sheets of iron or steel to be tested are mounted in the form of a ring between the poles of the magnet upon a support which tends to revolve, but is held by a spring. When the magnet rotates the sample under test turns by an angle at which the hysteresis torque balances the pull of the spring. Other forms of testing apparatus employ the same principle.

HYSTERESIS.—The lagging of magnetism, in a magnetic metal, behind the magnetizing flux which produces it. Hysteresis is due to the friction between the molecules of iron or other magnetic substance which requires an expenditure of energy to change their position. The expenditure of energy is converted into heat.

Ewing gives the value for the energy in ergs dissipated per cubic centimeter, for a complete cycle of doubly reversed strong magnetization for a number of substances as follows:

	Ergs.
Very soft annealed iron	9,300
Less soft annealed iron	16,300
Hard drawn steel wire	60,000
Annealed steel wire	70,000
Same steel glass hard	76,000
Piano steel wire annealed	94,000
Piano steel wire normal temper	116,000
Piano steel wire glass hard	117,000

Approximately 28 foot pounds of energy are converted into heat in making a double reversal of strong magnetization in a cubic foot of iron.

HYSTERESIS CONSTANT.—The work required to magnetize and demagnetize one cu. cm. of iron or any other magnetic material with unit magnetic flux density.

HYSTERESIS IN TRANSFORMER CORE.—In the operation of a transformer the a.c. causes the core to undergo rapid reversals of magnetism. This requires an expenditure of energy which is converted into heat.

This loss of energy is due to the work required to change the position of the molecules of the iron, in reversing the magnetization. Extra power then must be taken from the line to make up for this loss, thus reducing the efficiency of the transformer.

HYSTERESIS LOOP.—Loops plotted in graphic curves of cycles of magnetization to illustrate the waste of energy due to hysteresis.

HYSTERESIS LOSS.—The product of hysteresis constant $\times$ volume of iron $\times$ frequency $\times$ 1/6 power of the maximum flux density.

HYSTERETIC CYCLE.—A cycle of magnetization and its reversal, involving hysteresis.

HYSTERETIC LAG.—Lagging of magnetization caused by hysteresis.

I

I.—Symbol for electric current.

IA, IA METAL.—A nickel copper alloy employed in the construction of electrical instruments, resistances, etc. It is not affected by moisture; is permanent and has a very low temperature coefficient of resistance.

I-ARMATURE.—An armature having a core resembling the letter I; a girder or H armature.

I-BEAM.—A rolled joist or beam resembling the capital letter I in cross section. Such beams are economical of material through elimination of redundant material near the neutral axis.

ICE CLEARER.—A trolley wheel specially constructed for removing ice from the trolley wire.

IDEAL SOLENOID.—A solenoid conceived to be built up of a system of independent circular currents, equal, parallel, and uniform in direction.

IDENTICAL ELECTRODE CELL.—A variety of double fluid primary cell, having both electrodes of the same metal; a one-metal cell.

IDIO ELECTRICS.—A name formerly given to substances, such as, glass, amber and resin, which become electrified by friction.

IDIOSTATIC VOLT METER.—A volt meter in which there is present only the electricity to be measured, as distinguished from a heterostatic electrometer.

IDLE COIL.—In armature winding, when the number of slots does not satisfy the winding formula, an extra coil is inserted which serves to give the armature symmetry and adds to its strength, but which carries no current. The idle coil may be connected to an extra commutator bar on one side, or it may be insulated on both ends.

IDLE CURRENT.—A name sometimes given to that component of an alternating current at right angles to the voltage and contributing nothing to the power.

IDLE POLES.—Poles in a Crookes' vacuum tube, which are not intended to produce an electric discharge, but are introduced for other experimental purposes.

IDLER.—1. In gearing, a toothed wheel occupying an intermediate position in a train, which communicates motion from the driver to the follower.

2. A pulley or drum which supports a belt or prevents it coming into contact with a stationary part.

3. An adjustable pulley which bears against a belt for the purpose of preserving proper tension.

I.E.C.—Abbreviation for International Electro-technical Commission.

IGNITER.—1. A device, either portable or attached to a lamp or fire to light it.

2. A strip of carbon connecting the ends of the parallel carbons of an arc lamp of the Jablochkoff type, whereby, upon the passage of the current, an arc is formed.

3. A device used in low tension ignition for igniting the charge operating by the sudden breaking of contact between two electrodes (one fixed and one movable) to produce an electric arc. A primary induction coil in the circuit gives the necessary inductive effect to prolong the arc sufficiently for ignition.

IGNITION.—Setting on fire the charge in a gas engine by an igniter in low tension or "make and break" ignition, or by a spark plug in high tension or "jump spark" ignition. The common and popular terms make and break and jump spark should be avoided as neither system can operate without making and breaking the circuit and because the word "jump" should not be used with the word spark. The difference between arc and spark should be understood.

IGNITION COIL.—A primary or secondary coil forming a part of a low tension (make and break) or high tension (jump spark) ignition system respectively. Most ignition induction coils or "spark coils" as they are called, have terminals marked "battery," "ground," etc., and to short circuit the timer for the purpose of testing the vibrator, it is only necessary to bridge with a screw driver from the "battery" binding post to the "ground" binding post. It is a mistake to use a higher voltage than that for which the coil is designed, because it does not improve the spark and the contact points of the vibrator will be burned more rapidly, moreover, the life of the battery will be shortened.

IGNITION CONDENSER.—A fixed condenser shunted across the timer circuit for the purpose of stopping the primary current as rapidly as possible at break, thus suppressing an arc at break and producing the maximum voltage in the secondary circuit for the spark. Only mica condensers should be used as the paper condensers furnished on automobiles are very unreliable.

IGNITION DISTRIBUTOR.—A switching device used on high tension synchronous ignition consisting of a combination of timer and distributor elements working synchronously on one shaft.

IGNITION PLUG.—A screwed plug inserted into the cylinder wall or head of a gas engine; it has two electrodes or spark points, one of which is grounded to the cylinder and the other insulated. Generally called spark plug. Aeronautical spark plugs are designed for great heat and high compression.

IGNITION RESISTANCE UNIT.—A coil of iron wire wound on a porcelain spool and placed in the primary circuit to protect the ignition coil in case the operator forget to open the primary switch when stopping the engine. Current flowing through the iron coil heats it and increases its resistance considerably, thus cutting down the current and protecting the ignition coil.

IGNITION SAFETY GAP.—A gap shunted across the secondary circuit in a high tension ignition system especially where a magneto is used. The object being to protect the circuit from excessively high voltage.

IGNITION TIMER.—A rotating switch which controls the primary current only, opening the primary circuit each time a spark is required.

I.h.p.—Abbreviation for indicated horse power.

ILLUMINATING GAS.—Hydro-carbon gas supplied through piping from a central source or place of manufacture, and whose flame is used for lighting purposes.

ILLUMINATION.—The density of light flux projected on a surface; it denotes the art of using artificial sources of light, that is to say, the problem of illumination involves the selection and arrangement of these artificial sources of light so that the objects to be lighted will show up to the best advantage and with the minimum amount of artificial light.

ILLUMINOMETER.—A simple form of photometer for comparing illuminations with approximate accuracy. It works on the principle of an extinction photometer, the light being varied until certain test characters become invisible.

IMAGE.—The appearance of an object at a place where no object exists. When luminous rays, which pass through a small aperture into a dark chamber, are received upon a screen, they form images of external objects. Images thus formed are upside down because the luminous rays proceeding from external objects, and penetrating into the chamber, cross one another in passing the aperture.

IMAGE, ELECTRIC.—As defined by Maxwell: "An electrified point or system of points on one side of a surface, which would produce on the other side of that surface the same electrical action which the actual electrification of that surface really does produce."

IMBIBITION CURRENTS.—Currents in tissues due to the absorption of fluids.

IMBRICATED COIL WINDING.—A species of spiral coil winding in which the end connections are built up one above the other, either in a radial, or in a horizontal direction. The winding is used especially on the armatures of turbine alternators and dynamos.

IMMERSION BRAZING.—A method of brazing by dipping the article to be brazed in brazing solder. The brazing solder is melted in a pot on the coal fire, or better in a gas furnace, flux being placed on top of the solder. In brazing, hold the object first in the fire a little while to heat and coat the article with a film of flux. Then, when it is lowered into the solder, the latter will flow in the joint and firmly attach itself. Before dipping, the article to be brazed is coated with a special anti-flux graphite, covering all the surface except that which is to be brazed. The layer of flux in the pot may be kept from ½ inch to 2 inches deep.

IMMERSION OBJECTIVE.—The objective of a microscope from which the object to be examined can be suspended by a drop of clear liquid.

IMPACT.—The force of the collision of one body against another. Impact is direct and oblique. When a body hits a plane surface, it rebounds at an angle equal to that at which it approached the plane. If two perfectly elastic bodies impinge on each other, their relative velocities will be the same after impact as before; that is, they will recede from each other with the same velocity with which they approached.

IMPACT TRANSMITTER.—A type of radio transmitter in which energy is transferred from the exciting circuit to the oscillating circuit during one vibration of the exciting current.

IMPEDANCE.—The total opposition in an electric circuit to the flow of an alternating current. Impedance may be called the combination of: **a**, ohmic resistance, and **b**, spurious resistance, the latter being made up of inductance reactance and capacity reactance.

The impedance of an inductive circuit which does not contain capacity is equal to **the square root of the sum of the squares of the resistance and inductance, that is**

$$\text{Impedance} = \sqrt{\text{resistance}^2 + \text{inductance}^2}$$

When the frequency and inductance are given

$$Z = \sqrt{R^2 + (2\pi f L)^2}$$

in which: Z = impedance in ohms; f = frequency; L = inductance in henries.

In circuits containing resistance, inductance and capacity

$$Z = \sqrt{\text{resistance}^2 + (\text{inductance} - \text{capacity})^2}$$

or using symbols,

$$Z = \sqrt{R^2 + (X_i - X_c)^2}$$

$$= \sqrt{R^2 + (2\pi f L - \frac{1}{2\pi f C})^2}$$

here C = capacity in farads.

IMPEDANCE COIL.—A name given to a reactance or choke coil which is sometimes introduced into a circuit in place of a resistance, as with a.c. lamps to limit the current. It consists of a coil of insulated wire wound upon an iron core.

IMPEDANCE COUPLING.—The method of coupling two circuits by an impedance coil, that is, a self-inductance coil usually having an iron core.

IMPEDANCE FACTOR.—The ratio of the impedance to the ohmic resistance in an electric circuit.

IMPEDANCE OR DISTANCE TYPE RELAY.—An induction disc relay similar to the ordinary over current type relay, but with the addition of a voltage restraining coil which is connected mechanically to the disc and to the contact mechanism. The disc is rotated whenever the current in the current coil exceeds a definite value and is damped by the permanent magnets in such a manner that its speed is approximately proportional to the magnitude of the current. Instead of operating the contacts directly, the movement of the disc winds up a spring, one end of which is fastened to a shaft that is geared to the disc shaft. The other end of the spring is connected by means of a lever to a rocker arm pivoted at its center and mounted directly above the disc. This rocker arm carries the contact on one end. The core of the restraining coil is suspended from the other end.

IMPEDANCE RUSH.—The sudden burst of current which enters an inductive circuit at the moment it is closed.

IMPEDANCE TRIANGLE.—A right triangle drawn to scale in solving impedance problems. In the triangle, for instance, as applied to a circuit containing resistance and inductance, lay off with any convenient scale, the base of triangle = ohmic drop and the other leg (with same scale) = inductance drop and join the two legs, then the length of the third side thus obtained = impressed pressure.

IMPEDANCE WAVE TRAP.—In radio, a type of wave trap having a parallel resonance circuit which is placed in series with the aerial circuit.

IMPELLER.—1. That portion of a blower or centrifugal pump which acts directly upon air or water and sets it in motion. It consists of a disc or fan.

2. The rotary part of a non-reciprocating engine; that is, the piston of a rotary engine, corresponding to the rotor of a steam turbine.

IMPERFECT EARTH.—A fault in an electric circuit due to an imperfect grounding or connection with earth through a defect in the insulation; a partial earth.

IMPOUNDING RESERVOIR.—In hydraulics, a large reservoir where water supply from rivers may be received preparatory to filtering; the impounding reservoir is large enough to permit some preparatory settling.

IMPREGNATED CARBON.—Carbon prepared for use as an electrode in the flaming arc lamp. In order that the carbon shall give off at the temperature of the arc a strongly luminous vapor, it is sometimes impregnated with common salt which causes it to give, in the arc, a brilliant yellow flame. Other materials are also used for impregnating the carbon, especially calcium fluoride which produces a golden light of great intensity.

IMPREGNATED INSULATING MATERIAL.—Paper or cloth treated with a moisture proofing substance to not only render it moisture proof, but to improve its insulating quality.

IMPREGNATED OR MUMMIFIED WINDING.—Descriptive of the treatment, the coils of a winding receive in the making; that is, when a winding, after being covered with tape or other absorbent material, is saturated in an insulating compound and baked until the whole is solidified, it is said to be mummified.

IMPREGNATED POLE.—A wooden pole for carrying line wires, which has been protected against decay by having creosote or other preservative forced into the fibre of the wood. The life of the pole may in this way be increased from three to tenfold.

IMPREGNATING COMPOUND.—A preparation used to increase the insulating properties of fibrous materials and to render them moisture proof and able to withstand the effect of heat with less rapid deterioration.

IMPRESSED.—Brought to bear upon; pressure exerted upon, as the voltage impressed upon a circuit.

IMPRESSED FIELD.—An electric or magnetic field applied to a body or area in order to produce other fields of force.

IMPRESSED PRESSURE.—The voltage applied to a circuit; the full voltage at the beginning of the circuit, that is, the total pressure applied to a circuit tending to overcome ohmic and spurious resistance and produce a current in a forward direction.

IMPROPER FRACTION.—One whose numerator equals or exceeds its denominator.

IMPULSE.—A sudden increase in voltage which produces an impulsive rush of electricity or impulsive discharge, as distinguished from a constant voltage, which produces a steady current.

IMPULSE EXCITATION.—A method of producing a damped oscillatory current by momentary application of an exciting voltage whose duration is short compared with the duration of the current produced.

IMPULSE REPEATER.—A telephone device for repeating impulses from one line circuit into another and for performing other duties.

IMPULSE STEAM TURBINE.—A type in which the nozzle is of a diverging cross section, allowing the steam to expand therein; it thus attains a high velocity, and impinges upon the moving vanes. The steam, in passing through the wheel, imparts some of its kinetic energy to the blades, and leaves them at a lower velocity, but at the same pressure at which it left the nozzle.

IN BRIDGE.—A parallel or multiple connection in a circuit, as distinguished from a series connection.

IN PHASE.—Two alternating quantities are said to be in phase when there is no phase difference between them, that is, when the angle of phase difference equals zero. Thus, the current is said to be in phase with the pressure when it neither lags nor leads.

INCANDESCENCE, ELECTRIC.—The glowing of a substance when heated white hot by an electric current. Incandescence is produced by the passage of a current of high intensity through a conductor of high resistance; the temperature in a non-homogeneous conductor is highest in those portions where the resistance is highest and the radiation smallest.

INCANDESCENT BALL ELECTRIC LAMP.—An incandescent lamp having a carbon ball within an exhausted glass bulb; the carbon becoming luminous by the influence of high frequency electrostatic waves.

INCANDESCENT BOMBARDMENT LAMP.—An electric lamp in which the incandescence is produced by the molecular bombardment of an electric discharge in a vacuum.

INCANDESCENT LAMP.—An electric lighting device widely used and which lends itself to the greatest variety of uses. It operates on the principle of heating a wire to a white heat by sending an electric current through it. In construction, a slender filament of some conducting refractory material is enclosed in a glass chamber and connected to lead wires fused through the base of the chamber or "bulb." The bulb is exhausted of air as completely as possible and the exhaustion duct sealed. The object of placing the filament in a vacuum is to prevent oxidation. Carbonized paper or bamboo fiber was at first used for the filament, but this was superseded by carbonized cellulose which held the field for many years. Efforts to secure a filament of greater efficiency have resulted in important developments, among which may be mentioned the metallized filament in which the carbon is converted to graphite, and various filaments composed of rare metals as used in the osmium, tantalum, tungsten and other new lamps.

INCH POUND.—In mechanics, a unit of calculation; one pound lifted one inch.

INCH TON.—In mechanics, a unit of calculation denoting one ton lifted one inch.

INCIDENT RAYS.—The angle at which a ray meets a surface. When a ray of light meets a polished surface, it is reflected according to the two following laws:

1. The angle of reflection is equal to the angle of incidence.
2. The incident and the reflected rays are both in the same plane which is perpendicular to the reflecting surface.

INCLINATION COMPASS.—An inclinometer, or instrument, having a magnetic needle moving only in a vertical plane, designed to indicate the magnetic inclination or dip at any point on the earth's suface; also called inclination magnetometer.

INCLINATION MAP.—An isoclinic chart upon which is drawn a system of lines passing through all the points on the earth's surface which have the same magnetic inclination or dip.

INCLINATION OF MAGNETIC NEEDLE.—The dip of a magnetic needle; the angle which a magnetic needle, turning upon a horizontal axis, makes with the horizontal plane, due to the fact that in most places the lines of force are not horizontal. In the northern hemisphere it is the N pole of the needle which is depressed; in the southern hemisphere it is the S pole.

INCLINED COIL INSTRUMENT.—An a.c. induction instrument having a coil mounted at an angle to a shaft carrying a vane and pointer. A spring forms the controlling force and holds the pointer at zero when no current is flowing. In operation, when a current is passed through the coil, the iron tends to take up a position with its longest sides parallel with the lines of force, which results in the shaft being rotated and the pointer moved on the dial, the amount of movement depending upon the strength of the current in the coil.

INCLINED PLANE.—A slope or flat surface inclined to the horizon, on which weights may be raised. By such substitution of a sloping path for a direct upward line of ascent, a given weight can be raised by a power less than itself. The simplest example of the application of the inclined plane is that of a plank being raised at the rear end of a cart for the purpose of rolling in heavy articles, as barrels or hogsheads.

INCLINOMETER.—1. An inclination compass.

2. An instrument for measuring the rate of slope or inclination, by means of a spirit level and a graduated arc. A clinometer or batter measure.

INCOMMENSURABLE QUANTITIES.—Quantities that have no common measure.

INCREMENT.—The act or process of increasing; growth in bulk, quantity, number, value or amount.

INCREMENT KEY.—A telegraph key which not merely closes a circuit when contact is made, but produces an increment or increase in the line current.

INCREMENT KEY FOR QUADRUPLEX TELEGRAPHY.—A telegraph key which increases the strength of the line current for the operation of distant instruments in a quadruplex system.

INCRUSTATION.—In a steam boiler a coating over, the coating being commonly known as scale. It is due to the separation of impurities in the feed water which adhere to the metal.

INDETERMINATE EQUATIONS.—Those in which it is impossible to determine the values of the unknown quantities definitely.

INDEX OF REFRACTION.—In the passing of light from one medium into another, the ratio between the sines of the incident and refracted angles; the refractive index.

INDIA RUBBER.—An elastic gummy substance derived from the milky juice of a variety of tropical trees and plants. The best rubber, known as Para, comes from Brazil, Bolivia and Peru. India rubber has valuable insulating properties, and is largely used in covering electric cables, etc.

INDICATED HORSE POWER.—The horse power of an engine based on the mean effective pressure calculated from its indicator card. Do not confuse with brake horse power. In calculating horse power, do not use the old cumbersome formula:

$$\text{i. h. p.} = \frac{2\ \text{PLAN}}{33{,}000}$$

but use this

$$\text{i.h.p.} = .000004\ D^2LNP$$

in which

D=diameter of cylinder in ins.

L=length of stroke in ins.

N=revolutions per minute

P=mean effective pressure in lbs. per sq. in.

For a single acting engine take half of N; for a four cycle gas engine take one-quarter of N.

INDICATING INSTRUMENTS. — Various d.c. and a.c. meters such as ammeters, volt meters, watt meters, etc.

INDICATING LAMP.—A lamp in an electric circuit which is designed to indicate varying conditions of the circuit by the quality of its own light.

INDICATING SWITCH.—A switch which indicates whether its circuit is open or closed.

INDICATING WATT METER.—An electrical instrument for measuring power developed in a circuit, and designed to show instantaneous values of power, or the rate at which energy is consumed in a circuit.

INDICATOR.—An instrument used to record the pressure of a gas or liquid in an engine or pump cylinder at all points of the stroke as the piston moves to and fro. An indicator consists of a small cylinder having a piston which is acted upon by the pressure of the gas or liquid against the pressure of a spring. Its movement is multiplied by suitable gear and recorded on a paper "card" placed around a drum. The latter reproduces on a small scale the movement of the piston. From the card, the pressure at any point of the stroke can be measured and the mean effective pressure calculated.

INDICATOR CARD.—An outline traced by an indicator showing the actual steam pressure variation in the cylinder during one revolution. Indicator cards are "taken" not only for steam engines, but for gas engines, compressors, etc.

INDICATOR DIAGRAM.—In steam engine design a diagram is a figure drawn to pressure and volume scales representing proposed steam distribution in the cylinder during one revolution.

INDICATOR FLAP.—A disc of light metal which swings over the self-restoring indicator of a multiple telephone switchboard.

INDIFFERENT ELECTRODE.—An electrode employed in electro-therapeutics merely for the purpose of closing the circuit through the part of the body to be treated, as distinguished from the electrode which actually applies the treatment.

INDIRECT DISTRIBUTION.—Electric distribution which involves the introduction of various intermediary devices between the dynamo and the receptive devices.

INDIRECT ELECTROLYSIS.—Chemical decomposition occurring after the action of electrolysis, as distinguished from the electrolysis itself.

INDIRECT EXCITATION.—In electro therapeutics, a method of applying electric excitation to a muscle by placing the electrode upon the nerve leading to that muscle.

INDIRECT LIGHTING.—A method of lighting in which all of the light emitted from the unit is thrown first to the ceiling and from there diffused throughout the room. In such a system the ceiling acts as the light source, and the glare is reduced to a minimum. The resulting illumination is softer and more diffused and the shadows are less prominent.

INDIRECT RAYS.—X-rays generated at the surface of the glass of the tube.

INDOOR AERIAL.—Self defining. The length of indoor aerials is usually from 20 to 100 ft. It may be strung either in a straight line or in various directions, care being taken to thoroughly insulate it if bare wire be used. In case there be electric railway or power lines in the vicinity the aerial should be run at right angles to them to avoid interference.

INDOOR TRANSFORMER.—A non-weather proof transformer.

INDUCED.—Brought about by induction, as when a body receives an electric charge by the influence upon it of a neighboring charged body.

INDUCED ATOMIC OR MOLECULAR CURRENTS.—Currents conceived to be produced in the particles of a magnetic substance when influenced by the presence of lines of magnetic force.

INDUCED CHARGE.—The charge received on a conductor due to the influence of another electric charge in the vicinity of the conductor.

INDUCED CURRENT.—An electric current set up in a circuit by cutting lines of force; a current caused by electro-magnetic induction; as, in an induction coil when the strength of a current flowing through the primary winding varies, magnetic changes take place in the core and surrounding field which induce currents in the other or secondary windings.

INDUCED DRAUGHT.—A method of accelerating combustion in steam boilers in which a steam jet or a fan is located in the smoke flue, and which in operation draws the gases through the furnace and discharges them into the delivery stack. The nature of the service of an induced draught fan is necessarily more severe than that of a forced draught fan.

INDUCED ELECTRIC SURGINGS.—Electric oscillations set up in a conductor because of similar vibrations taking place in a neighboring conductor.

INDUCED ELECTROSTATIC CHARGE.—An electric charge received by a body brought within the influence of an electrostatic field.

INDUCED LIGHTNING DISCHARGE.—The back or return stroke of lightning; a discharge which occurs after the main discharge as the result of induction produced in the neighborhood of the original stroke.

INDUCED VOLTAGE IN TRANSFORMERS.—The voltage of the secondary current is (approximately) to the voltage of the primary current as the number of turns of the secondary winding is to the number of turns of the primary winding.

INDUCTANCE.—The total magnetic flux threading the circuit per unit current which flows in the circuit and which produces the flux. In this it must be understood that if any portion of the flux thread the circuit more than once, this portion must be added in as many times as it makes linkage. Inductance, or the coefficient of self-induction, is the capacity which an electric circuit has of producing induction within itself. Inductance is considered as the ratio between the total induction through a circuit to the current producing it. The unit of inductance is the henry. An inductance of one henry exists in a circuit when a current changing at the rate of one ampere per second induces a pressure of one volt in the circuit.

INDUCTANCE ANTENNA.—In radio, an antenna having a variable inductance coil. By varying the amount of inductance in the antenna circuit, the wave length is varied. Also called loading coil, or antenna loading inductance.

INDUCTANCE COIL.—An impedance coil.

INDUCTANCE REACTANCE.—The opposition to an *a.c.* due to inductance. The ohmic value of inductance. Expressed as a formula $X_i = 2\pi fL$, in which X_i = inductance in ohms; $\pi = 3.1416$; f = frequency; L = inductance in henrys.

INDUCTANCE RESISTANCE.—In an alternating circuit the ohmic equivalent of inductance. Preferably called spurious resistance.

INDUCTANCE UNIT.—The henry. Since one volt $= 10^8$ abvolts and since one ampere $= 10^{-1}$ abamperes then the unit of inductance or one henry $= 10^8 \div 10^{-1} = 10^9$ abhenrys. Since this unit (the henry) is so large, fractional units are often used, such as, the milli-henry (=one-thousandth henry) and the micro-henry (=one-millionth henry).

INDUCTEOUS BODY.—A term suggested by Faraday to describe a body which receives an electric charge upon coming into the sphere of influence of another electrified body.

INDUCTION.—A word introduced by Faraday; in general, an influence exerted by a charged body or by a magnetic field on neighboring bodies without apparent communication.

INDUCTION BRIDGE.—A balance arranged in a manner similar to a so called Wheatstone bridge and used for measuring induction.

INDUCTION COIL.—One or two coils of insulated wire wound around an iron wire core and based on the principle of self-induction or mutual induction respectively according as the coil is of the primary or secondary type.

INDUCTION EFFECT OF A.C.—The effect of induction, whether self-induction or mutual induction, is to set up a back pressure or spurious resistance, which must be considered, as it sometimes materially affects the calculation of circuits even in interior wiring. Besides variations in current strength, other conditions govern the amount of self-induction in a circuit, such as the shape of the circuit, and the character of the surrounding medium. In wiring, when iron conduits are used, the wires of each circuit should not be installed in separate conduits, because such an arrangement would cause excessive self-induction.

INDUCTION FACTOR.—In an a.c. circuit, the ratio between that element of the current which does no work and the total strength of the current.

INDUCTION FREQUENCY CONVERTER.—A type of frequency converter consisting of an induction motor having a rotor driven at such speed that the secondary frequency has the desired value for the delivery circuit.

INDUCTION INSTRUMENTS.—Volt meters, ammeters, etc., whose operation depends on induction. This principle was first applied by Ferraris and the instruments are sometimes called after him. They are for a.c. only, and there are two forms: a, shielded pole type; b, rotary field type.

INDUCTION MACHINE.—A machine for generating electricity for experimental purposes on the principle of electrostatic induction; also called influence machine. The Toepler-Holtz and Wimshurst machines are well known forms.

INDUCTION MOTOR.—A motor which runs asynchronously, that is, not in step with the alternations of the a.c. The armature, not being connected to the external circuit, is rotated by currents induced by the varying field set up through the field coils. The operation of a polyphase induction motor depends on the production of a rotating magnetic field by passing a.c. through the field magnets. This means that the poles produced by the a.c. are constantly changing their positions relative to the field winding, the latter being stationary; hence, the term rotating magnetic field. This field "rotating" in space about the axis of the armature induces currents in the latter. The reaction between these currents and the rotating field creates a torque which tends to turn the armature, whether the latter be at rest or in motion. The armature must rotate slower than the rotating magnetic field. The difference in speed is called the slip. There are numerous types of induction motors.

INDUCTION RADIO LOUD SPEAKER.—A type whose operation depends upon the production of eddy currents in the diaphragm by a varying magnetic field. In construction, a diaphragm is placed between two sets of concentric coils. Direct current is applied to the two sets of coils in opposite directions producing a radial field. The signal current is also passed through the coils which causes the steady field due to the d.c. to vary and which in turn induces eddy currents in the diaphragm. Since the eddy currents give polarity to the faces of the diaphragm these poles react with the poles of the coils, thus causing vibration of the diaphragm and resulting sound waves. Loud speakers of this type are extra powerful and therefore suitable for halls.

INDUCTION REACTANCE. — The ohmic value of inductance in an electric circuit, as distinguished from the capacity reactance.

INDUCTION REGULATOR AUXILIARIES.—Automatically operated regulators do not differ from the motor operated regulators in so far as the regulating itself is concerned, but it is necessary to provide a set of auxiliaries for accomplishing automatic operation. For the single phase regulator the auxiliaries consist of: a, relay switch; b, contact making volt meter; c, potential transformer; d, current transformer; e, line drop compensator; f, position indicator.

INDUCTION SCREEN.—A metal screen interposed between two electrified or magnetic bodies in order to reduce the effect of induction.

INDUCTION TELEGRAPHY.—A method of telegraphy by which messages may be sent from railway trains while in motion; the principle of induction permitting communication of impulses from the car to a wire running parallel with the track.

INDUCTION TYPE INSTRUMENT.—Electric measuring instruments for alternating currents based upon the principle of a revolving magnetic field produced by two alternating currents that are out of phase.

INDUCTION VOLTAGE REGULATOR.—A form of stationary induction apparatus consisting of a coil in shunt and a coil in series, with the circuit so arranged that the ratio of transformation between them is variable at will, and with the relative positions of the primary and secondary coils adjustable. In construction the primary has many turns of fine wire and the secondary a few turns of heavy wire. In operation, when the primary coil is turned to various positions the magnetic flux sent through the secondary coil varies in value, thereby causing corresponding variation in the secondary voltage, the character of which depends upon the value and direction of the flux.

INDUCTION WATT HOUR METER ADJUSTMENTS.—There are three adjustments: a, full load adjustment; b, light load adjustment; c, inductive load adjustment. The full load adjustment regulates the retarding torque of the short-circuited generator; the light load adjustment is a device for exactly counter-balancing friction torque, and the inductive load adjustment influences the driving torque of the motor element on inductive loads.

INDUCTION WATT METER.—An electrical instrument for measuring the power delivered to a circuit. The operation of the induction type is similar to that of the induction motor, depending upon the action of a revolving or shifting magnetic field upon a magnetic body capable of rotation.

INDUCTIVE CONNECTION.—A connection between two circuits depending upon the property of induction solely, without any metallic contact.

INDUCTIVE COUPLING. — In radio, a method of connecting two circuits by means of mutual induction as obtained by the use of a secondary induction coil.

INDUCTIVE DISTURBANCE.—A disturbance arising in telephone or telegraph circuits as the result of induction. Cross talk between telephone lines is an example of inductive disturbance; sometimes called inductive interference.

INDUCTIVE FEED BACK.—A method of feed back from an output to an input circuit through an inductive coupling.

INDUCTIVE LOAD.—A load in which the current lags behind the voltage across the load.

INDUCTIVE RESISTANCE REGULATOR.—A device for controlling the spurious resistance in a circuit by regulating the inductance.

INDUCTOMETER.—An indicating instrument for measuring self, and mutual inductance. Its operation depends on the relation of two coils (a primary and secondary), one of which can be moved in its relation to the other, the inductance, either self, or mutual, being registered on a scale calibrated in units of inductance.

INDUCTOPHONE.—An invention for picking up telegraphic messages from moving railroad trains by induction between a circuit on the train and coils along the line, in which a telephone receiver takes the place of a sounder.

INDUCTOR.—A wire lying in an armature slot and forming part of a coil; that part of a wire which moves in a magnetic field and in which an electric current or pressure is induced. The careless practice of using the word conductor for inductor should be avoided.

INDUCTOR ALTERNATOR.—A type in which both armature and field magnets are stationary, a current being induced in the armature winding by the action of a so called inductor in moving through the magnetic field so as to periodically vary its intensity. Practically obsolete.

INDUCTORS OF ELECTROSTATIC MACHINE.—The parts of a Holtz electric machine which receive the original charges. They consist of four tin foil discs connected in pairs by strips of tin foil and covered with paper.

INDUCTROSCOPE.—Any device for showing the existence of induction between electric circuits.

INERTIA.—That property of a body by virtue of which it tends to continue in the state of rest or motion in which it may be placed, until acted on by some force.

INERTIA, ELECTRIC.—That property of electricity by virtue of which it tends to remain at rest or in motion until acted upon by some external force. In an electric circuit the more inductance in the circuit the more pronounced this effect. For instance in the low tension circuit of an ignition system, a condenser is shunted across the breaker. During make the condenser is charged; at the instant of break the discharge of the condenser bucks the current and stops it much quicker than otherwise, which builds up sufficient voltage to force a spark across the gap of the plug, and also reduces considerably arcing across the breaker contacts.

INFERRED ZERO.—A zero upon a scale of measurement assumed for convenience in making calculations, though actually too remote to be arrived at.

INFINITY PLUG.—A plug in a resistance box, seated between two brass plates not otherwise connected, so that when it is withdrawn the circuit is opened, thus interposing a so called, infinite resistance.

INFLEXIBLE CONDUIT.—An underground conduit system so built that it will not admit of access to its conductors after it is once laid; a solid conduit.

INFLUENCE.—A term sometimes used for electrostatic induction.

INFLUENCE CHARGE.—An electric charge obtained by electrostatic induction.

INFLUENCE MACHINE.—An induction machine for generating electricity for experimental purposes on the principle of electrostatic induction. It depends upon the use of a small initial charge which acting by influence induces other charges which are conveyed by the moving parts of the machine to some point where they may serve to intensify the initial charge, or be drawn off by a suitable collector. The electrophorus is the simplest and earliest form, and its best known developments are the Wimshurst machine and the Toepler-Holtz machine.

INFRA RED RAYS.—Invisible rays of a spectrum which are below the red, i.e., those which have a greater wave length than the visible red rays. They have a slower rate of vibration than 400 billion per second.

INFRA ROENTGEN RAYS.—Grenz rays.

INGOT.—1. An oblong block into which such metals as gold, silver, copper, tin or alloys, are cast after purification. Such blocks usually bear the finer's or foundry stamp and are ready for remelting.

2. A slightly conical, hexagonal or cylindrical mass into which steel is cast before it is forged or rolled. The ingot moulds are usually of cast iron, of great thickness and accurately fitted. After pouring, as soon as the steel is set, the cotters are knocked out of the mould, and the red hot mass taken by the crane from the mould and placed in the soaking pits to anneal or reheat.

INGOT STEEL.—A term applied to mild steel produced by the Bessemer or open hearth process, as it is cast into the form of ingots, preparatory to further treatment.

INHERENT REGULATION. — An electric generator may be required to deliver at a certain speed, a voltage which is within specified percentage of a constant value when the load is varied. This is called its regulation, and when the voltage is regulated by the machine without the aid of auxiliary devices the act is known as inherent regulation.

INITIAL CONDENSATION.—In the operation of a steam engine the condensation during the period of pre-admission.

INITIAL VELOCITY.—The speed with which an object is originally endowed, or the velocity at which it is already moving, when modifying forces begin to act upon it.

INJECTION.—In construction, the saturation of telegraph poles with a preservative preparation to prevent decay; impregnation.

INK WRITER.—In telegraphy, a recording register employed wherever a permanent record of messages is desirable. A compact case of brass and glass encloses the clock work mechanism. When a current is flowing, the armature lever carrying the paper strip with it moves up against a disc which is kept moist with ink from an ink roller; when the current ceases a spring draws the lever and paper away from the printing wheel as the disc is called. In this way dots and dashes are recorded on the strip according to the duration of the contacts between the paper and the wheel.

INKLESS RECORDER.—A recorder for electric measuring instruments which does away with the usual pen, employing instead a sharp steel point which is forced against the paper every few seconds by means of an electro-magnet actuated by the driving clock. Thus, a series of dots or indentations is registered upon the chart.

INNERS.—The inner set of springs in the spring jack of a telephone switchboard.

INPUT.—1. The intake or energy absorbed by a machine during its operation, as distinguished from the output of useful energy delivered by it.

2. In a steam engine, the indicated horse power as distinguished from the brake horse power.

3. In an electric motor the watts÷746 as distinguished from the brake horse power.

4. In a dynamo or alternator, the power delivered to its driving pulley as distinguished from its output.

INPUT CURRENT.—The current absorbed by any electrical machine or device as indicated by an ammeter reading, as for instance the amperes taken by a motor.

INPUT TRANSFORMER.—In radio, the transformer of an amplifying stage which receives the impressed voltage from the input circuit.

INSERTION.—In mechanics, sheets of elastic material used to make joints between flanges of pipes, etc., consisting usually of India rubber, with canvas or duck inserted.

INSIDE ADMISSION.—In a steam engine, a reversal of the usual method generally followed with piston valves, in admitting steam through the central cavity on the cylinder face, the lap being provided on the inner edges of the valve, while steam is exhausted past the outer edges into the valve chest. This prevents high pressure steam coming into contact with the valve spindle glands, and materially shortens the steam passage from a high pressure to its intermediate cylinder. In a triple expansion engine, if the h.p. valve be inside admission, the intermediate valve will be outside admission, and the l.p. valve inside admission.

INSIDE BOX BRUSH.—A form of brush suitable for polishing the inner surfaces of metallic bodies preparatory to electroplating.

INSIDE CALIPERS.—An instrument for taking an internal measurement with precision, as in measuring a cylinder diameter.

INSIDE WIRING SYSTEMS.—The different methods of interior wiring may be conveniently grouped into the following general classes:

1. Open or exposed wiring: a, on knobs; b, on cleats.

2. Wires run in mouldings: a, wooden mouldings; b, metal mouldings.

3. Concealed knob and tube wiring.
4. Flexible armored cable wiring.
5. Flexible conduit wiring.
6. Non-metallic sheathed cable.
7. Rigid conduit.

8. Wiring under floors: a, duct or rectangular conduit; b, regular pipe conduit.
9. Wiring under plaster.
10. House wiring.
11. Power wiring.

Each of these methods of wiring has its special application and frequently several are used in the same building. Some of these methods are not as safe as others, and are not permitted in certain localities.

INSPECTION BOXES.—Boxes provided in a system of electric mains, having manholes to allow of inspection and repairs.

INSPIRATOR.—A lifting and forcing injector, in which two distinct sets of steam and water cones are combined within one body, one set for lifting and one for forcing; a double tube injector. Trade name for the Hancock double tube injector.

INSTALLATION.—1. The act of setting up an apparatus or erecting a plant for some special work.
2. The buildings, apparatus and accessories forming the entire plant.

INSTANTANEOUS.—A qualifying term used in giving properties and characteristics of apparatus indicating that no delay is purposely introduced in its action. This is a very poorly selected term and should be discontinued as it is impossible for any physical action to take place instantaneously.

INSTANTANEOUS CONTACT METHOD.—A method of ascertaining the form of the wave in an alternating current by contacts made at certain instants during each period of alternation.

INSTANTANEOUS CURRENT. — The strength of an electric current existing in a circuit at a given instant.

INSTANTANEOUS EFFICIENCY OF TRANSFORMER.—The efficiency of a transformer at a given instant.

INSTANTANEOUS RELAY, SO CALLED.—This type operates almost instantly on the occurrence of the abnormal conditions that it is to control. There is of course a slight time element comparable with that of an overload circuit breaker, but for practical purposes, the operation may be considered as instantaneous.

INSTANTANEOUS VALUE. — 1. A value taken at a given instant, and useful for that instant only, as distinguished from a value averaged for a length of time.
2. In an alternating current, the value of the wave taken at any point during a cycle.

INSTANTANEOUS VOLTAGE.—The voltage in a circuit at a given instant.

INSTRUMENT. — 1. A measuring device such as a volt meter, etc. Its measurements may be either indicating or recording.
2. A measuring device which measures the present value of the quantity under observation. The term instrument is used in two different senses: a, instrument proper; b, any necessary apparatus, such as shunts, shunt leads, resistor, reactors, condensers or instrument transformers. —NEMA.

INSTRUMENT SWITCH.—A small switch used in the instrument connections to transfer an instrument from one circuit or phase to another. Examples: ammeter switch, volt meter switch or voltage switch; synchronizing switch; power factor switch.—NEMA.

INSTRUMENT TRANSFORMER.—A form of transformer suitable for use with measuring instruments in which the conditions of current, pressure and phase in the primary or high voltage circuit are represented with acceptable accuracy in the secondary or low voltage circuit. Where switchboard instruments are to be used on currents higher than the listed internal or self-contained values, or in any case where the voltage is over 750 volts, it is universal practice to use transformers. Current transformers are supplied to reduce the line current by a definite ratio so that a 5 ampere instrument may be used. They also serve to insulate the instrument from the voltage of the line, and should always be selected so that their voltage rating covers the voltage on which they are to be used. Potential transformers are used to reduce the line voltage by a definite ratio so that the instruments having a nominal voltage range of 150 volts may be used.

INSTRUMENT ZERO.—The true zero upon the scale of a measuring instrument, as distinguished from a false zero arbitrarily chosen; the scale zero.

INSULATED BODY.—A body shielded by insulation against escape of electricity either to or from it.

INSULATED CONDUCTORS.—Wires for conducting electricity protected by a covering of insulating material.

INSULATED PLIERS.—Pliers provided with handles covered with insulating material.

INSULATED TROLLEY CROSSING.—A device placed at a point where trolley wires cross, and so insulated as to prevent electrical contact of the wires.

INSULATING BUSHING.—A bushing for an incandescent lamp socket made of insulating material.

INSULATING CEMENTS.—Adhesive compounds which not only cement bodies together, but at the same time serve as electric insulators between them.

INSULATING CONDENSER.—In radio, a condenser of the fixed type used to stop d.c. while permitting the flow of a.c. in the same circuit. Also called a stopping or blocking condenser.

INSULATING GLOVES. — Rubber gloves used to enable linemen and repairmen to handle live wires without danger of shock.

INSULATING JOINT.—A coupling which also serves as an insulator between the bodies joined.

INSULATING MATERIALS.—These are substances such as glass, sealing wax, silk, shellac, india rubber, resin and various compounds, which do not conduct electricity.

There is no perfect insulating material. Gases are almost perfect insulators, though a gas at low pressures may convey electricity freely. The specific resistance of some important insulating materials at ordinary temperatures is as follows:

Mica	8.4×10^7	megohms
Glass	$.9 \times 10^7$	"
Gutta percha	4.5×10^8	"
Shellac	9×10^9	"
Ebonite	2.8×10^{10}	"
Paraffin wax	3.4×10^{10}	"

INSULATING PAINT.—A paint that is unaffected by an electric current; it is made of fossil gum, a pigment, and a vehicle, usually spirit of naphtha.

INSULATING PAPER.—A paper used largely in covering steam pipes and steam surfaces to prevent the loss of heat, or on woodwork to protect it; also to prevent air currents through the walls of buildings.

INSULATING SLEEVE.—A sleeve joint of insulating material for splicing two ends of insulated wire.

INSULATING TAPE.—Tape, usually adhesive, rendered insulating by being saturated with an insulating compound, for the purpose of covering stripped ends and other exposed parts of insulated electric conductors.

INSULATING TUBE. — 1. An insulating sleeve.

2. An insulating tube designed to protect an insulated wire at the point where it runs through a partition or wall.

INSULATING VARNISH.—A prepared varnish for insulating surfaces of electrical appliances.

INSULATING WASHER.—A washer made of insulating material.

INSULATION.—Material having a tremendously high resistance so placed with respect to a conductor as to practically prevent leakage of current. Good insulating materials are: oils, porcelain, wool, silk, resin, gutta percha, shellac, ebonite, bakelite, paraffin, glass. On account of this property they are extensively used in all the branches of electrical industry where it is desirable to confine the current to definite limits.

INSULATION LEAKAGE.—The current flow through an insulator in accordance with ohm's law: $I = E \div R$. There is no such thing as a non-conductor and the use of the term for insulation is erroneous.

INSULATION RESISTANCE.—The ohmic resistance in an electric circuit offered by an insulating coating, cover, material or support to an impressed voltage, tending to produce a leakage of current through the same. By testing this resistance, a ready means is afforded of locating a fault in the insulation. There are no perfect insulators, hence the almost universally used term non-conductor is erroneous and should be avoided.

INSULATOR.—1. A conductor which offers a tremendously high resistance to the passage of electricity. Erroneously called non-conductor. The following list gives some insulators in the order of their efficiency, the most efficient being mentioned first: dry air, glass, mica, ebonite, gutta percha, sealing wax, silk, dry paper, porcelain, oils and slate.

2. A device for fastening and supporting a conductor. Glass and porcelain are employed almost universally for supporting overhead wires. Insulators made of these materials are superior to those made of other material such as hard rubber, or various compounds of vegetable or mineral matter, with the exception perhaps of mica insulators used on the feeders of electric railway lines.

INSULATOR FOR THIRD RAIL.—The method of insulating third rails of electric railroads consists of supporting them on malleable iron clips, which are so shaped that they can be threaded on spool insulators, the assembly being held in place by a through bolt which also engages and holds securely the wooden guard rails.

INSULATOR PIN.—A wooden pin attached to pole cross arms or brackets, upon which the insulators are screwed.

INT.—On an ignition coil an abbreviation marking for interrupter, indicating the terminal to be connected to the interrupter.

INTAGLIO.—An electro or die with the engraved parts sunk, or hollowed out, beneath the surface; an incised carving, as distinguished from a carving in relief.

INTAKE.—1. In a waterworks, the pipe by means of which water is drawn off from a well or other source into a receiving reservoir, standpipe or main.

2. In an internal combustion engine, the inlet pipe between the carbureter and the cylinder which conducts the mixture to the cylinder.

INTEGERS. — Numbers which represent whole things. Numbers are either integral, fractional or mixed.

INTEGRAL CALCULUS.—That branch of calculus which treats of the addition of infinitesimals to produce the quantity.

INTEGRATING DEMAND METER. — A meter which indicates or records the maximum demand obtained through integration. An integrating demand meter consists of a device in combination with an integrating meter whereby the energy consumption as measured by the meter is registered from time to time in such a way that the maximum demand may be determined from the record. There are two types: a, those showing the energy consumption in definite and consecutive demand intervals occurring at arbitrarily chosen times, such as 2:30 to 3:00 to 3:30, etc.; b. those recording on a tape or chart the number of equal and relatively small amounts or blocks of energy with respect to a separate and continuous record of time.

INTEGRATING METER.—A meter provided with a clock which operates a counting device through an intermediate gearing driven by the current.

INTEGRATING PHOTOMETER.—An instrument which gives directly, by one reading, the average light emitted around a meridian line. If the source of light be turned about a vertical axis through definite angles, and candle power readings be taken in each meridian, the mean spherical candle power can be obtained by taking the average of these.

INTEGRATOR.—A device which automatically counts or adds up items of calculation or measurement.

INTENSIFIER.—In hydraulics, a device frequently employed in place of the hydraulic accumulator, for converting a low pressure into a higher. The water at low pressure operates a piston in a large cylinder, which in turn operates a ram of smaller diameter in a smaller cylinder. The areas of the two cylinders are proportional to the difference in the low and high pressure required.

INTENSITY ARMATURE.—A term now rarely used, but formerly applied to an armature wound for a high resistance.

INTENSITY OF CURRENT.—The strength of an electric current. It is the quantity of electricity that flows past any point in a circuit in one second, and is measured by a unit called the ampere. The intensity of a current has to do only with the amperage and must be considered apart from the pressure or voltage.

INTENSITY OF EARTH'S MAGNETISM.—The strength of the earth's magnetic force at different points on the earth's surface. It varies slightly each day and at different times during the year, and occasionally sudden changes occur due to conditions known as magnetic storms.

INTENSITY OF MAGNETIC FIELD.—The force with which a magnetic field acts upon a unit magnetic pole; its unit is that intensity of field which acts with unit force upon a unit pole.

INTENSITY OF MAGNETIZATION.—The degree to which a magnet is magnetized; the quotient of the magnetic moment of a magnet divided by its volume.

INTER-ATOMIC ETHER.—The ether which is conceived to exist between the atoms which form the molecules of material substances.

INTERCEPTED ARC.—The part of the circumference between the intersection of two lines with the circumference.

INTERCEPTING VALVE.—On a compound locomotive, a valve whose movement in one direction is controlled by a spring, and in the other by steam pressure. The function of the intercepting valve is to cause the exhaust steam from the high pressure cylinder to be diverted, at the option of the engineer, either to the open air when working single expansion, or to the receiver when working compound.

INTER-COMMUNICATING TELEPHONES.—Those in which calls are made directly at each station without the aid of a P.B.X. operator, that is, each telephone has its own switchboard attached. Interphones are desirable in mills, factories, apartment houses, stores, office buildings, etc. The systems in general use are:

1. Two station; private line.

2. Code ringing; common talking.
3. Selective ringing; common talking.
4. Selective ringing; selective talking.
5. Master station; common talking.
6. Master annunciator.
7. Master annunciator; common talking.

INTER-COOLER.—A type of surface condenser placed between the two stages of a compound air compressor so that the heat of compression liberated in the first cylinder may be removed from the air as it passes to the second or high pressure compression cylinder. The cooling surface usually consists of nests or small brass or copper tubes through which water circulates.

INTER-CROSSING.—The cross system of running overhead wires to counteract the tendency to induction, in which the wires are crossed at intervals so as to change their relation to one another.

INTERFERENCE.—In radio. disturbing sounds of various kinds which are heard other than those sent out from the transmitting station. They are due to a multiplicity of causes.

INTERFERENCE ELIMINATOR.—In radio, a wave trap or other device for cutting out sounds other than those coming from the transmitting station to which the receiver is tuned.

INTER-FERRIC GAP OR SPACE.—The air gap in a magnetic circuit between iron faces.

INTERFLANGE.—The distance between the flanges of a spool or bobbin, being the available space upon which the wire may be wound.

INTERIOR CONDUIT.—A conduit suitable for use in the walls or floors of a building for the accommodation of electric wires.

INTER-LINKED POLYPHASE SYSTEM.—A system of polyphase currents in which one wire may act as return for another, instead of having each phase supplied with separate conductors throughout.

INTERLOCKING.—In train signaling, the operation of a system of switch, lock and signal apparatus so inter-connected that the movements of all members of the system must succeed each other in a predetermined order.

INTERLOCKING APPARATUS.—A system of interlocking levers by which railway switches and signals are operated from a tower, such that when the track has been properly set and the signal shown, it becomes impossible to clear another route that would interfere with the one already set.

INTERLOCKING, ELECTRIC.—In railway electric interlocking equipment, a system of interlocking in which the operated units are operated and controlled by electricity. The elements comprising an electric interlocking system are:

1. A source of power serving as a central energy supply for the entire interlocking.
2. A means of distributing energy to the various units for control, operation and indication.
3. The interlocking machine which places all units within the limits of the plant under the control of a leverman.
4. Motor operated switch and lock mechanisms for unlocking, throwing, locking and indicating the positions of various switches.
5. Mechanisms for clearing signal blades in response to lever movements.
6. Auxiliary devices such as tower indicators, track model, time releases, etc.
7. Automatic electric control exercised through the agency of track circuits, approach, route and detector locking.

INTERLOCKING ELECTRO-MAGNET.—An electro-magnet with interlocking armatures employed at railway crossings, whereby an approaching train rings a signal which automatically ceases when the train has passed.

INTERLOCKING MACHINE.—The principle of interlocking requires that before a signal can be cleared for the movement of a train, all switches, derails and frog points, over which the signal governs train movement, shall be in proper position and locked. To secure such protection for train movement it is desirable to concentrate the control of the various switches and signals at one point. The mechanism in which this concentration of control is secured is called an interlocking machine. The machine consists of small hand thrown levers, compactly located in a frame and arranged for the operation of circuit controllers, but restricted in their movement by both mechanical locking and electric locks.

INTERLOCKING PLANT.—A group of levers concentrated at a central point for operating certain switches and signals, and so arranged as to interlock such levers and make it impossible to give clear signals for conflicting routes. The advantages derived therefrom are safety, facility of operation and saving in cost of manual labor employed.

INTERMEDIATE CABLE.—A variety of submarine cable intermediate between the types used in deep water and at the shore-end.

INTERMEDIATE CURRENT SUPPLY.—In telegraphy an ungrounded source of current connected in series with a line wire at a station other than a terminal on a ground return telegraph circuit.

INTERMEDIATE CYLINDER. — 1. In a triple expansion engine the second cylinder into which the steam is expanded. 2. In a quadruple expansion engine there are two intermediate cylinders, known as the 1st and 2nd intermediate cylinders; the 2nd and 3rd stage expansion cylinders respectively.

INTERMEDIATE DISTRIBUTING BOARD.—In a telephone exchange, a secondary distributing board employed in connection with a multiple switchboard, so that any answering jack and drop may be connected to any operator's position.

INTERMEDIATE FREQUENCY.—In super heterodyne radio reception, a frequency between that of the carrier and the signal, which results from the combination of the carrier frequency and the locally generated frequency. It is higher in number of oscillations than audio frequency, but lower than radio frequency.

INTERMEDIATE FREQUENCY AMPLIFIER.—In radio super heterodyne sets an assembly of tubes and transformers placed between the first and second detectors.

INTERMEDIATE SWITCH.—A switch which enables an intermediate telephone station to communicate with a terminal without interfering with the line.

INTERMEDIATE TRANSFORMER. — In radio super heterodyne sets, iron core radio frequency transformers which are made to cover wave length of 10,000 meters or higher. The transformer used in the intermediate frequency amplifier.

INTERMITTENT CONTACT.—Contact between overhead wires which sometimes takes place as the result of swinging against each other, or from the effects of temperature changes.

INTERMITTENT CROSS. — A swinging cross; an intermittent contact between overhead wires due to swinging or other occasional cause.

INTERMITTENT CURRENT.—An electric current that starts and stops at regular intervals. Such current is obtained by placing in the circuit some type of interrupter as a vibrator. The mechanism of an electric bell is so arranged as to supply an intermittent current to the magnets.

INTERMITTENT DISCONNECTION. — A fault which occurs intermittently in a line or circuit.

INTERMITTENT DUTY.—A requirement of operation or service consisting of alternate periods of load and rest so apportioned and regulated that the temperature rise at no time exceeds that specified for the particular class of apparatus under consideration.—NEMA.

INTERMITTENT EARTH. — A swinging earth contact; an intermittent contact with the earth caused by swinging or other occasional fault.

INTERMITTENT INTEGRATING METER.—An integrating meter which does not continuously compute the use of energy, but sums it up at definite intervals.

INTERMITTENT MOVEMENT.—In a motion picture camera or projector, a mechanism so arranged and geared together that while the film is being shifted, the light is excluded from the lens and admitted during the stationary periods.

INTERMITTER.—A name sometimes given to a contact breaker or interrupter, a device for automatically making and breaking an electric circuit.

INTERNAL CAPACITY.—The capacity between conductors in any electrical device, as between elements of a vacuum tube.

INTERNAL CHARACTERISTIC.—The characteristic curve of a shunt wound dynamo on open circuit, the shunt circuit being active.

INTERNAL COMBUSTION ENGINE.—A general term which includes all classes of engine in which the power is produced by combustion of the fuel; such as: "gas," kerosene, oil and Diesel engines. In these engines the working cycle is completed in two strokes or four strokes called (incorrectly) two cycle and four cycle, respectively.

INTERNAL DROP.—In a primary or secondary cell, especially a primary cell, the loss in voltage during current flow due to the internal resistance of the cell.

INTERNAL MAGNETIC CIRCUIT.—That portion of a magnetic circuit included within the core of the magnet.

INTERNAL MAGNETIC FIELD.—That portion of a magnetic field included within the core of the magnet.

INTERNAL POLARIZATION.—A polarization which takes place in living organic tissues when a strong electric current is passed through them.

INTERNAL POLES OF DYNAMO.—The poles of the electro-magnetic field of a dynamo.

INTERNAL RESISTANCE OF CELL.—In a primary or secondary cell, the internal opposition to current flow which limits the amperage on short circuit. Thus a new dry cell will show about 25 amperes, and a storage cell about 300 amperes. This wide difference is due to the difference in internal resistance of the two cells.

INTERNAL RESISTANCE INDUCTION MOTOR.—An asynchronous motor having an armature so constructed as to obtain a high resistance (ohmic or spurious) while starting and a low resistance while running without external connections. The high resistance may be in the form of: a, grids; b, high resistance winding; c, high reactance winding. One type of internal resistance motor employs a combination of: a, high resistance squirrel cage; b, low resistance lap winding, and another type a combination of: a, high resistance squirrel cage; b, low resistance phase winding. The high reactance type is commonly called a double squirrel cage motor.

INTERNATIONAL AMPERE.—The legal value of the ampere as fixed by the International Congress of Electricians, held at Chicago in 1893; one-tenth of the unit of current of the c.g.s. system of electro-magnetic units, represented as the uniform current which deposits silver at the rate of .001118 gram per second from a solution of given fixed strength of nitrate of silver in water. Experimental results show that the international ampere is nearly the same as the absolute ampere.

INTERNATIONAL CANDLE.—A unit of illumination standardized in 1909 from agreements effected between the three National Standardizing Laboratories of France, Great Britain, and the United States. Since that time this unit has been maintained by means of standard incandescent lamps in these laboratories. The international candle is the same as the Pentane candle, Bougie candle, and American candle. One international candle=1.11, Hefner candles=.104 carcel unit.

INTERNATIONAL COULOMB.—The quantity of electricity which passes any section of an electrical circuit in one second, when the current in the circuit is one international ampere. One international coulomb is nearly the same as the absolute coulomb.

INTERNATIONAL ELECTRICAL UNITS.—These units were fixed by the International Electrical Congress at Chicago in 1893 and slightly modified by the London Electrical Conference in 1908. The International Committee of Weights and Measures has decided to discard these units in the near future.

INTERNATIONAL FARAD.—The capacity of a condenser which on receiving a charge of one international coulomb produces a pressure difference of one international volt across its terminals. 1 international farad=.9995 absolute farad.

INTERNATIONAL HENRY. — The inductance which produces a pressure of one international volt when the current is changing at the rate of one international ampere per second. One international henry equals 1.0005 absolute henrys.

INTERNATIONAL JOULE.—The energy required to transfer one international coulomb between two points having a pressure difference of one international volt. One international joule equals 1.0005 absolute joules.

INTERNATIONAL MORSE CODE.—A modification of the American Morse Code in which no spaces are used.

INTERNATIONAL OHM.—The standard Board of Trade (B.O.T.) unit. The unit of resistance in common use being the resistance offered at the temperature of melting ice to an unvarying electric current by a column of mercury 14.4521 grams in mass of uniform cross sectional area and 106.3 centimeters in length.

INTERNATIONAL VOLT.—The unit of electric pressure in general use being that pressure which when steadily applied to a conductor having a resistance of one international ohm will produce a current of one international ampere. One international volt equals 1.0005 absolute volts.

INTERNATIONAL WATT.—The product of one international ampere times one international volt. One international watt= 1.0005 absolute watts.

INTERPHASE TRANSFORMER.—An auto-transformer, or a set of mutually coupled reactors, which is sometimes used in conjunction with transformers supplying rectifiers to modify current relations in the rectifier by causing a greater number of anodes of different phase relations to carry current at any instant than would otherwise carry current.

INTERPOLAR GAP OR SPACE.—The air space between the pole pieces of a dynamo or motor.

INTERPOLE.—A small auxiliary pole introduced between two main field poles of a motor or dynamo in order to produce a compensating field under heavy loads; a compensating or commutating pole.

INTERPOLE DYNAMO.—A machine provided with auxiliary poles between the main field poles, thereby constituting a compensating field which serves to reduce the sparking due to high frequency of commutation.

INTERPOLE MOTOR.—A d.c. motor which has in addition to the main poles, a series of interpoles, placed between the main poles. The object of these poles is to provide an auxiliary flux or "commutating" field at the point where the armature coils are short circuited by the brush. Sometimes called commutating pole motor.

INTERPOLE MOTOR CHARACTERISTICS.—Some of the features are: Constant or adjustable speed and momentary overloads without sparking; constant brush position; operation at adjustable speeds on standard supply circuits of 110, 220 and 550 volts; constant speed with variable load, reversal without changing the position of the brushes.

INTERRUPTED.—Broken in upon; having the continuity of the current broken; as, by a contact breaker.

INTERRUPTED CONTINUOUS WAVES.—In radio, waves produced by modulation of continuous waves at audio frequency during signaling.

INTERRUPTED CURRENT SYSTEM.—A method of electric distribution by continuous currents broken at regular intervals.

INTERRUPTED GALVANIC CURRENT.—In electro-therapeutics, a current consisting of a series of uni-directional impulses with interruption of uniform duration. Nearly all clinicians employ this current for testing for the reaction of degeneration, for if the muscle fail to respond it means that a final diagnosis can be made.

INTERRUPTED OSCILLATORY WAVE CURRENT.—In electro-therapeutics, a form of wave current which has the same frequency and duration of impulse as the oscillatory wave; it will likewise be found to be free from skin effect. This current gives the same intense nerve stimulation as the interrupted galvanic, without its sudden shock and skin irritation; therefore it is frequently of very definite use for starting a new case when pronounced stimulation and severe muscle contractions are not desired.

INTERRUPTED RAPID SINUSOIDAL CURRENT.—In electro-therapeutics, an alternating current interrupted at the end of each cycle. Adjustment 10 to 90 interruptions per minute. The periods of rest prevent undue fatigue. Neiswanger recommends this current in nerve degeneration. Waggoner states, "If we split the rapid sinusoidal current into segments with an interrupter, we have one of the finest currents for regeneration of nerve function." Eberhart writes, "It is a true tonic to the nerves and it is the best form of sinusoidal current we have for regenerating impaired nerve function."

INTERRUPTER.—1. A magnetic vibrator.
2. Any device for rapidly making and breaking a circuit.
3. In ignition, a device for breaking the primary circuit at the time a spark is required.

INTERSECTION.—1. The point where two lines cut or cross each other.
2. The locus of all points common to two surfaces.

INTERSTAGE TRANSFORMER.—In radio series amplification, a transformer with its primary connected to the plate circuit of one amplifying tube and the secondary to the grid circuit of the tube in the next amplification stage.

INTER-VALVE.—In radio, the British expression for inter-stage.

INTRA-POLAR ELECTROLYSIS.—The electrolysis which occurs immediately between electrodes, apart from that which takes place about them.

INTRINSIC BRILLIANCY.—The intensity of the light per unit area of the luminous source.

INTRINSIC BRILLIANCY OF CRATER.—The total quantity of light emitted by an electric arc, being the product of the intrinsic brilliancy multiplied by the area of the crater. From experiments of M. Violle, it appears that the intrinsic brilliancy of the crater remains constant when the power supplied is raised through a considerable range. The intrinsic brilliancy of a fully developed arc has been estimated at 190 candle power per square millimeter of crater area.

INTRINSIC ELECTRIZATION.—Electrification of a body due to natural causes inherent in the substance.

INTRINSIC INTENSITY OF LIGHT.—The amount of light given by a luminous source per unit area.

INTRINSIC MAGNETIZATION.—Impressed magnetization, as distinguished from that caused by electric currents.

INVERSE DUPLEX PRINCIPLE.—In radio, this is a slight commercial variation of the reflex circuit. The refinement being that the work is evenly distributed between the tubes so that none is overloaded as in the straight reflex.

INVERSE RATIO.—That formed by inverting the terms of a given ratio; thus, 8:9 is the inverse of 9:8.

INVERSE RESONANCE.—A name sometimes used for parallel resonance.

INVERSE SQUARE LAW.—Electric forces and various other physical phenomena are observed to decrease in intensity as the point of application recedes from the point or source from which the effect proceeds. If the intensity of a force, as, for instance, magnetic attraction, at a given point be f, and the distance of the point from the source of the force be r, the law may be expressed in an equation as follows:

$$f=k\div r^2$$

in which k is a constant.

INVERSE TIME.—1. A relay protective principle in which the time of operation of relays varies approximately inversely with the magnitude of the current. This permits lower current settings, thus giving increased sensitivity. Under abnormal conditions, if a fault produce a slight over current for a long enough time or a large enough over current for a short time, the protective device operates.

2. A qualifying term applied to any relay indicating that there is purposely introduced a delayed action which delay decreases as the operating force increases.—NEMA.

INVERSE TIME LIMIT RELAY.—An induction instrument type relay in which the time delay is obtained by a specially designed rotating induction disc similar to that used in watt meters. This relay is not as rugged mechanically as the solenoid relay, and the contacts are not as heavy, although it affords instrument accuracy and gives satisfactory operating characteristics. In operation, the movement of a contact pin on a gear closes the contacts. The current calibration is obtained by using different taps in the current coil, and in this way controlling the speed of the disc. The time calibration is obtained by adjusting the distance through which the disc travels before contact is made.

INVERSION, ELECTRIC.—A method by which, when the solution of a problem in electro-statics has been obtained, it is possible by a geometrical process to obtain the solution of another.

INVERSION OF IMAGES.—In electrostatics the application of the mathematical theory of inversion in the solution of problems. When any one problem is solved, the solution of another may be deduced by a purely geometrical process.

INVERTED ARC LAMP.—An arc lamp in which the negative carbon is above the positive instead of being below it, as is usually the case.

INVERTED CONVERTER.—A name sometimes given to a rotary converter for changing direct currents into alternating currents.

INVERTED L AERIAL.—One with end connected lead in.

INVERTED ROTARY CONVERTER. — A name sometimes given to a converter that is run as a d.c. motor for supplying a.c. When so run, the speed increases when the field becomes weak, and lessens when the fields strengthen, but the ratio to each other of the direct and alternating voltage remains unchanged.

INVERTED SYPHON.—In hydraulics, a conduit, shaped like a gigantic U, by means of which water mains are carried underneath rivers, etc., the water rising as high on the further shore as on the other, owing to a fundamental principle of hydrostatics.

INVISIBLE SPECTRUM.—The infra-red rays at one end of the spectrum and the ultra-violet rays at the other, which cannot be perceived by the eye.

INVOLUTE TEETH.—Cogs whose curves are formed by the involutes of a circle, the root and the point of such teeth forming one continuous curve. This gives these teeth the property of working smoothly with each other if the distance between the wheel centers be varied, which is a necessary point in rolling mills and the like where the axes of the wheels are apt to approach or recede from one another.

INVOLUTION OR POWER OF A NUMBER.—The continued multiplication of a number by itself a given number of times. The number is called the root or first power, and the product is called the power. The second power is called the square; the third power the cube. The higher powers are called the fourth power, fifth power, etc. The power to which a number is to be raised is indicated by a small "superior" figure called an exponent placed to the right and above the number as 2^2 read two square.

INWARD FLOW TURBINE.—In hydraulics, a water motor consisting essentially of two horizontal rings of buckets, one ring being enclosed within the other, and its buckets or chutes becoming the guides to a column of water, which having descended by gravity under a definite head, is caused to impinge on the buckets of the inner ring and to turn it by reaction.

ION.—An atom of matter carrying a positive or negative charge of electricity.

IONIC ATTRACTION.—The attraction between anions and cations.

IONIZATION.—1. The process of electrically charging neutral atoms or molecules either positively or negatively.

2. Separation into ions, as when an electrolyte is dissolved.

3. As applied to gases, which have free ions in small numbers, it is the breaking up of atoms into positive and negative ions by the application of proper external energy, thus producing electric conductivity in gases.

IONIZED LAYER.—In radio, a name sometimes given to the **Heaviside** layer.

IONS.—1. The products of electrolysis which appear at the electrodes; the component which appears at the anode is called the **anion**, or electro-negative component, and that which appears at the cathode is called the **cation** or electro-positive component.

2. In gases, the elements to which and to whose motion, under the action of electric forces, is supposed to be due their electric conductivity.

I.p.—Abbreviation for initial pressure.

I.p.c.—Abbreviation for intermediate pressure cylinder. The second stage expansion cylinder of a triple expansion engine.

IR DROP.—The reduction or "drop" in voltage due to an increase in resistance of a conductor caused by the heating effect of a current flowing in a conductor.

I^2R LOSS.—The power consumed by the heating effect of a current passing through a conductor. It is equal to the square of the current $\times$ the resistance.

I.R.E.—Abbreviation for Institute of Radio Engineers.

IRIDESCENCE.—An effect of the interference of light upon certain surfaces, exhibiting intermingling colors, as of the rainbow.

IRIDIUM LAMP.—An incandescent lamp employing, for filament material, the rare metal, iridium, in the form of a powder mixed with a binding medium and squirted into threads. The low voltage of this lamp and the scarcity of iridium prevent the commercial success of this type.

IRISING.—Gradually narrowing the field of vision.

IRON.—One of the metallic elements. It is obtained from ores in which it is combined with earthy or stony substances and frequently with carbon, phosphorus, sulphur, arsenic, magnesia, etc. Carbon decreases the permeability, increases coercive force and hysteresis losses and also increases the electrical resistance of the iron. Silicon increases the permeability and reduces the hysteresis loss. The permeability of iron is changed but little by moderate increases of temperature but when a temperature around 1400° F. is reached, iron becomes non-magnetic.

IRON CEMENT.—In steam engineering, the material used for making rust joints. It consists of iron borings, passed through a ⅛ or ¼ sieve, mixed with sal ammoniac and dampened. Sulphur is usually added.

IRON-CLAD.—Covered with, or clad in iron, as an iron clad magnet.

IRON-CLAD ARMATURE.—An armature which has its windings sunk into deep channels or grooves in the surface of its core.

IRON-CLAD DROP.—An annunciator having an iron-clad electro-magnet.

IRON-CLAD DYNAMO.—1. A dynamo having an iron-clad armature.

2. A dynamo in which the iron of the field magnet encloses both the magnet coils and the armature.

IRON CLAD MAGNET.—One whose magnetizing coil is almost entirely surrounded by iron. The effect of the iron casing is to greatly reduce the magnetic reluctance of the magnetic circuit.

IRON-CLAD SOLENOID.—One surrounded by an iron cover and operating a plunger in the solenoid.

IRON CORE.—The mass of iron forming the central portion of an electro-magnet or armature around which the coils are wound. The core may be: a, solid, or b, built up. For a solid cast iron core, since its sectional area must be considerably more than wrought iron, a much greater quantity of copper is required for the magnetizing coils. Built up cores of iron sheets or iron wires are used to reduce eddy currents to a minimum.

IRON CORE COIL.—A coil of wire wound around a core composed of numerous lengths of wire or sheets of iron as distinguished from an air core. Example of iron core coils are: ignition coil with wire core, dynamo field coil with sheet iron core.

IRON CORE LOSS.—The electric losses occurring in armatures and transformers due to hysteresis and eddy currents in the iron of the core.

IRON MAGNETIC CIRCUIT.—A term sometimes applied to a magnetic circuit completed wholly within iron; a ferric-magnetic circuit.

IRON OR CORE LOSSES.—Various losses in a transformer due to: a, hysteresis; b, eddy currents; c, magnetic leakage (negligibly small). The hysteresis loss depends upon the quality and amount of the iron in the core, the magnetic density at which it is worked and the frequency. When specially annealed silicon steel is used for the core, and a low degree of magnetization is employed, the hysteresis loss is reduced to a minimum. Eddy current loss is reduced to a minimum by laminating the core.

IRON PYRITES.—A natural metallic sulphide of iron, utilized in the manufacture of sulphuric acid, sulphate of iron and alum. It is sometimes mistaken for gold, but may be distinguished by its hardness and brittleness.

IRON RELUCTANCE.—Magnetic resistance due to the iron present in a magnetic circuit.

IRON VANE INSTRUMENT.—An a.c. ammeter or volt meter having an iron vane attached to the shaft that carries the pointer and working on the principle that a piece of soft iron placed in a magnetic field and free to move, will move into such position as to conduct the maximum number of lines of force. There are two types: 1, inclined coil; 2, magnetic vane.

IRON WIRE.—This kind of wire is largely used for telegraph and telephone lines, although it is rapidly being replaced by copper in long lines. There are three grades of iron wire:

1. Extra best best (E. B. B.) which has the highest conductivity and is the nearest to being uniform in quality, being both tough and pliable;

2. Best best (B. B.), which varies more in quality, is not so tough, and is lower in conductivity. It is frequently sold as E. B. B.;

3. Best (B.), which is the poorest grade made, being more brittle, and lowest in conductivity. Iron wire should be well galvanized.

IRRECIPROCAL CONDUCTION.—Electrical conduction in which the current suffers a change by a reversal of direction.

IRREGULAR MAGNETIC FLUX.—A converging or diverging magnetic flux.

IRREVERSIBLE CYCLES.—A substance is said to pass through a cycle of operations, when its volume, pressure and temperature, are altered in such a way, that after a series of changes it returns to its original state. When these series of changes can take place in one way only, the cycle is said to be irreversible.

IRREVERSIBLE HEAT EFFECT.—The heat produced by an electric current in a homogeneous conductor; it is the same regardless of the direction of the current; also called the **Joule effect.**

IRRITABILITY, ELECTRIC.—The tendency to irritation of animal tissues when exposed to an electric current or discharge.

I SECTION.—In building, a rolled I beam.

ISOBARIC SURFACE.—A surface in the air, all points of which have the same barometrical pressure.

ISOBARS.—Lines drawn upon a map or chart connecting places on the earth's surface in which the barometric pressure is the same; also called isobaric or isobarometric lines.

ISOCHASMIC CURVES.—Lines drawn upon a map bounding zones of the earth's surface which have the same annual number of auroras.

ISOCHROMATIC.—Of the same color or tint; of uniform color throughout.

ISOCHRONISM.—The property of performing oscillations in equal spaces of time.

ISOCHRONIZE.—To cause to vibrate in equal spaces of time.

ISOCHRONOUS.—A term applied to two or more different motions which occur in equal periods of time.

ISOCHRONOUS OSCILLATIONS OR VIBRATIONS.—Vibrations, as of a pendulum, performed in equal intervals of time.

ISOCHRONOUS GOVERNOR.—A governor which is very steady at one fixed speed, but which requires only a slight variation in speed to make the arms fly up or down, according as the speed increases or lessens. This is effected by placing a cross piece upon the governor spindle, the two ball arms being hinged to this piece in a crosswise manner, so that the ball is on the opposite side of the spindle to its pin. Care should be taken in designing such a governor that it is not over-sensitive.

ISOCLINAL, OR ISOCLINIC.—Having equal magnetic inclination or dip.

ISOCLINIC LINES.—Lines drawn upon a map passing through points upon the earth's surface which have the same magnetic inclination or dip.

ISOGONIC LINES.—Lines drawn upon a map passing through points on the earth's surface which have the same magnetic declination.

ISOLANTITE.—An insulating material especially desirable for high frequency currents.

ISOLATED ELECTRIC LIGHTNING.—Electric lighting by means of an installation situated on the premises, and not depending upon a general distributing station.

ISOLATED PLANT.—A private electrical installation deriving energy from its own generator driven by a prime mover.

ISOLATED STATION SWITCHBOARD.—A telephone switchboard for a sub-station, or for private use.

ISOLATING SWITCH.—A switch whereby an electric lamp may be cut out of a circuit without affecting the other lamps on that circuit.

ISOLUX.—An irregular curve joining points of equal illumination on a scale drawing of given area. Incorrectly called lines.

ISOMERIC CHANGE OF IONS.—This change at the anode means increasing the positive charge on an anion or decreasing the negative charge on a cation.

ISOMETRIC PROJECTION.—A method of perspective drawing of mechanical objects. It enables three sides to be seen at one view, being a projection on lines equally inclined to the three principal axes of the object delineated, the angles remaining the same as in plane drawing.

ISOTHERMAL EXPANSION.—Expansion at constant temperature; heat being added during the process to maintain the temperature constant. The volume of a perfect gas, according to Mariotte's law, varies inversely as its pressure when the temperature is kept constant. The curve constructed from this law is called the isothermal curve, or curve of equal temperatures, and is the common or rectangular hyperbola.

ISOTHERMAL LINES.—1. In physics, lines of equal temperature, as opposed to adiabatic curves. Isothermal lines are those produced on diagrams of work under varying pressure with constant temperature.

2. Lines drawn upon a map passing through points upon the earth's surface which have the same mean temperature.

ISOTROPIC.—A term applied to bodies which have equal properties in all directions.

ISTHMUS METHOD OF MAGNETIZATION.—A method by which magnetization may be strongly concentrated by placing a narrow neck of iron between the poles of an electro-magnet.

J

J.—Symbol for joule, the unit of electrical energy.

JABLOCHKOFF CANDLE.—An early form of arc lamp consisting of two parallel carbons separated by a thin strip of insulating material, the electric arc being formed across the tips of the two carbons, and maintained by an alternating current in order that both carbons may be consumed equally.

JABLOCHKOFF IGNITER.—A little carbon strip placed across the tips of the parallel carbons of a Jablochkoff candle in order to start the arc between them.

JACK.—In telephony, a spring jack; a form of metallic spring contact set in the switchboard and forming the termination of a subscriber's line, connections with which are made by three wire cords terminating in plugs which are inserted through a hole in the board leading into the jack.

JACK HOLE.—A hole in a telephone switchboard through which a plug is inserted into a spring jack.

JACK PANEL.—A panel in a telephone switchboard supplied with spring jacks.

JACK SCREW.—A device for raising heavy weights, in which the power of the screw is applied.

JACK SWITCH.—A switch controlled by a spring jack.

JACKETED MAGNET.—A term sometimes applied to a short cylindrical electromagnet having an outer tube united to the iron core at the bottom; an ironclad magnet.

JACOBI'S LAW.—The maximum work is done by an electric motor when the reverse voltage equals one-half of the impressed voltage.

JAG BOLT.—A tail bolt whose shank or tail is roughed up by jagging.

JAM NUT.—A nut placed in contact with the main nut on the same bolt to keep the main nut from turning.

JAMMING.—In radio reception, interference from an undesired transmitter.

JANDUS LAMP.—A form of arc lamp in which the arc itself is enclosed in a small and almost air tight glass cylinder.

JAPAN.—A variety of enamel sometimes used for the insulation of electrical machines, as when the smooth core of an armature is japanned to increase the insulation of the conductors from the iron body.

JAR.—A unit of electrostatic capacity used chiefly in the British Navy. It is equal to .0011 microfarad.

JAR, ELECTRIC.—The Leyden jar, an early form of electric condenser. It consists of a wide mouthed glass cylindrical vessel coated inside and out, up to a certain distance from the top, with tin foil. The coatings from the two plates of the condenser which can be charged to a high voltage difference by an electrostatic machine. By connecting the inner surface of the foil, which is connected to a brass knob at the top, with the outer coating, a powerful spark discharge may be obtained. The capacity of a Leyden jar is equal to the quantity of electricity divided by the voltage which such quantity produces.

JAW.—The stationary contact member of a switch.

JENNY POLE SUPPORT.—Two legs of suitable length pivoted near one end and arranged so as to support a telegraph or power wire pole during erection.

JET CONDENSER.—A chamber or vessel within which the exhaust steam from an engine meets a spray or jet of water and is condensed. The heated cooling water, condensed steam, and liberated air are removed from the condenser by the air pump, which delivers the water into the hot well, whence the feed water supply is taken by the pumps, the surplus escaping through the overflow.

The jet condenser is commonly used where a large quantity of fresh water is available. Under ordinary conditions, the temperature of the hot well varies from 110° to 130° F. Usually the amount of injection water required is from twenty-five to thirty times the feed water. The exact amount is:

$$Q=WH\div R$$

in which, Q=pounds of injection water per pound of steam condensed; W=weight of steam condensed; H=heat units given up by one pound of steam in condensing; R=rise in temperature of the injection water.

JET PHOTOMETER.—An instrument for measuring the intensity of a gas light by taking into consideration the height of a burning jet under uniform pressure and temperature conditions.

JIB CRANE.—One that lifts weights at the extremity of an inclined arm or jib; this differs from a derrick, in that the load cannot be lifted by the topping lifts or peak blocks, as the jib is supported by rigid stays.

JIGGER.—In radio, a transmission variable ratio transformer which couples the antenna and oscillator circuits.

JOCKEY GEAR.—A gearing connected with a cable laying apparatus, consisting of so called jockey wheels which ride over the cable as it passes over the drum to preserve a uniform tension so as to avoid slipping.

JOCKEY WHEEL.—A heavy wheel which rides over the cable upon the drum of a cable laying apparatus, so as to maintain the tension and avoid slip.

JOHNSEN-RAHBEK EFFECT. — Attraction between two materials when they have unlike static charges. Also called electrostatic adhesion.

JOINING UP.—The act or process of making an electrical connection.

JOINT.—The tying together of two single wire conductors so that the union will be good both mechanically and electrically. There are a number of joints extensively used, such as, a, pig tail; b, bell hanger's; c, Western Union; d, turn back; e, Britannia; f, scarfed; g, duplex. A good electrical joint should have conductivity, mechanical strength, durability and facility for insulation. In making a joint it may be brazed, soldered, welded or as usually made, the two ends of the conductors are brought into close metallic contact and secured in position by twisting the ends. This is known as a dry joint.

JOINT ADMITTANCE.—The combination of several parallel-connected admittances.

JOINT CONDUCTANCE.—The combination of several parallel-connected conductances.

JOINT COOLING TRAY.—A tray containing ice water, or a special cooling mixture, employed to hasten the cooling of a cable core joint.

JOINT RELUCTANCE.—The combination of several parallel-connected reluctances.

JOINT RESISTANCE.—The combination of several parallel-connected resistances.

JOINTING.—The process of uniting the ends of two single wire conductors. The word joint is commonly used incorrectly for splice.

JOUBERT'S WAVE MEASUREMENT.—A step by step method. The apparatus used consists of a galvanometer, condenser, two two-way switches, resistance and adjustable contact maker. The contact maker is attached to the alternator shaft so that it will rotate synchronously with the latter. By means of the adjustable contact, the instant of "making" that is, of "closing" the testing circuit may be varied, and the angular position of the armature, at which the testing circuit is closed, determined from the scale, which is divided into degrees. A resistance is placed in series with one of the alternator leads, such that the drop across it, gives sufficient pressure for testing.

JOULE EFFECT.—The heat produced by the resistance offered by a conductor to the flow of an electric current.

JOULE'S ELECTRO-MAGNET.—An electromagnet having a hollow cylindrical core with a segment cut off along its length.

JOULE'S EQUIVALENT OF HEAT.—A red coal 1 B.t.u. $\asymp$ 772 ft. lbs. Prof. Rowland (1880) and others give higher figures. The present standard as used in Marks and Davis' steam tables is 777.52. The value 778 is sufficiently accurate for ordinary calculations.

JOULE, JAMES PRESCOTT.—Born 1818, died 1889. An English physicist. At the age of nineteen, he invented an electromagnetic engine. He was the first to ascertain the mechanical equivalent of heat, working for forty years in its determination. In 1847 he stated the doctrine of the conservation of energy. He made many important researches in electricity and thermodynamics, discovering the law known as Joule's law for determining the relation between the heat and the current pressure and time in an electric circuit. His name has been given to the unit of electric work, the joule.

JOULE'S LAW.—The law first stated by Joule, that the quantity of heat developed in a conductor by the passage of an electric current is proportional to the resistance of the conductor, to the square of the strength of the current, and to the duration of the flow.

JOULEAN HEAT.—The heat due to the work performed by an electric current in overcoming the resistance of the circuit in which it flows.

JOURNAL BEARING.—A support including a cap and pillar surrounding a shaft journal. The practice of lining journal boxes with a metal that is sufficiently fusible to be melted in a common ladle is not always so much for the purpose of securing anti-friction properties as for the convenience and cheapness of forming a perfect bearing in line with the shaft without the necessity of boring it. Boxes that are bored, no matter how accurately, require care in fitting and attaching them to the frame or other parts of a machine.

JOURNAL FRICTION.—The friction of a shaft in its bearings. From experiments, it appears that the friction of a perfectly lubricated journal follows the laws of liquid friction much more closely than those of solid friction. According to Thurston, gun bronze, babbitt, and other soft white alloys have substantially the same friction; in other words, the friction is determined by the nature of the unguent and not by that of the rubbing surfaces, when the latter are in good condition. The soft metals above referred to on account of deficient conductivity, run at higher temperatures than the bronze.

JOY STICK.—A control lever of an airplane operating the controlling surfaces, usually the wing flaps and elevators.

JUMP SPARK.—In electric ignition for internal combustion engines, a system in which the primary current is converted by a secondary induction coil into a secondary current of sufficiently high tension to cause a spark to jump an air gap between two points carried by a spark plug screwed into an opening in the cylinder of the engine.

JUMP SPARK IGNITION.—High tension ignition.

JUMPER.—In wiring, a conductor used to make electrical connection between terminals, or around a break in a circuit. It is generally used as a temporary shunt or short circuit around a faulty lamp or receptive device on a series connected circuit, to enable it to be readily removed or repaired.

JUMPING POINT.—In testing the range of arc light carbons, a point during the lengthening of the distance between the carbons at which the arc makes small jumps or sputters out of the crater in the upper carbon.

JUNCTION BOARD.—A telephone switchboard for the terminals of junction lines.

JUNCTION BOX.—A box, or casing, provided in an underground distribution system in which the feeders and mains are connected and other connections are made; a fishing box.

JUNCTION LINE.—A telephone line between two exchanges, as distinguished from a subscriber's line; a junction.

JUNCTION SURFACE OF PRIMARY CELL.—In a primary cell, the surface of the electrodes in actual contact with the electrolyte.

JUNK.—Old rope; old planking; scrap iron; odds and ends.

JUNK PACKING.—An early form of packing for steam engine pistons.

JUTE.—The coarse strong fiber of an East Indian plant largely used for gunny sacks, cordage, etc. In electric practice, jute is employed as an insulating material, especially when saturated with an insulating compound.

K

K—Symbol for dielectric constant.

KAOLIN.—A white clay resulting from the decomposition of feldspar, used for making the finest porcelain, hence the name, china clay. Experiments have been made with kaolin for insulating purposes.

KAPP COEFFICIENT.—A factor inserted in the formula for voltage of alternators to correct for the inefficiency of the winding in generating the theoretical voltage. In practice, the coils are often more or less distributed, that is, they do not always subtend an exact pole pitch; moreover, the flux distribution, which depends on the shaping and breadth of the poles, is often quite different from a sine distribution. Hence, the coefficient 2.22 in the voltage formula is often departed from, and in the general case the voltage formula may be written

$$E_{v(r)}=kfZN\div10^8$$

where k, is a number which may have different values, according to the construction of the alternator. This number k, is called the Kapp coefficient because its significance was first pointed out by Prof. Gisbert Kapp.

The value of k, is further influenced by a "breadth coefficient" or, spread or span "factor."

KAPP LINE.—A unit line of magnetic force proposed by Kapp. It is equal to 6,000 c.g.s. lines of force, with the square inch as the unit area.

KARSTEN'S FIGURES.—A name sometimes given to breath figures which are produced by electrifying a coin or other piece of metal resting upon a sheet of dry glass and then breathing upon the place where the coin lay. In this way a faint image of the coin is reproduced upon the glass.

KATALYSIS.—An unusual spelling of catalysis.

KATELECTRONIC CURRENT.—The electric current at the cathode on passing a constant current through a nerve.

KATHION.—An occasional form of spelling cation.

KATHODE.—An occasional form of spelling cathode.

KATHODE RAYS.—See cathode rays.

KEEP ALIVE CIRCUIT.—In a mercury arc rectifier, the vapor maintaining heat circuit.

KEEPER.—The armature of a magnet; the bar of soft iron placed across the poles of a horse shoe magnet to prevent loss of magnetism.

KELVIN BALANCE.—An accurate standard instrument invented by Lord Kelvin for measuring electric currents by their direct magnetic action.

KENNELLY HEAVISIDE LAYER.—In radio, properly called the Heaviside Kennelly Layer.

KENOTRON.—Trade name for a highly exhausted two element rectifying vacuum tube.

KERITE.—A variety of artificial vulcanite prepared for insulating purposes.

KERITE TAPE.—Tape insulated by a coating of kerite.

KERR EFFECT.—The effect produced in dielectrics when subjected to electrostatic stresses, so that they become double refracting in their relation to a beam of polarized light. Dr. Kerr showed, in 1877, that a ray of polarized light is also rotated when reflected at the surface of a magnet. If the light be reflected at a point on the side of the magnet, when the plane of polarization is parallel with the plane of incidence, the rotation is in the same direction as that of the magnetizing current.

KEY.—In telegraphy, a device for making or breaking the contacts which control the passage of the current. It consists of a steel lever, swung on a pivot, having a rubber handle, which the operator grasps lightly with the thumb and forefingers. On pressing the lever downward, a platina point projecting under the lever is brought into contact with another platina point set into an insulation of rubber in the base of the key, so that there can be no electrical connection between them unless the key is pressed down or closed.

An extra lever at the side of the key is called the "circuit-closer," and is used as a means of keeping the circuit closed when the hand of the operator is not on the key.

KEYBOARD TRANSMITTER.—A variety of telegraph transmitter used with the printing or dial telegraph system.

KEY CLICK OR THUMP.—In telegraphy, the sound produced in a receiver due to continual oscillation after the key has been opened.

KEY FILTER.—An impedance placed in series or in parallel with a transmitter key to prevent too sudden building up of voltage and current.

KEY MODULATION.—In radio telegraphy, a method of producing code signals by varying the amplitude or frequency of a carrier wave by key operation.

KEYLESS FIRE ALARM BOX.—A type of fire alarm box, which, instead of opening with a key, has a glass front which must be broken before the alarm can be set.

KEYLESS WALL SOCKET.—A lamp socket fitted to a wall having terminals to which the flexible wires leading to the lamp are connected by a plug block.

kg.—Abbreviation for kilogram.

KICK.—1. In general, a recoil.

2. Any impulsive movement imparted in telegraphy to delicate instrument parts by a discharge from the line.

KICK BOX.—In house wiring, a fitting for protecting wires at the points where they enter or emerge from the floor.

KICK OF RELAY.—An impulsive movement imparted to the tongue of a telegraphic relay by an electric discharge from the line.

KILERG.—The same as kilo-erg.

KILLING WIRE.—1. A method of straightening wire by applying tension to it.

2. The loss of elasticity suffered by the contact springs of switches when heated to excess by the electric current.

KILO.—A prefix often used with a physical unit to designate a quantity one thousand times as great.

KILO-AMPERE.—A unit of current, equal to 1,000 amperes.

KILO-AMPERE BALANCE. — An ampere balance which measures electric current in terms of kilo-amperes.

KILOCYCLE.—One thousand cycles. In house lighting and similar circuits, where a comparatively low frequency is used, it is usual to refer to the frequency in cycles per second. However, in radio circuits, where currents as high as 300,000,000 cycles per second are used, it is preferable to divide by 1,000, thus converting to kilocycles. The speed of radio waves is approximately 186,000 miles or 300,000,000 meters per second. Assuming that a transmitting station is using a wave length of 500 meters, the frequency will be obtained in cycles per second by dividing the velocity of the waves by the length of a single wave, which in this case would be equal to 300,000,000 (appx.) divided by 500, equalling 600,000 cycles per second or (reduced to kilocycles by dividing by 1,000) 600 kilocycles.

KILO-DYNE.—A unit of force, equal to one thousand dynes.

KILO-ERG.—A unit of work, equal to one thousand ergs.

KILO-GAUSS.—A unit of magnetic flux density, equal to one thousand gausses.

KILOGRAM.—A unit of mass in the metric system corresponding to a standard mass of platinum kept in Paris, equal to one thousand grams or 2.2046 lbs.: abbreviated **kg.**

KILOGRAMMETER.—A unit of work; the work done by a force equal to the weight of one kilogram acting through a distance of one meter, equivalent to 7.233 foot pounds.

KILO-HENRY.—A unit of self-induction, equal to one thousand henrys.

KILO-JOULE.—A unit of work, equal to one thousand joules.

KILO-LINE.—A unit equal to 1,000 lines of force or 1,000 Maxwells.

KILO-METER.—A unit of length in the metric system equal to one thousand meters, 3,280.899 ft., or .62137 statute miles.

KILOVOLT.—A unit of pressure equal to one thousand volts.

KILOVOLT-AMPERE.—The unit of apparent power in alternating current circuits as distinguished from **kilowatts** which represent the true power.

KILOVOLT METER.—An instrument used in X ray work which can be relied upon to furnish a constant index of voltage although it may not indicate the actual voltage.

KILOWATT.—A unit of electric power, equal to one thousand watts. Electric power is usually expressed in kilowatts. As the watt is equal to 1/746 horse power, the kilowatt or 1,000 watts=1.34 h. p. Careful distinction should be made between **kilowatts** and **kilovolt amperes.**

KILOWATT HOUR.—The work performed by one kilowatt of electric power during an hour's time.

KILOWATT HOUR METER.—A type of recording watt meter measuring in terms of kilowatt hours.

KILO-WEBER.—A unit of magnetic flux equal to one thousand webers.

KINE.—A term proposed for the c.g.s. unit of velocity equal to one centimeter per second.

KINEBOOTH.—A fire proof room of approved construction in which motion picture projectors, stereopticon projectors, effect projectors, spotlights, and auxiliary apparatus and equipment are located, the word **kinebooth** has been adopted and accepted by architects and engineers to define that particular section of a building.

KINEMATICS.—1. That branch of mechanics which treats of motion without reference to mass or to the causes of motion, as distinguished from dynamics.

2. The theory of the motions of parts of machines whereby they are constrained to fulfill their various functions, one variety of motion being employed to produce another.

KINETIC ENERGY.—The energy of a moving body by virtue of its momentum.

KINETIC THEORY OF GASES.—That theory of the properties of gases based upon the assumption that a gas consists of separate molecules, each possessing a finite mass and velocity, and obeying the ordinary laws of motion.

KINETIC THEORY OF MATTER.—The theory that the molecules composing matter are in a perpetual state of rapid motion, constantly colliding with one another.

KINETICS.—That branch of dynamics which treats of forces that cause or change motion in bodies, as opposed to statics.

KING LEG.—The principal or vertical leg of a tripod supporting a derrick, etc.; the other legs are known as **queen legs.**

KING POST TRUSS.—A truss or roof principal constructed with a king post.

KINNERSLEY'S THERMOMETER. — An electric air thermometer consisting of a glass vessel enclosing air, and communicating with a tube partly filled with water or other liquid. Two metal rods are led into this tube and a filament of gilt paper or thin wire is suspended between the two rods. When an electric discharge passes between the rods, the enclosed air is heated and expands which causes a movement in the indicating column of liquid. Observations with the instrument show: a, that the heating effect of a charge in a wire of given length is inversely proportional to the square of the wire's cross section area, and b, that the total heat evolved is jointly proportional to the strength of the charge and to the fall of pressure.

KINRAIDY SPARK GAP.—A water cooled quenched spark gap.

KIRCHHOFF'S LAWS.—1. The algebraic sum of the currents flowing toward any point in a network is zero.

2. The algebraic sum of the products of the current and resistance in each of the conductors in any closed path in a

network is equal to the algebraic sum of the voltages in that path.

KISH.—A shop term for the black scales of graphite which separate and float on the surface of a slowly cooling mass of molten iron. The whole of the scum is also called kish.

KLYDONOGRAPH.—A surge indicator. It consists of a photo plate, dielectric and a metal plate, all enclosed within a dark box. If the two plates be connected in a circuit and voltage impressed, on developing the photographic plate, figures will appear that will give pertinent information concerning the nature of the voltage impressed. If the voltage be in the form of a surge, that is, uni-directional, either with a sheer front or tapered front, the figure on the photographic plate will differentiate between the tapered front and the abrupt front, and it will also indicate whether the surge was of positive or of negative polarity.

KNEADING TOOLS.—Tools for pressing into shape hot gutta percha when covering an insulated joint.

KNIFE BREAK SWITCH.—A switch consisting of a movable blade of copper or brass which makes electric contact between two contact springs.

KNIFE SWITCH.—A switch having one or more hinged blades which engage with spring clips when closing the circuit. A knife switch should be used when the capacity of the circuit exceeds 10 amperes and it should be installed so that gravity tends to open the switch.

KNOB AND TUBE WIRING.—Wiring especially for lighting circuits, supported by knobs and tubes. It may be concealed between floors or walls of buildings or exposed. Knob and tube wiring should be discouraged as far as possible, as it is subject to mechanical injury, is liable to interference from rats, mice, etc. As the wires run according to this method are liable to sag against beams, laths, etc., or are likely to be covered by shavings or other inflammable building material, a fire could easily result if the wires become overheated or short circuited. Before installing concealed knob and tube wiring it should first be ascertained if this method be permitted by the local ordinances.

KNOCKOUT.—In outlet boxes for house wiring, a disc fitted into a hole in an outlet box. Each box has several discs which are removed or "knocked out" (hence the name) where it is desired to insert wires into the box.

KNOT.—A nautical mile, equal to 6,080.26 feet, or 1.15 statute miles.

KNOT POUND.—A conductivity standard, applied to the copper of submarine cables.

KNUCKLE.—The sharp bend at the middle of a diamond coil which is necessary to permit the coil ends to properly cross each other.

KNURLED.—Milled; having the edges cut into a succession of ridges to afford grip for the fingers; as, the head of a screw or the edge of a coin.

KOHLRAUSCH'S LAW.—A law applied to the atoms in a solution undergoing electrolysis, viz.: that the rate of motion of each atom for a given liquid is independent of the element with which it may have been in combination.

KORDA AIR CONDENSER.—In radio, a type of variable condenser. Invented by Korda in Germany in 1893.

KRIZIK'S CORES.—Iron bars for magnetizing cores so shaped that the attraction or pull is nearly equal in all positions of the solenoid.

KRUPP METAL.—This is a special grade of nickel steel adapted for resistors.

KRUSS' OPTICAL SCALE.—A scale devised for obtaining the dimensions of a flame.

KRYPTOL.—A mixture of graphite, carborundum, silicate and clay in granular form, employed in electric furnaces.

KUZEL PROCESS.—An early method of forming tungsten into a filament. It consists in forming a colloidal solution of the metal by maintaining an electric arc between tungsten terminals under water. This solution is then brought to a pasty consistency and squirted into a filament which is afterward treated by heating with the electric current.

KVA.—Abbreviation for kilovolt amperes.

Kw.—Abbreviation for kilowatt.

KYANIZE.—To preserve wood, such as telegraph poles, from decay, by a process of impregnation with a solution of corrosive sublimate, or chloride of mercury. The proportions are one pound of sublimate to ten gallons of water for maximum strength, or one pound to fifteen gallons as a minimum. About twenty-four hours per inch of thickness are required for saturation.

KYMOGRAPH.—An instrument for recording the angular oscillations of an air craft in flight with respect to axes fixed in space. The reference direction is usually given by a gyroscope or a beam of sun light.

L

L.—Symbol for inductance or self-induction.

LABILE.—An electrode which is kept moving over the surface during the passage of an electric current.

LABILE GALVANIZATION.—In electro-therapeutics, the process of applying the current to any part of the human body, in which one electrode is fixed and the other is moved with a slipping motion over the parts treated.

LAG.—That condition where the phase of one a.c. quantity lags behind that of another. The term is generally used in connection with the effect of inductance in causing the current to lag behind the impressed pressure. Lag is measured in degrees that is in the actual alternation, if the current lag say 45° behind the pressure, it means that the coil rotates 45° from its position of zero induction before the current starts. The angle of lag may have any value from 0° to 90°.

LAG AND LEAD.—Alternating currents do not always keep in step with the alternating volts impressed upon the circuit. If there be inductance in the circuit, the current will lag; if there be capacity, the current will lead in phase.

LAGGED DEMAND METER.—A meter in which the indication of the maximum demand is subject to a characteristic time lag. Lagged demand meters are so constructed as to require a certain time interval for the indication to reach the point corresponding to the value of the load. There are two types: a, those in which the speed of the indicator in moving up its scale under constant load, is constant, or at any load, is proportional to the load; b, those in which the speed diminishes with the time of the deflection. The demand interval for meters of this class is ordinarily considered to be the time required for the instruments to indicate 90% of the full value of a steady load which is thrown suddenly on it.

LAGGING A METER.—Adjusting a watt meter so that it shall read correctly on inductive and non-inductive loads.

LAGGING CURRENT.—The retardation of an alternating current behind the impressed voltage which produces it. Inductance causes the current to lag below the pressure in that it tends to prevent changes in the strength of the current. When two parts of a circuit are near each other, so that one is in the magnetic field of the other, any change in the strength of the current causes a corresponding change in the magnetic field and sets up a reverse pressure in the other wire. This induced pressure causes the current to reach its maximum value a little later than the pressure and also tends to prevent the current diminishing in step with the pressure.

LAMELLAR DISTRIBUTION OF MAGNETISM.—A distribution of magnetism such that the substance in which it exists can be divided into thin shells or layers, in which the magnetic particles are so arranged that one face of each layer contains all the north poles and the other face all the south poles, thereby producing a strong field.

LAMELLAR MAGNET.—A magnet possessing a lamellar distribution of magnetism.

LAMINA.—A thin layer of metal or mineral, as of mica, tissue, etc. **Laminæ** is the plural of **lamina.**

LAMINATE.—To beat, roll or press into thin sheets, as a metal.

LAMINATED CORE.—An armature core built up of layers of insulated iron plates in order to prevent the formation of Foucault currents in the metal.

LAMINATED OR STRIP BRUSH.—A commutator brush consisting of a number of strips of copper or brass, laid one upon the other and soldered at one end. They are incorrectly called tangential brushes; they are beveled at the end and set inclined to the line of tangency so that the ends of all the sheets will make contact.

LAMINATION OF ARMATURE CORE.—The building up of an armature with a number of thin discs cut or stamped out to the required shape and bolted together, for the purpose of reducing the tendency to eddy currents.

LAMP ADAPTER.—A contrivance to adapt an incandescent lamp to any bracket or chandelier; or to adapt lamp bases to sockets of different make.

LAMP ANNUNCIATOR. — In telephone switchboards, miniature incandescent lamps employed instead of mechanical drops for attracting the attention of the operator They are usually one-third candle power lamps mounted in opaque tubes with small opalescent glass jewels.

LAMP BASE.—The brass base which is cemented by plaster to the bulb of an incandescent lamp, and which contains the contacts for bringing the filament into connection with the electric circuit.

LAMP BULB.—The glass vacuum chamber containing the filament of an incandescent lamp; the lamp chamber.

LAMP CAP.—A term sometimes applied to the base of an incandescent lamp.

LAMP CLAMP.—A clutch designed to grip the carbon holder of an arc lamp.

LAMP CUT OUT.—1. An automatic device for cutting an arc lamp out of a circuit when its carbons become consumed.

2. An automatic cut out, used with series connected incandescent lamps, which acts promptly when a circuit through a lamp is broken, and short circuits it.

LAMP DIMMER.—A variable resistance connected in series with incandescent lamps to reduce the brightness or the light output to a desired value. The "steps" in a dimmer should be so proportioned as to cause a steady rather than a jerky increase or decrease in the illumination. Several circuits may be dimmed in unison by interlocking the individual dimmer levers.

LAMP EFFICIENCY.—This is usually expressed by the ratio of the total luminous flux (light) to the total power consumed. In the case of the incandescent lamp it is expressed in lumens per watt. This practice has generally superseded the former one of using the ratio of watts per candle (mean spherical or mean horizontal). When resistance, reactance or other power consuming accessory is used with the lamp, the statement of efficiency should indicate whether or not the wattage consumed by the accessory is included. In the case of a lamp depending upon combustion, efficiency may be expressed in lumens per thermal unit consumed per unit of time. For example, "lumens per B.t.u. consumed per hour."

LAMP, ELECTRIC.—A lamp which depends for its source of light upon the effects of an electric current. Electric lamps may be grouped into three classes: a, incandescent lamps in which the source of light is the incandescence of a refractory substance upon the passage of a current; b, arc lamps in which a luminous arc is maintained by an electric current between suitable electrodes, and c, vapor lamps in which the vapor in an exhausted glass tube becomes an incandescent stream of high conductivity.

LAMP FILAMENT.—The conducting thread which becomes incandescent upon the passage of an electric current in an incandescent lamp.

LAMP FOOT.—One 16 candle power lamp at a distance of one foot from the point of supply. This unit facilitates laying out wiring and calculating the drop.

LAMP INDICATOR.—1. A device in a central station by which the condition of the electric current in the mains may be observed.

2. A miniature incandescent lamp used in a telephone switchboard as a signal to the operator that a subscriber is calling.

3. A pilot lamp.

LAMP OR VOLT METER SYNCHRONISM INDICATOR.—The simplest method of synchronism indication. It consists of a lamp or preferably a volt meter connected across one pole of a two pole switch connecting the incoming machine to the bus bars, the other pole of the switch being already closed.

LAMP PANEL.—A group or "bank" of incandescent lamps mounted upon a single base and serving as a voltage indicator, or to show the occurrence of faults in the line.

LAMP PENDANT.—The lamp cord used in connection with a pendant incandescent lamp.

LAMP ROD.—The metallic rod by which the positive carbon of the usual type of an arc lamp is supported.

LAMP SIGNAL SWITCHBOARD.—A telephone switchboard employing miniature incandescent lamps as annunciators, instead of mechanical drops.

LAMP SOCKET.—The socket provided with contacts, into which the base of an incandescent lamp is designed to fit; the lamp receptacle.

LAMP SOCKET RHEOSTAT.—A resistance placed within the socket of an incandescent lamp, by which the intensity of the light can be varied.

LAND MARK BEACON.—Any electric light designed to indicate the position or height of an object that is a hazard to air craft in flight.

LANDING DIRECTION LIGHT.—Any electric light designed to indicate either by itself or in conjunction with other lights the direction in which landings at air ports are to be made.

LANDING FLOOD LIGHT.—Any electric flood light designed for location of an air port to illuminate the surface of the landing area.

LANDING GEAR.—The wheels and supports of an airplane for landing.

LANTHANUM.—A rare metal belonging to the same group as aluminum.

LAP JOINT.—1. A wire joint in which the two ends are laid side by side, bound together and soldered. The Britannia joint is an example.

2. In belting, a joint made by overlapping the ends and securing them together.

LAP WINDING.—An armature winding in which the ends of the coils come back to adjacent segments of the commutator; the coils of such a winding lap over each other.

LARGE CALORIE.—A French heat unit equal to the amount of heat required to raise the temperature of one kilogram of water one degree Centigrade. It is 1,000 times as great as the calorie.

LARGE POWER MOTOR.—A motor built on a frame having a continuous rating of 1 h.p. open type, at 1700-1750 r.p.m. or larger.—NEMA.

LATENT HEAT OF STEAM.—The amount of heat necessary to convert one pound of water at the boiling point into saturated steam of the same temperature. It is made up of: a, the internal latent heat, and b, the external latent heat. The work done by the steam in making room for itself against the pressure of the superincumbent atmosphere is called the external work of vaporization. The author does not agree with the generally accepted calculation for the external latent heat, or external work of vaporization and holds that it is wrong in principle. The common method of calculating this work is based on the assumption that the amount of atmosphere displaced per pound of steam, is equal to the volume of one pound of saturated steam at the pressure under which it is formed; it is just this point wherein the error lies. The author holds that the displacement of the atmosphere must be referred to a stationary water level because it must be evident that at the beginning of vaporization the atmosphere was already displaced to the extent of the volume of water to be vaporized. See Audel's Engineers and Mechanics Guide, Vol. I, page 31, for full explanation.

LATERAL CONTROL.—On an air plane each wing is provided with a hinged flap near its elevator, being so connected to the joy stick by cables and pulleys that when the stick is moved to the right or left the flaps will be inclined upward on the side toward which the stick is moved and downward on the other side.

LATERAL DISCHARGE.—An impulsive discharge, as from a Leyden jar, taking place through an alternative path which offers less resistance than the direct path.

LATERAL STABILITY.—The sidewise balance of an air plane.

LATOUR ALTERNATOR.—A machine having several stators and rotors for multiplying frequency. The frequency of one stage furnishes power for producing the frequency in the next stage.

LATTICE POLE.—A type of steel pole with lattice work construction for bearing special strain in carrying overhead wires or cables.

LAUNCH, ELECTRIC.—An open boat propelled by an electric motor operated by a storage battery placed under the floor or seats. This form of motive power is objectionable on account of: a, excessive weight; b, small radius of operation; c, time required for frequent charging; d, corrosive action of battery fumes, etc., etc.

LAWS OF CHEMICAL ACTION IN PRIMARY CELLS.—1. The amount of chemical action in a cell is proportional to the quantity of electricity that passes through it.

2. The amount of chemical action is equal in each cell of a battery connected in series.

LAWS OF ELECTRICAL RESISTANCE.—1. The resistance of a conducting wire is proportional to its length.

2. The resistance of a conducting wire is inversely proportional to the area of its cross section, and therefore in the usual round wires is inversely proportional to the square of its diameter.

3. The resistance of a conducting wire of given length and thickness depends upon the material of which it is made—that is, upon the specific resistance of the material.

4. The resistance in general increases with the temperature.

LAWS OF ELECTROLYSIS.—According to Faraday:

1. The amount of chemical action in any given time is equal in all parts of the circuit.

2. The number of ions liberated in a given time is proportional to the strength of the current passing.

3. When the same current passes successively through several cells containing different electrolytes, the weights of the ions liberated at the different electrodes will be equal to the strength of the current multiplied by the electrochemical equivalent of the ion.

LAWS OF ELECTRO-MAGNETIC INDUCTION.—There are certain laws of electromagnetic induction which, on account of the importance of the subject, it is well to carefully consider. They are as follows:

1. Faraday's discovery: To induce a current in a circuit, there must be a relative motion between the circuit and a magnetic field, of such a kind as to alter the number of magnetic lines embraced in the circuit.

2. The voltage (or current) induced in a circuit is proportional to the rate of increase or decrease in the number of magnetic lines embraced by the circuit.

3. When a straight wire cuts 100,000,000 lines of force at right angles per second, an electric pressure of one volt is induced.

4. By joining in series a number of inductors or coils moving in a magnetic field, the electric pressures in the separate parts are added together.

5. A decrease in the number of magnetic lines which pass through a circuit induces a current around the circuit in the positive direction.

6. An increase in the number of magnetic lines which pass through a circuit induces a current in the negative direction around the circuit.

7. The approach and recession of a conductor from a magnet pole will yield currents alternating in direction.

8. The more rapid the motion, the higher will be the induced voltage.

9. Lenz's law. The direction of the induced current is always such that its magnetic field opposes the motion which produces it.

LAWS OF ELECTRO-MAGNETIC SYSTEM.—1. When a magnet is placed near an electric circuit, every portion of the circuit is acted upon by a force urging it in such a direction as to make it enclose within its embrace the greatest possible number of lines of force.—Maxwell's rule.

2. Every electro-magnetic system tends to change the configuration of its parts so as to make the flux of magnetic lines through the exciting circuit a maximum.

LAWS OF HEAT.—Heat is transmitted in three ways: a, by conduction, as when the end of a short rod of iron is placed in a fire, and the opposite end becomes warm, this is conducted heat; b, by convection, such as the warming of a mass of water in a boiler, and c, by radiation, as that diffused from a piece of hot metal or an open fire. Radiant heat is transmitted, like sound or light, in straight lines in every direction, and its intensity diminishes inversely as the square of the distance from its center of radiation.

LAW OF INVERSE SQUARES.—1. The force exerted between two magnetic poles is proportional to the product of their strengths, and inversely proportional to the square of the distance between them. Also known as Coulomb's law.

2. The intensity of the illumination due to a given point source, varies inversely as the square of the distance from the source.

LAWS OF MAGNETIC FORCE.—1. Like magnetic poles repel one another; unlike magnetic poles attract one another.

2. The force exerted between two magnetic poles varies inversely as the square of the distance between them.

LAWS OF REFLECTION.—In optics: 1. The angle of reflection is equal to the angle of incidence. 2. The incident and the reflected rays are both in the same plane which is perpendicular to the reflecting surface.

LAWS OF REFRACTION.—1. Light is refracted whenever it passes obliquely from one medium to another of different optical density.

2. The index of refraction for a given substance is a constant quantity whatever be the angle of incidence.

3. The refracted ray lies in the plane of the incident ray and the normal.

4. Light rays are bent toward the normal when they enter a more refractive medium, and from the normal when they enter a less refractive medium.

LAWS OF THERMODYNAMICS.—The theory of heat considered as a form of energy, is useful in advanced studies of the theory of steam, gas, air engines, etc. The first two laws of thermodynamics are as follows:

1. Mechanical energy and heat are mutually convertible in the ratio of 777.52 foot pounds for the British thermal unit. (Joule: originally 772 foot pounds.)

2. A self-acting machine, unaided by any external agency, cannot convert heat from one body to another at a higher temperature. (Clausius.)

LAY.—The length of one complete turn in multiple wires or cables. For example: 1 inch lay in twisted pair is one complete twist per inch.

LAY OF WIRES.—The manner in which wires are caused to make a complete twist about a central core or axis.

LEAD.—1. That condition where the phase of one alternating quantity is in advance of the other. The term is generally used in connection with the effect of capacity in causing the current to lead or be in advance of the pressure. Lead is measured in degrees, that is, in the alternation, if the current lead say 45° in advance of the pressure, it means that the current starting from position of zero induction when the coil is 45° behind this position. Lead may vary from 0° to 90°.

2. An insulated conducting wire which leads from an electric source to any main, feeder, station, instrument, circuit, etc.; in general, one of the conductors in a system of electric distribution.

LEAD OF BRUSHES OF DYNAMO.—An advance in position given to commutator brushes beyond the normal neutral plane to bring them into the commutating plane, to avoid sparking.

LEAD OF BRUSHES OF MOTOR.—In order to prevent sparking, a position of the brushes upon a motor commutator a little back of the diameter between the poles; being a negative lead.

LEAD OF CURRENT.—When the capacity of an a.c. circuit is more effective than the induction, the current leads the pressure.

LEAD VARIATION.—In series dynamos giving a constant current, the brushes require practically no lead. In shunt and compound dynamos the lead varies with the load, and therefore the brushes must be rotated in the direction of rotation of the armature with an increase of load, and in the opposite direction with a decrease of load.

LEAD IN.—In radio the wire which connects an aerial to the receiving set.

LEAD.—A lustrous, blue gray metal, soft enough to be cut with a knife or to leave a mark on a piece of paper; it is malleable and ductile, but is not a good conductor of heat and electricity as compared with other metals. Melting point: 621° F.; coefficient of expansion per degree F., .0000157; specific heat, .031; conductivity (heat and electricity), 8.5 (silver=100), tensile strength (lead pipe), 2,200 lbs. per sq. in.; specific gravity, 11.35 to 11.37; weight, .41 lb. per cu. in.

LEAD ACCUMULATOR.—A storage cell consisting of lead plates immersed in dilute sulphuric acid.

LEAD BURNING.—A process, sometimes erroneously called autogenous soldering. It consists of joining pieces of lead together by simply placing the edges to be joined close to, or overlapping each other and then melting them so that they flow and intermingle with each other, forming one piece, and retaining the same condition of unison on solidifying. In some cases a strip of lead is melted at the same time as the edges; this makes a raised, and consequently a stronger seam. The process is useful only for joining lead to lead and would not answer so well for joining lead to copper or to brass.

LEAD COVERED CABLE.—An underground cable protected by a covering of lead outside the insulation.

LEAD MONOXIDE.—Commonly called litharge. A substance employed for the active material of storage battery plates, especially for pasting the negative plate in the Faure type of cell.

LEAD PEROXIDE.—The lead compound, employed to form the positive plate of a storage battery cell. It has a reddish brown or chocolate appearance in the cell.

LEAD PLATING.—Depositing a layer of lead upon an object by electro-plating, generally as a protection against the action of mineral acids, as when gun barrels are coated with lead peroxide to prevent rust.

LEAD SHEATHING.—A covering of lead applied to a cable in order to protect it from injury while underground.

LEAD SLEEVE.—A sleeve of lead fitted over a joint in a lead covered conductor.

LEAD SPONGE.—The condition of the plates of the Plante type of storage cell after the "forming" process by which the metallic lead of the plates is made spongy or porous. In the Faure type, the active material of the negative plate becomes lead sponge after being exposed to electrolysis.

LEAD SULPHATE.—A chemical compound which is formed upon discharging a storage battery by an action called sulphation in which the lead oxide, PbO, is changed into lead sulphate by the sulphuric acid of the electrolyte. It is a white substance, possessing a high resistance and tends to destroy the activity of the cell.

LEAD TIN ALLOY.—A combination of lead and tin, making an alloy which will melt at a low temperature, and hence is suitable for safety fuses. For example, an alloy of one part tin, and one of lead, will melt at 401° F.

LEAD WIPED JOINT.—The prevailing type of pipe joint in the days when "plumbing was plumbing." The lead pipe ends having been properly prepared, the joint may be wiped by one of several methods. In the one hand method take solder from pot with ladle and pour lightly on the joint, the ladle being moved backward and forward, so that too much solder is not put in one place. The solder is also poured an inch or two on the soiling, to make the pipe of proper temperature. The operator keeps pouring and with the left hand holds the cloth to catch the solder, and also to cause the same to tin the lower side of the pipe, and to keep the solder from dropping down. By the process of steady pouring, the solder now becomes soft and begins to feel shaped, firm and bulky.

When in this shape and in a semi-fluid condition the ladle is put down, and, with the left hand, the operation of wiping is begun, working from the soiling toward the top of the bulb. If the lead cool rapidly, it is reheated to a plastic condition by a torch, or a heated iron. When the joint is completed, it is cooled with a water spray, so that the lead will not have time to alter its shape.

LEADER CABLE.—In aviation, a conductor buried in a landing field for induction signaling to guide a pilot in landing.

LEADING EDGE.—The front or entering edge of an airplane wing.

LEADING IN TUBE.—An insulating tube for the protection of leading in wires as they are admitted to a building.

LEADING IN WIRES.—1. Conductors leading from an overhead circuit into a building.

2. The wires that make the connection between the filament of an incandescent lamp and the electric circuit.

LEADING HORNS.—The projections of the pole pieces of a dynamo which extend in the direction of the rotation of the armature. Introduced by Gravier and later modified by Lundell to prevent distortion of field. When the dynamo is working at small loads, the flux in the gap is nearly uniform, but at heavy loads, the distortion due to the armature current forces the flux forward and saturates the forward horn, thus preventing much change in its flux density, on account of the saturation and the diminishing area.

LEAK DETECTOR.—An air craft instrument which detects the presence of hydrogen and light gases in the air and which can be adapted to find leaks in a container inflated with such a gas.

LEAKAGE.—The escape of electric current through defects in insulation or other causes. A certain amount of magnetic flux escapes through the air in operating dynamos. It is this leakage flux which affects watch springs in the vicinity of electric generators.

No matter how well insulated a charged conductor may be, or how dry the atmosphere, the conductor slowly loses its charge, and in a few days the dissipation of the charge is complete.

The rate of discharge depends upon the difference of voltage between the charged conductor and the surrounding medium, hence, the discharge is more rapid at the beginning than afterwards. If the voltage be measured at equal intervals, it will be found to have diminished in a decreasing geometric series. For a negatively electrified conductor, the rate of discharge is greater than for one positively electrified.

LEAKAGE CONDUCTOR.—In a telegraph circuit, a conductor providing a direct path to earth for leakage currents in order to prevent their interfering with neighboring lines.

LEAKAGE DETECTOR.—A ground detector.

LEAKAGE INDICATOR.—An instrument for detecting leakage in an electric circuit: a magnetic explorer.

LEAKAGE METHOD OF MEASURING INSULATION.—A method of determining the degree of insulation by measuring the leakage from an insulated body.

LEAST COMMON MULTIPLE.—The least number that is exactly divisible by two or more numbers.

LEAT.—In hydraulics, a channel for water dug on the ground level; it differs from the launder in that the latter is an artificial conduit carried at a slight elevation above the ground.

LEATHER BELTING.—A material widely used for driving machinery. It is used single or double, sometimes treble for a main drive, the thickness of each single strip ranging from 3-16 inch to 5-16 inch. The strips are spliced, cemented, or sewn together to make up the necessary length and width, and are finally united at the ends by lacing, cementing or riveting. The ultimate stress of leather belting is 3,000 to 5,000 lbs. per square inch of section. For a single belt the usual working load is 33 lbs. per inch of width.

LEATHERS.—In hydraulics, cup or hat leathers as used in pumps or hydraulic presses.

LECHER WIRES.—A slide wire instrument for measuring short waves.

LECLANCHE CELL.—An open circuit primary cell invented by Leclanche, French electrician and was the first cell in which sal-ammoniac was used. This cell is in general use for electric bells, its great recommendation being that, once charged, it retains its power without attention for a considerable time. In construction, two jars are employed; the outer one, of glass, contains a zinc rod, and is charged with a solution of ammonium chloride, called sal-ammoniac. The inner jar is of porous earthenware, containing a carbon plate, and filled with a mixture of manganese peroxide and broken gas carbon. When the carbon plate and the zinc rod are connected, a steady current of electricity is set up, the chemical action which takes place being as follows: the zinc becomes oxidized by the oxygen from the manganese peroxide, and is subsequently converted into zinc chloride by the action of the sal-ammoniac.

LEDUC CURRENT.—In electro-therapeutics, an interrupted direct current, each pulse of which is approximately of the same current strength and same duration.

LEFT HANDED ARMATURE WINDINGS.—Windings applied to an armature in a counter-clockwise direction.

LEFT HANDED DYNAMO OR MOTOR.—A machine rotating in a counter-clockwise direction as seen from the pulley.

LEFT HANDED ROTATION.—Movement of a rotating body in a direction from right to left, or in the opposite direction of the hands of a clock as they are seen to move when one reads the time; **counter-clockwise rotation.**

LEG.—1. In a telephone exchange, a branch wire employed to bring an operator's instrument into direct connection with two or more subscribers.

2. One side of a switch circuit.

LEG KEY.—A telegraph key provided with a screw projecting from its base by which it may be secured to a table.

LEG OF CIRCUIT.—1. A branch or lateral circuit connected with the main circuit.

2. One of the leads of a metallic circuit.

LEGAL OHM.—A unit of resistance adopted by the International Congress of Electricians at Paris in 1884, but to which legal sanction was never given. It is the resistance of a column of mercury 1 sq. millimeter in area of cross-section, and 106 centimeters in length at the temperature of 0° C. or 32° F.

LEGAL QUADRANT.—The value of the quadrant as fixed by the electrical congress of 1884 in Paris, as being equal to 9.978 kilometers.

LEGGING KEYBOARD.—In a telephone exchange, a keyboard for directly connecting an operator with two or more subscribers.

LENARD EFFECT.—The effect produced by Lenard in passing cathode rays out into the air through an aluminum "window" in a Crookes tube.

LENARD RAYS.—Cathode rays which have passed outside of a Lenard tube.

LENARD TUBE.—A variety of Crookes tube having a piece of aluminum sealed into the glass at the end opposite the cathode, thereby forming a "window" through which Lenard rays can pass. Also called **cathode ray tube.**

LENGTH OF SPARK.—The width of the spark gap or the sparking distance between the terminals of an induction or spark coil, being the distance through air that the disruptive discharge can take place, varying as the difference of voltage and the pressure of the air.

The length of spark increases with the electric pressure. It diminishes with an increase of air pressure, hence, the high voltage required for ignition of internal combustion engines (10,000 to 30,000 volts) due to the compression of the fuel mixture. The length of spark varies for different gases, for instance, it is nearly twice as long in hydrogen as in air at the same density. The voltage required to produce a given length of spark depends on the shape of the electrodes and not on the kind of metal used. Pointed electrodes produce the longest spark with a given voltage.

Faraday, using two spheres of different sizes as electrodes, found the spark length greater when the smaller sphere was positive than when it was negative.

LENS.—A piece of glass or other transparent substance with one or both sides curved. Both sides may be curved, or one curved and the other flat. The object of a lens is to change the direction of rays of light, and thus magnify objects, or otherwise modify vision. That is, it causes the rays to converge or diverge in passing through the lens.

LENS CLASSIFICATION.—There are various kinds of lenses and they may be classed as:

1. Convex: a, double convex; b, plano convex; c, concavo convex.

2. Concave: a, double concave; b, plano concave; c, convex concave.

LENS LAMP.—An incandescent lamp having a lens sealed into one side of its bulb for focusing the light.

LENZ' LAW.—The direction of the induced current is always such that its magnetic field opposes the motion which produces it.

LESSER CALORIE.—The calorie, as distinguished from the greater calorie. It is the heat required to raise the temperature of 1 gram of water 1° C. at a mean temperature of 15° C. This is sometimes called the 15° calorie; also the small calorie.

LEVEL, ELECTRIC.—The state of an electrified surface in which there is no difference of pressure.

LEVEL OF EARTH, ELECTRIC.—A term referring to the electrical conductivity of the ground.

LEVER SWITCH.—A type of switch for light duty. Its distinguishing feature is that the blade, pivoted at one end and operated by a handle at the other end, swings in a plane parallel with the base. A switch of this type if placed vertically should be in such position that gravity tends to open the circuit.

LEYDEN JAR CONDENSER.—A type of condenser consisting of a glass jar coated inside and out to a certain height with tinfoil, having a brass rod terminating in a knob passed through a wooden stopper, and connected to the inner coat by a loose chain. Used in making static electricity experiments. The jar may be charged by repeatedly touching the knob with the charged plate of the electrophorus or by connecting the inner coating to one knob of an electrical machine and the outer coating to the other knob. The discharge of a condenser is effected by connecting the plates having an opposite charge, by means of a discharger.

L.f.—Abbreviation for low frequency.

LICHTENBERG'S DUST OR ELECTRIC FIGURES.—A method of investigating the distribution of electricity devised by Lichtenberg. It consists of sifting a mixture of powdered red lead and sulphur upon a sheet of pitch or dry glass, the surface of which has been rubbed by the knob of a Leyden jar; the powder then assumes curious forms illustrative of the electrification.

LIFE OF LAMP.—The number of burning hours for which a lamp is specifically designed. This life varies with the service, and for tungsten filament lamps bears a definite relation to the light output of the lamp. In general, it can be said that if the life be lengthened the light output will be decreased and if the life be shortened, the light output will be increased. The most economic life of a lamp is determined by considering the cost of the lamp, the cost of making renewals, and the cost of power per unit of light output consumed throughout life. Generally speaking, the cost of the lamp is a really small part of the total operating cost. Lamp life is now usually expressed in terms of life to burnout.

LIFT.—1. The vertical component of the pressure of the air acting on the inclined surfaces of airplane wings which tends to lift the machine.

2. In pump installation, the height in feet from the surface of the water supply to the intake of the pump (strictly speaking, to the face of the plunger or piston). When the barometer reads 30 ins. the pressure of the atmosphere is 14.74 lbs. per sq. in. and this pressure will maintain or balance a column of water 34.042 ft. high when the column is exhausted to a 30 in. vacuum, and the water is at a temperature of 62° F. In other words, the pressure of the atmosphere then lifts the water to such height as will establish equilibrium between the weight of the water and the pressure of the air. Lift may be classed as static and dynamic. The latter takes into account the friction of the water in the suction pipe.

3. In pump operation, the practical limit of lift is from 20 to 25 ft. When the water is warm, the height to which it can be lifted decreases, on account of the increased pressure of the vapor.

4. British name for elevator.

LIFTING CAPACITY OF MAGNETS.—The weight that a magnet of given size can lift depends upon the form of the material and the evenness of the surfaces which must be gripped by the magnet. It might be possible to lift 20,000 lbs. or more, under favorable conditions, and only 1,000 lbs. or less, under adverse conditions, the same magnet being used in each case.

For instance, when there is a solid mass of steel or iron and a surface which affords a good magnetic contact, naturally, a much greater weight can be lifted than when there are a number of pieces which not only cling to the magnet but to each other, or in case the material is of such a form that a comparatively small surface is in contact with the magnet poles.

LIFTING MAGNETS.—A type of magnet used in connection with power operated cranes and hoists, for lifting magnetic material, especially where such material must be handled in bulk. There are several types of lifting magnets: **a, pig**, for material of irregular shape, piled indiscriminately; **b, plate**, for lifting straight shapes from orderly piles; **c, bipolar**, for handling irregular and regular shapes; **d, special**, designed for some special class of material.

LIGHT.—That form of radiant energy which affects the eye so that objects become visible.

LIGHT BATH, ELECTRIC.—In electro-therapeutics, a form of treatment in which the invalid is exposed to the rays from incandescent lamps.

LIGHT CELL.—A name sometimes given to a photo-electric cell.

LIGHT CHOPPER.—A device used to produce a pulsating current by interrupting the light directed to a photo cell.

LIGHT, ELECTRIC.—Light produced by the passage of an electric current through: a, arc lamps; b, incandescent lamps; c, vacuum tube lamps; d, luminous tube lamps.

LIGHT ENERGY.—The spectrum of light or radiant energy received from the sun is divided into three general bands: a, invisible infra-red band; b, luminous band; c, ultra-violet band.

LIGHT LINE AERIAL.—An electric light wire used as an aerial. Connection with the set is made by a plug with condenser attached and flexible lead to the set.

LIGHT WAVE LENGTH UNITS.—There are three units used in the measurement of light wave lengths:

Unit	Symbol	Millimeters
Angstrom	A. U.	One ten millionth
Millimicron	Mu or uu	One millionth
Micron	u	One thousandth

To convert millimicrons into Angstrom units multiply by 10; Angstrom units into millimicrons divide by 10. If a dime, which is about a millimeter in thickness, be divided equally into ten million parts, one part would approximate the size of an Angstrom unit.

LIGHT WAVES.—Radiant energy vibrations or waves of a frequency that affect the sense of sight.

LIGHTING BRANCH CIRCUITS.—Circuits supplying energy to lighting outlets only.

LIGHTING CIRCUITS.—Circuits for maintaining a system of electric lights.

LIGHTING MAINS.—In an electric lighting system of house wiring, the conductors which are prolongations of the "feeders." They run from the outside lines to the distribution center.

LIGHTNING.—An electric discharge occurring in the atmosphere from cloud to cloud, between cloud and earth or within a cloud. When such a discharge between cloud and earth terminates on a transmission line, a distribution line, electric machinery or other objects, it is called a direct stroke of lightning. Although direct strokes may be destructive, they usually strike electrical systems only in the transmission circuit.

LIGHTNING ARRESTER.—1. A device for providing a path by which lightning disturbances or other static discharges are passed to the earth. A lightning arrester is a device intended primarily to prevent damage to electrical apparatus which may be caused by disturbances due to lightning. There are numerous types.

2. A device providing a path for electric current between any electric circuit and the earth, through which, upon occurrence of a lightning surge, current will be conducted in sufficient amount to reduce the over voltage of the circuit caused by the surge, and after this reduction, the current will cease to be so conducted.

LIGHTNING ARRESTER, CHARACTERISTIC ELEMENT.—That part of a lightning arrester which controls the discharge current and which suppresses the follow current.

LIGHTNING ARRESTER CLASSIFICATION.—Lightning arresters may be classified:

1. With respect to their use, as to

a. The kind of circuit to be protected such as power or communication circuit.

b. Location: that is, whether it be for use on distribution circuits or at large stations.

c. Weather protection; whether indoor or outdoor type.

d. Nature of generated current; whether d.c. or a.c.

e. The system of connection; whether it be earthed or non-earthed.

2. With respect to control of follow current, as

a. Valve type.

b. Follow current type.

LIGHTNING BOLT.—The flash of a discharge of lightning.

LIGHTNING JAR.—A Leyden jar coated with metallic filings which exhibit scintillating sparks when the jar is discharged.

LIGHTNING ROD.—A conducting rod or cable erected on the outside of a building and connected to earth, in order to afford protection from lightning by carrying the lightning discharge into the ground; or to prevent lightning by leading the electricity from the earth to the cloud without disturbance.

LIGHTNING STROKE.—A discharge of lightning from the clouds to the earth.

LIGHTNING TUBE.—A fused tube produced in sand, earth or rock by the action of lightning. Also called **fulgurite.**

LILLIE WIRE JOINT.—A method of joining wires in which the connector consists of a strip of copper curved longitudinally in opposite directions, the wires being slipped into the curved channels and twisted in opposite directions.

LIME LIGHT.—The oxyhydrogen flame or calcium light. Hydrogen burns in air with a non-luminous hot flame. If it burn in combination with oxygen instead of with air, the heat is greatly intensified. By allowing this flame to impinge upon a small cylinder of lime (calcium oxide) an exceedingly brilliant light results.

LIMIT SWITCH.—In an electric elevator, a switch automatically operated by the car for opening the circuit and limiting the travel of the car.

LINE.—In general, a conducting wire between stations in a system of electric communication or distribution.

LINE ADJUSTER.—In a telegraph line, a device for adjusting relays to counteract the effects of leakage.

LINE ARRESTER.—A lightning arrester in the circuits of a telegraph or telephone line.

LINE BATTERY.—In telegraphy, the battery often called the main battery which is used in operating the main line, as distinguished from the **local battery.**

LINE DROP.—The difference in voltage along a transmission line between two given points due to the resistance of the line between the two points. The voltage at any point is $E=I\div R$ in which $R=$resistance of the line up to the point.

LINE DROP COMPENSATOR.—A device placed in the volt meter circuit of a distribution system which compensates for the line drop so that the actual voltage at a distant point on the distribution system may be read at the station.

LINE DYNAMOMETER.—A form of dynamometer used in overhead line construction to obtain the proper degree of tension in a wire; a **tension ratchet.**

LINE JACKS.—The spring jacks of a telephone switchboard connected with subscribers' lines.

LINE OF INDUCTION.—The correct name for the questionable yet almost universally used term **line of force.** Lines of induction may be imagined as existing in a magnetic field in quantity at every part proportional to the flux of induction at the part considered, and every where in the direction of the induction.

LINE PEG.—The connecting plug in a telephone switchboard.

LINE PRESSURE COMPENSATOR.—In an alternating current system, a compensating device attached to a volt meter by means of which allowance is made for a drop in voltage.

LINE SPECTRUM.—A spectrum of light consisting of more or less sharply defined lines which are arranged without any apparent regularity.

LINE WIRE TIER.—A short binding wire by which a line wire is tied to an insulator.

LINES OF MAGNETIC FORCE.—Lines assumed to exist in a magnetic field of force, tracing the paths along which magnetism acts. If a thin piece of paper be placed over a bar magnet and fine iron filings be sprinkled over it, the particles of iron will arrange themselves in regular curves between the poles and map out or define lines in a magnetic field which scientists call lines of force.

The forms of the curves show not only the direction of the magnetic force, but they also enable us to draw conclusions as to its intensity. When the force is great the curved lines are thick and sharply defined, and when it is weak the lines are thin and less plain.

The lines of force are also to be found in the neighborhood of wires through which electric currents are passing. They are the outward effect produced by the passage of an electric current, but the most singular fact is that they can also be the cause of an electric current.

LINEAR CAPACITY.—A quantity equal to the capacity of a conductor divided by its length.

LINEAR DENSITY, ELECTRIC.—The quantity of electricity upon a charged surface considered in relation to the length of the surface.

LINEAR DISTORTION.—In radio wave transmission, **amplitude distortion.**

LINEAR MEASURE.—A measure of length. There are various measures of length, such as: Long measure; surveyors' or old land measure; nautical measure, etc.

LINEMAN'S DETECTOR.—A portable galvanoscope used by linemen in tracing circuits and localizing faults in the erection and repair of telegraph lines or other electric circuits.

LINK FUSE.—A safety fuse containing a link of fusible material.

LINK INSULATOR.—A form of insulator for high tension transmission lines, consisting of a number of porcelain discs held together by wire and links and hung from the cross arm. The line wire is attached to the side or top by tie wires.

LINK SHOE.—In electric traction, a form of third rail contact shoe which is suspended by two links from the yoke bolted to the shoe beam.

LINKAGES.—The linking together of lines of magnetic force and the conducting coils through which they pass; the total number of linkages being the product of the magnetic flux by the number of turns in the coil.

LIQUID BARRETER.—An early radio electrolytic detector, invented by Fessenden, in which a platinum wire contacts with nitric or sulphuric acid in a small cup. Obsolete.

LIQUID COMPASS.—A standard type of mariner's compass in which the bowl is filled with a mixture of alcohol and water which serves to overcome the effect of vibration upon the needle.

LIQUID DAMPING.—A method of damping the swing of the needle of a measuring instrument by fluid friction. Oil damping is commonly used when moving parts are heavy, a rotating paddle turning against the oil in which it is immersed.

LIQUID LEVEL ALARM.—An electric alarm given by the action of a float upon a make and break mechanism, when a certain liquid falls below or exceeds a given level; a water level alarm.

LIQUID MEASURE.—

4 gills (gi.)	=1 pint (pt.)
2 pints	=1 quart (qt.)
4 quarts	=1 gallon (gal.)*
31½ gallons	=1 barrel (bbl.)
2 barrels or 63 gallons	=1 hogshead (hhd.)

Unit equivalents

hhd.	bbl.	gal.	qt.	pt.	gi.
				1=	4
			1=	2=	8
		1 =	4=	8=	32
	1 =	31½=	126=	252=	1,008
1 =	2 =	63 =	252=	504=	2,016

Scale—ascending, 4, 2, 4, 31½, 2; descending, 2, 31½, 4, 2, 4.

* NOTE.—There are two kinds of gallons: the U. S. gallon=231 cu. ins.; the British Imperial gallon=277.274 cu. ins.

LIQUID RESISTANCE.—Pure water is sometimes employed for the control of the electric current. The water is usually contained in a wooden box called the "water box." Metal terminals are immersed in the water and the resistance is adjusted by varying the degree to which the terminals are immersed or by changing the distance between them. Liquid resistances are often convenient in connection with electrical testing.

LIQUID RHEOSTAT.—A water rheostat.

LIQUID THERMOSTAT. — A thermostat which acts by the expansion of a liquid when heated.

LIQUIDS AS CONDUCTORS.—With respect to the conducting properties of liquids, they may be divided into three classes: a, those which are insulators, as turpentine, petroleum and many oils; b, those which conduct without decomposition, as mercury; c, those which conduct and are decomposed, as dilute acids and solutions of metallic salts, etc.

LISTENING KEY.—A key or cam controlled by a lever, by which a telephone operator is enabled to connect his telephone with the line of any subscriber.

LITHANODE.—Compressed peroxide of lead prepared for use as electrodes in storage batteries.

LITHARGE.—The yellow oxide of lead, also known as lead monoxide and massicot. A compound of lead and oxygen which when made into a paste with sulphuric acid or with a solution of magnesium sulphate is pressed into the holes of the negative plate or a storage battery, when the "pasting" process is employed in forming.

LITMUS PAPER.—A paper prepared and sold by druggists, used for indicating certain impurities found in boiler feed water. Water turning blue litmus paper red, before boiling, contains an acid, and if the blue color can be restored by heating, the water contains carbonic acid.

LITZENDRAHT WIRE.—A multi-strand wire having transpositions to reduce skin effect.

LIVE FRONT SWITCHBOARD.—One having live parts on the front of the panels. —NEMA.

LIVE LOAD.—One that is put on suddenly, or is accompanied with vibrations; as the force exerted by the connecting rod of an engine, or by a train crossing a railway bridge; a varying load.

LIVE STEAM.—Steam issuing under pressure from a boiler, capable of doing work as distinguished from exhaust steam, that is, steam which has done work.

LIVE WIRE.—A wire in actual use as a part of an electric circuit, especially one through which a strong current is passing.

LOAD.—1. In general, the work sustained by a machine.

2. As applied to a dynamo, the output in watts.

3. The resistance offered to a motor by the machinery it drives apart from the friction of its own parts.

LOAD CURVE.—A curve plotted on coordinate paper, having time (hours) represented by abscissæ and output by ordinates.

LOAD CURVE OF STATION.—The characteristic curve tracing the electric output of a central station at every moment throughout the day.

LOAD EQUALIZING.—When a number of compound dynamos of different outputs, or make, are running together in parallel, it frequently happens that all their characteristics are not exactly similar, and therefore the load is unequally distributed among them, some being overloaded, while others do not take up their proper share of the work. If the difference be small, it may be compensated by means of the hand regulator; if large, however, other means must be taken to cause the machines to take up their due proportion of the load. If the shunt coils of the several dynamos be provided with small adjustable resistances, in the form of German silver or copper ribbon inserted in series with the coils, the distribution of the current in the latter may be altered by varying the resistance attached to the individual coils, and thus the effect of the shunt coils upon the individual armatures in raising the pressure may be adjusted, and the load thus evenly divided among the machines.

LOAD FACTOR.—The ratio of the average load to the maximum load. There are two kinds of load factor: the annual and the daily. The annual load factor is obtained as a percentage by multiplying the number of units sold (per year) by 100, and dividing by the product of the maximum load and the number of hours in the year. The daily load factor is obtained by taking the figures for 24 hours instead of a year.

LOAD INDICATING RESISTOR. — One which is used in a feeder circuit in conjunction with suitable relays for the purpose of determining the value of the connected load.—NEMA.

LOAD LIMITING RESISTOR.—One which is used in a circuit for the purpose of reducing the current in that circuit to a safe value.—NEMA.

LOAD LOSSES OF TRANSFORMERS.—These are the losses in the windings due to load current, stray losses due to stray fluxes in the windings, core clamps, etc. and in some cases with parallel windings, losses due to circulating current.—NEMA.

LOAD PANEL.—In a system of electric distribution, a switchboard supplied with the devices for recording the electric output of the central station.

LOAD RATIO CONTROL.—A system which permits changing the voltage ratio of a transformer without interrupting the load. Load ratio control equipment can be applied to practically all regulation problems, above a point where it is not economical to use induction regulators. This method of control involves the use of two local circuits capable of carrying the load simultaneously. This permits picking up the load on one ratio before it is dropped from another.

LOADED ANTENNA.—A radio antenna having in its circuit a variable inductance coil by means of which the wave length may be altered.

LOADED LINE.—One in which the normal reactance of the circuit has been altered for the purpose of increasing its transmission efficiency.

LOADED TRANSFORMER.—When the load on a transformer is increased, the primary of the transformer automatically takes additional current and power from the supply mains in direct proportion to the load on the secondary. When the load on the secondary is reduced, for example by turning off lamps, the power taken from the supply mains by the primary coil is automatically reduced in proportion to the decrease in the load. This automatic action of the transformer is due to the balanced magnetizing action of the primary and secondary currents.

LOADING COIL.—In radio, a primary induction coil for increasing the self-induction (and hence the resonance wave length) of an aerial or other circuit. Some coils have multi-taps so that the inductance can be varied.

LOADING INDUCTANCE.—In radio, a loading coil.

LOCAL ACTION OF PRIMARY CELL.—Wasteful chemical action which goes on in a primary cell when the circuit is open, due to impurities in the zinc or to the varying density of the electrolyte. Such action may also occur when the circuit is closed without contributing to the useful current.

LOCAL ARMATURE CURRENTS.—In an a.c. commutator motor the currents produced by the transformer pressure in the coils undergoing commutation. They are large, because the maximum transformer action occurs in them, that is, in the coils short circuited by the brushes.

LOCAL BATTERY.—In telegraphy, a battery for a local circuit, supplying the current for the station instruments.

LOCAL BATTERY CIRCUIT.—In telegraphy, the circuit operated by the local battery of a station.

LOCAL CURRENTS.—1. Useless electric current sometimes generated in an armature core producing injurious heat. This tendency is reduced by laminating the core. Local currents are also known as eddy currents or Foucault currents.

2. In a primary cell, chemical action that tends to eat away the zinc, owing to the impurities in the metal. It may be prevented by amalgamating the zinc.

LOCAL JACK.—In a multiple telephone switchboard, the answering jack by means of which the operator responds to a signal received at the operator's section.

LOCAL OSCILLATIONS.—In radio superheterodyne receivers, oscillations produced at the receiver for the purpose of combining with the incoming oscillation to produce a beat frequency.

LOCALIZED CAPACITY.—Capacity introduced into a circuit at special points in addition to that already existing in the circuit.

LOCATING OUTLETS.—In house wiring, if concealed wiring is to be installed, the outlets should be marked on the ceilings and walls with a pencil cross at the spot, marking also the location of switches, etc. If a ceiling outlet is to be placed at the center of the ceiling, it is first located on the floor and then transferred to the ceiling by means of a plumb bob.

LOCATION OF OPENS.—In testing, the process of finding a fault in a wire or cable at some distant point. The test is based on the fact that the capacity of wires in a cable is ordinarily a measurable quantity, which, in wire of uniform diameter, is proportionate to length. In making the test, a fault finder is used together with a buzzer, dry cells to operate it, small induction coil and telephone receiver.

LOCK NUT.—A nut having an inwardly projecting pin or other means for holding it against a possibility of jarring loose.

LOCK OUT SYSTEM.—A telephone system containing a lockout mechanism for securing secrecy in party lines, so that a subscriber may not intrude upon and overhear the conversation of other subscribers on the line, nor interrupt when the line is already busy.

LOCKED ROTOR TORQUE.—Minimum torque of a motor developed at rest for any position of the rotor with full voltage.

LOCKING RELAY.—One which renders some other relay or other device inoperative under predetermined values of current or voltage, etc.—NEMA.

LOCOMOTIVE, ELECTRIC.—A car or engine carrying an electric motor for drawing trains, especially in electrified systems of interurban or trunk line railways. Electric motors vary greatly in form as no standard shape is yet established. In the smaller locomotives, the motor is usually geared to the driving axle by what is called single reduction; in the larger type the motor is directly connected without gearing.

LOCOMOTIVE HEADLIGHT SYSTEM.—A method of train lighting in which the current is provided by a turbine driven dynamo located on top of the locomotive boiler forward of the stack. This arrangement, though originally intended only to furnish current for the head light, is now sometimes used to light the entire train. The lighting of the entire train by a single turbine dynamo set has some advantages over the individual dynamos used in the axle drive system. The simplest and least expensive installation is the non-battery system.

LOCUS.—A straight line, surface or curve regarded as traced by one or more points or a line moving under specified conditions. The locus of the tip of a clock hand is a circle.

LODESTONE.—A variety of magnetite, or the magnetic oxide of iron, possessing in a natural state the properties of a magnet; a natural magnet. It was the first substance in which the phenomenon of magnetism was observed, and not until the tenth or twelfth century was it discovered that lodestones possessed the property of pointing north and south when hung up by a thread. This property was turned to advantage in navigation, and from that time the magnet received the name of lodestone or "leading stone." It is commonly, though incorrectly, spelled loadstone.

LOG.—1. An abbreviation for logarithm.

2. A stick of timber butted on the ends; a piece of timber, trimmed of branches, etc., ready for the saw mill.

3. The engine room log kept by the chief engineer, giving a tabulated summary of the performances of the machinery, and the consumption of fuel, together with all repairs executed, etc.

LOG, ELECTRIC.—An electric apparatus devised for measuring the speed and progress of vessels at sea.

LOGARITHM.—In higher mathematics, one of a class of artificial numbers, devised by Napier (A. D. 1600), to abridge arithmetical calculations, and by the use of carefully prepared "Tables of Logarithms," to shorten the difficult operation of raising to powers and the extraction of roots.

LONG COIL MAGNET.—An electro-magnet wound with many turns of fine wire, for use on long circuits where there is high resistance.

LONG DISTANCE TELEPHONE.—A term sometimes applied to toll line systems for communicating to distant points. Special switchboards are provided for connecting local to distant subscribers, and specially constructed cables join the various stations.

LONG DISTANCE TRANSMISSION.—The transmission of electric current for lighting, traction, power driving or other purposes from a generating center to distant points at which the current is utilized. In long distance transmission, high tension alternating currents are used by both three phase three wire and two phase four wire systems, the former being preferred for greatest distances because of its economy of copper.

LONG DIVISION.—A method of division in which the operations are written down in full, the method being applied with large divisors of two or more figures as 13,765÷126. To apply short division with such a large divisor would involve too great a mental effort.

LONG MEASURE.—

12 inches (ins. or ″)	=1 foot
3 feet	=1 yard
5½ yards or 16½ feet	=1 rod
40 rods	=1 furlong
8 furlongs or 320 rods	=1 statute mile

Unit equivalents

				ft.	ins.
			yd.	1=	12
		rd.	1=	3=	36
	fur.	1=	5½=	16½=	198
mi.	1= 40=		220=	660=	7,920
1 =	8=	320=	1,760=	5,280=	63,360

Scale—ascending, 12, 3, 5½, 40, 8; descending, 8, 40, 5½, 3, 12.

LONG SHUNT DYNAMO.—A dynamo in which one end of the shunt winding is connected to one of the brushes and the other end to the terminal connecting the series winding with the external circuit. Theoretically the long shunt is preferable to the short shunt as being the more efficient; however, in practice, the gain is not very appreciable and the short shunt is generally used.

LONG TON MEASURE.—

28 lbs.	=1 quarter
4 quarters	=1 long hundred weight
20 hundred weight	=1 long ton

Unit equivalents

		qr.	lbs.
	cwt.	1=	28
l. t.	1=	4=	112
1 =	20=	80=	2,240

Scale—ascending, 28, 4, 20; descending, 20, 4, 28.

Also (in Great Britain):

14 lbs.	=1 stone
2 stone=28 lb.	=1 quarter
4 quarters=112 lb.	=1 long cwt.
20 hundred weight	=1 long ton

LONG WAVES.—Radio waves of a length of 600 meters or more, frequencies lower than 500 kilo-cycles.

LONGERONS.—The fore and aft members of an airplane body framework. The longitudinals.

LONGITUDE.—In geography and navigation, the arc or distance east or west on the earth's surface intercepted between the meridian of a given place and the meridian of some other place from which longitude is reckoned, usually from Greenwich, England, but also, sometimes from the capitol of a country, as from Washington or Paris. The longitude of a place is expressed either in degrees or in time; as, that of New York is 74° or 4 h. 56 min. west of Greenwich.

LONGITUDINAL MAGNETIZATION.—Magnetization of an iron bar such that the magnetic axis of each molecule coincides in direction with the length of the bar; a state of magnetic saturation.

LONGITUDINALS.—The fore and aft members of an airplane body framework.

LOOM, ELECTRIC.—A loom for Jacquard weaving in which metal plates are substituted for the perforated cards, and electro-magnets are used for their operation.

LOOP AERIAL.—A radio aerial consisting of several turns of wire wound upon a light frame work which is sometimes mounted on a vertical shaft permitting the loop to be rotated to any desired position.

LOOP BRACKET.—A bracket with one or more insulators at a point where a loop is introduced into a circuit; a spreader bracket.

LOOP BREAK.—An insulating device for holding the ends of a conductor which has been cut for the introduction of a loop.

LOOP CIRCUIT.—1. A branched or parallel circuit.

2. A circuit not having a ground return; a metallic circuit.

LOOP CUT OUT.—A cut out included in an electric loop.

LOOP SYSTEM OF DISTRIBUTION.—An early method of distribution in an electric lighting system in which each lamp obtained its current through a separate circuit of its own.

LOOP TEST.—A method of locating a fault in a telegraph or telephone circuit when there is a good wire running parallel with the defective one. In the process the good and bad wires are joined at their distant ends and one terminal of the battery is connected to a Wheatstone bridge, while the other terminal is grounded. There are several methods known as: a, Murray loop; b, Varley loop, and c, special loop.

LOOP WINDING.—A lap winding, in which the connections, instead of progressing in a "wave" around the core, are made between adjacent coils in series.

LOOPS.—In a radio wave train, points of maximum amplitude.

LOOPS OF MUTUAL INDUCTION.—Lines of induction in an electrical circuit caused by the varying intensity of the current in an adjacent circuit.

LOOPING-IN.—A term sometimes applied to the method of wiring a series telephone party line, in which the line circuit passes from one instrument to the next throughout the entire circuit.

LOOSE CARBON TRANSMITTER.—The granular carbon or dust telephone transmitter, in which a mass of carbon grains is held between flat carbon electrodes for varying the resistance of the circuit.

LOOSE CONNECTIONS, TERMINALS, ETC.—In a dynamo or motor, when any of the connecting cables, terminal screws, etc., securing the different circuits are loose, sparking at the brushes, as a rule, results for the reason that the vibration of the machine tends to continually alter the resistance of the various circuits to which they are connected.

LOOSE COUPLER.—In radio, a secondary induction coil with sliding secondary winding withdrawn more or less from the primary winding. The degree of coupling is said to be loose when the coupling coefficient is .5 or less.

LORENZ COIL.—A basket wound inductance coil.

LOSS OF RESIDUAL MAGNETISM.—When a dynamo loses its residual magnetism it can be made to build up by temporarily magnetizing the field. To do this a current is passed through it from another dynamo, or from the cells of a small primary battery. Usually, this will set up sufficient initial magnetism to allow the machine to build up. The battery circuit should be broken before the machine has built up to full voltage.

LOUD SPEAKER.—A radio device designed to convert the amplified audio frequency currents into sound waves. In other words a loud speaker changes varying electric currents into sound waves. In order to do this the construction of the loud speaker must be such that it will cause the varying electric currents to set in vibration a diaphragm similar to that used in a telephone receiver, only larger. The vibration of the diaphragm sets into vibration a large volume of air which produces the sound. There are numerous types of loud speakers.

LOUD SPEAKER CLASSIFICATION.—With respect to the principle involved loud speakers may be classed as: a, magnetic; b, balanced armature; c, "dynamic" or moving coil; d, induction; e, metal strip; f, electro-static or condenser; g, Piezo-electric. Speakers which use a permanent magnet are called magnetic speakers; those using an electro-magnet are generally known as dynamic speakers.

LOUD SPEAKER EFFICIENCY.—This depends on how near the sound waves approach a true reproduction of the sound waves broadcast at the transmitting station. It is hardly necessary to state that the efficiency of most loud speakers is very low and even that of the best is far from perfect.

LOW FREQUENCY.—1. A comparatively small number of complete cycles of vibration performed in a unit of time.

2. In radio, audio frequency as compared with radio frequency.

3. In combined power and lighting circuits, 25 cycles as compared with 60 cycles. If the line of vision be directed at a small angle to an incandescent light on a 25 cycle circuit, the flicker of the light due to the low frequency can be seen.

LOW LAGGING POWER FACTOR.—In general, on systems where the power factor is low the cause is almost entirely in induction motors. Unreasonably low power factor will usually be found due to: a, the use of motors of inferior design and construction requiring larger magnetizing current than necessary; b, the use of motors too large for the duty they perform; c, the practice of allowing motors to run idle or lightly loaded.

LOW PASS FILTER.—In radio, a discriminating filter which rejects frequencies higher than a certain frequency.

LOW POWER FACTOR.—A condition which causes increased current for motors and higher energy losses in the distribution system. These wiring losses due to low power factor in some cases become extremely large when compared with the total energy required by the plant and in many cases the plant wiring is so taxed by the heavy current that it is too small to give satisfactory service.

LOW TENSION IGNITION.—"Make and break" ignition. Preferably called low tension ignition.

LOW TENSION IGNITION: DISADVANTAGES.—Mechanical complication, excessive noise, wear of the igniter points, and possible leakage through the igniter.

LOW VACUUM.—An enclosed space from which the air or gas has been exhausted to an imperfect degree, so that a greater or less amount of residual gas remains. In condensing steam engine operation a vacuum less than 24 inches may be considered low.

LOW VOLTAGE RELAY.—Generally used for the protection of motors in the event of a temporary weakening or failure of the pressure. They are also used in connection with a low voltage release or shunt trip coil on an oil switch or a circuit breaker.

LOW VOLTAGE RELEASE.—On a rheostat, a magnetic device which holds the lever on the ON position against the tension of a spring until the voltage falls a predetermined amount; the spring then turns the lever to the off position. The low voltage release consists of an electro-magnet sector on the pivot end of the rheostat operating lever, and a strong spring which tends to return the arm to the off position. The magnet is mounted directly below the pivot of the lever and its coil is connected in shunt across the line in series with a protecting resistance.

LOW VOLTAGE SYSTEM.—One which operates on a pressure less than 750 volts.

LOXODOGRAPH.—An electrical instrument in which the joint action of magnetism and photography is utilized for recording the course of a vessel at sea.

L.p.c.—Abbreviation for low pressure cylinder.

L.s.—Abbreviation for lighting switch.

L.t.—Abbreviation for low tension.

LUBRICANT ON COMMUTATOR.—In most cases it will be found that a little lubricant is needed on the commutator in order to prevent cutting of the latter by the brushes, and this is especially the case when hard strip brushes are used. The quantity of oil so used should be very small, a few drops smeared upon a piece of clean rag, and applied to the commutator while running, being quite sufficient. It is advisable to use mineral oil, such as vaseline, or any other hydrocarbon. Animal or vegetable oils should be avoided, as they have a tendency to carbonize, and thus cause short circuiting of the commutator, with attendant sparking.

LUBRICATION. — 1. In machinery, the process of lubricating, that is, of supplying to moving parts and their bearings, grease, oil or other lubricant.

2. The theory of lubrication, is the interposition of a film of unguent between the two surfaces which are supposed to rub together by reason of the motion of one of them. The friction of the surfaces on the unguent is less than their friction on one another, so that lubrication lessens friction, saves power and diminishes the risk of damage, wear and tear.

LUG.—A fitting which connects a conductor to the contact block of a switch.

LULLIN'S EXPERIMENT.—Two peculiar effects observed by Lullin when a piece of cardboard is pierced by a spark: a, a slight burr is raised on each side, as if the hole had been made from the interior outward; b, if the two electrodes are not exactly opposite each other, the hole is found to be nearer the negative point. When the experiment is tried in a vacuum, no such displacement of the hole occurs.

LUMEN.—The unit of luminous flux. The luminous flux emitted in a unit solid angle by a uniform point source of one international candle.

LUMEN-HOUR.—The unit of quantity of light. One lumen continued for one hour.

LUMINESCENCE.—The phenomenon, exhibited by certain bodies, of absorbing light waves and then emitting again a sufficient portion of them to be visible. Luminescence has two manifestations, fluorescence and phosphorescence.

LUMINOMETER.—A name given to a form of photometer. It consists of a box with two tubes opening into it. One of the tubes admits the light while the observer looks through the other at a card of printed matter illuminated by the light to be measured. The distance at which the card can be read is that which determines the illuminating power of the lamp.

LUMINOSITY.—1. The quality of being luminous or light giving.

2. As applied to color sensation, the brightness of the color.

LUMINOUS ABSORPTION.—The absorption of light rays by a body through which they are passing; as illustrated by the effect upon the intensity of an electric light by the globe of the lamp.

LUMINOUS ARC LAMP.—An arc lamp in which the luminosity is intensified by introducing some substance not carried by the ordinary carbon electrodes.

LUMINOUS EFFECTS OF SPARK.—When a disruptive discharge takes place, the spark is usually a thin brilliant streak of light. If metallic balls be used as sparking electrodes the distance between the balls modifies the character of the spark, viz.: When the balls are close together the spark appears as a single thin and brilliant line. If the distance be increased, the spark takes an irregular zigzag form, following the path of least resistance. The presence of minute particles of dust or other matter floating in the air causes the zigzag path. The brilliancy of the spark depends upon the quantity of current, and the color varies with the nature of the metal of the electrodes because the spark tears away minute particles of the metal and volatilizes them in its passage.

LUMINOUS FLUX.—The rate of passage of radiant energy evaluated by reference to the luminous sensation produced by it.

LUMINOUS PANE.—An insulated square of glass having a narrow strip of tin foil fastened upon it in parallel or zigzag rows, on which spaces are cut to represent any desired pattern; when an electric discharge is passed through the foil the design becomes reproduced in luminous flashes.

LUMINOUS RADIATOR.—A portable heating device consisting of a metal frame with polished copper reflector containing one or more luminous heating units.

LUMMER BRODHUN PHOTOMETER.—A form of photometer including an optical train mounted in a sight box, and provided with an optical device for viewing both sides of the screen at once.

LUNAR INEQUALITY.—Slight variations of the magnetic declination and inclination of a magnetic needle due to the effect of the moon upon the earth's magnetism.

LUX.—The practical unit of illumination, using the metric system of measurement, the illumination of a surface one square meter in area receiving an evenly distributed flux of one lumen, or the illumination produced at the surface of a sphere having a radius of one meter by a uniform point source of one international candle situated at its center. Since 1 sq. meter is equal to 10.76 sq. ft. one foot candle is equal to 10.76 lux. This unit is used in France and other countries where building dimensions are given in meters.

M

M.—Symbol for mutual inductance.

m.—Abbreviation for: a, mass; b, meter; c, minute; d, strength of magnetic pole; e, momentum.

m.a.—Abbreviation for milli-ampere.

MACHINE.—A term sometimes applied to rotative electrical apparatus signifying indeterminately a dynamo, alternator, motor, converter, etc.

MACHINE BOLT.—A bolt screwed at one end, with a head on the other, used to secure two pieces together, passing through clearance holes in both, and fastened with a nut on the far side. The head of a machine bolt is generally square or hexagonal, although round, snap, countersunk, or other heads are used for special purposes.

MACHINE SCREW THREADS.—In the A.S.M.E. standard for machine screw threads, the basic form is the same as that of the U. S. standard system, but certain definite limits are given both for screw and tap threads.

MADE CIRCUIT.—A closed or completed circuit.

MAGAZINE FUSE.—A safety fuse provided with duplicate fuses in reserve, so that when one becomes burned out, a new fuse may readily be substituted.

MAGNALIUM.—An alloy of aluminum and magnesium with 90-98% aluminum. It is used largely in Europe for engine parts, scientific instruments, telephone and telegraph apparatus, etc.

MAGNE-CRYSTALLIC ACTION.—A name given by Faraday to the behavior of crystalline bodies under the influence of magnetic force, such that the magnetism varies according to the axes of crystalization. He found, in experimenting with a crystal of bismuth, that it tended to point with its axis of crystallization along the lines of the field axially.

Plucker endeavored to connect the magne-crystallic action of crystals with their optical behavior. In bodies, which like slate, have cleavage, the planes of cleavage are usually at right angles to the magne-crystallic axis.

MAGNEPROBE.—A magnet in the form of a probe for recovering iron and steel particles from the body.

MAGNESIA.—The oxide of magnesium. A light white powder with a slight alkaline reaction. It is nearly insoluble in water and melts only at the temperature of the electric furnace. It is therefore used for crucibles and furnaces for high temperature processes.

MAGNET.—A body possessing the property of attracting to itself particles of iron. A natural magnet is a piece of magnetite or magnetic oxide of iron which will attract other iron, will repel or attract similar magnets according to their relative positions, and when suspended so as to be free to turn will set itself in a definite direction with respect to the earth's magnetic poles. An artificial magnet is a piece of iron or steel which has acquired magnetic properties. An electro-magnet is a piece of iron which has been magnetized by an electric current passing through a wire coiled about the iron. A polarized electro-magnet is one whose core is a permanent magnet. Such magnets are used in duplex telegraphy. The armature of this magnet is released only by a current in a fixed direction.

MAGNET BRAKE.—A friction brake controlled by electro-magnetic means.—NEMA.

MAGNET COIL.—A conducting coil of insulated wire wound around the core of an electro-magnet.

MAGNET CORE.—The bar of iron or steel about which a magnet coil is wound to form an electro-magnet.

MAGNET STEEL.—Any steel having properties suitable for making permanent magnets.

MAGNET STONE.—Magnetite, the magnetic ore of iron, a chemical combination of iron with oxygen, possessing the power of attracting iron as a natural magnet; the lodestone.

MAGNET WIRE.—Insulated annealed copper wire made in sizes ordinarily ranging from 0 to 40 B & S gauge and with various insulations, such as single, double or triple cotton or silk, with asbestos and cotton and with paper Enamel will serve to advantage as insulation anywhere that single cotton may safely be used, up to about No. 14 B & S gauge.

MAGNETIC ÆOLOTROPY.—The quality of a mass of iron by which it shows different susceptibilities to magnetism in different directions.

MAGNETIC ATTRACTION.—The attraction exerted by magnetic poles of opposite polarity upon each other.

MAGNETIC AUSTRAL FLUID.—The imaginary fluid formerly supposed to exist at the south pole of a magnet.

MAGNETIC BEARING.—The angle formed by a line drawn to an object from the eye of an observer, and the line of the magnetic meridian in which the observer stands.

MAGNETIC BEARING COMPASS.—An instrument for observing the magnetic bearing of a place.

MAGNETIC BELTING.—A type of machinery belting having iron strips inserted at intervals in its length, so that, in passing over a magnetized pulley, the grip on the pulley is strengthened.

MAGNETIC BLOW OUT.—1. A device by means of which an arc accidentally arising in the parts of an electrical instrument may be extinguished by the action of an electro-magnet.

2. A strong electro-magnet provided in the controller of an electric car to blow out the arcs and sparks arising from the frequent disconnections made with the controller, thereby preventing the destruction of the contacts and brushes.

MAGNETIC BLOW OUT ARRESTER.—A lightning arrester constructed for a magnetic blow out of the follow current. In operation, when the lightning voltage comes on the line, it causes the spark gap to break down and a discharge occurs through the gap and the resistance rod to ground. Part of the line current following the discharge shunts through the blowout coil, producing a strong magnetic field across the spark gap. The magnetic field blows out the discharge arc and restores normal conditions.

MAGNETIC BRAKING.—A method of braking in which the braking force is furnished by an electro-magnet and current for operating the magnet being obtained from the traction motors acting as dynamos being driven by the momentum of the cars.

MAGNETIC BRIDGE.—An instrument for measuring the resistance offered by an iron core to the passage of magnetism.

MAGNETIC CAGE.—Magnetic force does not act across a screen of iron or other magnetic material if sufficiently thick. Hence, if a magnet be placed inside a hollow iron ball, no outside magnet will affect it on account of the magnetic lines of force being conducted off through the iron sphere instead of penetrating it. A shell of iron will isolate the inside space from external magnetic influences and is therefore called a magnetic cage.

MAGNETIC CHART.—A map upon which lines are drawn connecting different points upon the earth's surface having the same magnetic conditions. These lines may be isogonic lines connecting places which have the same declination, or isoclinic lines joining points of the same inclination or dip.

MAGNETIC CIRCUIT.—The path taken by magnetic lines of force. The greater part of such a circuit is usually in magnetic material, but there are often one or more air gaps included.

MAGNETIC CLUTCH.—A clutch operated by an electro-magnet for obtaining a grip upon any moving part of an apparatus.

MAGNETIC CLUTCH SYNCHRONOUS MOTOR.—A type so constructed that the field magnets are free to rotate on the shaft except when engaged magnetically by a clutch. In operation, the motor is started in the same manner as the standard synchronous motor when started under light load conditions, as the control equipment prevents excitation of the clutch during the starting period.

Operation of the motor starter connects the motor to the line and applies field excitation, the field freely rotating upon roller bearings between the shaft and field spider. The clutch can now be excited at the will of the operator by pressing the "in" push button. This starts rotation of the motor driven drum of the clutch control which closes the clutch coil circuit contactor, placing d.c. excitation on the clutch coil. As the drum rotates, successive steps of resistance in series with the clutch coil are cut out, increasing the exciting current to the clutch coil and causing the two halves of the clutch to be drawn together. This brings their friction surfaces into contact and thus the driven half of the clutch is brought up to synchronous speed.

MAGNETIC COERCIVE FORCE.—The reverse magnetizing force necessary to completely remove the residual magnetism from a substance that has been magnetized. The better the quality of the iron the less the remaining magnetism and hence the less coercive force required.

MAGNETIC COMPENSATOR.—A magnetic device for overcoming the influence of local attraction upon the needle of a ship's compass.

MAGNETIC CONDUCTION CURRENT.—The rate of flow of magnetism through a magnetized body.

MAGNETIC CONTACTOR.—A device operated by an electro-magnet to close and open contacts in a circuit.

MAGNETIC CONTROL OF GALVANOMETER NEEDLE.—The adjustment of the directive tendency of a galvanometer needle by the use of a controlling or compensating magnet.

MAGNETIC CORE.—In an armature, magnet, transformer, etc., the iron stampings or laminæ which when assembled form a metallic path for the magnetic circuit.

MAGNETIC COUPLE.—A pair of equal and opposite forces which act upon a magnetic needle so as to bring it into the earth's magnetic meridian.

MAGNETIC CREEPING.—A gradual increase in magnetism which proceeds in a body under constant magnetizing force; viscous hysteresis; sometimes called time hysteresis.

MAGNETIC CROSS FLUX.—A magnetic flux in a transformer opposing the usual flux, and causing magnetic loss.

MAGNETIC CURVE TRACER.—An instrument for tracing the characteristic curve representing the varying magnetic intensity of a mass of iron under varying alternations of the magnetizing current.

MAGNETIC CURVES.—Curved lines representing the direction of the magnetic force, shown by the self-arrangement of iron filings when sprinkled upon a piece of paper or glass which is gently jarred by tapping while held in a magnetic field; magnetic figures.

MAGNETIC DAMPING.—A method of bringing the points of an indicating instrument quickly to rest by the reaction of magnetic fields produced by eddy currents.

MAGNETIC DECLINATION.—The angle between the magnetic meridian of a place upon the earth's surface as indicated by the compass needle, and the geographic meridian of that place. This difference is due to the fact that the magnetic pole to which the needle points does not coincide with the earth's geographic north pole.

MAGNETIC DEEP SEA THERMOMETER.—A thermometer for ascertaining deep water temperatures, employing a magnet for resetting the registering markers.

MAGNETIC DEGREE.—The 1/360th part of the angle subtended, at the axis of a machine, by a pair of its field poles. One mechanical degree is thus equal to as many magnetic degrees as there are pairs of poles in the machine.

MAGNETIC DENSITY.—The number of lines of magnetic force passing through a magnet or magnetic field per unit area of cross section.

MAGNETIC DETECTOR.—In radio, a variety of receiving instrument for detecting the arrival of electro-magnetic waves, based upon the principle that rapidly alternating currents permanently modify the magnetization of a magnetized steel bar.

MAGNETIC DEVIATION.—Variation of the magnetic needle due to special local conditions other than the true magnetic variation of the place, shown when iron is present in the vicinity of the needle, especially on shipboard.

MAGNETIC DIFFUSION.—A leakage of magnetic flux that often takes place along paths that stray from the main magnetic circuit and are lost. Some of this leakage takes place through the air, and it is this that affects watch springs in the neighborhood of electric generators.

MAGNETIC DIP.—Magnetic inclination.

MAGNETIC DISTURBANCE.—Slight irregular variations of the magnetic needle, such as the disturbance due to a "magnetic storm."

MAGNETIC DIVINING ROD.—A name given to a dipping needle used to reveal the presence of iron ore in the ground.

MAGNETIC DRAG.—The opposition to the motion of an inductor in a magnetic field in inducing a current, the direction of the induced current (in accordance with Lenz' law) being such as to oppose the motion producing it. Hence in the operation of a dynamo, considerable driving power is required to overcome this magnetic drag on the armature.

MAGNETIC EFFECT OF CURRENT.—When a current flows along a conductor, a magnetic field is set up. The space both outside and inside the substance of the conductor (especially the former), becomes a "magnetic field" in which delicately pivoted or suspended magnetic needles will take up definite positions and magnetic materials will become magnetized.

MAGNETIC EFFLUVIUM.—A name given by the earliest investigators of magnetic properties to the phenomenon now known as magnetic flux, or lines of force.

MAGNETIC ELEMENTS.—The characteristics of the terrestrial magnetism at any point on the earth's surface, as shown by the effect on the magnetic needle: they are, a, intensity; b, declination or variation; c, inclination or dip.

MAGNETIC EQUATOR.—1. A line joining all the places on the earth's surface where there is no inclination or dip, that is, where the magnetic needle is quite horizontal; a line midway between the magnetic poles; the aclinic line.

2. The section of a magnet halfway between its poles.

MAGNETIC EXPLORER. — An exploring coil connected with a galvanometer for the purpose of investigating an electromagnetic circuit in order to detect magnetic leakage, etc.

MAGNETIC FATIGUE OF TRANSFORMER CORE.—A waste of power by hysteresis in the iron core of a transformer due to repeated cycles of magnetization; aging of a transformer core.

MAGNETIC FIELD.—The region, surrounding a magnet, through which magnetic forces act; the space around the magnet in which the compass needle or other detector of magnetism will be affected

The magnetic field is said to be comprised of lines of force. It is most intense near the poles of the magnet and as the distance from the magnet is increased, these lines of force become weaker and weaker, until they finally disappear.

MAGNETIC FIELD INTENSITY.—The ampere turns, or gilberts per centimeter length of path of a magnetic circuit.

MAGNETIC FIGURES.—A term used to denote magnetic curves.

MAGNETIC FILAMENT. — One of the chains or threads of polarized magnetic molecules conceived to exist in a magnetized substance.

MAGNETIC FLUX.—The average field intensity of a magnet multiplied by its area; its unit is the maxwell.

MAGNETIC FLUX DENSITY OR INTENSITY.—The total lines of magnetic force passing through a magnet or magnetic field per unit area of cross section; magnetic density.

MAGNETIC FOCI.—Points on the earth's surface, in the vicinity of the magnetic poles, where the earth's magnetic force is greatest.

MAGNETIC FORCE.—The force by which attraction and repulsion is exerted by the poles of a magnet.

MAGNETIC FRICTION.—A term sometimes applied to hysteresis.

MAGNETIC GEAR SHIFT.—A system of solenoids and press button switches used for shifting automobile transmission gears, there being a separate solenoid and button for each gear and one for neutral. Pressing a push button does not energize one of the solenoids; it merely partially closes the circuit to a certain solenoid, but the circuit is not completely closed until the clutch is thrown out. Not standard practice.

MAGNETIC GEARING.—Friction gear in which wheels are drawn together by magnetic adherence.

MAGNETIC HELIX.—A solenoid, or coil of insulated wire wound around a core.

MAGNETIC IGNITER (ERRONEOUSLY CALLED SPARK PLUG).—A low tension ignition device for igniting the charge. A plug shaped casing contains a fixed and a movable contact and has attached a coil which is energized from the primary circuit and separates the contacts at the time of ignition.

MAGNETIC INCLINATION.—The inclination or dip of the magnetic needle. The angle which the needle makes with the horizontal when it is free to move in a vertical plane. The inclination varies at different parts of the earth's surface and also changes from year to year. At the north magnetic pole the needle would dip straight down.

MAGNETIC INDUCTION.—The communication of magnetism to iron by the mere presence of a magnet without actual contact, an action similar to electrostatic induction. If a short thin unmagnetized bar of iron be placed near some iron filings, and a magnet be brought near the bar, magnetism will be induced in the bar by the presence of the magnet. It will be found that the iron bar thus magnetized has two poles; the pole nearest the pole of the magnet being of the opposite kind and the pole at the further end of the bar being of the same kind.

MAGNETIC INDUCTIVE CAPACITY.—A term sometimes applied to permeability which is the ratio between the number of lines of magnetic force per unit area running through a magnetizable substance and the magnetizing force applied to the substance.

MAGNETIC INERTIA.—The quality of a magnetic substance which causes it to acquire and part with magnetism slowly.

MAGNETIC INTENSITY.—The amount of the earth's magnetic force at any place; in the northern hemisphere it is the resultant of two component forces at right angles to each other, one acting in a vertical direction tending to depress the north seeking pole of a magnetic needle, and the other acting in a horizontal direction compelling the needle to point to the magnetic north.

MAGNETIC IRON ORE.—A native oxide of iron, possessing the property of attracting iron fragments. When crystallized it is known as lodestone. The ore is found largely in Arkansas, Spain, Sweden and other parts of the world, though not always in the magnetic condition. It sometimes occurs in crystals having an octahedron form. Magnetic oxide of iron is also called magnetite.

MAGNETIC KEY.—A type of automatic no current circuit breaker.

MAGNETIC LAG.—The tendency of induced magnetism in iron and steel to lag behind the magnetizing force which produces it; also called magnetic inertia and magnetic viscosity.

MAGNETIC LATITUDE.—Latitude on the earth's surface considered with reference to the magnetic equator.

MAGNETIC LEAKAGE.—Stray lines of magnetic force which leak around an armature instead of passing through it. In the design of alternators the drop of voltage on an inductive load is mainly dependent upon the magnetic leakages, primary and secondary.

They increase with the load, and, what is of more importance, they increase with the fall of the power factor of the circuit on which they may be working. This is one reason why certain types of alternator, though satisfactory on a lighting circuit, have proved themselves unsatisfactory when applied to a load consisting chiefly of motors.

MAGNETIC LEAKAGE FACTOR.—In a dynamo the ratio of the total magnetic flux generated to the useful flux entering the armature.

MAGNETIC LIMBS.—The parts of a magnet core; the legs of an electro-magnet.

MAGNETIC LINE PROTECTOR.—A device including an electro-magnet for protecting electrical apparatus connected with an overhead line from injury by lightning.

MAGNETIC LINES OF FORCE.—Certain lines or directions in which magnetic induction takes place through a magnetic substance.

MAGNETIC LINES OF A LOOP.—If a current flow through a loop, the lines of force both inside and outside the loop, will cross the plane of the loop at right angles, and all those which cross the loop on the inside will pass through the plane in one direction, while all on the outside will return through the plane in the opposite direction. The direction of the lines of force is easily determined by the cork screw rule.

MAGNETIC LINES OF A SOLENOID.—When a current flows through a solenoid the lines of force set up must be thought of as closed loops linked with the current. The conductor conveying the current passes through all the loops of force and these are, so to speak, threaded or slung on the current line of flow.

MAGNETIC LOUD SPEAKER.—A type in which a bipolar permanent magnet is used. On each pole of the magnet is mounted a coil of wire having a large number of turns, the two coils being connected in series. In operation varying currents coming from the plate circuit of the last tube varies the resultant magnetization (of coils and permanent magnets) accordingly causing the diaphragm to vibrate and produce sound waves.

MAGNETIC MAPS.—Charts on which all places having the same declination are joined by a line called an isogonic line; the line passing through places of no declination is called an agonic line.

MAGNETIC MATERIAL. — A substance which readily causes magnetism or becomes a magnet. Iron and steel in their different forms are the only important magnetic materials.

MAGNETIC MERIDIAN.—A great circle assumed to pass over the earth's surface through the magnetic axis determined by a magnetic needle at rest.

MAGNETIC METALS.—The following metals in addition to iron are recognized as magnetic: nickel, cobalt, chromium and cerium. With respect to magnetic properties, only cobalt and nickel are comparable with iron, in fact they all are inferior.

MAGNETIC METAL SEPARATOR.—1. A machine employed in sorting out iron particles from brass turnings and filings by means of magnetic attraction. The turnings are fed into the machine and pass between rolls armed with magnets, and iron or steel fragments adhering to the latter are swept off into receptacles by brushes, against which the magnets revolve, while the brass falls straight through.

2. A similar device which has been employed to separate iron from finely pulverized ore.

MAGNETIC MODULATOR.—In radio, a device which has an iron core acted upon by a variable magnetizing current. The resulting changes of magnetic flux cause modulation.

MAGNETIC MOMENT.—As applied to a uniform bar magnet, the product of the strength of one of its poles by the distance between the poles.

MAGNETIC NEEDLE.—A small slender steel magnet mounted on a pivot or suspended by a thread, so as to be free to move in one or more planes. It naturally takes a position pointing north and south in the direction of the earth's magnetic poles.

MAGNETIC NORTH.—The direction indicated by the north pole of a magnetic needle when free to turn upon its axis.

MAGNETIC OBSERVATORY.—A place for observing and recording variations of the earth's magnetism.

MAGNETIC PARADOX.—A peculiar effect produced by placing the north pole of a strong magnet at some distance from the north pole of a weak magnet. The north pole of the weak magnet will be repelled, but will be attracted when the strong magnet is brought quite near. The reason for this is that the magnetism induced in the weak magnet will be of the opposite kind and the pole of the magnet will be attracted. When the strong magnet is quite close to the weak one, the induced magnetism may overpower and mask the original magnetism of the weak magnet.

MAGNETIC PARALLELS.—A term sometimes applied to the isoclinic lines, the lines drawn upon a map joining places which have the same magnetic inclination or dip.

MAGNETIC PERMEANCE.—A measure of the flux which will be produced in a magnetic circuit by a given magnetic force. It is the reciprocal of reluctance. A circuit with unit permeance will require unit magnetic force to produce unit flux.

MAGNETIC PICKUP.—A phonograph device in which the vibrations of a needle in traversing a phonograph record produces signal currents in the electrical part of the device.

MAGNETIC PLUG.—A make and break ignition plug in which the terminals are separated by the action of a magnet within the plug.

MAGNETIC POINTS OF CONVERGENCE. —Points on the earth's surface connected by the isogonic lines.

MAGNETIC POLARITY.—Distinction as to the poles of a magnet, whether positive or negative.

MAGNETIC POLARIZATION.—A condition attributed to the molecules of a magnetic substance to account for the nature of magnetism.

MAGNETIC POLES.—1. The ends of a magnet, where the attractive force is greatest. In the bar magnet that end which tends to point north is called the north or positive pole, and the other the south or negative pole.

2. Those points on the earth's surface, in the neighborhood of the geographic poles, where the dipping needle would stand vertical.

MAGNETIC PRESSURE.—A force similar to voltage or electric pressure. It is the force which produces magnetic flux and is measured by the work done in moving a unit magnet pole through a magnetic circuit.

MAGNETIC PROOF PIECE.—A bar of iron employed for testing the strength and distribution of magnetism in a magnet

MAGNETIC PROOF PLANE.—A small exploring coil joined in circuit with a sensitive galvanometer for the purpose of indicating the number and direction of the lines of force in a magnetic field.

MAGNETIC RECTIFIER.—A magnetic vibrator device so constructed and tuned with the alternations of the current to be rectified as to change it to a unidirectional current.

MAGNETIC RELUCTANCE.—The resistance against the passage of magnetic lines of force offered by the mass of a material. It is proportional to the length of the material, and inversely proportional to the area of the cross section and the permeability.

MAGNETIC REMANENCE.—The power in a substance which resists magnetization and demagnetization, such that when the magnetizing influence is withdrawn the substance will retain a certain amount of residual magnetism; magnetic retentivity.

MAGNETIC REPULSION.—The repulsion exerted by like magnetic poles against each other.

MAGNETIC RESISTANCE.—Magnetic reluctance.

MAGNETIC RESISTIVITY.—The specific resistance of a substance to magnetism, considered as the resistance of a centimeter cube of that substance.

MAGNETIC RETARDATION.—A retardation in the process of magnetizing shown by iron and steel; magnetic inertia or lag.

MAGNETIC RETENTIVITY. — Magnetic remanence.

MAGNETIC ROTATION OF POLARIZED LIGHT.—Faraday effect.

MAGNETIC SATURATION.—The state of a magnet which has reached the highest degree of magnetization to which it can attain. A magnet, just after being magnetized, will appear to have a higher degree of magnetism than it is able to retain permanently: that is, it will appear to be super-saturated, since it will support a greater weight immediately after being magnetized than it will do after its armature has once been removed.

MAGNETIC SCREEN.—A hollow box or case of soft iron surrounding a body for the purpose of protecting it from the influence of an external magnetic field, used for example, to prevent a watch becoming magnetized, or for protecting the needle of a marine galvanometer from the influence of the earth's magnetism; a magnetic shield.

MAGNETIC SEPARATOR.—A machine consisting of a magnetized iron cylinder or drum, for separating magnetic substances like iron ore or iron filings and chips from mixtures, by causing them to adhere while the waste particles fall away.

MAGNETIC SHELLS.—The thin sheets in lamellar distribution of magnetism, made up of magnetic particles so arranged that one face of each layer contains north seeking magnetism and the other face south seeking magnetism; also called lamellarly magnetized magnets.

MAGNETIC SHIELD.—In radio receiving sets, a metallic box like casing to protect the elements of the set from magnetic fields.

MAGNETIC SHUNT.—In a magnetic circuit, a path through which a part of the lines of force are diverted in order to weaken the field, or to establish a shunt circuit.

MAGNETIC SOUND.—Descriptive of the Page effect.

MAGNETIC STICKING.—A tendency which the armature of an electro-magnet sometimes has of adhering to the poles after the current has ceased to flow in the coils.

MAGNETIC STORMS.—Irregular disturbances of terrestrial magnetism simultaneously affecting the magnetic needle in various portions of the globe, supposed to be caused by great disturbances in the solar system; they frequently occur when the aurora is visible.

MAGNETIC STRAIN.—The effect upon any substance produced by the action of magnetic lines of force.

MAGNETIC STRAIN GAUGE.—A small cylindrical device for precision measurement of minute displacements. Especially valuable is its ability to record such movements under changing conditions. With an oscillograph, it has been used to measure stress in rails under impacts of a locomotive, and the strain in driving rods. Its operation depends on a change in reluctance of two magnetic circuits as an armature is moved in an air gap. An oscillograph is used for dynamic tests.

MAGNETIC STREAM LINES.—The lines of magnetic force, being the paths followed by magnetic induction through a magnetic substance.

MAGNETIC STRENGTH.—In a magnetic circuit, the number of lines of force per unit of cross sectional area.

MAGNETIC STRENGTH OF SOLENOID.—This depends upon: a, current strength; b, type of core; c, number of turns of wire. In designing a solenoid refer to a diagram showing pull due to solenoids of different lengths (with plunger 1 sq. in. in cross section). On the diagram take a point which is considerably below the maximum as this will allow for enough extra attraction to overcome any friction, and also to keep the load moving, and by assuming a low point for the necessary pull, the effective range will be greatly increased.

MAGNETIC SUBSTANCE.—Gilbert makes a distinction between magnets and magnetic substances. A lump of iron has no distinguishable fixed poles and no magnetic equator; it will attract either pole of a magnet no matter what part of the lump be presented to the magnet. This, according to Gilbert, is a magnetic substance as distinguished from a true magnet which has poles.

MAGNETIC THEODOLITE.—An instrument for measuring the angle of declination of the magnetic needle.

MAGNETIC TIME CONSTANT.—A quantity used to express the time required for the current in an electric circuit to arrive at 63.2% of its full value when a constant voltage has been impressed upon the circuit. The current theoretically requires an infinite time to reach its full strength as the impressed voltage is opposed by a reverse voltage due to inductance.

MAGNETIC TRACTION.—The pull or lifting power of an electro-magnet when its poles are in contact with its armature or keeper; the tractive force.

MAGNETIC UNITS.—A system of units in terms of which magnetic quantities and phenomena may be expressed. The magnetic units are derived from the fundamental units of length, mass and time, and are concerned with the force exerted between two magnetic poles. A few of them have been given specific names: as, gauss, the unit of magnetic field intensity; the maxwell, the unit of magnetic flux, and the oersted, the unit of reluctance.

MAGNETIC VANE AMMETER.—An instrument consisting of a small piece of soft iron or vane mounted on a shaft that is pivoted a little off the center of a coil. The principle upon which the instrument works is that a piece of soft iron placed in a magnetic field and free to move will move into such position as to conduct the maximum number of lines of force. The current to be measured is passed around the coil producing a magnetic field through the center of the coil. The magnetic field inside the coil is strongest near the inner edge, hence, the vane will move against the restraining force of a spring so that the distance between it and the inner edge of the coil will be as small as possible. A pointer, attached to the vane shaft moves over a graduated dial.

MAGNETIC VANE VOLTMETER.—An indicating instrument in which two discs or vanes of soft iron, one fixed and the other free to move, repel each other; the swing of the movable vane indicating the pressure difference.

MAGNETIC VARIATION TRANSIT.—An instrument for measuring the angle of the magnetic declination.

MAGNETIC VARIATIONS.—The elements of the earth's magnetism are subject to variations which occur in some cases every day, in others every year, and in still others at long intervals, sometimes extending over centuries. The changes that take place daily are known as diurnal variations, those that are observed yearly are called annual variations, while the changes that require many years are called secular variations.

MAGNETIC VISCOSITY.—A tendency to retardation shown by induced magnetism in iron or steel; **magnetic lag.**

MAGNETIC WHIRLS.—If a wire be moved near a magnet across a space in which there are magnetic lines, the motion of the wire, as it cuts across those magnetic lines, sets up magnetic whirls round the moving wire.

The moving conductor so cuts the magnetic lines as to alter the number of lines of force that pass through the circuit. If a conducting circuit, as a wire ring or single coil, be moved along in a uniform magnetic field, so that only the same lines of force pass through it, no current will be generated. However, if a coil be tilted in its motion across the uniform field, or rotated round any axis in its own plane, the number of lines of force that traverse it will be altered, and currents will be generated. These currents will flow round the ring coil in the right handed direction (as viewed by a person looking along the magnetic field in the direction in which the magnetic lines run) if the effect of the movement is to diminish the number of lines of force that cross the coil; they will flow round in the opposite sense, if the effect of the movement is to increase the number of intercepted lines of force. If the field of force be not a uniform one, then tne effect of taking the coil by a simple motion of translation from a place where the lines of force are dense to a place where they are less dense, will be to generate currents.

MAGNETIC WRITING.—A variety of magnetic figures produced by writing with the pole of a magnet upon a thin sheet of steel and sprinkling iron filings upon it. The writing is reproduced by the lines of filings clinging to the magnetized parts.

MAGNETINE.—A name formerly given to the imaginary fluid in which magnetic phenomena were supposed to occur

MAGNETISM.—1. The peculiar property possessed by certain substances, especially iron or steel, in virtue of which they exert forces of attraction or repulsion according to fixed laws.

2. That branch of science which treats of magnets and magnetic phenomena.

The theory proposed to account for the magnetization of iron is as follows: Each molecule of iron is supposed to be, and to remain always, magnetic. In an unmagnetized iron bar these molecular magnets are arranged irregularly; the molecules resist being turned out of their usual positions. Hence when a magnetizing force is brought to bear upon them, the first effect is to turn the molecules round, whose axes are already most nearly in the direction of the magnetizing field.

As the magnetizing force increases others are turned, increasing thereby the apparent magnetism; at last, all are turned with their poles in the direction of the magnetizing field.

When this is the case, no further application of magnetizing force, however great, can increase magnetization. This is the point of saturation. On removing the magnetizing force, those molecules which have not been much strained out of their position, fall back to their old directions; but those which have been greatly strained have acquired a permanent magnetic set, and hence remain permanently magnetic.

MAGNETISM OF ROTATION.—A theory founded on the experiment of Arago's disc, that there exists a sort of magnetism in rotating bodies.

MAGNETITE.—The magnetic oxide of iron. A mineral which is attracted by a magnet, and sometimes acts as a magnet and attracts iron; **lodestone.**

MAGNETITE ARC LAMP.—A form of arc lamp containing a positive electrode of pure copper and a negative electrode consisting of a steel tube packed with a fine powder composed of oxide of iron (magnetite) and the oxides of chromium, titanium, etc.

MAGNETIZATION BY DOUBLE TOUCH.—A method of magnetizing a bar or needle in which two bar magnets with their opposite poles together, slightly separated by an interposed piece of wood, are placed upon the middle of the bar to be magnetized, and then drawn back and forth several times along the bar, leaving off at the middle starting point.

MAGNETIZATION BY SEPARATE TOUCH.—A method of magnetizing a bar or needle by the use of two bar magnets placed with their opposite poles together at the middle of the bar, and then drawn apart simultaneously several times from the middle to the ends.

MAGNETIZATION BY SINGLE TOUCH.—A method of magnetizing a bar or needle by simply stroking each surface from end to end in one direction with the pole of a permanent magnet.

MAGNETIZATION CURVES.—Characteristic curves tracing the relation of the magnetizing force to the resulting magnetic intensity. Magnetization curves are constructed by laying off the various values of the magnetizing force as abscissas, and the corresponding values of the magnetic intensity as ordinates.

MAGNETIZE.—1. To communicate magnetism to a substance.
2. To become magnetic.

MAGNETIZING COIL.—A coil of insulated wire cemented together by shellac, carpenter's glue or gum copal, for the purpose of making magnets. The bar of iron is magnetized by passing it through the opening in the center of the coil while an electric current is passing through the turns.

MAGNETIZING CURRENT OF TRANSFORMER.—The current which enters the primary of a transformer when its secondary is on open circuit.

MAGNETIZING CURRENTS.—Electric currents which, by passing through a coil of wire wound around a core of iron, produce a strong degree of magnetization in the iron, thereby creating an electromagnet.

MAGNETO.—A rotating machine for converting mechanical energy into electrical energy in which the armature rotates in a field produced by permanent magnets instead of electro-magnets as in a dynamo. Formerly magnetos were extensively used for automobile ignition, but have been largely replaced by the storage battery charged by a dynamo operated by the engine.

MAGNETO BLASTING MACHINE.—A magneto for generating electricity for blasting purposes.

MAGNETO CALL BELL.—In local battery telephone practice, a ringer for signaling purposes responding to currents sent out from the magneto generators at other stations. It contains a polarized electromagnet designed to move its armature according to the direction of the current sent through it.

MAGNETO CHEMICAL CELL.—A primary cell composed of steel bar magnets with their poles immersed in a solution of oxalic acid.

MAGNETOD.—A name used for designating the force exhibited in animal magnetism or mesmerism.

MAGNETO ELECTRIC BRAKE.—A device for damping a galvanometer needle, in which an inverse current is established in the galvanometer coils for the purpose of checking the swing of the needle.

MAGNETOGRAM.—An automatic record of the movements of a machine called the magnetometer used for measuring the strength and direction of the earth's magnetism at any place.

MAGNETOGRAPH.—An instrument for recording the variations of any of the earth's magnetic elements.

MAGNETO IGNITION.—In internal combustion engines the use of a magneto for producing the electric current required to ignite the charge.

MAGNETOMETER. — An instrument for measuring the intensity of magnetic force, especially that of terrestrial magnetism. It consists of a magnetized bar suspended by two wires passing over a pulley. The magnet is held by a frame provided with a graduated scale. A mirror supported by a vertical post attached to a frame, serves to reflect a scale placed below a distant reading telescope. This form of magnetometer is called the bifilar magnetometer, and was the one used by Gauss in his study of the earth's magnetism. Other types are: the differential and the self-recording.

MAGNETOMETRY.—The science of measuring the intensity of magnetic fields, especially the intensity of the earth's magnetism, by the use of the magnetometer.

MAGNETOMOTIVE FORCE. — A clumsy term for magnetic pressure. When a coil passes around a core several times, its magnetic pressure is proportional both to the strength of the current and to the number of turns in the coil. The unit is the gilbert. Since one ampere turn=1.2566 gilbert.

magnetic pressure=
1.2566 × turns × amperes

There is no logical reason for using such ridiculous terms as magnetomotive force, electromotive force, alternating current generator, etc.

MAGNETO-OPTICS.—That branch of physics which treats of the effects produced upon light rays in passing through a magnetic field or when reflected from the surface of a magnet.

MAGNETOPHONE.—An apparatus for increasing the volume of sound, consisting of a horseshoe magnet in front of which is a perforated iron disc, and on the other side a small induction coil connected with a telephone.

MAGNETOSCOPE.—An instrument for detecting the presence of magnetic force, without measuring its intensity.

MAGNETOSTATICS.—That branch of physics which treats of stationary magnetic phenomena.

MAGNETO TELEPHONE SYSTEM. — A system which employs two or three dry cells at each telephone to supply the necessary talking battery instead of using a common battery.

This instrument is used in the so-called magneto telephone system where each telephone user signals or calls the telephone exchange or other telephones on the line by turning the crank of a small hand generator or magneto. This system has been made obsolete by the development of the common battery system, and is used only in small isolated plants.

MAGNUS'S LAW.—A law of thermo-electricity stated by Magnus, that in a homogeneous circuit the temperature may vary from point to point, without producing any current.

MAGPIE CABLE.—A telephone cable containing double pairs of conductors.

MAHLER'S CALORIMETER.—A device for testing the heating value of coals. It consists of a strong steel vessel or bomb, immersed in water, and protected against radiation. One gram of the coal to be tested, is placed in a platinum boat within the bomb, and then oxygen gas is introduced under a pressure of twenty to twenty-five atmospheres. The coal is then ignited explosively by an electric spark. The heat of combustion is absorbed by the surrounding water, and its quantity is determined by the rise in temperature of the water, corrections being made for the heat capacity of the apparatus itself. The accuracy of the apparatus is such that duplicate tests will not vary more than two parts in one thousand.

MAHOGANY.—A tree found in Central America and the West Indies whose wood is highly valued; it is of a rich reddish or yellowish brown color, sometimes of figured grain, and hard enough to take a beautiful polish.

MAIN.—1. One of the principal conductors in a system of electric light or power distribution.

2. A principal pipe; as, in a gas or water-works system, through which a locality is supplied, branches leading off to various side streets, from which again supply pipes lead to individual buildings.

MAIN TRUNK LINE.—A main telephone line connecting one city with another, and serving as the principal member through which the system of communication is conducted and extended.

MAJOR AXIS.—The longer axis of a body, real or imaginary, passing through it on which it may be supposed to revolve.

MAJOR INSULATION OF TRANSFORMERS.—The insulation placed between the windings and core and between the primary and secondary windings. For large core type units with concentric windings, this insulation is simply and effectively secured by the use of special insulating cylinders and oil ducts extending the full length of the core. In the interleaved construction the major insulation between windings usually consists of sheets of pressboard and oil ducts, while between windings and core the above mentioned cylinders or pressboard sheets may be used. For very small units the major insulation consists usually of mica, sometimes applied as sheets, etc.

MAKE AND BREAK IGNITION.—Electric ignition of explosion motors, effected by bringing two platinum points together and then separating them, thus forming an arc. The points are brought together by mechanical means, and separated very quickly by a spring, a low tension current being employed which is derived from either a primary or a storage battery.

While it is possible to produce a spark by simply breaking a low tension circuit, it is necessary in order to have a spark of sufficient intensity and duration to introduce into the circuit a primary induction coil, which consists of a long iron core wound with a considerable length of low resistance insulated copper wire; the length of the core and the number of turns of the wire determining the efficiency. Make and break ignition is preferably called low tension ignition.

MAKE IMPULSE.—In telephony, an impulse due to a temporary flow of current.

MAKE UP VALVE.—In a marine condensing steam plant, a valve controlling a pipe line from the feed water tank to the feed pump suction. In operation when the water gets low in the boiler, the water level may be brought back to the desired working level by opening slightly the make up valve allowing more water to enter the pump suction line. When the pump is engine driven the action is very satisfactory—no racing due to lack of water, or stopping by sudden flooding.

MALACCA TIN.—A metal also called Banca tin and Straits tin. It is sold in pyramids weighing about one pound each.

MALACHITE.—A double carbonate and hydrate of copper, found in many places, especially in Siberia. A very valuable copper ore, but used as an ornamental stone on account of its beautiful green color.

MALLEABLE CASTINGS.—Cast iron which is changed into a composition approaching that of wrought iron, by the following process, in which excess carbon is eliminated. The castings are carefully cleansed by pickling, then stacked in trays within an annealing furnace covered over by mill scale or other oxides of iron. Heat is applied, the contents are rapidly brought up to a white heat, and then allowed to cool very gradually, generally taking a week in so doing. Gear wheels, conveyor parts, and many small details of machinery subject to shock are made by this process.

MANDREL.—1. A shaft or spindle on which an object may be fixed for rotation. Mandrels for lathes are named from some feature of mechanism; as adjustable mandrel; expanding mandrel; screw mandrel (having a screw thread); traversing mandrel (having lengthwise motion).

2. In underground cable construction a metallic cylinder used to insure proper alignment in laying a single duct conduit by being drawn through the duct as each section is laid on.

3. Inside patch vulcanizer for automobile tires.

MANGANESE.—A metal resembling and possessing a remarkable affinity for iron. It is generally found in the form of oxides, and is widely used as a chemical reagent and oxidizer. Conjointly with hydrochloric acid, it evolves chlorine gas; combined with chlorate of potash and caustic potash, it forms permanganate of potassium, a well known disinfectant; is added to steel to neutralize phosphorus, and also has the valuable property of rendering that metal non-magnetizable.

MANGANESE DIOXIDE OR BINOXIDE.—A chemical compound of manganese and oxygen. It occurs in nature crystallized in prisms with a silver luster. In this state it is called pyrolusite. In a powdered form, it is known as black oxide of manganese, and when mixed with plumbago it is used as a depolarizer in the Leclanche cell and in dry batteries.

MANGANESE STEEL.—A mixture of steel with the metal manganese, producing an alloy of greater toughness and strength than ordinary steel.

MANGANIN.—An alloy of manganese, copper and nickel, having a small resistance temperature coefficient, and, therefore, useful in making standard resistance coils.

MANHOLE.—1. In an underground conduit system, a vault built under the street, having a circular opening at the street surface covered by a cast iron cover, and large enough to conveniently admit a man, so that access may be had to the conduit ducts and the cables.

2. An opening by which to enter a steam boiler, tank, sewer, aqueduct, or the like, for cleaning, repairing, or inspecting.

MANOMETER.—1. An instrument, consisting essentially of a bent tube partly filled with mercury, for measuring the pressure of gases.

2. A general term including all varieties of pressure gauges, such as tube, spring, syphon and mercurial types.

MANOMETRIC FLAMES.—A peculiar effect produced on a flame by sound waves. With Koenig's apparatus, it will be seen that the resulting image will differ according to the strength, timbre and other characteristics of the sound.

MANUAL CONTROLLER.—One having all of its basic functions performed by hand.—NEMA.

MANUAL PRIVATE BRANCH TELEPHONE EXCHANGE. — A manually operated switchboard located in office buildings, stores, etc., having a number of stations usually called P.B.X.'s. These P.B.X.'s are connected to the telephone Central Office by means of lines called trunks, and have extension lines radiating to the various extension stations in the subscriber's establishment. This saves considerable expense in installation. There are two types: a, multiple; b, non-multiple.

MANUAL REMOTE CONTROL SWITCHBOARDS.—One with manually operated circuit breakers mounted apart from the board and operated by means of handles or levers on the board.—NEMA.

MANUAL REPEATER.—In telegraphy, a repeater or translator operated by hand, instead of mechanically, as the automatic repeater. Obsolete.

MANUAL RINGING.—A method of telephone ringing which is effected by and continues with the operation of a key.

MANUAL TELEPHONE SYSTEM.—One in which the calling party gives his order to an operator who completes the call directly by hand, either with or without the assistance of one or more additional operators.

MARBLE.—A kind of limestone of varying color and markings capable of taking and retaining a high polish. It is largely used for switchboard panels because of its good insulating qualities.

MARGIN RATIO.—In a non-polar simplex telegraph system, the ratio of the current flowing through a receiving instrument when operated, to that flowing when not operated.

MARINE COMPASS.—A form of magnetic compass, suspended in such a manner as to remain as horizontal as possible during the motion of the ship. Since modern ships are constructed largely of metal, the magnetic effects thus set up are corrected by fixing compensating masses of iron in suitable positions. The marine compass is also called mariner's compass.

MARINE GLUE.—A glue composed of india rubber, shellac, and a solvent oil, such as coal tar naphtha; it is applied hot to canvas, wood, etc., where a water-tight joint is desired.

MARINE JUNCTION BOX.—A junction box for electrical connections, of special watertight construction suitable for use on shipboard.

MARINE WIRING DEVICES.—The wiring devices used on vessels serve the same needs as elsewhere. Sockets of the familiar Edison base type hold ordinary electric lamps. Standard 110 volt current is used extensively for lighting the larger boats because lamps and other supplies for that voltage are most easily secured. On small pleasure yachts where storage batteries must be used, space considerations limit the size of the battery and its voltage. Wherever possible 110 volt current should be used for lighting.

MARINER'S COMPASS.—In navigation, an instrument for determining direction. It consists, in its simplest form, of a magnetic needle suspended upon a pivot and attached to a card marked with thirty-two points of direction. These points of the compass are also called rhumbs. The glass covered case containing the compass is supported upon gimbals in order to preserve a horizontal position.

MARIOTTE'S LAW.—The volume of a gas is inversely proportional to its (absolute) pressure at constant temperature. Expressed as a formula:

$$p\ v = p'v';\ \text{or}\ p\ v = \text{a constant}$$

in which, p=pressure at a volume v, and p'=pressure at a volume v'. The constant varies with the temperature, everything else remaining. Air compressed to seventy-five atmospheres, has a volume about two per cent less than that computed by Mariotte's law. This law is also known as Boyle's law.

MARK BUOY.—A buoy used in submarine cable operations for merely staking out a position, and not, like the cable buoy, for securing the cable.

MARKED END OR POLE.—The north pole of a magnet, so called because it is usually marked to distinguish it from the south pole.

MARKING CURRENT.—In double current automatic telegraphy, the current which completes the local circuit and records the dots and dashes of the message, as distinguished from the spacing current.

MARKING DISC.—In Morse's system of writing telegraphy, a metal disc which rotates against the ink roller and records the message upon the paper strip.

MASS.—The quantity of matter which a body contains, the weight of the body being the measure of the earth's pull or the force of gravitation upon the mass. The mass of a body is a constant quantity while the weight varies according to the variation in the force of gravity at different places.

If g=the acceleration due to gravity, w=weight and m=mass, then:

$$m=w\div g$$

from which

$$w=mg.$$

MASS ATTRACTION.—The universal attraction which all bodies exert upon one another.

MASSICOT.—The yellow oxide of lead. It does not differ chemically from litharge though different in color and mechanical condition. When the massicot is melted it has a reddish tint and is called litharge.

MASTER CLOCK.—The standard clock which controls the movement in dependent clocks in a system of electric timekeeping; the primary, or controlling clock; a telegraphic clock.

MASTER CONTROLLER.—On electric cars a device which controls the starting and accelerating of the car. Closing and opening of main motor circuits are accomplished indirectly by the master controller energizing or de-energizing the control circuits of the switches in the control box or switch group.

MASTER OSCILLATOR.—In a radio telephone transmitting circuit, a small extra audion used to supply the power to excite the grid circuit.

MASTER SWITCH.—1. One which controls the operation of other switches.

2. One which serves to govern the operation of contactors and auxiliary devices of an electric controller.—NEMA.

MASTER VIBRATOR MULTI-COIL.—In ignition, an assembly of several secondary coils for multi-cylinder engines. All operated by one vibrator.

MAT.—In electro-plating, a dead or dull finish obtained by leaving the metal unburnished after it has been deposited.

MATHEMATICS. — That science which treats of the exact relations existing between quantities or magnitudes. The science of quantities is afterwards divided into pure and mixed mathematics.

MATRIX.—In phonograph recording, a metal disc master record, from which additional records are made.

MATTE.—An impure metal obtained in the smelting of various ores; as, copper or silver. Called also coarse metal.

MATTEUCCI'S MUSCLE PILE.—A voltaic pile composed of muscular tissues cut from animals and laid one upon another, so that the interior surface of one piece comes into contact with the exterior of the next, thereby generating an electric current sufficient to deflect the needle of a galvanometer.

MATTHIESSEN, AUGUSTUS.—Born 1831, died 1870. An English chemist and physicist, distinguished for his researches in the electrical conductivity of metals and alloys, and for the construction of electrical standards (1860-65).

MATTHIESSEN'S COPPER STANDARD.—A standard of resistance in wire, being the resistance offered by one meter of pure copper wire of a diameter such as to weigh one gram per meter, and having a resistance equal to .141729 international ohm at 0° C.

MAXIMUM DEMAND.—The greatest of all the demands which have occurred during a given period. It is determined by measurement, according to specifications, over a prescribed time in service.

MAXIMUM GRAVITY.—The highest specific gravity that the electrolyte of a storage battery will reach by continued charging, indicating that no acid remains in the plates.

MAXIMUM STARTING CURRENT.—The greatest value reached by the starting current of a motor. For squirrel cage induction motors starting currents may be between four and five times the full load current.

MAXIMUM VALUE OF ALTERNATING CURRENT WAVE.—The highest value (+ or —) reached during the cycle. This maximum value is not used to any great extent, but it shows the maximum to which the pressure rises, and hence, the greatest strain to which the insulation of the alternator is subjected. Calling average pressure 1 volt, then maximum =1.57 volts. Calling maximum pressure 1 volt, then virtual value=.707 volt and average value=.637 volt. All referred to the sine curve.

MAXIMUM, VIRTUAL AND AVERAGE VOLTS.—1. The virtual value of an alternating pressure or current is equivalent to that of a direct pressure or current which would produce the same effect. If a Cardew volt meter be placed on an alternating current circuit in which the wave form corresponds to the sine curve in which the volts are oscillating between maxima of +100 and —100 volts, it will read 70.7 volts, though the arithmetical mean is really only 63.7; notwithstanding this, 70.7 steady volts would be required to produce an equal reading. The word effective is commonly, yet erroneously used for virtual.

2. "I adhere to the term virtual, as it was in use before the term efficace which was recommended in 1889 by the Paris Congress to denote the square root of mean square value. The corresponding English adjective is efficacious; but some engineers mistranslate it with the word effective. I adhere to the term virtual mainly because the adjective effective is required in its usual meaning in kinematics to represent the resolved part of a force which acts obliquely to the line of motion, the effective force being the whole force multiplied by the cosine of the angle at which it acts with respect to the direction of motion. Some authors use the expression 'R. M. S. value' (meaning 'root mean square') to denote the virtual or quadratic mean value."—S. P. Thompson.

MAXIMUM VOLTS AND AMPERES.—In the operation of an alternator the pressure and strength of the current are continually rising, falling and reversing. During each cycle, there are two points at which the pressure or current reaches its greatest value, being known as the maximum value. This maximum value is not used to any great extent, but it shows the maximum to which the pressure rises, and hence, the greatest strain to which the insulation of the alternator is subjected.

MAXWELL.—The unit of magnetic flux, being the amount of magnetism passing through every square centimeter of a field of unit density, that is, one gauss (one line of force per sq. cm.).

MAXWELL, JAMES CLERK.—Born 1831, died 1879. A Scottish physicist and writer on electrical and physical subjects. In 1857 he obtained a prize for an able essay on Saturn's rings. He was the author of the kinetic theory of gases (1860), and he gained the Rumford medal the same year for his discussion of colors in relation to color blindness. He is best known, however, for his researches in electricity and magnetism, beginning in 1356 with his paper on "Physical Lines of Force" and culminating in his great "Treatise on Electricity and Magnetism" published in 1873. He propounded (1873) the electro-magnetic theory of light, founded the science of electro-optics, and advanced the conception of electro-magnetic waves, by which he laid the foundation of the science of wireless telegraphy.

MAXWELL'S ELECTRO-MAGNETIC THEORY OF LIGHT.—A theory propounded by Maxwell, that, since luminous and electro-magnetic waves are transmitted with the same velocity in the same medium, light itself is an electro-magnetic phenomenon.

MAXWELL'S RULE.—A rule formulated by Maxwell for determining the mutual action of an electric circuit and a magnet placed near it, as follows:

Every portion of the circuit is acted upon by a force urging it in such a direction as to make it enclose within its embrace the greatest possible number of lines of force.

MAY EFFECT.—The property of light by which with suitable apparatus, electrical resistance may be varied.

MAZDA LAMP.—The trade mark Mazda is not the name of a thing but the name of a service. This trade mark, registered in the United States Patent Office, on an incandescent lamp signifies that the manufacturer of the lamp has had the advantage of the most recent findings of the Research Laboratories of the General Electric Co. The filaments of all Mazda lamps are at present made of tungsten. In a Mazda B lamp the filament operates in a vacuum. In a Mazda C lamp the filament operates in an inert gas.

McINTIRE SLEEVE JOINT.—A method of joining wires in which a sleeve is used consisting of two copper tubes soldered together, and having bores corresponding to the size of the wires to be joined; the ends of the wires being inserted by a special tool the whole is twisted together, no solder being required.

MEAN EFFECTIVE PRESSURE. — In a steam engine, the difference between the mean forward pressure and the mean back pressure; it is the net average pressure tending to move the piston. The mean effective pressure obtained from an indicator card is always less than the corresponding theoretical diagram. In design it is approximated by multiplying the theoretical m.e.p. by a diagram factor and the success of this calculation depends upon the experience of the designer in selecting the proper diagram factor.

MEAN HEMISPHERICAL CANDLE POWER.—A unit of illumination of a lamp (upper or lower) being the average candle power of the lamp in the hemisphere considered. It is equal to the luminous flux emitted in that hemisphere divided by 2π.

MEAN PROPORTIONAL.—1. A number that is both the second and third terms of a proportion.

2. When three numbers are proportional, the second term is called the mean proportional between the other two.

MEAN SPHERICAL CANDLE POWER.—The average candle power of a lamp in all directions in space. It is equal to the total luminous flux of the lamp in lumens divided by 4π.

MEAN ZONAL CANDLE POWER.—The average candle power of a lamp over a given zone. It is equal to the luminous flux emitted in that zone divided by the solid angle of the zone.

MEASUREMENT OF LIGHT.—Light can be measured with great accuracy, owing to an invariable law which is similar to the law of gravitation. The intensity of light is as the square of its distance; thus, if two lights of unequal power be made to shine on the surface of a smooth plaster wall, and a book or card be interposed, the two shadows produced by the crossing of the rays will differ in blackness in the same degree as the powers of the two lights; the stronger light will produce the darker shadow. To obtain the difference in power of the two lights, the stronger light must be moved backward or the lesser light forward until both shadows are the same tint, which the eye can tell with precision.

MEASUREMENTS, ELECTRICAL. — Measurements of the various effects exhibited in electrical phenomena, especially practical measurements in connection with the electric circuit. Every system of measurement is based upon some experimental fact or law. An electric current can: a, cause a deposition of metals from their chemical solutions: b, heat the wire that it flows through; c, attract (or repel) a parallel neighboring current; d, accumulate as an electric charge that can repel (or attract) a neighboring charge of electricity; e, produce in its neighborhood a magnetic field; that is, can exert a force upon the pole of a magnet placed near it, as for example, in galvanometers.

Instruments for measuring currents of electricity are of many styles. As a mysterious and invisible element is dealt with, the measurement is indirect. The effects of currents of various pressures and volumes are what are measured, not the currents themselves.

MEASURES OCCASIONALLY USED.—

1000 mils	=1 in.
1 hand	=4 ins.
1 span	=9 ins.
1 military pace	=2½ ft.
1 fathom	=6 ft.
1 cable length	=120 fathoms.

TABLE

Nautical Measure

6,080.26 ft. or 1.15156 statute miles=1 nautical mile or knot.*

3 nautical miles=1 league.

60 nautical miles or 69.168 statute miles=1 degree (at the equator).

360 degrees=circumference of earth at equator.

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* The British Admiralty takes the round figure 6,080 ft. for length of the "measured mile" used in trials of vessels. The length between knots on the log line is 1/120 of a nautical mile, or 50.7 ft. when a half minute glass is used; so that a speed of 10 knots is equal to 10 nautical miles per hour.

MECHANICAL CHARACTERISTIC OF MOTOR.—A characteristic curve in which the torque and speed of a motor are taken as co-ordinates.

MECHANICAL CIRCUIT CLOSER. — A mechanism for closing a circuit, operated without the aid of electricity.

MECHANICAL DEPOLARIZATION. — A method of preventing polarization of a primary cell by merely agitating it, or by lifting the cathode plate now and then into the air.

MECHANICAL DRAUGHT. — A general term for the various methods of accelerating combustion under boilers by mechanical means. Mechanical draught is produced in several ways as by: a, steam jet; b, pressure in the ash pit (forced draught); c, suction in the stack (induced draught); d, combined pressure and suction (balanced draught).

MECHANICAL EFFECTS IN DIELECTRIC.—According to Siemens, the glass of a Leyden jar is warmed after being several times rapidly charged and discharged, from which it would appear that the changes of stress in the dielectric are accompanied by a molecular movement.

MECHANICAL EFFECTS OF DISCHARGE.—The discharge of electricity from a conductor is influenced somewhat by the shape of the terminals when the discharge takes place. An electric machine capable of giving a long spark when the knuckle is presented to the knob, will, on fastening a needle to the conductor, discharge the electricity so effectually at its point that only very short sparks can be drawn at the knob, while a fine brush or jet of pale blue light will appear at the point. An air current is set up of sufficient intensity to blow aside the flame of a lighted candle when brought near. The air current can be felt by the hand and is due to a mutual repulsion between the electrified air particles near the point and the electricity collected on the point itself. A click, similar to that heard when an iron bar is magnetized, is audible when a Leyden jar is discharged.

MECHANICAL EFFECTS OF MAGNETIZATION.—1. It was discovered by Joule that a bar of iron will increase 1/720000 of its original length when magnetized, and according to Bidwell, it will contract again when highly magnetized. When rods are stretched by a weight, they contract more when magnetized, than do unstretched rods.

2. A faint metallic click is heard when a bar is either magnetized or demagnetized. Magnetism is accompanied by internal friction, as is evident by the heating of a bar when magnetized and demagnetized in rapid succession

3. Sir W. Grove showed that water containing finely divided magnetic oxide of iron becomes clear on magnetizing in the direction of the magnetization, indicating that the particles of iron set themselves end-on, thus allowing more light to pass between them. A piece of iron when twisted, tends to untwist on being powerfully magnetized.

MECHANICAL EFFICIENCY.—The ratio of the useful work performed by a machine to the energy expended in producing it. Thus, the indicated horse power of a certain engine is 475 and the brake horse power, 380. For these two values, the mechanical efficiency=380÷475=.8 that is 80%.

MECHANICAL EQUIVALENT OF HEAT.—The mechanical energy equal to the heat necessary to raise 1 lb. of water 1 degree F. The experiments made by Joule (1843-50) show that 1 unit of heat=772 units of work. This is known as the mechanical equivalent of heat or Joule's equivalent. More recent experiments by Prof. Rowland (1880) and others give higher figures: 778 is generally accepted, but 777.6 is probably more nearly correct, the value 777.52 being used by Marks and Davis in their steam tables. The value 778 is sufficiently accurate for ordinary calculations.

MECHANICAL RECTIFIER.—A form of commutator operating in synchronism with an alternator and commutating or rectifying the negative waves of the alternating current. One application of a mechanical rectifier is its use on a compositely excited alternator.

MECHANICALLY OPERATED VALVE.—On a gas engine either the admission or the exhaust valve when operated by a cam or mechanical means. The exhaust valve is always mechanically operated, whereas the intake is sometimes opened automatically by the suction of the piston.

MEDIATE DIFFERENTIATION.—In calculus, the process of differentiating a variable with respect to some other variable. It is used when it is necessary to find the differential of several terms, some containing x and some y.

MEDICAL INDUCTION COIL.—In electrotherapeutics, an induction coil suitable for producing faradic currents.

MEG OR MEGA.—A prefix to a unit of measurement to denote one million times that unit.

MEGACYCLE.—In radio, one million cycles per second when used as a frequency unit.

MEGA-DYNE.—A unit of force equal to one million dynes.

MEGA FARAD.—A unit of capacity equal to one million farads.

MEGA-JOULE.—A unit of electrical energy equal to one million joules.

MEGALASCOPE, ELECTRIC.—An instrument provided with a magnifying apparatus, for the medical examination of the internal cavities of the human body.

MEGALINE.—A convenient term employed in considering lines of electro-magnetic flux. A megaline is equal to one million lines.

MEGA-VOLT.—A unit of pressure equal to one million volts.

MEGA-WEBER.—A unit of magnetic flux equal to one million webers.

MEGERG.—A unit of work equal to one million ergs.

MEGGER.—An instrument for measuring high resistances.

MEGGER TESTING SET.—An instrument for insulation testing and high resistance measurements. It consists essentially of a direct reading true ohm meter of the permanent magnet, moving coil type mounted in a suitable case with a hand driven magneto or provided with other means for supplying d.c. voltage for the test.

MEGOHM.—A unit of electrical resistance equal to one million ohms.

MEGOHM BOX.—A set of standard high resistances for testing. A typical box contains five resistances of 200,000 ohms each. The six pillars are petticoat insulated, the resistances being placed between each pair of pillars. There is a double contact post on top of each pillar so that these can be connected together with copper links.

MEGOHM MILE.—An insulation resistance in wire equal to one megohm per mile.

MEGOHM SENSITIVITY.—The number of megohms resistance that must be placed in series with the galvanometer in order that from an impressed pressure of one volt there shall result the standard deflection.

Inasmuch as the galvanometer coil resistance is usually negligible in comparison with the total resistance in series, the megohm sensitivity is only another way of stating the current sensitivity. The number representing the megohm sensitivity is the reciprocal of the number representing the current sensitivity. The megohm sensitivity is the constant usually stated for galvanometers to be used for measuring insulation resistance.

MEGOHMIT. — An insulating material which is prepared in various forms, viz.: a, thin sheets of mica built up with shellac, called **hard megohmit**; b, sheets of mica stuck together by vegetable adhesives, called **flexible megohmit**; c, flexible megohmit covered with Japanese paper, called **mica paper**; and d, flexible megohmit covered with linen, called **mica linen**.

MEMBRANE DIFFUSION.—When two different liquids are separated from each other by a membrane or other porous partition, there arises a tendency for the liquids to pass through the membrane. This diffusion through a membrane is usually termed **osmose** or **osmosis**.

MENSURATION.—The process of measuring the length of lines, the area of surfaces, and the volume of solids.

M.e.p.—Abbreviation for **mean effective pressure.**

MERCERIZED COTTON.—Cotton which has been chemically treated to resemble silk. Looks like spun silk, but fades more readily.

MERCURIAL COMMUTATION.—Changing the direction of an electric current through a mercurial contact.

MERCURIAL THERMOSTAT.—An apparatus for closing an electric circuit by means of a mercurial contact effected by the expansion of mercury when heated.

MERCURY.—One of the metallic chemical elements; also called quick silver. It is fluid at ordinary temperatures; becomes a solid at —38° F. and bolts at 675° F. Weight approximately ½ lb. per cu. in. Electric conductivity low.

MERCURY AIR PUMP.—A pump for producing a vacuum, consisting essentially of a small vertical tube leading from a reservoir of mercury at its top, the vessel to be exhausted being attached to the side of the tube near the top, so that the suction of the falling mercury exhausts the air; the Geissler or Sprengel mercurial pump.

MERCURY ARC POWER RECTIFIER.—Large rectifiers of the mercury arc type are made in various sizes with ratings from about 150 to 2,000 kw. at voltages up to about 1,800 volts. For higher d.c. voltages up to 6,000 volts, the current ratings are somewhat reduced.

For a rectifier layout in its simplest form there is only one important auxiliary provided, namely, the vacuum pump set, a high vacuum being absolutely essential.

MERCURY ARC RECTIFIER TUBE LOSSES.—There are two kinds of losses in the tube: 1, arcing, or leakage from one anode to the other, and 2, the mercury arc voltage drop. This drop does not depend on the load, the energy represented by the drop being converted into heat, which is dissipated at the surface of the containing vessel. According to Steinmetz, the limit of voltage must be very high, as 36,000 volts has been rectified.

MERCURY INTERRUPTER.—A device for operating X ray bulbs from an induction coil where the source is direct current. It rapidly opens and closes a circuit carried by a jet of mercury which strikes against a revolving toothed wheel.

MERCURY SWITCH.—A type of switch which employs mercury as one of the contacts. In operation, the circuit is closed and opened by the other contact dipping into and rising from the mercury.

MERCURY TURBINE MECHANICAL INTERRUPTER.—A device for interrupting the current supplied to medical induction coils. In construction, mercury is placed in an iron vessel connected by a binding post on the side of the electric current. Through the top is a shaft that is rapidly rotated by a belt from the motor. On the lower end of this shaft is a hollow disc, to which is attached a vertical tube extending to the bottom of the mercury receptacle. This tube is fitted with a screw feed and on one side of the disc is a hole and nozzle connecting directly to the vertical tube. As the shaft revolves, the mercury is lifted through the tube and forced in a stream from the nozzle on the edge of the disc. Just beyond the circle described by this disc is an iron ring insulated from the top, and connected by a binding post on the top to the electric current. This ring has two segments opposite each other, extending down below the revolving disc. As the disc revolves, the stream of mercury strikes first one segment, completing the electrical circuit and sending the current through the primary of the coil. It then passes through the open space between the segments, breaking the contact, and striking the other segment, making contact again, and so on, completing the revolution, making and breaking circuit twice. The rate of these interruptions is varied by the speed at which the revolving disc rotates and is controlled through a separate rheostat that varies the speed of the motor.

MERCURY VAPOR RECTIFIER.—A device for changing alternating into direct current, invented by Peter Cooper Hewitt. It consists essentially of a glass bulb into which are sealed two iron or graphite anodes and one mercury cathode, and a small starting electrode. The bulb is filled with mercury vapor under low pressure. The action of this device depends on the property of ionized mercury vapor of conducting electricity in one direction only. This type of rectifier is especially useful in charging storage batteries.

In operation no current will flow until the starting or negative electrode resistance has been overcome by the ionization of the vapor in its neighborhood. To accomplish this the voltage is raised sufficiently to cause the current to jump the gap between the mercury cathode and the starting cathode, or by bringing the cathode and starting electrode together in the vapor by tilting and then separating them, thus drawing out the arc. When this has been done, current will only flow from the anode to the mercury cathode, and not in the reverse direction. The terms vapor or arc as applied to rectifiers do not indicate a different principle; the Westinghouse Company employ the former term and the General Electric Company the latter as a distinguishing title or trade mark.

MERIDIAN.—Any great circle assumed to pass over the earth's surface through the poles and at right angles to the equator.

MESH.—The engagement of one tooth or set of gear teeth with another, as of two spur gears, or of a rack and a pinion.

MESH GROUPING.—In a polyphase circuit, a method of winding the armature coils so that they are close together forming a closed circuit, and having the line wire attached to the points of junction between the coils. Commonly called delta grouping.

MESSAGE WIRE.—In a railway block system, a wire for sending local messages along the road.

MESSENGER CALL BOX.—A box electrically connected with a central office for calling messengers, policemen, firemen, etc. Each box has make and break attachments which are operated by turning a crank, thereby transmitting to the central office a number corresponding to that of the signaling box.

MESSENGER WIRE. — A steel rope stretched tightly between poles for the purpose of supporting aerial cables which do not have sufficient strength to support their own weight.

METAL.—An element that forms a base by combining with oxygen. It is uzually a good conductor of heat and electricity; generally, hard, heavy, malleable and tenacious. Metals, as known to the ancients were: gold, silver, copper, iron, tin and lead.

METAL MOULDING.—This kind of casing for wires, also known as raceway, provides a metallic box-like covering which fits snugly over the wires and protects them from injury. As compared with wooden moulding, the metal moulding takes up less room and has a better appearance.

METAL RECTIFIER.—A type of rectifier whose operation is based on the contact of dissimilar metals; a dry junction rectifier.

METAL STRIP RADIO LOUD SPEAKER.—A magnetic type in which a metal strip is suspended between the poles of a permanent or electro-magnet and the signal current passed through the strip. The reaction between the steady field of the magnet and varying field of the strip causes the latter to vibrate. The metal strip being the diaphragm, the sound waves are produced direct without any drive gear.

METAL VOLTAMETER.—A name sometimes given to a silver or copper voltameter which measures an electric current by the amount of metal deposited by electrolysis.

METAL WEDGES.—Retainers used sometimes for a.c. motor windings. The wedges consist of two strips of steel held in place at the top of the slot by a strip of brass. The steel parts lie in the wedge grooves and the brass part in a recess formed by the two steel pieces. The whole is insulated from the punchings by a thickness of fish paper.

METALLIC ARC.—An electric arc maintained between electrodes composed of metal.

METALLIC ARC WELDING.—A method of welding in which a metallic electrode is used. The electrode forms a terminal for creating the arc, and also supplies the added or "filler" metal by melting. When welding with the metallic electrode an arc is drawn between the parent metal or work and the welding rod, which causes the melted rod to flow across the arc into the molten pool of the parent metal. This deposition of metal is accomplished by contact made between the molten metal and the globules formed on the end of electrode filler wire. The concentration of thermal energy at the terminal of the wire electrode causes a small part of the work being welded to melt almost instantaneously, and an intermittent flow of metal across the arc stream.

METALLIC CIRCUIT.—An electric circuit not employing a ground return; a circuit formed of metallic conductors throughout.

METALLIC CIRCUIT PLUG.—A telephone switchboard plug which makes connections with a metallic circuit by double conductors, one attached to the tip of the plug, and the other to its sleeve.

METALLIC FILAMENT.—An incandescent lamp filament made of tantalum, tungsten or other metals. Tungsten is the metal generally used.

METALLIC FLAME ARC LAMP.—A luminous arc lamp in which the luminosity of arc is intensified by using in d.c. lamps, negative electrodes of a material the incandescent vapor of which gives a highly luminous spectrum.

METALLIZED FILAMENT.—A carbon lamp filament which has been heated to an extremely high temperature in a carbon tube electric furnace before and after flashing.

METALLIZED FILAMENT LAMP.—An incandescent lamp employing a carbon filament which has been subjected to an excessive heat in a form of electric furnace, so that the texture of the filament has more of the characteristics of a metal than of carbon. Metallized filament lamps operate at a much higher temperature producing a white light.

METALLOCHROMES. — Symmetrical rings of varied colors due to deposits of lead peroxide, observed by Nobili in his experiments in electrolyzing a solution of lead; Nobili's rings.

METALLOGRAPHY.—The science of examining prepared metallic surfaces under the microscope. After careful polishing and grinding to a smooth surface, the structure is brought out by etching with acid, the surface being preserved for subsequent examination by a coat of transparent varnish. By this method of investigation, the crystalline structure of metals has been demonstrated and the behavior of the molecules under stresses or hardening and annealing is made apparent.

METALLOID.—A term applied to certain elements which present both metallic and non-metallic characteristics, thus partaking of the properties of both metals and non-metals. Antimony, arsenic and tellurium are examples.

METALLURGY.—The science which treats of the reduction of metals from their ores.

METEORIC IRON.—Masses of nearly pure iron found in various parts of the world, varying in weight from a few pounds to many tons. Containing 1 to 2 per cent of nickel, having twice as much combined hydrogen as ordinary malleable iron, and being generally oxidized outside with an unoxidized interior, it is shown to be of extra terrestrial origin, that is, it is thrown off by some other planet, or is encountered by the earth on its orbit, having formed part of one of those shoals of wandering bodies known as meteorites, which, flaming through friction with the atmosphere, become "shooting stars."

METEORITE.—A mass of stone or metal that has become detached from some celestial body and fallen upon the earth.

METEOROGRAPH, ELECTRIC.—An apparatus for making continuous observations of meteorological phenomena and electrically recording the same, so that the changes of temperature, the direction and velocity of the wind, the height of the barometer, the rainfall, etc., are automatically and continuously registered.

METEOROLOGY.—That branch of physics which is concerned with the study of atmospheric phenomena.

METER.—1. A unit of length in the metric system. It is equal to that of a standard platinum bar, kept in Paris, and representing approximately a ten-millionth part of a quadrant of the earth's meridian measured from the equator to the pole through Paris; one hundred centimeters or 39.37 inches.

2. An electric indicating instrument as a volt meter, ammeter, etc.

METER-AMPERES.—In radio, a basis for estimating a transmitter's radiation strength. Maximum antenna current in amperes $\times$ antenna effective height in meters $=$ radiation strength $=$ meter amperes.

METER BRIDGE.—A slide wire bridge.

METER CANDLE.—A unit of illumination equal to the light of a standard candle at a distance of one meter.

METER, ELECTRIC.—In the commercial distribution of electricity, an instrument for measuring and recording the quantity of electricity supplied to a consumer.

METERS, MISCELLANEOUS.—In addition to the familiar ammeter and volt meter, there are a few other instruments very frequently used, such as: a, power factor meters; b, phase indicators; c, synchronism indicators; d, frequency meters; e, surge indicators or klydonographs.

METER READING.—Begin at the left and set down for each dial the lower figure next to each hand, not necessarily the figure nearer the hand, that is if the hand be say between 1 and 2 and nearer 2, set down 1 for the reading of this dial. Proceed in the same way for the other dials. Some meters are subject to a multiplying constant so stated on their face and the registration of such meters must be multiplied by the constant as shown, to determine the actual consumption of electrical energy. The constant is the measure of the mechanical adjustment in the register of the meter and is the ratio between the registration of the dial hands and the true consumption. This adjustment is made always by the manufacturer of the meter and is never changed in service.

METER TESTING WITH STANDARD.—To obtain best results there should be one man at each meter so that simultaneous readings may be taken on both instruments, and the man at the standard meter should maintain the voltage constant while a reading is being taken, by means of a rheostat in the field circuit of the generator supplying the current.

METERING PIN.—In a carbureter a needle valve regulating the flow of gasoline through the nozzle and automatically controlled by the suction of the engine or mechanically, by connection with the throttle lever.

METHVEN SCREEN.—An upright metal screen pierced with a narrow rectangular aperture, and fixed opposite the flame of an Argand burner, for the purpose of establishing a standard of illuminating power.

METRIC SPARK PLUG.—An ignition plug in which the screwed connection to cylinder head has a straight thread measured in millimeters.

METRIC SYSTEM.—A method of measurement adopted in France in 1795 and its use was authorized in Great Britain in 1864, and in the United States in 1866. The important feature of the metric system is that it is based upon the decimal scale, hence, the student should first acquire a knowledge of decimals before taking up the metric system. The meter is the base or unit of the system and is defined as the one ten-millionth part of the distance on the earth's surface from the equator to either pole. Its value in inches should be remembered: 1 meter = 39.37079 ins.

Mfd.—Abbreviation for microfarad.

Mho.—A unit of conductance being the reciprocal of the ohm. It is the conductance of a body having a resistance of one ohm. Note that **mho** is **ohm** spelled backwards.

MHOMETER.—An instrument for measuring electrical conductance in terms of the mho.

MICA.—A mineral substance, distinguished by nearly perfect cleavage, largely used for insulating purposes because of its excellent properties of insulation and durability. Mica is capable of being split into elastic sheets of extreme thinness. It is either colorless or presents some shade of light brown, gray, smoky brown, black, and occasionally green or violet. It is generally more or less transparent. Mica possesses an electrical resistance of 84,000,000,000,000 ohms per cubic centimeter and is an ideal insulator, except for the fact that it frequently contains impurities that reduce its dielectric efficiency, and also when used as insulation for spark plugs, owing to its laminated structure, oil and gas may be forced by the pressure of compression between the sheets composing the insulating sheath, thus, in time, producing short circuiting of the current.

MICA IGNITION CONDENSER.—A small condenser with mica dielectric especially designed for ignition service. The practice of automobile manufacturers of supplying paper condensers as standard equipment is very objectionable. Paper condensers are not reliable.

MICA UNDERCUTTER.—A device for undercutting the mica insulation between commutator bars of an armature. There are various types. Some are motor driven having adjustable gauges so as to cut at a uniform and pre-determined depth.

MICABOND.—An insulating material made of mica backed with cloth or paper.

MICANITE.—An insulating material consisting of small pieces of mica built up into sheet form by shellac cement under pressure. It is an excellent insulator, and is employed in making induction coils.

MICRO.—A prefix to a unit of measurement to denote one-millionth part of that unit.

MICRO-AMPERE.—A unit of current equal to one-millionth of an ampere.

MICRO-COULOMB.—A unit of electric quantity equal to one-millionth of a coulomb.

MICRO-DRIVE.—A method of automatic leveling of elevators in which a small constant speed motor is geared down so as to drive the elevator at an exceedingly low speed (low enough so as to make a final stop from this speed in a very short distance) just before stopping.

MICRO-FARAD.—A unit of electric capacity equal to one-millionth of a farad.

MICRO-GILBERT.—A unit of magnetic force equal to one-millionth of a gilbert.

MICRO GLOW LAMP.—A name for a diminutive incandescent lamp.

MICRO-GRAPHOPHONE.—A multiple non-metallic diaphragm phonograph in which separate diaphragms act upon a single diaphragm in recording the speech, so that more intense vibrations may be produced in reproducing sound.

MICROHM.—A unit of resistance equal to one-millionth of an ohm.

MICROMETER.—An instrument for measuring very small dimensions or angles with precision. By means of the vernier which forms a part of the instrument, measurements to one ten-thousandth of an inch can be easily taken.

MICROMETER CALIPERS. — A curved frame of U shape, having at its open side a hardened anvil on one extremity and a micrometer at the other, rendering it easy to take measurements between them.

MICROMETER GAP.—A form of ground leak for an aerial circuit to relieve the circuit of heavy charges. It consists of an adjustable spark gap.

MICRON.—A unit of length equal to the thousandth part of a milli-meter or the millionth part of a meter. It is used in measuring wave lengths of light, degree of vacuum (height of a column of mercury as in a barometer but measured in microns or fraction of a micron) and in other cases where very short distances are concerned. The so-called visible spectrum includes wave lengths from approximately .4 to .7 microns.

MICROPHONE.—A device for intensifying sound. In operation, a diaphragm set in vibration by sound waves causes corresponding variations in the resistance of a mass of loosely packed carbon granules, thus producing corresponding variations of electric current. At the other end of the line this variable current acting on an electro-magnet causes a diaphragm in the receiver to vibrate synchronously with the microphone diaphragm thus reproducing the sound.

MICROPHONE INDUCTION COIL.—An induction coil used with a telephone transmitter.

MICROPHONE RELAY. — A microphone combined with a telephone so that a message transmitted over the telephone is repeated by the microphone over another line.

MICROSCOPE. — An optical instrument provided with a lens or a combination of lenses, for examining objects too small to be observed with the naked eye.

MICRO-SEISMOGRAPH.—A sensitive electrical instrument for indicating and recording slight earthquake vibrations.

MICRO-TASIMETER.—An instrument for measuring extremely slight temperature or moisture changes, by the varying pressure exerted upon a carbon button.

MICRO-VOLT.—A unit of pressure equal to one-millionth of a volt.

MIGRATION OF IONS.—The movement of the ions toward their respective electrodes, which takes place in a solution during the process of electrolysis.

MIKE.—An objectionable name for a microphone.

MIL.—A unit of length equal to one-thousandth part of an inch, used especially in the measurement of diameters of wires.

MIL FOOT.—A volume one mil in diameter and one foot long. This unit is used as a basis for computing the resistance of any given wire. The resistance of a wire of commercially pure copper one mil in diameter and one foot long is taken as a standard in calculating the resistance of wires, and has been found to be equal to 10.79 ohms at 75° F.

MIL FOOT RESISTANCE UNIT.—The resistance of a copper wire is equal to its length in feet, multiplied by the resistance of one mil foot (10.79 ohms) and divided by the number of circular mils, or the square of its diameter.

Expressed as a formula:

$$\text{ohms} = \frac{\text{length of wire in ft.} \times 10.79}{\text{circular mils}}$$

MILD STEEL.—A class of steel of great tenacity and ductility which is an alloy of iron with a very small percéntage of carbon; it has a crystalline structure and is weldable but cannot be hardened. Mild steel is used for the cores of electro-magnets.

MILE OHM.—In telephone and telegraph practice, the weight of a piece of wire one mile long having a resistance of one ohm. To ascertain the mileage resistance of any wire divide the weight per mile ohm, by the weight of the wire per mile. The weights per mile ohm of different grades of line wire are as follows: B. B. wire, about 5,700 lbs.; E. B. B. wire, about 5,000 lbs.; steel wire, about 6,500 lbs. The approximate weights per mile of various sizes of galvanized telegraph wire are as follows:

No. (Trenton gauge)	4	5	6	7	8
Lbs., per mile	720	610	525	450	375
No. (Trenton gauge)	9	10	11	12	13
Lbs., per mile	310	250	200	160	125

MILLER-COWEN MACHINE. — A school demonstration machine used to illustrate the working principles of both d.c. and a.c. machines.

MILLI.—A prefix to a unit of measurement denoting one-thousandth part of that unit.

MILLI-AMMETER. — An instrument for measuring the strength of an electric current in terms of milli-amperes.

MILLI-AMMETER FOR RADIO TUBE PLATE.—This instrument (Hickok) is of the double scale type, having ranges of 20 milliamperes on the low scale and 200 milliamperes on the high scale. The switch for changing the scale range is located at the left of the meter. To use this meter as a separate instrument, insert the 4 lead cable plug in the UX tube holder and disconnect all the cables from the binding posts. The plate milliammeter will now be in series with the "positive B battery" post on the tester and the brown or plate cable.

MILLI-METER.—A unit of length in the metric system of weights and measures equal to one-thousandth of a meter, or .03937 inch.

MILLI-MICRON.—One billionth part of a meter. Used as a unit of radio wave length.

MILLI-PHOT.—An illumination unit which is equal to .001 lumen per sq. cm.=10 lux or .93 foot candle approximately.

MILLI-VOLT METER.—An instrument calibrated to read to the one-thousandth of a volt.

MILLIKEN REPEATER SYSTEM.—In telegraphy a repeater system consisting of two extra magnet relays and two tongue contact repeaters with suitable connections. The repeaters are provided with two contacts, one for the local circuit of the opposite extra magnet, and the other for the closing of the opposite main line circuit. When one of these repeaters opens, its local contact is always broken very shortly before the main line contact is broken, while in closing the opposite takes place. The outgoing signals cannot disturb the line on the incoming side.

MIMIC BUS.—A single line diagram of the main connections of a system constructed on the face of a switchboard, usually of metal strap and so arranged that the control switches represent their breakers. Disconnecting switches other than those used as purely isolating switches are usually represented by a mimic device.—NEMA.

MINE EXPLODER.—A magneto suitable for exploding a blast.

MINE LOCOMOTIVE.—A trolley type electric locomotive designed to meet certain space limitations. The standard voltages for trolley type mine locomotives are 250 and 500 volts. The 500 volt trolley has proved dangerous, due to workmen coming in contact with it. The 250 volt standard is the prevailing practice.

MINERAL OIL.—Oil of mineral origin is either petroleum, or some of its distillates. It comes from oil wells, or oil bearing shale. Its widest use is for illuminating purposes, but it is also extensively employed for lubrication of machinery in situations where it is impracticable to use animal oils, such as sperm, or lard.

MINERS' DIAL.—A compass provided with a magnetic needle, a horizontal dial graduated to 360°, and sights through which stations may be observed in order to ascertain the direction of lines. The instrument is used for underground surveying, hence its name.

MINERS' INCH.—In mining laws of various regions, the quantity of water that will pass an opening of one square inch in twenty-four hours under a head of six inches.

MINIATURE LAMP.—1. Small incandescent lamps are employed as signals in central energy telephone switch boards. They are usually of one-third candle power, tubular in form, mounted in opaque tubes provided with glass jewels. The terminals of the filament are joined to metal contact pieces on opposite sides of the bulb.

2. Diminutive forms of incandescent lamps adapted to delicate surgical operations.

3. Small lamps used on automobiles.

MINIMUM WIDTH OF BRUSH.—In dynamo and motor design minimum width may be taken as one and one half times the thickness of the commutator segments. A carbon brush should be thick enough to cover two and one-half commutator segments.

MINIUM.—The red oxide of lead commonly used to paste on the positive pasted plates of a storage cell. It is a rare mineral, occurring as a pulverulent decomposition product of other lead ores. Minium has been found in small quantities in many localities where galeno or cerusite occurs.

MINOR INSULATION OF TRANSFORMERS.—The insulation placed between adjacent turns and between coils of the same winding. The minor insulation between coils of the same winding usually consists of pressboard sheets and oil ducts. For very small units treated cloth or fibre may be used. Since the difference of pressure is small between the adjacent turns, the insulation need not be very thick. It may consist of one or more wrappings of cotton or treated paper tape around each conductor. For small round conductors, enamel together with the cotton may be used.

MINOTTO'S CELL.—A modification of Daniell's cell, dispensing with the porous cup and adopting the gravity principle, in which a copper disc rests on the bottom of the jar, above which is a thick layer of crystals of copper sulphate, then a mass of moist sawdust upon which rests a zinc block.

MINUS CHARGE.—A negative electric charge which is indicated by the minus sign (—). It is the kind of electrification that is developed on resinous substances by rubbing with flannel or fur.

MIOPHONE.—In electro-therapeutics, an apparatus for examining the muscles

MIRROR GALVANOMETER.—A class of galvanometer in which a light beam striking on a small mirror attached to the needle system is reflected on a distant scale, thus acting as a multiplier for the needle movement.

MIRROR RECEIVER.—A mirror galvanometer for receiving signals over submarine cables.

MISFIRING.—A failure to ignite the charge within the cylinder of a gas engine, usually caused by a weak battery, partial or entire breaks in the primary circuit, or almost any defect in the ignition system.

MIXED CURRENT SYSTEM.—A method which employs alternating current on the transmission line because of the saving in copper, converting it to direct current at the points of distribution.

MIXED NUMBER.—An integer and a fraction united.

MIXER TUBE.—In a radio super-heterodyne receiver, the first detector.

MIXING KEY.—A key employed for producing the charge in the mixed charge capacity test of a submarine cable.

MIXTURE.—A general term for the fuel of a gas engine consisting of a compound of air with a hydrocarbon. A mixture is termed "rich" or "fat," when it contains an excess of gasoline, and "poor" or "lean" when it does not contain sufficient gasoline.

mm.—Abbreviation for millimeter.

Mmf.—Abbreviation for magnetomotive force.

Mmfd. — Abbreviation for micro-microfarad.

MOBILITY OF IONS.—In electrolysis, the electrolyte is regarded as composed of positive ions called cations and negative ions called anions. These ions move along the lines of electric force which pass through the electrolyte from one electrode to the other. The mobility or migration velocity is the speed with which the ions move when acted upon by unit force.

MOCK ANTENNA.—An artificial antenna.

MODALITIES.—Various forms of electric current used in electro-therapeutics. Some of these are simple currents as a.c. or d.c. and others resultant currents formed by the combination of simple currents and various modifications.

MODIFIED CABINET PROJECTION.—A system of drawing in which the 45° axis is placed at a different angle for convenience to suit special conditions.

MODULATED CURRENT.—In radio, a current whose amplitude is periodically varied as for instance, the variation amplitude of a carrier current in accordance with the vibrations of a microphone.

MODULATION.—The process by which the amplitude or frequency of a carrier wave is varied in accordance with a signal wave.

MODULUS.—A term used in mathematics, mechanics and physics, being "a number or quantity that measures a force or effect," hence, the primary signification of modulus is a measure; the modulus of a machine means the same as its efficiency.

MOIST CELL.—A so called dry cell. The word battery for cell is often used erroneously.

MOISTURE IN STEAM.—The usual amount of moisture in boilers of good design working at full load is about 2%. In the absence of super-heaters, a boiler should be fitted with a combination of separator, collector and dryer to obtain dry steam. See Audel's Engine and Mechanical Guide, Vol. 5, page 2,406.

MOISTURE RESISTING APPARATUS.—Apparatus so constructed or treated that it will not be readily injured by moisture. Such apparatus shall be capable of operating in a very humid atmosphere, such as that found in mines, evaporating rooms, etc.—NEMA.

MOL.—A term sometimes used for gram-molecule, the number of grams of a substance equal to its molecular weight.

MOLECULE.—The smallest particle of a compound which can maintain the properties of the compound. It consists of a combination of two or more atoms of different kinds.

MOLECULAR ATTRACTION.—The attraction exerted by one molecule upon another, as apart from the attraction of gravitation. The cohesion of bodies and chemical affinities are examples of this force, the tensile strength of a bar of steel being due to the attraction which its molecules have for each other.

MOLECULAR CHAINS.—The chains in which, according to Grotthuss's hypothesis, the molecules of an electrolyte arrange themselves in the process of electrolysis.

MOLECULAR CONFIGURATION.—The irregular arrangement of the molecules in a mass of iron before they are acted upon by a magnetizing force.

MOLECULAR DECOMPOSITION OR DISSOCIATION.—The breaking up of a molecule of matter into its constituent atoms.

MOLECULAR FORCE.—A force exerted between molecules but only at infinitely small distances.

MOLECULAR MAGNETISM.—The magnetism which is assumed to exist inherently in the molecules of a magnetizable substance, according to the physical theory of magnetism.

MOLECULAR SHADOW.—In a high vacuum tube, a well defined shadow cast by any object interposed in front of the cathode in the path of the discharge of electrified molecules; an electric shadow.

MOLECULAR TRANSFER OF HEAT.—The conduction, or transference, of heat from molecule to molecule in a solid body.

MOLECULAR VIBRATIONS. — Vibrations set up among the molecules of the diaphragm of a telephone transmitter by the influence of the magnet, as distinguished from mass or molar vibration.

MOLYBDENITE CELL.—A light sensitive cell. This exhibits a far less inertia period than does the selenium cell. The simplest cell design of this kind is to secure a thin lamina (crystal) and fasten two wires at opposite ends, and by means of a soft solder be made to hold rigidly.

MOMENT OF COUPLE.—1. The product of two component forces which imparts a twist or turning movement to a body capable of rotation.

2. Applied to an electric motor, the moment of couple or the torque is the twisting force which is exerted upon the armature by the passage of an electric current through it. The two components of the torque are a, the pull-measured in pounds and b, the distance in feet from the center of the shaft to the point where the pull is applied.

MOMENT OF MAGNET.—The product of the strength of one of the poles of a uniform bar magnet by the distance between the two poles.

MOMENTARY CONTACT SWITCH.—A type of house switch in which pressure on the button closes the circuit as long as the button is held in. Releasing the button opens the circuit. The two circuit type has two separate single pole switches, each controlling a separate circuit. Both buttons cannot be operated at the same time.

MOMENTUM.—The quantity of motion in a moving body, obtained by multiplying the mass of the body by its velocity. Momentum might also be defined as numerically equivalent to the number of pounds of force that will stop a moving body in one second or the number of pounds of force which, acting during one second, will give it a given velocity.

MOMENTUM, ELECTRIC.—A property of the electric current which on account of inductance, resists a change in its rate of flow. In high tension ignition, a condenser is necessary in the primary circuit to act as a brake by introducing a reverse pressure to help bring the current quickly to rest at the instant the contact breaker breaks the primary circuit.

MONEL METAL.—A natural alloy made from an ore containing copper and nickel. It usually contains from 24 to 28% of copper and from 67 to 74% of nickel, also .5 to 5.25% of iron. It has the strength of steel. Melting point 2480° F. Weight .32 lb. per cu. in., 543 lbs. per cu. ft. Specific gravity about 8.87.

MONITOR SPEAKER.—In sound pictures, a loud speaker placed in the kinebooth so that the projector operator can hear how the sound is coming over.

MONITORING RADIO RECEIVER.—One used to test the operation of a transmitting station. It is used to reduce station interference.

MONOCHROMATIC PHOTOMETRY.—The measurement of homogeneous or monochromatic light; that is, light containing but one color.

MONOCYCLIC ARMATURE.—The armature of a monocyclic alternator wound with an ordinary coil winding in slots and an auxiliary or "teaser" winding in smaller slots midway between those of the main winding.

MONOCYCLIC SYSTEM.—An alternating current system due to Steinmetz which employs a special type alternator. The alternator has a main single phase winding, an auxiliary or teaser winding connected to the central point of the main winding in quadrature therewith. The teaser coil generates a voltage equal to about 25% of that of the main coil so that the pressure between the terminals of the main coil and the free end of the teaser is the resultant of the pressure of the two coils. By various transformer connections it is possible to obtain a practically correct three phase relationship so that polyphase motors may be employed. In this system, two wires leading from the ends of the single phase winding in the alternator supply single phase current to the lighting load, a third wire connected to the end of the teaser being run to points where the polyphase motors are installed.

MONOPHASE.—Single phase applied to a single pressure wave supplied by a simple alternator to a two wire circuit.

MONOPHOTE ARC LIGHT.—A lamp operated singly upon its own circuit and having the whole current pass through its arc regulating mechanism.

MONOPLANE.—An airplane having only one lifting surface or pair of wings.

MONO-TOOTH WINDING.—A concentrated winding.

MOORE LIGHT.—An early form of vacuum tube lamp. It consists of a long tube in whose ends are fitted carbon electrodes, connected to the outside by platinum wire sealed in the glass. The completed tube is exhausted in position by means of a portable mechanical vacuum pump to a pressure claimed to be about .000367 lb. absolute per sq. in. In operating a vacuum tube for luminous phenomena, there is a critical point of rarefaction at which the conductivity is a maximum and the tube normally works at a point a little below this. The pressure is regulated automatically. If the regulating valve admit atmospheric air (oxygen or nitrogen) the tube gives a rose colored light. If nitrogen alone be admitted the light is yellow, and when carbon dioxide is admitted, it becomes a close imitation of daylight. The rose colored tubes consume .65 watt per candle power, and the white light tubes, about 1½ watts per candle power.

MOP.—In electro-plating, an implement for polishing plated surfaces.

MORDEY ALTERNATOR.—An alternator designed by W. M. Mordey, an English engineer; its armature is fixed, the field magnet being rotated, and the lines of force in the various fields projected through the armature coils are all in one direction, the pole pieces on one side of the armature coils being all of north polarity, and those on the other side of south polarity.

MORDEY EFFECT.—A phenomenon first observed by Mordey of decreasing hysteresis in the armature when the dynamo is at full load.

MORDEY'S METHOD.—A method of measuring the variation of voltage around the commutator by use of a single exploring brush and volt meter. It consists in connecting one terminal of the volt meter (preferably an electrostatic one) to one brush of the machine, and the other terminal to the exploring brush, which can be moved from point to point, readings being taken at each point.

MORIN'S LAWS OF FRICTION.—1. The friction between two bodies is directly proportional to the pressure; that is, the coefficient is constant for all pressures.

2. The coefficient and amount of friction, pressure being the same, is independent of the areas in contact.

3. The coefficient of friction is independent of velocity, although static friction (friction at rest) is greater than the friction of motion.

Denton says: "I do not believe there is a particle of proof in any investigation of friction ever made, that Morin's laws do not hold for ordinary practical oil cups or restricted rates of feed."

MORSE EMBOSSER.—The Morse recorder.

MORSE INK WRITER OR INKER.—A form of Morse recorder in which the attraction of the armature raises an inked wheel against the paper ribbon and thereby prints upon it the dots and dashes of the message.

MORSE LIGHT.—A signal flash light used to convey messages according to the Morse Code.

MORSE RECORDER OR REGISTER.—An early form of telegraphic receiving instrument consisting essentially of an electro-magnet moving an armature which is arranged to emboss the dots and dashes of the message upon a paper ribbon drawn through the instrument by clockwork; it is now wholly suppplanted in the United States by the sounder.

MORSE, SAMUEL FINLEY BREESE.—Born 1791, died 1872. An American inventor, famous for his invention of the electric telegraph (1835). He began life as an artist; in 1832 he became interested in certain experiments which were going on in Paris for the transmission of electricity over long distances and for the next three years he devoted himself to the problem of sending messages by that means. His first model was completed in 1835 and in 1837 he first put his system into operation. After several years of discouragement because of lack of recognition, he was awarded an appropriation of $30,000 by Congress for an experimental line from Washington to Baltimore. After this, success was rapid and before his death, his system had been adopted by the leading countries of the world. In 1842 he laid, in New York Harbor, the first submarine cable ever successfully attempted. He received very high honors from the heads of European powers and his own government as a great benefactor of civilization.

MORSE SYSTEM OF TELEGRAPHY.—A system of electric transmission of signals developed by S. F. B. Morse. With exception of very short lines, the system requires three instruments: a key, relay and sounder. In operation, by making and breaking the circuit with the key, the dots and dashes, or "clicks" of the Morse alphabet are transmitted along the line.

MORSE TAPPER.—A sounder invented by Morse which produces a tapping sound by the movements of a lever attached to the armature of an electro-magnet.

MORSE TELEGRAPHIC ALPHABET.—The system of dots and dashes devised by Morse as a code for telegraphic signaling. The American Morse code, used in the United States and Canada, is the original Morse alphabet; the International Morse code employed abroad has certain modifications and differs considerably from the American code, the signals for some of the letters of the latter depending on the length of the spacings between the dots and dashes.

MORTON WAVE CURRENT.—In electrotherapeutics, an interrupted current obtained from a static machine by applying to the part to be treated a flexible metal electrode connected to the positive terminal of the machine, the negative terminal being grounded and a suitable spark gap being employed between the terminals.

MOTHER.—A metal master disc for recording sound for sound pictures.

MOTION PICTURE CAMERA.—A photographic device for taking motion pictures. It consists of a camera similar to the ordinary camera and provided with an intermittent film feed mechanism. The whole mechanism is so arranged and geared together that while the film is being shifted, the light is excluded from the lens and admitted during the stationary periods.

MOTION PICTURE MACHINE.—A common though objectionable name for a motion picture projector or apparatus for projecting motion pictures upon a screen.

MOTION PICTURE PROJECTOR.—A machine for projecting moving pictures upon a screen, usually provided with apparatus for reproducing synchronized sound.

The projector proper consists essentially of:

1. An optical system, comprising
   a. Source of light;
   b. Lens $\begin{cases}\text{objective.}\\ \text{condenser;}\end{cases}$

2. Intermittent film feed-system, comprising
a. Upper reel;
b. Upper steady feed sprocket;
c. Steady drum;
d. Film gate;
e. Intermittent sprocket;
f. Intermittent movement;
g. Shutter;
h. Lower steady feed sprocket;
i. Lower reel;
j. Lower reel drive;
k. Operating crank and drive;
l. Numerous presser rollers.

Besides these various essential parts, safety devices such as fire shutter, fire valves, film shields, etc., are provided.

MOTOMETER.—A type of thermometer placed on the filler cap of an automobile radiator to indicate the temperature of the air or vapor above the water, so that the operator will know when the engine is working with the circulating system at too high a temperature. An unnecessary device. The temperature of the water cannot rise above 212° Fahr. unless the cap be screwed on very tightly and the overflow pipe be clogged. Dangerously low water in the radiator will be indicated by the formation of steam.

MOTOR.—1. A machine for converting electric energy into mechanical energy as an a.c. or d.c. motor.
2. A machine for converting hydraulic energy into mechanical energy, as a water motor.
3. The use of the word motor for engine is objectionable.

MOTOR BOAT.—A small craft propelled by a gas engine. Sometimes, though incorrectly called power boat.

MOTOR-BOATING.—Pulses of sound at low audio frequency coming from a loud speaker. They are due to feed backs between amplifying stages.

MOTOR CIRCUIT SWITCH.—A switch used to stop a motor when at full running current, but not intended to open the motor circuit with stalled rotor current flowing. The switch may also serve to disconnect the motor and its controller when necessary for repairs, etc.

MOTOR CONVERTER.—A combination of an induction motor with a synchronous converter, the secondary of the former feeding the armature of the latter with current at some frequency other than the impressed frequency; a cascade converter.

MOTORCYCLE.—A bicycle driven by a gas engine. There are various types. Single and multi-cylinder engines are used. Late models have four cylinder engine, transmission, etc. An objectionable item is the noise of the exhaust and manufacturers are apparently doing nothing to overcome this defect.

MOTORCYCLE ENGINES.—The prevailing type is the four cycle air cooled engine, one, two and four cylinders. The twin type of cylinder engine is the most popular, and the cylinders are usually placed 42° to 45° apart. Early motorcycles had belt drive, but it was found objectionable and was replaced by chain or shaft and bevel gear drive. Three speed transmissions are used. Generally magneto ignition is provided.

MOTOR, ELECTRIC.—A machine for converting electrical energy into mechanical energy. All the early attempts to introduce motors failed, chiefly because the law of the conservation of energy was not fully recognized. Early experimenters discovered by placing a galvanometer in a circuit with a motor and battery, that when the motor was running, the battery was unable to force through the wires so strong a current as that which flowed when the motor was standing still. Moreover, the faster the motor ran, the weaker did the current become, because of the bucking or reverse voltage induced by the motion of the motor coils in the field. There are many types of d.c. and a.c. motors and satisfactory service depends largely upon proper selection.

MOTOR FOR TELPHERS.—The sizes of motor for telphers and hoists will depend upon the class of work to be done; the motors for telpher tractors vary from 5 to 15 h.p., and for the hoists from 3 to 75 h.p., the loads being from 500 lbs. to 30,000 lbs. The load factor for the tractor motor is .25 and for the hoisting motor .16.

MOTOR GENERATOR SET.—A combination of a motor and a dynamo or an alternator used in place of a rotary converter when it is desirable that the generating element be independent of the a.c. line voltage so that any degree of voltage regulation can be obtained. To meet varied conditions there are numerous combinations such as:
1. Synchronous motor.........dynamo
2. Induction motor............dynamo
3. Direct current motor.......dynamo
4. Direct current motor.......alternator
5. Synchronous motor.........alternator
6. Induction motor............alternator

An advantage of motor generator sets over converters on high frequency circuits, is that the generator can be designed with a few poles and brushes set far apart, which greatly reduces the chance of flashing over in hunting.

MOTOR STANDARDS.—The supports upon which an electric motor rests.

MOTOR STARTER.—A rheostat, sometimes called a starting box, inserted in the armature circuit of a shunt motor to prevent an excessive rush of current before the motor attains its speed. As the speed of the motor increases the resistance is gradually cut out.

MOTOR STARTING RHEOSTAT.—A resistance provided to prevent too great a rush of current into a motor when starting; a motor starter.

MOTOR SUSPENSION.—In electric traction, the method of suspending a motor from the truck of an electric car. There are three principal types of suspension, the nose suspension, the side bar suspension and the cradle suspension. Other methods are modifications of these three. In the nose suspension, one end of the motor is carried by a lug or suspension bar while the other end is supported by the axle. In the side bar suspension, the motor is attached to the axle as usual, and the rest of its weight is borne by two parallel side bars resting upon springs. The third type consists of a cradle resting in front upon a cross beam, which is supported by the side frames of the truck and at the back, being carried on the arm that carries the axle bearing. This cradle supports the motor.

MOTOR TELEGRAPH PRINTING SYSTEM.—A system of printing telegraphy employing a pair of synchronous motors, one at each end of the line.

MOTOR TRANSFORMER.—A term sometimes applied to a dynamotor.

MOULD AND HAND WINDING.—The mould winding method is sometimes employed in winding small motors of the induction type. It takes its name from the fact that the pole coils are first wound on a mould and then placed in the slots. In most cases, one pole set of coils is wound together so that individual coils do not have to be connected together after being placed in the slots. As far as the final results are concerned, the mould type of winding has the same general appearance as the hand type. Any mould wound small motor can be hand wound, that is, one wire at a time wound in by hand when it is repaired. The starting windings of motors with either mould wound or hand wound main windings are generally skein wound, although they too may be mould wound, but they should not be hand wound because the resistance of the starting winding is very important, and in the case of a hand winding, would vary too much

MOULDED CARBONS.—Artificial carbons for arc lighting prepared by mixing ground graphite and pure carbon powder, forming a paste by the addition of some adhesive substance, and then moulding or squeezing into shape.

MOULDED CORE.—Iron dust or particles cemented together. Such construction permits making cores of any shape without difficulty.

MOULDED MICA.—An insulating material made up of pulverized mica mixed with a suitable cement and moulded into shape under pressure.

MOULDING WIRING.—A method of wiring a building by running the conductors along the walls and ceilings under suitable mouldings.

MOUSE MILL MACHINE.—A form of electric influence machine invented by Lord Kelvin.

MOUTH PIECE.—1. An opening suitable for receiving the sound waves emitted by the voice, as in telephone transmitters, phonographs and similar instru-

2. That part of a boiler furnace through which the fuel is introduced and often some air. The lower side of the mouth piece is the **dead plate.**

MOVIETONE.—The variable density method of sound reproduction on film.

MOVING COIL GALVANOMETER.—The d'Arsonval type of galvanometer, one of the two principal classes of galvanometer. A small coil is suspended by a fine wire between the poles of a magnet, with its axis at right angles with the lines of the field. Current enters the coil by its suspension and leaves it by a flexible wire below it.

MOVING COIL INSTRUMENT.—A type of ammeter or volt meter consisting of a moving coil to which is attached a pointer and which is pivoted between the poles of a permanent magnet. The coil moves between these poles and a fixed soft iron core and is held in the normal position by two spiral springs above and below the coil. The springs also serve to make electrical connection with the coil. When a current passes through the coil, magnetic lines are set up in it which are at an angle to those passing from one pole of the permanent magnet to the other. The lines of force, which formerly passed from one pole of the magnet to the other by straight lines or by short curved ones, are "stretched" on account of the field produced by the current in the coil, and in trying to shorten themselves, tend to twist the coil through an angle. This tendency to move is resisted by the two spiral springs, hence the coil moves until equilibrium is established between the two opposing forces.

MOVING IRON INSTRUMENT.—A type of ammeter or volt meter in which a soft iron needle is pivoted inside of a coil and is held out of line with the axis of the coil by means of a permanent magnet when the instrument is idle. In this position the pointer, which is attached to the needle, stands at the zero mark of the scale. If a current be passed through the coil, magnetic lines of force are set up in its center, which tend to pull the needle into line with them and, therefore, with the axis of the coil. This pull is resisted by the permanent magnet and the amount of deflection of the needle from the zero position depends upon the strength of the current or the voltage according to whether the coil is wound to indicate amperes or volts. This type of instrument depends for its action upon the pull of flux in endeavoring to reduce the reluctance of its path. Moving iron instruments are classed as: a, plunger; b, inclined coil; c, magnetic vane.

MOVING IRON OSCILLOGRAPH.—A device for measuring wave form due to Blondel, which consists of a very thin vane of iron suspended in a powerful magnetic field, thus forming a polarized magnet. Near this strip are placed two small coils which carry the current whose wave form is to be measured. The moving iron vane has a very short period of vibration and can, therefore, follow every variation in the current. Attached to the vane is a small mirror which reflects a beam of light upon some type of receiving device.

M. S.—1. Abbreviation for meter per second. 2. Mean square.

MU FACTOR.—In radio, amplification factor of a vacuum tube. The symbol is the Greek letter mu. A high mu tube is one having a high amplification factor.

MULTI-CIRCUIT ARC DYNAMO.—An arc light dynamo having a number of circuits wound upon its armature in order to prevent too high voltage in any one circuit.

MULTI-COIL WINDING.—A distributed winding.

MULTI-CONDUCTOR CABLE.—It consists of a number of individually insulated wires (either solid or stranded) which may or may not be grouped together within an outer covering. Sometimes an outer sheath of lead, steel wires or bands is placed over the cable. The term "cable" is a general one, and in practice, it is usually applied only to the larger sizes.

MULTI-GAP LIGHTNING ARRESTER.—A form of arrester in which a number of cylinders are arranged in series so as to break up the arc into several short lengths.

MULTI-METER.—A "universal" electrical measuring instrument designed to serve the purposes of a volt meter, ammeter, ohmmeter, ground detector and Wheatstone bridge. It consists essentially of a combination of a Wheatstone bridge, a battery of twelve silver chloride cells and an indicating instrument with detachable shunts.

MULTI MU TUBE.—A variable mu vacuum tube.

MULTI-PHASER.—An alternator producing two or more single phase alternating voltages differing from each other in phase; a polyphase alternator or polyphaser.

MULTIPLE CABLE.—In telephony, a cable which multiplies together two or more sections of switch banks by connecting together their terminals.

MULTIPLE CIRCUIT.—A method of connection in which current consuming devices are connected across the two leads or mains forming the circuit. Usually called parallel circuit.

MULTIPLE CONNECTION.—A term sometimes used for parallel connection.

MULTIPLE JACK.—In a multiple telephone switchboard, one of a series of spring jacks provided for each section of the board, each series containing as many jacks as there are lines entering the exchange.

MULTIPLE LIGHTNING FLASH.—A forked lightning flash appearing as a combination of flashes.

MULTIPLE PAIR BRUSH ROCKER OR YOKE.—A rocker or yoke carrying several pairs of brushes so that they may be readily shifted together upon the commutator.

MULTIPLE P. B. X. SWITCHBOARD.—A type of private branch telephone exchange in which the extension lines and the central office trunks are repeated along the face of the switchboard at every four panels, so that a call coming into the switchboard will simultaneously cause a lamp to be lighted at every appearance of that particular line and allow an operator, who is not busy at that moment, to answer the call. This feature enables the switchboard to be made up of any number of operating positions up to the limiting quantity.

MULTIPLE QUADRUPLEX.—In quadruplex telegraphy, a system of repeating messages from one line to another.

MULTIPLE SERIES CONNECTION.—A means of connection in which parallel connected groups are arranged in series.

MULTIPLE SWITCH.—A switch having contacts for several circuits.

MULTIPLE TELEGRAPHIC REPEATER.—An instrument for retransmitting a telegram from one circuit to two or more other circuits.

MULTIPLE TELEPHONE RECEIVER.—A receiver designed for use in multiple telephony.

MULTIPLE TELEPHONE SWITCHBOARD.—A switchboard designed for use in exchanges in which the number of subscribers is too great to be handled at a simple switchboard. The multiple board is divided into sections, each section containing a spring jack or terminal for every line entering the exchange, but having line drops of those subscribers only whose calls are received at that particular section; thus each operator answers the calls of only a comparatively small group of subscribers.

MULTIPLE TRANSMISSION.—In radio transmitting, two or more signals on one carrier by means of double modulation.

MULTIPLE UNIT CONTROL.—A system of operating electric trains in which each motor car is equipped with a motor controller and a master controller. The motor controller establishes the proper motor connections by means of the master controller operated by the motorman. The master controller instead of directly making the motor changes, merely actuates the motor controller. When the cars are coupled together they are operated by the master controller on the front car, the other master controllers being locked automatically.

MULTIPLE WHEEL PRINTING TELEGRAPH.—A printing telegraph apparatus having several discs or wheels for printing the messages as received.

MULTIPLE WINDING.—A lap winding as distinguished from a wave winding. Do not confuse with multiplex winding. A multiple winding has as many circuits from negative to positive brushes as there are poles in the machine.

MULTIPLES.—In a multiple telephone switchboard, the spring jacks belonging to the same subscriber, repeated at the various sections of the board.

MULTIPLEX CIRCUIT.—In telegraphy, a circuit arranged for the simultaneous transmission of one or more messages in both directions. Both duplex and quadruplex are examples of multiplex, whereas diplex is not.

MULTIPLEX WINDING.—An armature winding with two or more independent sets of coils. The number of paths in parallel is equal to that of the simplex winding multiplied by the number of independent windings.

MULTIPLICATION.—The process of taking one of two given numbers as many times as there are units in the other. The number to be multiplied or increased is called the multiplicand; the number by which the multiplicand is multiplied is called the multiplier; and the result thus obtained the product. The multiplier and multiplicand which produce the product are called its factors.

MULTIPLIER.—1. A resistance winding often located outside the instrument case of a volt meter by means of which the volt meter may measure pressures beyond its ordinary range.

2. A device in which an electric conductor is coiled several times around a magnetic needle to show that the deflecting force increases with the number of turns; an early form of galvanometer sometimes called Schweigger's multiplier.

MULTIPLYING POWER OF SHUNT.—A quantity by which the current passing through a shunt galvanometer must be multiplied, in order to obtain the value of the full current measured.

MULTIPOLAR ARMATURE.—An armature designed to rotate between more than two field magnet poles.

MULTIPOLAR BRUSH GEAR.—In large multipolar machines, the commutator brushes are held at the proper point of commutation by a gear consisting of arms offset from a cast iron rocker ring, which is itself supported by brackets projecting from the magnet yoke.

MULTIPOLAR ELECTRIC BATH.—In electro-therapeutics, a bath provided with a number of electrodes.

MULTIPOLAR FIELD MAGNETS.—These generally consist of four, six, eight or more poles, arranged in alternate order around the armature. They may be arranged in two classes according as the poles are salient or consequent poles. A type of multipolar field magnet extensively used, consists of a ring of iron having four pole pieces projecting inwardly, over which the exciting coils are slipped, the ring forming a common yoke for all the poles. As a rule, it is made in two portions, bolted together horizontally, so that the upper portion may be lifted off for examination of the armature.

MULTI-PRE-SET THEATER SWITCHBOARD.—A type which allows the operator to set up the lighting for several scenes while the first scene lighting is being used.

MULTI-SLOT WINDING.—A name sometimes given to a distributed winding.

MULTI-SPEED OR CHANGE SPEED MOTOR.—One which can be operated at any one of several distinct speeds (these speeds being practically independent of the load), but which cannot be operated at intermediate speeds. For example, a d.c. motor with two armature windings, or an induction motor with a primary winding, capable of various pole groupings.

MULTI-STAGE AMPLIFIER.—In radio, two or more stages of series or cascade amplification. Usually called two stage or three stage amplification.

MULTI-STAGE CENTRIFIGUAL PUMP.—One having numerous impellers or fans arranged in series, the delivery of one going to the suction of the succeeding one. By these means, it is possible to deliver to as great a height as with a reciprocating pump, retaining the advantages of rotary motion.

MULTI-SWITCH STARTER.—A d.c. motor starter consisting of a set of separately mounted resistors and a panel carrying a group of switches and protective devices. The switches are single pole, with heavy copper contact pieces bolted in place. Powerful coil springs are compressed when the switches are closed, so that the contacts are held firmly together. The first switch of single-pole starters, and the first two switches of double pole starters, close and open the circuit; these switches are provided with arc shields and blowout coils. A mechanical interlocking device makes it impossible to close the switches in any way but the proper order. Each starter is equipped with an overload release and a low voltage release, which throw open all the switches in event of an overload or a failure of voltage. In order to insure the closing of all the switches, a pendant switch in series with the low voltage release coil must be held closed until the last switch of the starter is closed; if this button is released before the last switch is closed, all the switches promptly open. The last switch automatically closes the release coil circuit. The motor is started by closing the switches one at a time, in regular consecutive order. In the single-pole type, the first switch closes the armature circuit with all the resistance in series and connects the shunt field of shunt and compound wound motors directly across the line; each succeeding switch short circuits a section of resistance. In the double pole type the first two switches must be closed in order to admit current to the motor.

MULTI-VOLTAGE CONTROL.—Variable voltage elevator control.

MULTI-WIRE INVERTED L AERIAL.—A multi-wire aerial with end connected lead in.

MUNTZ METAL.—Named after Muntz of Birmingham, England, its inventor. It consists of 60 per cent copper and 40 per cent zinc; is very ductile, can be forged when hot and has an ultimate tensile strength of 49,000 lbs. per sq. in.

MURIATIC ACID.—Hydrochloric acid.

MURRAY LOOP TEST.—A method of locating a fault in a telegraph or telephone circuit when there is a good wire running parallel with the defective one. In the process, the good and bad wires are joined at their distant ends and one terminal of the battery is connected to a Wheatstone bridge, while the other terminal is grounded.

MUSCLE CURRENTS.—Electric currents occurring in the muscular tissues.

MUSCULAR CONTRACTIONS.—It was discovered in 1790 that when a portion of muscle of a frog's leg, hanging by a thread of nerve bound with a silver wire was held over a copper support so that both nerve and wire touched the copper, the muscle immediately contracted.

MUSCULAR PILE.—A voltaic pile once constructed by Matteucci, consisting of muscular tissues cut from animals and laid one upon another in such a way as to generate an electric current sufficient to deflect the needle of a galvanometer.

MUSH COIL.—A type of armature coil in which the winding is not applied in regular layers and turns.

MUSHET STEEL.—A self-hardening tool steel containing about 8½ to 9 per cent of tungsten and 1½ to 2 per cent of manganese. It is remarkably hard and tough, being especially suitable for turning chilled rolls. It cannot be worked when cold except by grinding, and should be forged to shape by hammering, care being taken not to break it, reheating the tool several times while it is being dressed, and finally, when to its proper shape, hammering it lightly until the color has faded.

MUSHROOM ANCHOR.—A form of anchor without flukes, resembling a mushroom in shape, employed to prevent the dragging of buoys in submarine cable operations.

MUSHROOM DEPOSIT. — A peculiarly shaped deposit which collects upon the negative carbon of an enclosed arc lamp.

MUSICAL SPARK.—Spark transmission at rather high audio frequency spark discharge.

MUTE ANTENNA.—A name sometimes given to an artificial antenna.

MUTUAL ACTION OF MAGNETIC FIELDS.—Whenever any of the lines of force forming part of two separately generated magnetic fields traverse a common space, there is a decided action between the two sets of lines, the tendency being to so alter their paths that as many lines as possible shall coincide in direction. This mutual action takes place independently of the means by which the fields are generated, whether by currents in two wires or by permanent magnets.

MUTUAL CAPACITY.—In two neighboring conductors, the capacity effect of one upon the other.

MUTUAL FLUX.—In a transformer, the magnetic flux flowing through both coils as distinguished from a flux confined to either one of them.

MUTUAL INDUCTION.—The effect of a variable current in a circuit in causing or inducing a current in a neighboring circuit. For example, if a circuit including a battery and a switch be placed near another circuit, formed by connecting the two terminals of a galvanometer by a wire, it will be found that whenever the first circuit is closed by the switch allowing a current to pass in a given direction, a momentary current will be induced in the second circuit, as shown by the galvanometer. A similar result will follow on the opening of the battery circuit, the difference being that the momentary induced current occurring at closure moves in a direction opposite to that in the battery circuit, while the momentary current at opening moves in the same direction. Secondary induction coils or coils having two windings as high tension ignition coils or transformers operate on the principle of mutual induction, whereas primary induction coils having only one winding such as low tension ignition coils, operate on the principle of self-induction. Mutual induction is the effect of one alternating current circuit upon another.

MYCALEX.—An insulating material made of ground mica and lead borate. The mixture is moulded to any special shape desired.

MYOGRAPH.—An instrument for measuring the contractions and relaxations of muscular tissues.

MYRIA.—A prefix used with a physical unit to designate a unit ten thousand times as great.

MYRIACYCLE.—Ten kilocycles or 10,000 cycles per second.

MYRIAVOLT.—A unit of pressure equal to ten thousand volts.

MYRIAWATT.—A unit of electrical power equal to ten thousand watts.

N

N.—1. Symbol for number of conductors or turns.
2. North pole of magnet.

N or n.—Symbol for number of anything.

N. A. C. C.—Abbreviation for National Automobile Chamber of Commerce.

N. A. C. C. HORSE POWER RATING FORMULA.—A formula originally adopted by the A. L. A. M. (Association of Licensed Automobile Manufacturers) which was merged with the non-licensed manufacturers' association, after the Selden patent expired, into what is now the N. A. C. C. (National Automobile Chamber of Commerce). The formula is Horse power$=$diam$^2\times$number of cyl$\div$2.5.

NADIR.—That point of the heavens directly opposite the zenith; the point directly under the place where we stand; hence, the lowest point; the place or time of greatest depression.

NAPIER.—A neper.

NAPIERIAN LOGARITHMS.—In mathematics, those logarithms of which the base is 2.7182818 so called from Napier, the inventor of logarithms. Also called hyperbolic logarithms.

NASCENT STATE.—The state in which an atom of matter exists at the moment it is freed from chemical combination, when it possesses extraordinary properties of chemical affinity.

NATIONAL ELECTRICAL CODE.—A uniform code of rules first formulated in 1898, based upon the requirements of fire underwriters, in accordance with which all interior electric wiring must be performed in order to secure insurance upon the building wired. The code is annually revised to meet new requirements. Copies of the code may be had by applying to the National Board of Fire Underwriters at Chicago or at the nearest Underwriter's Inspection Bureau.

NATIONAL METAL MOULDING.—A protective covering for exposed wires. This moulding is made in two types, each in two wire and four wire sizes, giving the workman a choice of laying in or fishing wires. The laying in form consists of a base and capping or cover made of steel.

NATIVE COPPER.—Copper which is mined in the metallic state. It occurs in the district of Lake Superior and is highly esteemed on account of its purity, which renders it superior to any other copper for electrical purposes.

NATURAL CRYSTAL.—A crystalline mineral which conducts electricity in one direction only. Used as a detector.

NATURAL CURRENT FROM CABLE BREAK.—A weak electric current set up at the point where a fault or break occurs in a cable.

NATURAL DRAUGHT AIR COOLED TRANSFORMER.—In this type, the case containing the windings is open at the top and bottom. The column of air in the case expands as its temperature rises, becoming lighter than the cold air on the outside and is consequently displaced by the latter, resulting in a circulation of air through the case.

NATURAL FREQUENCY.—Resonance frequency.

NATURAL LAW.—A law of the natural or material universe, a physical law. The law of gravitation is a natural law.

NATURAL LOGARITHM.—A Napierian logarithm, that is, one having as a base the number 2.71828.

NATURAL MAGNET.—Certain hard black stones which possess the property of attracting small pieces of iron and have the remarkable property of pointing north and south when hung up by a string. The ancients called these stones magnes lapes. They are known as lodestones or "leading stones" or load stones; commonly, though incorrectly spelled loadstone.

NATURAL PERIOD.—A complete period of vibration or cycle of periodic change fulfilling without interference its natural course.

NATURAL RECTIFIER.—Descriptive of a mineral which possesses the property of passing the electric current in only one direction.

NATURAL WAVE LENGTH.—In a radio circuit, a wave length corresponding to the resonant frequency. The fundamental wave length.

NAUTICAL MILE.—A unit of distance at sea, equal to 6080.26 feet, or 1.15156 statute miles; a knot, or naut.

N. B. S.—Abbreviation for New British Standard wire gauge.

N-CONDUCTOR CABLE.—A combination of N conductors insulated from one another. It is not intended that the name as here given be actually used. Cables are called "3 conductor cable," a "12 conductor cable," etc. In referring to the general case, it is called a multiple-conductor cable.

NEBULÆ.—Cloud like luminous masses in the heavens situated far beyond the solar system. They have been observed through the telescope to consist, in many cases, of clusters of very distant stars.

N.E.C.S.—National Electrical Code Standard (of the National Board of Fire Underwriters).

NEEDLE.—1. The pointer which swings over the dial of an electric or other measuring instrument.

2. A light magnetized steel pointer suspended upon a pivot in a mariner's compass so as to set itself in a north and south position along the earth's magnetic meridian.

3. In dial telegraphy, the indicator which swings to the left or right according to the telegraphic code.

NEEDLE GAP.—A device used to measure high voltages by passage of a spark across a variable gap between two pointed rods.

NEEDLE INSTRUMENT.—The instrument employed as receiver in the needle telegraph. It consists, in its simplest form, of a vertical galvanometer in which a magnetic needle is deflected to the right or left over a dial, when a current is sent in one direction or another around a coil surrounding the needle.

NEEDLE POINTS.—1. Points of needles, used to fasten fine cabinet work together as dowels.

2. Needles used as points for compasses, dividers and other mathematical instruments, to avoid tearing holes in the paper. The needles are usually locked in the point by means of a nut and bolt, so as to be easily renewable.

NEEDLE TELEGRAPHY.—A system of telegraphy once widely used in England, but now almost wholly superseded by the Morse system; its operation depended upon the right and left swings of a magnetic needle over the face of a dial according to a code of motions comprising the entire alphabet.

NEEDLE VALVE.—One consisting of a long fine point to its spindle, the point just fitting into a hole which its motion opens or closes. Needle valves are designed for standard working pressures for controling air, gas, gasoline and other liquids requiring close regulation. A desirable type of valve for returning excess boiler feed water to the hot well in small condensing marine steam plants.

NEGATIVE.—1. The opposite to positive.

2. In electrical apparatus, the pole or direction toward which the current is supposed to flow, that pole which wastes away the least in an arc lamp or during electrolytic processes.

3. In a vacuum tube the direction of flow of the electrons is contrary to the usual conception of the direction of flow of electricity, which is considered to be from positive to negative. The reason for this is that before the discovery of electrons experimenters decided to consider that current flowed from positive to negative as a sort of arbitrary rule. This rule has continued in use even though later experiments seemed to prove the contrary to be true. Therefore, current is always considered to flow from positive to negative, although the electrons actually travel in the opposite direction.

NEGATIVE AND POSITIVE.—An electric pressure less than that of the earth is called negative, and when greater, it is called positive.

NEGATIVE BIAS.—In a radio vacuum tube a voltage impressed on the grid lower than the voltage of the negative end of the filament.

NEGATIVE CARBON.—In a d.c. arc lamp, the lower carbon rod to which the current flows across the arc from the upper, or positive carbon.

NEGATIVE ELECTRIFICATION.—A charge of resinous electricity, or that developed by rubbing sealing wax with flannel; a negative charge.

NEGATIVE ELECTRODE.—A negative element.

NEGATIVE ELEMENT.—In a primary cell, the electrode (of copper, carbon, etc.) by which the current leaves the cell. Accordingly it must be evident that the terminal of the negative element is positive.

NEGATIVE GLOW.—In electrical discharges between electrodes in a high vacuum tube, a luminous region seen next to the Crookes' dark space.

NEGATIVE GRID.—In a radio tube a control grid having a negative bias.

NEGATIVE ION.—An atom combined with an electron; sometimes called anion.

NEGATIVE LEAD.—In valve gears, the amount by which the steam port is closed to admission when the piston is at the

NEGATIVE LIGHTNING.—A term applied to those branches of a flash of lightning which show black in a photographic negative.

NEGATIVE PHASE OF ELECTROTONUS.—In electro-therapeutics, an effect of reducing the voltage in a nerve, produced when a current is passed through the nerve in a direction opposite to that of the nerve current.

NEGATIVE PLATE OF STORAGE CELL.—The plate, composed of pure lead with a spongy surface, from which the current flows toward the positive plate in the process of discharging; it is usually of a grayish color.

NEGATIVE POLE.—1. The south seeking pole of a magnet.

2. In a primary cell, the pole of the positive element, being negative to the external circuit.

NEGATIVE PROLONGED IMPULSE.—In electro-therapeutics, the sinusoidal current, although free of polar effects, will, according to Pflueger, cause irritability at the negative pole and in order to overcome the irritability, it follows that the reversals of polarity must take place, according to Prof. Emil DuBois Reymond's findings and that the current is reversed not only suddenly, but the reversals must also take place a larger number of times in a given period. The larger the number of reversals per minute, the shorter the time of irritability. This fact is fully demonstrated by the diathermy currents, where the reversal of polarity takes place many thousands or even millions of times per second.

NEGATIVE TEMPERATURE COEFFICIENT.—The property of a substance whereby resistance decreases with rise of temperature. Substances having negative temperature coefficients are mostly liquid conductors and carbon.

NEGATIVE VOLTAGE.—A pressure less than that of the earth, the latter being taken as zero.

NEGATRON TUBE.—A four element vacuum tube having a filament, two plates and a rod grid. The filament is located between the two plates. The tube is designed to obtain negative resistance characteristics.

N.E.L.A.—Abbreviation for National Electric Light Association, now Edison Electrical Institute.

NEON GAS.—One of the natural gases in the air prevalent in the proportion of one part of neon to every 65,000 parts of air. When neon gas, as in a Neon luminous tube light is excited by passing electric current through it; the gas glows with a characteristic color.

NEON OSCILLATOR.—The combination of a neon lamp and a variable condenser.

NEON VACUUM TUBE LIGHT.—A vacuum tube lamp containing a small amount of Neon gas and an electrode at each end of the long tube. When current is applied, the tube glows with an orange red color. Various other gases alone and in combination are used to secure other colors. For a blue light mercury is introduced into the tube which vaporizes. For a green light, the contents of the tube are the same as for a blue light, and an amber colored glass is used instead of the transparent glass.

NEPER.—A unit for power measurement in the Napierian system=½ nat. log. of the ratio of the two powers considered.

NERNST LAMP.—An incandescent lamp having for its light giving element, a pencil composed of the refractory oxides of rare earth, termed the "glower," which becomes incandescent upon the passage of an electric current. The glower is an insulator when cold, but becomes a conductor when heated. The necessary heat is conveyed to the glower by means of "heaters" consisting of thin porcelain tubes wound with fine platinum wire and coated with a refractory paste. A cut out device opens the circuit through the heater when the glower arrives at the proper temperature, and a steadying resistance called the "ballast" prevents the glower's burning out.

NET OR COMMERCIAL EFFICIENCY.—If an entire power plant be regarded not merely from the standpoint of combined efficiency of the power system but also takes into consideration its cost, depreciation, maintenance, etc., a true idea of the actual cost of the power is obtained. A factor may be found which takes into account all these items and which is called the net efficiency. It must be evident that this is a most important point, for upon it depends the actual cost of the power.

NETWORK.—A number of sources of power interconnected in such a manner that any or all of the power sources may be drawn upon to feed into any one of the power consuming stations.

NEUTRAL ARMATURE.—The unmagnetized armature of a neutral, or non-polarized telegraph relay; a non-polarized armature.

NEUTRAL BUS BAR.—In the three wire system of electrical distribution, a bus bar connected to a point between the two dynamos.

NEUTRAL CURRENTS.—Stray electric currents which traverse the ground, often escaping from electric railway and other electric systems, earth currents.

NEUTRAL FEEDER.—A feeder connected with the neutral wire in a three wire system.

NEUTRAL LINE OR SECTION OF MAGNET.—In a bar magnet, the portion of the magnet lying midway between the two poles, a region where there appears to reside no magnetic attraction whatever; the equator of the magnet.

NEUTRAL PLANE.—An imaginary plane passing through the axis of the armature and in the position of zero induction with distorted field, that is, at right angles to the plane of maximum induction.

NEUTRAL POSITION OF BRUSHES.—The position of the brushes corresponding to zero induction with a distorted field

NEUTRAL RELAY.—A telegraph relay in which the armature of the electro-magnet is not magnetized; a non-polarized relay.

NEUTRAL SALT.—In chemistry, a salt which exhibits neither acid nor alkaline properties.

NEUTRAL WIRE.—In a three wire system the middle wire which is connected to the lead joining the two electrical sources which are in series. The neutral wire keeps the system balanced in case of unequal loading, that is, a current will flow through it, to or from the current sources according to the preponderance of load on the one side or the other.

Theoretically, the size of the neutral wire has to be only sufficient to carry the largest current that will pass through it. A large margin of safety, however, is allowed in practice so that its cross section ranges from about one-third that of the outside line, in large central station systems, to the same as that of each outside line in small isolated systems.

NEUTRALIZED OR COMPENSATED A.C. MOTOR.—A series a.c. motor having a neutralizing coil to diminish the armature self-induction. The neutralizing coil is wound upon the frame 90 magnetic degrees or half a pole pitch from the field winding and arranged to carry a current equal in magnetic pressure and opposite in phase to the current in the armature.

NEUTRALIZING CONDENSER.—In radio, a condenser used to balance a circuit.

NEUTRODONS.—The small neutralizing condensers placed between successive tubes in a neutrodyne radio receiving set.

NEUTRODYNE.—A radio circuit due to L. A. Hazeltine which uses five tubes, two stages of tuned and neutralized radio frequency amplification, with detector and two audio frequency stages. In the neutrodyne circuit the feed back tendency of the radio frequency amplification with consequent oscillation, is eliminated. This is done by specially designed small size neutralizing condensers placed between successive tubes. The special neutralizing condensers are called neutrodons. The capacity of these is very low, being approximately equal to the internal capacity of a vacuum tube. By reason of this equality, any tendency of a large amount of radio frequency current to pass back through the tube through the grid is defeated and instead is neutralized by the combination of the neutralizing capacities, the inter-element capacity of the vacuum tubes and the secondary windings of the tuned radio frequency transformers. This effect is in reality a bucking one, since the current is made to take two paths.

NEUTRON.—A proton and an electron in very close union existing in the nucleus. For decades previous to the discovery of the neutron it was supposed that the atom was made up of a relatively heavy core, the nucleus composed of protons and some electrons tightly packed, but still independent, and a series of electrons which revolved about the nucleus, much like the planets around the sun. Then came the discovery that the neutrons existed in the nucleus.

NEWTON, SIR ISAAC.—Born 1642, died 1727. An English mathematician and physicist, famous for his discovery of the universal law of gravitation. He also discovered the binomial theorem, differential and integral calculus, and first computed the area of the hyperbola. He invented a reflecting telescope in 1668. He completed his famous work "Principia" in 1687, embodying his views upon the attraction of gravitation. After this he took active part in public affairs, receiving many distinctions and honors and at his death was buried in Westminster Abbey.

NEWTON'S LAWS OF MOTION.—1. If a body be at rest it will remain at rest; or if in motion, it will move uniformly in a straight line until acted upon by some force.

2. If a body be acted upon by several forces, it will obey each as though the others were non-existent, and this, whether the body be at rest or in mo-

3. If a force act to change the state of a body with respect to rest or motion, the body will offer a resistance equal and directly opposed to the force. In other words, every action is opposed by an equal and opposite reaction.

N.h.p.—Abbreviation for nominal horse power.

NIAUDET'S DISC ARMATURE. — It is equivalent to a ring armature, having the coils turned through an angle of 90°, so that all the coils lie in a plane perpendicular to the axis of rotation. The main difficulty with this type has been in constructing it so that it will be strong and capable of resisting wear and tear. It was introduced in an effort to avoid the losses due to eddy currents and hysteresis present in the other types of armature. Obsolete.

NIB.—A deposit which forms on the negative carbon when an arc is maintained between two parallel carbons.

NICKEL.—A grayish white malleable ductile metal capable of a high polish. It is magnetic but is not easily oxidized, hence its use in nickel plating. An addition of 5 per cent of nickel increases the tensile strength of steel one-half; the metal is used in nickel plating, as mentioned above, and alloyed in equal proportions of copper and zinc (1/3 of each) it constitutes German silver, much employed for mathematical and drawing instruments, and for resistance wires. Nickel becomes non-magnetic at 650° F. Melting point of commercial nickel, 2550 to 2900° F. approx.; thermal conductivity, 14.2 (silver=100); electrical conductivity 12.9 (silver=100); linear expansion, .00000695.

NICKEL BATH.—A bath for nickel plating, in which the solution is prepared from nickel salts, or other double sulphate of nickel and ammonia.

NICKEL FACING OF ELECTROTYPE.—A layer of nickel sometimes deposited upon the face of an electrotype to increase its durability.

NICKEL IRON CELL.—A storage battery cell devised by Edison which is claimed to be lighter and more enduring than the lead cell, and better suited to electric vehicle service. The active material of the positive plate is peroxide of nickel, and that of the negative plate finely divided iron.

NICKEL PLATING.—Electro-plating an object with nickel by suspending the object to be plated as the cathode in a nickel bath, while a sheet of rolled nickel forms the anode. Nickel does not adhere very well to iron or steel articles, and furthermore, if after being plated upon steel, the article becomes scratched, the steel rusts, and the rust, getting beneath the nickel film, causes it to peel off.

NICKEL PLATING SOLUTION.—The best solution is that which is made up of the double sulphate of nickel and ammonium, in the proportion of 12 ounces to one pound of the double salt to each gallon of solution. The crystals should be dissolved in boiling water in a wooden tub, frequently stirred and cold water added to make up the desired quantity. After the solution has become cool it should be filtered.

NICKEL SILVER.—An alloy of copper, nickel and zinc having somewhat the same color and luster as silver. Also called German silver.

NICKEL STEEL.—Ordinary soft steel to which has been added a small percentage of nickel; it has been found that the addition of about three per cent (3.16 to 3.32) produces the most favorable results.

NICKELINE.—A nickel alloy specially prepared for use in electrical instruments, resistances, etc.

NIEWENGLOWSKI RAYS.—Ethereal radiations capable of affecting a photographic plate. They are given off by phosphorescent bodies after exposure to sunlight.

NIGGER.—A shop name for any fault encountered in the working of electrical apparatus; a bug.

NIGGER ENGINE.—In Mississippi River steam boat practice, a pair of oscillating or reciprocating engines connected by gearing to a capstan.

NIGHT EFFECT.—In radio, a fading or weakening of radio signals especially on wave lengths shorter than 400 meters.

NIGHT SWITCH.—In a telephone exchange, a switch by which the switchboard drops are placed in connection with a night bell which summons the operator the instant a drop falls.

NIL INDICATOR.—A null indicator.

NIPPLE.—A piece of pipe not exceeding 12 ins. in length, threaded at each end. This is the pipe manufacturer's definition; in pipe fitting, any short length of pipe with a male thread on each end; nipples are classified according to length, as close, short and long.

NIPPLE OF CARBON.—The point formed upon the tip of the negative carbon in a d.c. arc lamp, just below the crater of the positive carbon.

NITER (NITRE).—A biting, white nitrate; niter is used in the arts under the name of saltpeter, especially in the manufacture of gunpowder.

NITON.—An inert gas contained in radium emanation regarded as an element, symbol Nt, atomic weight, 222.4. Also called radon.

NITRATE.—A salt formed by the action of nitric acid on a base.

NITRATE OF SILVER.—A salt employed in silver plating. It is formed by the chemical action of nitric acid upon silver, pure silver being added in small quantities to a warm mixture of one part distilled water to four parts strong nitric acid.

NITRATE OF SODA.—The commercial name for sodium nitrate, also known as Chili saltpeter, occurring in immense quantities just below the surface in Peru and Chili.

NITRIC ACID.—Also known as aqua fortis. A compound of hydrogen, nitrogen, and oxygen. A powerful reagent extensively used in the manufacture of explosives, coal tar colors, commercial nitrates, as an oxidizing agent, etc. In the Grove and Bunsen primary cell, nitric acid is used as a depolarizer. It is also used in silver plating to form the nitrate of silver salt.

NITROGEN LAMP.—An incandescent lamp in which the filament is placed in a nitrogen filled tube.

NO LOAD CURRENT.—A very small current which flows in the primary of a transformer when the secondary is open. The reason for this is as follows: The alternating current flowing in the primary winding causes repeated reversals of magnetic flux through the iron core. These variations of flux induce pressures in both coils; that induced in the primary called the reverse pressure is opposite in direction and very nearly equal to the impressed pressure, that is, to the pressure applied to the primary winding. Accordingly the only force available to cause current to flow through the primary winding is the difference between the impressed pressure and reverse pressure, this difference being called the effective pressure.

NO VOLTAGE RELEASE.—An automatic device on a rheostat consisting of a magnet, whose attracting force holds the lever in the on position against the resistance of a spring. If the voltage fail, the lever is rotated to off position by the action of a spring.

NOBILI'S RINGS.—A phenomenon observed when electrolysis takes place through a lead solution when the anode is a plate of polished metal lying horizontally under a platinum wire as a cathode. The deposit takes place in rings showing rainbow tints; also called **metallochromes.**

NODES.—1. In a circuit through which an oscillatory current is passing, points of constant pressure located between each loop of vibration.

2. Points in a transversely vibrating body, as a string or wire, which remain at rest between two successive vibrating loops; **nodal points.**

NODON VALVE.—An electrolytic rectifier having an aluminum or aluminum alloy cathode and the other electrode, which has considerably more surface, is the containing vessel. The electrolyte is a neutral solution of ammonia phosphate.

NODULAR DEPOSIT.—In electro-plating, a deposit of uneven thickness caused by insufficient current density.

NOISE ELIMINATOR. — An apparatus placed in a window to eliminate outside noise, comprising a labyrinth of acoustically treated passage-ways so designed as to break up the air current flow and absorb outside sound.

NOISELESS RECORDING.—A film sound recording, discriminating device which rejects sounds other than those intended for the film, that is, sounds known as "background noises."

NOISY ARC.—An arc lamp which emits a hissing sound, usually as the result of too much current; a **hissing arc.**

NOISY BEARINGS.—Many bearings become noisy or broken from incorrect line up on engine with driving shaft and coupling. Excessive side or end pressure on bearings, especially a tight drive chain, produces noise and wear.

NOMINAL HORSE POWER.—In the early days Watt, according to Seaton, found that the mean effective pressure usually obtained in the cylinders of his engines was 7 lbs. per sq. in. He had also found the proper piston speed$=128\times$the cube root of the strokes per minute, and his engines were arranged to work at this speed, so that he estimated the power which would be developed when at work to be

$$\text{N.H.P.}=A\times 7\times 128\times \sqrt[3]{S}$$

In which A=area of piston in sq. ins.; S=number of strokes per minute. The term nominal horse power is now obsolete and is only of historical interest.

NON-ARCING FUSE.—A safety fuse made of a non-arcing metal which will melt without forming an arc.

NON-ARCING LIGHTNING ARRESTER.—A lightning arrester employing fuses made of non-arcing metal.

NON-ARCING METAL.—An alloy obtained by uniting certain metals of the cadmium group which have such properties that electrodes made of them cannot sustain an arc.

NON-ARCING MULTI-GAP ARRESTER.—A lightning arrester whose operation is due to air gaps and non-arcing metals. The action is such that the "line current" which follows the lightning discharge follows as an arc, but is stopped at the end of one alternation because of the property of the non-arcing metals to carry an arc in one direction, but requiring an extremely high voltage to start a reverse arc. The non-arcing metals ordinarily employed are alloys of zinc and copper. Plain multi-gap arresters operate satisfactorily with the smaller machines and on circuits of limited power, particularly low voltage circuits.

NON-BREAK SYSTEM.—A one-way transmission channel.

NON-CONDUCTOR.—A name erroneously used for insulator. There is no such thing as a non-conductor of electricity.

NON-FERRIC.—Not containing iron.

NON-FERROUS METALS.—Those not obtained from iron.

NON-INDUCTIVE CIRCUIT. — A circuit having no inductance, or one in which the inductance is neutralized by capacity. In a non-inductive circuit the current is in phase with the voltage, unless the capacity be more than enough to neutralize the inductance. When this condition obtains, the current leads the voltage.

NON-INDUCTIVE COIL.—A coil having a single winding so wound that the inductance of one half of the winding is opposed and neutralized by that of the other half. Such a coil may be wound by doubling the wire upon itself and then winding the two parallel halves side by side.

NON-LINEAR. — A term descriptive of changes in two quantities which do not vary proportionately.

NON-LUMINOUS RADIATION. — Invisible radiation, as of light waves outside the range of the visible spectrum, and of heat waves which are insensible to the eye; obscure radiation, as distinguished from light.

NON-MAGNETIC.—A property of any substance which cannot be magnetized. There are many non-magnetic materials, iron and steel being the important exceptions.

NON-MAGNETIC STEEL.—Certain grades of nickel steel, and other steel alloys, which can be rendered practically unmagnetizable.

NON-METALLIC SHEATHED CABLE.—A cable built up by first sheathing a rubber covered Code wire, in a tough, closely laid jacket of laminated kraft tape, which is permanently held in place by a cotton braid. After saturation with special compounds this semi-finished conductor is armored with a second jacket of long fibre kraft tape, and a fire and moisture resistant compound applied. Two or more of these heavily armored conductors are then gathered, with their reinforcing filler cords, under an extra heavy fabric braid, and the cable given two final impregnations of fire and moisture resistant compounds. This type of cable is designed for the wiring of residences and similar buildings of frame or semi-frame construction which are generally classified as dry locations, and in which the difference in pressure between two conductors does not exceed 300 volts.

NON-MULTIPLE HARMONIC SIGNALING.—In telephony, a method which employs frequencies which are not integral multiples of the lowest frequency.

NON-MULTIPLE P.B.X. SWITCHBOARD. A type of private branch telephone exchange in which the extension lines and the Central Office trunks appear at only one spot on the face of the switchboard. Switchboards having this limiting device are made up of a few operating positions and are designed to fulfill a lighter demand for telephone service.

NON-PHANTOMED CIRCUIT.—A two wire circuit, which is not arranged for use as the side of a phantom circuit.

NON-POLAR RELAY.—In telegraphy, a relay operating in response to a change in the strength of the current in the controlling circuit, irrespective of the direction of the current. It has an unmagnetized armature. A non-polarized or neutral relay.

NON-REACTIVE LOAD.—In an alternating current circuit, a load in which any inductance in the circuit is neutralized by capacity so that the current is in phase with the voltage.

NON-RENEWABLE CARTRIDGE FUSE.—A fuse in which the fusible element is encased in a fibre tube filled with a non-inflammable material and closed at the end with ferrules. On arcing, part of the fusible element is vaporized, and the filling compound absorbs or chills and condenses this vapor, rendering it non-conducting and thereby extinguishing the arc.

NON-SYNCHRONOUS GAP. — A rotating spark gap in which the interruptions are not in phase with the instants of maximum voltage.

NORMAL.—1. A perpendicular.

2. A line perpendicular to a tangent at the point of tangency. The normal lying in the plane of the curve.

3. A line perpendicular to a plane.

NORMAL AND ABNORMAL SLIP.—In marine propeller propulsion, the percentage of slip varies considerably. Assuming the propeller used is correct for the installation, normal slip, as given by Hyde Windlass Co., is "from 15 to 25%, depending upon the type of boat. In some cases, however, if the hull of the boat be of heavy construction and of bluff lines, a slip of 30% is common." Evidently this refers to gas engine installations, because gas engines usually run at speeds too high for good propeller efficiency. Seaton states that "the slip generally should be about 8 to 10% at full speed in well formed vessels with moderately fine lines; in bluff cargo boats, it rarely exceeds 5%"—this relates to steam rigs, and the wide difference between 30 and 5% slip may be attributed to the better combination of engine speed and propeller dimensions in the case of the steam engine. According to one manufacturer of propeller wheels, "the best results are obtained on motor boats with a slip of from 15 to 25%."

NORMAL MAGNETIC DAY.—A day in which there are no extraordinary variations in the earth's magnetic elements.

NORMAL NEUTRAL PLANE.—An imaginary plane passing through the axis of the armature perpendicular to the magnetic field of the machine when there is no flow of current in the armature. It is the plane in which the brushes would be placed to prevent sparking when the machine is in operation were the field not distorted by armature reaction, and were there no self-induction in the coils.

NORTH.—That one of the four cardinal points of the compass, at any place, which lies in the direction of the true meridian and to the left hand of a person facing the east; the direction opposite to the south.

NORTH POLE.—That point on the earth, ninety degrees from the equator, toward the north.

NORTH POLE OF MAGNET.—The pole of a magnet, or magnetic needle, which tends to point to the north; also known as the boreal, marked, north seeking, positive, plus (+), and red pole.

NORTH SEEKING POLE.—The north pole of a magnet.

NOSE DIVE.—A dangerously steep airplane descent.

NOSE MOTOR SUSPENSION.—A method of suspending a motor upon a car truck, in which one side of the motor case rests upon the axle, while a projecting lug upon the other side rests upon a steel crossbar.

NOTCHING.—A qualifying term applied to any relay indicating that a number of separate impulses is required to complete its operation.—NEMA.

NOTE MAGNIFIER.—The British term for audio frequency amplifier.

N-RAYS.—Blondlot rays.

NULL INDICATOR.—A zero voltage or zero amperage indicator. Used in null or nil method of testing, as in bridge measurements.

NULL OR NIL METHOD.—A method of making electrical measurements in which comparison is made between two quantities by reducing one to equality with the other, the absence of deflection from zero of the instrument scale showing that the equality has been obtained; the zero method.

NUMBER 1 SIDE OF QUADRUPLEX SYSTEM.—In telegraphy, that portion of the quadruplex which causes and responds to the reversals of polarity.

NUMBER 2 SIDE OF QUADRUPLEX SYSTEM.—In telegraphy, that portion of the quadruplex which causes and responds to the increase and decrease of current strength.

NUMERATION.—The system of reading numbers.

NUMERATOR.—That part of a fraction which expresses the number of parts taken.

O

O.—Abbreviation for ohm, the practical unit of electrical resistance.

OBLIQUE AND PARALLEL CIRCUIT LAWS.—The following are the laws which apply to oblique and parallel circuits as discovered by Ampere:

1. Two portions of circuits crossing obliquely attract each other if both the currents run either toward or from the point of crossing and repel each other, if one runs to and the other from that point.

2. Two parallel portions of a circuit attract each other if the currents in them are flowing in the same direction and repel each other if the currents flow in opposite directions.

3. The force exerted between two parallel portions of circuits is proportional to the product of the strengths of the two currents, to the length of the portions, and inversely proportional to the simple distance between them.

OBLIQUE ANGLE.—Any angle except 0, 90, 180, 270 or 360 degrees.

OBLONG.—1. Descriptive of a rectangle that is not extremely elongated.

2. Having one principal axis longer than the other, or others.

OBSCURE RADIATION.—1. That portion of the radiation from a light source which fails to emit light but passes off in heat.

2. In a luminous spectrum, radiation existing beyond the violet rays, invisible to the eye but known by their chemical action as actinic or chemical rays.

OBSERVED RADIO BEARING.—The angle between the direction of a received radio wave and an arbitrary fixed line, such as the center line of a ship.

OBTUSE ANGLE.—One greater than a right angle.

OD.—A supposed force alleged by Reichenbach to account for the phenomena of mesmerism or animal magnetism.

ODOMETER.—An instrument mounted on the dashboard of an automobile for measuring the distance traveled in miles and 10ths of a mile. A separate dial which can be reset to zero is used for recording trip mileage.

ODORSCOPE.—An apparatus for testing odors, in which a carbon contact is designed to be so influenced by the action of the odor as to affect the indication of a galvanometer.

ODYLIC RAYS.—Alleged streamings of the od force supposed to be emitted from certain crystals, or from poles of magnets and recognized only by its effects on peculiarly sensitive persons. Supposed to account for mesmerism or animal magnetism.

OERSTED.—The unit of reluctance or magnetic resistance, being the reluctance offered by a cubic centimeter of vacuum.

OERSTED, HANS CHRISTIAN.—Born 1777, died 1851. A Danish physicist, noted for his experiments on the magnetic needle with the electric current; he discovered (1820) that a magnetic needle was deflected by an electric current in a wire passing over and under it, and he first suggested the idea (1821) that light is a manifestation of electro-magnetism.

OERSTED'S DISCOVERY.—The important discovery made by Hans Christian Oersted, the Danish scientist, in 1819, of the magnetic effects of the electric current. In 1820 he showed that a magnet tends to set itself at right angles to a wire carrying an electric current. He also found that the way in which the needle turns, whether to the right or to the left of its usual position, depends upon the position of the wire that carries the current, whether it be above or below the needle, and on the direction in which the current flows through the wire.

OFFSET CALCULATIONS.—1. In pipe or conduit fitting, an offset is a change of direction (other than 90°) in a conduit bringing one part out of, but parallel with the line of another. The following rule will be found convenient for calculating 45° elbows:

Rule—For each inch of offset add 53/128 of an inch and the result will be the length between centers of the elbows. Instead of using fittings such as elbows, tees, Ys, etc., turns in the direction of the conduit are usually made by bending.

2. A convenient method is by the use of constants.

Rule—To find length between centers of elbows, multiply offset by constant for the elbow used.

OFFSET FITTING.—A pipe fitting for joining two parallel pipe lines. In piping sometimes part of the pipe line must be in a position parallel with, but not in alignment with the balance of the pipe. An experienced pipe fitter can offset the line by bending the pipe, but ordinarily where the offset or distance between the two pipe axes is of standard dimension, an offset fitting can be used to advantage.

OHM.—1. The practical unit of electrical resistance = one billion or 10^9 abohms (known as the true ohm).

2. The legal ohm was recommended in 1884 by a Commission of the International Congress of Electricians, Paris, although it was never given legal sanction. It is defined as the resistance at 0° C. of a column of mercury 106 cm. in length and 1 sq. mm. in cross section.

3. The international ohm as defined by the International Electrical Congress at Chicago in 1893 and slightly modified by the London Electrical Conference in 1908 = the resistance at 0°C. of a column of mercury of uniform cross section, having a length of 106.3 cm. and a mass of 14.4521 grams. Experimental results show that one international ohm = 1.0005 absolute ohms. The International Committee of Weights and Measures has decided to discard the international units in the near future.

OHM, GEORG SIMON.—Born 1787, died 1854. A German physicist, noted for his researches with electric currents. He formulated (1827) the law known as Ohm's law, which underlies all modern electrical theory and measurement.

OHM MILE.—The mile ohm, a wire one mile in length and having a resistance of one ohm. A No. 3 B & S gauge copper wire has a resistance of 1.038 ohm per mile, approximately one ohm.

OHM'S LAW.—In a given circuit, the amount of current in amperes is equal to the pressure in volts divided by the resistance in ohms, that is:

$$\text{current} = \frac{\text{pressure}}{\text{resistance}} = \frac{\text{volts}}{\text{ohms}}$$

Expressed as a formula

$$I = \frac{E}{R} \text{ from which } E = IR \text{ and } R = \frac{E}{I}$$

In the formula
I=current strength in amperes.
E=pressure in volts.
R=resistance in ohms.

OHMAGE.—The resistance of an electrical circuit in ohms.

OHMIC.—1. Relating to true electrical resistance measured in ohms.
2. In a.c. circuits, descriptive of the true resistance as distinguished from the spurious resistance.

OHMIC DROP.—Drop in voltage in a circuit due to resistance. The drop in voltage between any two given points A and B in a circuit is obtained by the formula:

$$\text{drop} = E - IR$$

in which
E=voltage at point A
I=amperes at point B
R=resistance of wire between points A and B.

OHMIC RESISTANCE.—1. Opposition to electric current flow due to the material, size and temperature of the conductor. Measured in ohms.
2. The true resistance as distinguished from the spurious resistance.

OHMIC VALUE OF CAPACITY—An equivalent which is calculated from the equation:

$$X_c = \frac{1}{2\pi f C}$$

in which X_c=ohmic value of capacity; f=frequency; C=capacity in farads.

OHMIC VALUE OF INDUCTANCE.—An equivalent which is calculated from the equation

$$X_l = 2\pi f L$$

in which X_l=ohmic value of inductance; f=frequency; L=inductance in henries.

OHMMETER.—A form of galvanometer for measuring electrical resistance in which a pointer indicates directly the number of ohms in the resistance under measurement.

OIL BREAK SWITCH.—One in which the circuit is broken under oil. The oil switch is used mostly on high pressure a.c. circuits, because of the fact that the oil tends to cause the current to break when at its zero value, thus preventing the heavy arcing which would occur with an air break switch, and the consequent surges in the line which are so often the cause of breakdown of the insulation of the system.

OIL CIRCUIT BREAKER.—A type of switch in which the circuit is broken under oil. Specially adapted for high voltage a.c. circuits of large power. The oil breaker terminates the a.c. wave at its normal zero value, eliminating excessive surges in the connected circuits and reduces fire and life hazards.

OIL CIRCUIT BREAKER OPERATION.—When an oil circuit breaker is opened under load, an arc is formed between the stationary and the moving contacts, the size of the arc depending upon the voltage, the amount of current and rate of contact separation. The heat of the arc disintegrates some portion of the arcing contact and some of the oil surrounding the contacts forms a gas bubble. The gas bubble is almost immediately carried away from the contacts and if the contacts have been sufficiently separated, the arc will persist only until the next zero of the current wave.

OIL COOLED TRANSFORMER.—A type in which the coils and core are immersed in oil and provided with ducts to allow the oil to circulate by convection and thus serve as a medium to transmit the heat to the case, from which it passes by radiation. The oil, heated by contact with the exposed surfaces of the core and coils, rises to the surface, flows outward and descends along the sides of the transformer case from the outer surface of which the heat is radiated into the air.

OIL DAMPING.—A method of bringing the moving parts of an electric measuring instrument quickly to rest by means of the resistance offered to a vane or paddle by the oil in which it is immersed.

OIL FILLED CABLE.—An extra high tension cable (voltage up to 132,000) in which the whole cable is kept constantly filled with oil under pressure both in the hollow core of the conductor and throughout the surrounding insulation. The unique advantage of this type of construction is that should the lead sheath be expanded or distorted, or the internal elements of the cable be displaced by temperature variation or other causes, the spaces thus formed will be immediately filled with oil, while in a solid insulation type voids would be formed, causing ionization and ultimate failure. It is thus evident that this new type of cable should be able to operate safely over a much larger range of copper temperature and, therefore, of load than a solid insulation type, even if the latter be operated at only 66,000 volts or less.

OIL INSULATION FOR STORAGE BATTERY.—The use of resin oil or some other non-evaporating oil, in the cups of the mushroom insulators upon which the storage cells rest.

OIL SWITCH.—In high tension electric transmission, a form of circuit breaker designed to effect the breaking of the circuit under paraffin oil; an oil break switch.

OIL TRANSFORMER. — A transformer which is kept insulated by being immersed in oil, which serves to insulate the coils from each other and the core, and at the same time acts as a cooling medium by conducting the heat away from the coils to the air or to a system of water pipes. In the case of high voltage transformers, any accidental static discharge such as that due to lightning, which might destroy one of the air insulated type, might be successfully withstood by one insulated with oil, for if the oil insulation be damaged, it will mend itself at once.

OILED CLOTH.—Muslin or cotton cloth treated with linseed oil to increase the insulating strength.

OILED PAPER.—Insulating paper saturated with oil or varnish to render it a better insulator.

OKONITE.—A compound of high resistance employed for insulation purposes.

OLDHAM COUPLING.—A driving connection consisting of two flanges attached to the shafts to be connected and a disc placed between them. Each flange has a groove which registers with a keylike ridge on each face of the disc, machined to a loose fit to give some flexibility to the connection.

OLIVETTE BOX.—An apparatus for throwing a flood of colored light upon a stage, consisting essentially of an arc lamp enclosed in a box having a window of colored glass.

OMNIBUS BARS. — Commonly called bus bars, the main switchboard conductors to which the current is led from a dynamo or alternator through suitable cables, switches and indicating instruments.

OMNIGRAPH.—An instrument for converting the perforations in a tape or disc of insulating material into audible code signals.

ONDOGRAPH.—A device for measurement of alternating current waves. The Hospitalier ondograph is a development of the Joubert step by step method of wave form measurement. Its principle of operation consists in automatically charging a condenser from each 100th wave and discharging it through a recording galvanometer, each successive charge of the condenser being automatically taken from a point a little farther along the wave.

ONDOMETER.—A name sometimes used for a frequency meter.

ONE FLUID CELL.—A primary cell containing a single electrolyte such as dilute sulphuric acid, into which the plates dip as distinguished from the two fluid cell employing a liquid depolarizer.

ONE FLUID THEORY.—A theory of electricity proposed by Benjamin Franklin. According to this theory, there is a single electric fluid uniformly distributed in all bodies, but when a body is subjected to friction, the electricity becomes unequally distributed between the thing rubbing and the thing rubbed, creating a condition known as positive and negative electricity, according as one body has more or less of the fluid than the other.

ONE POLE SWITCH.—A single pole switch.

ONE TO ONE TRACTION DRIVE.—On traction elevators, a method of transmitting power from the power unit to the car by means of frictional contact of the rope in passing one or more times around the drive pulley. This arrangement, since it does not employ a drum where size has to be considered, can be used for lifts of any height and is the prevailing type.

ONE WAY DOOR TRIGGER.—A door switch which gives an electrical signal only when the door is opened.

ONYX.—A kind of quartz, resembling agate, made up of layers of different colors, often sharply defined. Varieties which are brought from Algeria and Mexico are now used largely for decorative finish, building purposes, etc.

OOLITE.—A limestone composed of small grains, more or less spherical in shape, each formed of concentric coats of calcium carbonate around a nucleus, usually a grain of sand; used for building and valued on account of the ease with which it may be worked and its soft and pleasing color. Also known as oolitic freestone and Indiana marble.

OPALINE.—Trade name for a translucent glass designed to soften and diffuse the light of an electric lamp.

OPEN AERIAL.—A condenser aerial.

OPEN ANTENNA.—A condenser antenna.

OPEN ARC LAMP.—Any form of arc lamp in which the air has free access to the arc as distinguished from the enclosed arc lamp, from which the air is largely excluded.

OPEN BOX CONDUIT.—A simple form of underground conduit consisting of an open wooden trough of sufficient size to contain the cables; after the cables are laid, it is completed by filling with hot pitch and nailing on a wooden cover.

OPEN CIRCUIT.—1. A circuit, the electrical continuity of which has been interrupted, as by opening a switch.

2. Dynamos are affected by open circuits in different ways, depending upon the type. Series machines require closed circuit to build up, while an open circuit is necessary with the shunt machine. In case of open circuit due to a fault, look for: a, broken wire or faulty connection; b, brushes out of contact; c, safety fuse blown; d, circuit breaker open; e, switch open; f, external circuit open.

OPEN CIRCUIT ALARM.—A burglar alarm which operates when the circuit is closed. Open circuit systems are generally installed in small office buildings, small factories and lodging houses, where maximum protection must give way to limitation of expenditure. As current is employed at the time of alarm only, satisfactory service depends upon careful installation and periodic inspection and test of system.

OPEN CIRCUIT BATTERY.—A battery of open circuit primary cells designed only for intermittent use, such as ringing electric bells and for telephone work. The cells soon become exhausted upon closed circuit, but regain working order while resting between periods of activity.

OPEN CIRCUIT CELLS.—A single fluid primary cell intended for intermittent service. In open circuit cells, polarization does not have much opportunity to occur, since the circuit is closed for such a short period of time; hence these cells are always ready to deliver a strong current when used intermittently. A typical open circuit cell is the Leclanche cell. Open circuit cells quickly become exhausted on closed circuit, but gradually recover when the circuit is opened again.

OPEN CIRCUIT INDUCTION.—Inductive effects produced in open circuits due to oscillatory discharges taking place in neighboring circuits; oscillatory induction.

OPEN CIRCUIT JACK.—A type of jack switch which operates to close a circuit on insertion of a plug.

OPEN CIRCUIT METHOD OF CONTROL.—A method of making the transition from series to parallel connection of electric railway motors. This is the method of series paralleling used with the L type of platform controllers most of which also use the method of parallel resistors. These controllers were built only for large equipments, from 350 to 500 h.p. at 500 volts, and since for equipments of such capacity it is now common practice to use unit switch control, L type controllers may be considered as practically obsolete. Of course a number of L controllers which were installed in past years are still in successful operation.

OPEN CIRCUIT SYSTEM.—In telegraphy, a system of signaling in which the battery is placed to the line only when a message is being transmitted, at other times remaining on open circuit.

OPEN CIRCUIT VOLT METER.—An electrostatic volt meter.

OPEN CIRCUITS IN ARMATURES.—These are: a, caused mechanically by armature rubbing on some part inside frame such as projecting bolt or some part that may work loose and cut wire; b, caused by ground or short burning through a wire and causing an open.

OPEN CIRCUITS IN COMMUTATORS.—These are due to: a, poor or faulty soldering gradually gets dirty, making for poor connection and causing heat. Windings oxidize and no longer make connection, causing an open; b, overloading which causes overheating, melting out solder and resulting in an open; c, either commutator or core loose on shaft. This causes vibration at point where windings enter commutator which will in time crystallize and break wires.

OPEN COIL ARMATURE.—An armature so wound that the coils are kept separate, each coil in its simplest form, having a separate two part commutator, so that each commutator segment has only one end of one coil connected with it; the coils being open or disconnected at the commutator when the brushes are removed.

OPEN CORE MAGNET.—One whose core is the only metallic part of the magnet path.

OPEN CORE TRANSFORMER.—A type in which the magnetic circuit is partly through iron and partly through air.

OPEN DELTA CONNECTION.—A method of connecting two transformers so that they form only two sides of a "delta" or triangular connection, in place of the three sides with three transformers in a regular delta connection.

OPEN HEATER.—Apparatus for heating boiler feed water consisting essentially of an open chamber in which the exhaust steam and water to be heated are brought into intimate contact by spraying the water through the steam, both the water and the condensate going to the boiler. An important advantage of the open heater is that by means of a series of pans, scale forming substances can be precipitated before the water enters the boiler, such arrangement being called a purifier.

OPEN LINK FUSE.—A length of fusible metal having a terminal at each end. When an open fuse "blows" as a result of overloading, the rupture is accompanied by a flash and by spattering of the fused material. With large currents this phenomenon is a source of danger and the use of enclosed fuses is accordingly recommended whenever the rating of the fuse exceeds 25 amperes.

OPEN MACHINE.—One of either the pedestal bearing or end bracket type, with no restriction to ventilation other than that imposed by good mechanical construction.—NEMA.

OPEN MAGNETIC CORE.—A magnet core in an open iron magnetic circuit.

OPEN-PHASE RELAY.—One which functions by reason of the opening of one phase of a polyphase circuit.

OPEN SLOT WINDING.—Coils for an open slot a.c. motor winding usually are fully insulated and treated with varnish before winding. They are of two kinds: a, phase coils; b, plain coils. The phase coils differ from the plain ones only in that they are more heavily insulated on the ends to withstand the voltage between groups which is much higher than the voltage between coils.

OPERATING JET CONDENSERS.—After the engine is warmed up as usual and ready to start, open slightly the auxiliary injection valve which admits water under pressure to condense the first few strokes of exhaust steam, since the air pump has not established a vacuum. Then open the throttle and gradually bring engine up to speed, at same time opening the main injection valve, after which close the auxiliary injection valve. The admission of water previous to starting protects the valves of the pump from the effects of the heat, although when they are in good order, sufficient water remains in the outfit to do so. When running under load, the vacuum is regulated by the opening of the main injection valve. When stopping, gradually close the injection valve as the speed decreases having it entirely shut by time the throttle is, to allow the last revolutions of the pump to remove the water. At this time some prefer to open slightly the injection valve and for a few seconds to have valves covered with water.

OPERATING REPULSION MOTORS.—1. To start the motor: a, if without starter, close the main switch; b, if a starting box be used, see that the arm is in the OFF position. Then close the main switch (the line switch should always be either fully closed or fully open) and move the lever of the starting device firmly on to the first contact; hold it there for two or three seconds to allow the motor armature to accelerate slowly; then move the rheostat lever from one contact to the next until it is in running position.

2. To stop the motor: a, open the main switch; b, if a starter be used, be sure that the starting lever is returned to the OFF position by the time the motor stops.

OPERATING SLIP RING MOTORS. — In starting (combined operation, primary and secondary control): a, see that the control handle is in the OFF position; b, see that the disconnecting or separate overload protective switch, if used, is closed.

1. Constant Speed Motors.—Move the handle of the starting device slowly to the full speed position. Starting resistors have a time limit of acceleration from zero to full speed in 15 seconds, 30 seconds and 60 seconds, depending upon the type of resistor used.

2. Adjustable Speed Motors.—Move the handle of the starting device slowly to any desired speed point. The resistors for this type of control must be rated for continuous duty on any speed point. In stopping, return the handle of the starting device to the OFF position. For other types of apparatus, such as automatic, see further instructions furnished with the apparatus.

OPERATING SQUIRREL CAGE MOTORS.—When starting with hand operated compensator, move the compensator switch lever to the starting position and when the motor comes up to speed (in about 5 to 20 seconds) throw the lever quickly to the running position.

OPERATOR'S POSITION.—At a multiple telephone switchboard, the place occupied by an operator before a particular section, provided with a complete operator's equipment.

OPERATOR'S SET.—The telephone equipment of an operator's position at a section of a multiple switchboard; the set used by an operator at a telephone exchange.

OPERATOR'S SHELF.—A shelf at a telephone switchboard upon which the operator's equipment is placed.

OPPOSITE PHASE.—A 180° phase difference.

OPPOSITE POLES.—Magnetic or electric poles of different, unlike or opposite sign; thus north (n) and south (s), or positive (+) and negative (—) are opposite poles.

OPPOSITION.—Descriptive of two alternating quantities having a phase difference of 180°. In an alternating current circuit, if the angle of lag of or lead between current and pressure waves be 180°, the waves are said to be in opposition.

OPTIC AXIS.—A line with reference to which the eye is symmetrical, being a straight line passing through the pupil and crystalline lens; the axis of the eye.

OPTICAL EFFICIENCY OF LIGHT.—The ratio between the heat rays or obscure radiation, and the light rays, or luminous radiation, emitted by a source of light.

OPTICAL PYROMETER.—A type of radiation pyrometer for extra high temperature measurement. It is based upon the relation of color and temperature in glowing "black bodies," the color of such a body changing with increasing temperature from red to yellow and finally to white. The temperature is viewed through a tube containing a small glow lamp connected to a battery through an ammeter and a resistance. The point of disappearance of the filament is noted by the ammeter reading and the corresponding temperature found from a table.

OPTICS.—That part of physics which deals with light and vision.

OPTIMUN COUPLING.—In radio, a degree of coupling giving maximum transfer of energy.

ORAL ANNUNCIATOR.—An electric annunciator operating in connection with a speaking tube; a speaking tube annunciator.

ORDINARY JACKS.—In a multiple telephone switchboard, the multiple jacks which are duplicated at each section of the board, as distinguished from the answering jacks belonging only to those lines whose calls are received at a particular section.

ORDINATE.—The distance of any point from the axis of abscissæ (the X axis) measured on a line parallel with the axis of ordinates, that is, the Y axis.

ORGAN, ELECTRIC.—A pipe organ in which the keyboard is electrically connected with the pipes. This method has the advantages of an easy action, that is, requiring very little pressure to depress the keys, and permits locating the console at any distance from the organ.

ORGANIC CHEMISTRY.—The branch of chemistry which treats of the substances which form the structure of organized beings and their products whether animal or vegetable; called also chemistry of the carbon compounds.

ORIENTATION OF MAGNETIC NEEDLE.—The arriving of a magnet needle at a position of rest in the earth's magnetic meridian.

ORIGINATING CALL.—The original call of a subscriber received at a telephone exchange, requesting connection with another subscriber.

ORNITHOPTER.—A form of air craft heavier than air deriving its chief support and propelling force from flapping wings.

ORTHOGRAPHIC PROJECTION.—A system of drawing in which only one side of an object is shown in one view; a working drawing. The views necessary to represent an object are: a, plan; b, front elevation; c, end elevation. The erroneous use of the term sheer plan among boat builders is objectionable. It would require a stretch of the imagination to consider an elevation as being a plan.

OSCILLATING.—Alternately surging first in one direction and then in the reverse direction.

OSCILLATING ARC.—The electric arc used in radio arc transmission.

OSCILLATING CIRCUIT.—A reactive circuit in which induction and capacity are in such proportion that an oscillating current can be set up.

OSCILLATING CURRENT.—An electric current which alternately reverses its direction in a circuit in a periodic manner, the frequency being dependent solely on the constants of the system.—B.E.S.A.

OSCILLATING DISCHARGE.—An oscillatory or surging discharge; the discharge of a condenser through a circuit; the sudden make and break of a circuit; the electrostatic charge in a circuit caused by a lightning stroke; all giving rise to oscillating currents.

OSCILLATING ENGINE.—One with a pivoted cylinder and having the crank pin bearing attached to the end of the piston rod. It has the advantage of being compact, but is not suited to high steam pressures. Formerly used to some extent on side wheel vessels. Invented by James Watt in 1763. Sometimes used as capstan engine on Mississippi River steam boats. An adaptation of the oscillating engine for high expansion working is the author's double acting transfer expansion jacketed oscillating marine engine described in Audel's Engineers and Mechanics Guide, Vol. 3, page 1074.

OSCILLATING INTERMITTENT CURRENTS.—Oscillating currents of the type produced by the discharge of a static condenser.

OSCILLATING MAGNETO.—An ignition magneto whose armature does not revolve but is moved only a little way by means of a lever or cam, which is then suddenly released. A spring then causes the armature to move back very fast. It is on this fast return of the armature that the current is generated in the armature winding.

OSCILLATING NEEDLE.—A needle employed to measure a magnetic force by the number of oscillations it makes when disturbed from a state of rest in a magnetic field. It follows a law similar to the law of a vibrating pendulum, that the square of the number of oscillations in a given time is proportional to the force.

OSCILLATING STRESSES.—In mechanics, stresses by which structures or the members of structures are placed alternately in tension and compression; as, for example, in counterbraced structures subject to alternate moving loads. The conclusions deduced from the experiments in this direction show that when a bar is subject to these oscillations in stresses, the total stress on the bar is equal to their sum; that is, supposing a tensile stress of two tons and a compressive stress of two tons, alternately applied, the equivalent is a total stress of four tons.

OSCILLATING VOLTAGE.—A voltage having a constant period of vibration, but usually with varying amplitude; the voltage of an alternating current.

OSCILLATION CONSTANT.—In circuits containing electric vibrations, the square root of the capacity of the circuit multiplied by the square root of the self induction. In different circuits having the same oscillation constants, the natural periods of vibration are the same.

OSCILLATION POINT.—In radio, the critical current, or that current at which oscillation begins

OSCILLATION TRANSFORMER.—An air core high frequency transformer for coupling a transmitting set oscillator to the antenna.

OSCILLATOR.—A device for producing oscillations of a frequency determined by the physical constants of the system.

OSCILLATORY CURRENT.—1. In a reactive circuit, a high frequency current flowing back and forth between the inductance and capacity, the amplitude gradually decreasing.

2. In electro-therapeutics, the oscillatory wave currents have proven the most desirable by the patients, and to be the most efficient in results. The oscillatory wave current can be used whenever the rapid sinusoidal wave currents are indicated.

OSCILLATORY WAVE SUSTAINED PEAK CURRENT.—In electro-therapeutics, a current whose waves rise and fall more abruptly than the oscillating current and is maintained at the maximum for most of the wave length.

OSCILLOGRAPH.—An instrument for determining the form of a.c. waves. It consists of a galvanometer having a moving system capable of extremely rapid vibration, fitted with a suitable arrangement for recording the vibrations. The deflection at any instant is practically proportional to the current flowing through it at that instant, in spite of the fact that the current may be varying very rapidly in strength and direction. It must be critically damped, as any tendency to overshoot would distort the wave form from its true shape. Oscillographs are classed as: a, cathode ray; b, glow light; c, moving iron; d, moving coil.

OSMIN LAMP.—A type of tungsten incandescent lamp having a squirted filament of powdered tungsten prepared by a colloidal process and held together by an organic binding material. This lamp shows remarkable life and high efficiency.

OSMIUM.—A rare metal employed as a filament in a certain type of incandescent lamp. It is nearly twice as heavy as lead and is almost infusible. It is malleable and ductile with high electric resistance. The pure metal is not drawn into fine wire for filaments, but finely divided osmium is mixed into a paste which is forced through dies producing threads which are formed by heating by an electric current in the presence of certain gases.

OSMIUM LAMP.—A type of incandescent lamp used to some extent in European countries. It was invented by Dr. Welsbach who designed the Welsbach burner

The filament composed of pure porous osmium is made in long U shaped loops anchored to a glass rod in the base of the bulb. Osmium lamps have long life and great candle power with low watt consumption.

OSMOMETER.—An instrument for measuring the action of osmose.

OSMOSE, ELECTRIC.—The passage of an electrolyzed liquid into another liquid through an intervening porous partition; also called osmosis. Porret observed that if a strong current be led into certain liquids, a porous partition being placed between the electrodes, the liquid is carried by the current through the porous partition until it is forced up to a higher level on one side than on the other. This electric action is most pronounced when the experiment is made with liquids which are poor conductors. The movement of the liquid takes place in the direction of the current.

OSMOTIC PRESSURE.—The pressure exerted between liquids of different densities which gives rise to the phenomenon of osmose.

OSTEOTOME, ELECTRIC.—A surgical saw operated by electricity.

OTOPHONE.—A small portable microphone set for those hard of hearing. Also called **acousticon.**

OUDIN, CURRENT.—In electro-therapeutics, a high frequency current of very high voltage.

OUT CURRENT OF TELEPHONE RELAY OR REPEATER.—The current of the local circuit connected with a telephone relay, which current acts on the second line wire with reinforced strength when influenced by the receiver diaphragm of the first line.

OUT OF PHASE. — Phase difference, as between current and pressure in an alternating current, the phase difference being measured by the angle. When the phase difference is 90°, the two alternating quantities are said to be in quadrature; when it is 180°, they are said to be in opposition. When they are in quadrature, one is at a maximum when the other is at zero, when they are in opposition, one reaches a positive maximum when the other reaches a negative maximum, being at each instant opposite in sign.

OUTBOARD BEARING.—1. On a dynamo or motor, the bearing at the commutator end.

2. On a steam engine, the bearing farthest from the crank.

OUTBOARD MOTOR.—A small, compact power unit for propelling a boat of small or moderate size. It is designed to be placed outboard and clamped to the stern. The outfit consists of a small gas engine with fuel tank mounted on top of a column having at the bottom a propeller with a shaft and bevel gear drive.

OUTDOOR INDUCTION VOLTAGE REGULATORS.—Automatically operated regulators connected to the main feeders which compensate for line drop.

OUTDOOR TRANSFORMER.—A weatherproof transformer.

OUTERS.—In the three wire system of electrical distribution, the positive and negative mains as distinguished from the central neutral wire.

OUTGOING CALL.—A call sent from a telephone exchange, as distinguished from a call received by the exchange.

OUTLET.—A point on the wiring system at which current is taken to supply fixtures, lamps, heaters, motors and current-consuming devices generally.

OUTLET BLOCK.—A safety cut out located at an outlet.

OUTLET BOX.—A house wiring fitting consisting of a small sheet metal box having in its walls a number of holes, closed with discs or knockouts. Where the concealed wires are to enter the box one of the discs is knocked out. Inside the box the wires are exposed for attachment of devices and fixtures.

OUTPUT CHOKE.—In radio, the combination of an induction coil connected in series with the loud speaker and an induction coil in parallel. The induction coil while passing d.c. freely, will retard the modulated currents and the condenser will pass a.c. and block d.c.

OUTPUT CIRCUIT OF VACUUM TUBE.—The filament plate circuit.

OUTPUT OF DYNAMO.—The available electrical power delivered by a dynamo at its terminals, measured in watts or kilowatts. The volts and amperes from which the watts are calculated being measured at the terminals of the machine, the net output being the number of amperes multiplied by the volts at the terminals.

OUTPUT OF MOTOR.—The mechanical power delivered to the pulley of a motor measured as brake horse power.

OUTRIGGER.—1. The framework of an airplane connecting the main surface with an elevator placed in advance of it.

2. A horizontal bar attached to a telegraph pole in order to truss it against a lateral strain.

3. An arm for suspending an arc lamp at the desired distance beyond its support.

OUTSIDE AIR GAP.—An auxiliary air gap.

OUTSIDE CALIPERS.—An instrument for taking an external measurement with precision, as in measuring a piston diameter.

OUTSIDE WIRING.—Wiring that is attached to the surface. Not concealed.

OVAL ARMORED CABLE.—A type of cable made oval or flat shaped for under plaster work. It consists of a welded rigid tube, with an oval cross section 13/32 inch high × 31/32 inch wide, shallow enough so that it can be embedded in and completely covered by plaster of ordinary thickness when fastened directly to fireproof under body of concrete, tile or brick.

OVER-CHARGE.—A storage battery sometimes becomes over charged in cars run mostly during the day or regulator adjusted to too high charging rate, causing buckled plates; shedding of active material; over-heating. Gravity will be about 1.275. Better remedy is to reduce charging rate rather than burn lights.

OVER COMPOUNDED DYNAMO.—A compound dynamo having more turns in the series winding than is necessary to maintain a constant voltage at the terminals. If a greater number of turns be used in the series winding than is required for constant voltage at the brushes for all loads, the voltage will rise as the load is increased and thus make up for the loss or drop in the transmission lines, so that a constant voltage will be maintained at some distant point from the dynamo. The usual degree of overcompounding is 5 to 10%. Overcompounding is designed for incandescent lighting where there is considerable length of transmission lines.

OVER COMPOUNDING.—Increasing the series windings in a compound wound dynamo in order that it may preserve a constant voltage at the extremities of its circuit.

OVER CURRENT.—The simplest protective principle is that which uses a so-called instantaneous over current to distinguish between normal and abnormal condition. An example of the over current principle is the ordinary series trip coil when used without a time device. Since transient excess current must be considered as normal, it is necessary to make the protective scheme inoperative under these transient conditions.

OVER CURRENT RELAY.—One which uses a so-called instantaneous over current to distinguish between normal and abnormal conditions. An example of over current principles is the ordinary series trip coil when used without a time device. Since transient excess current must be considered as normal, it is necessary to make the protective scheme inoperative under these transient conditions.

OVER CURRENT WITH UNDER VOLTAGE.—A relay protective principle. According to this principle, when there are short circuit conditions, the voltage at points close to the fault is very low when the current is very high, while the voltage is progressively higher and the current is substantially the same at points nearer the generating station. The protective device using this principle is essentially an over current inverse time device in which the time setting is automatically adjusted to be proportional to the voltage, so that the lower the voltage the lower is the time setting. Therefore, the ends of the faulty section nearest the short circuit clear in the minimum time, while the time settings at all other points on the system automatically assume higher values. This principle is usually combined with the directional principle.

OVERDISCHARGE.—On automobile battery system this usually is caused by faults in electric system, internal short circuits due to shedding of active material of battery plates and is indicated by gravity less than 1.150 and voltage less than 1.8 on discharge.

OVERFLOW OF LEYDEN JAR.—A disruptive discharge of a Leyden jar which sometimes takes place around its rim.

OVERHEAD CONDUCTOR.—A conductor suspended overhead, as distinguished from one placed underground; an aerial conductor.

OVERHEAD CRANE.—A machine for lifting, lowering and moving a load in a horizontal direction. The essential motions are obtained by three motors: a, hoisting motor; b, longitudinal propelling motor, and c, transverse propelling motor.

OVERHEAD GROUND WIRE.—A form of lightning arrester consisting of a wire placed over service wires and grounded.

OVERHEAD SYSTEMS.—The various kinds of transmission lines in which the wires are suspended overhead on poles, towers or other methods of support.

OVERHEATED COMMUTATOR.—This condition will decompose carbon brushes and cover the commutator with a black film which offers resistance and increases the heat. If carbon brushes become hotter than the other parts, use higher conductivity carbon.

OVERLAP SPLICE.—A splice in which the strands of the rope are laid over one another instead of interweaving.

OVERLAPPING BLOCK SYSTEM.—A railway block system in which the signals, operated by a train as it enters a section, are situated at some distance behind the entrance of that section.

OVERLOAD CAPACITY. — The capacity which an electrical machine or apparatus has of carrying an overload without suffering serious injury by heating. sparking or mechanically weakening.

OVERLOAD OF DYNAMO.—It may happen through some cause or other that a greater output is taken from the machine than it can safely carry. When this is the case, the fact is indicated by excessive sparking at the brushes, great heating of the armature and other parts of the dynamo, and possibly by the slipping of the belt (if a belt-driven machine), resulting in a noise. The causes most likely to produce overload are: a, excessive voltage; b, excessive current; c, reversal of polarity of dynamo; d, short circuits or grounds in dynamo or external circuits. If at any time it be necessary to run an engine driving a shunt or compound dynamo at a lower speed than the normal, the voltage and output of the dynamo can generally be maintained at their ordinary value by coupling up the shunt coils in parallel, thus increasing the strength of the current flowing in the shunt circuit and the strength of the field correspondingly. Care should be taken, however, that the coils do not overheat with the increased current.

OVERLOAD OF MOTOR.—An excessive mechanical load put upon an electric motor so that it fails to operate economically and is in danger of injury from overheating, etc.

OVERLOAD PROTECTION.—The effect of a device operative on excessive current to cause and maintain the interruption of current flow to the device governed. When it is a function of a controller for a motor, the device employed shall provide for interrupting any operative overloads, but shall not be required to interrupt short circuits.—NEMA.

OVERLOAD RELAY.—1. A relay with a series trip coil connected directly in series with the line and chiefly used with high pressure oil break switches for overload protection. If current transformers be used on the same circuits for other purposes and have sufficient capacity to admit of adding a relay coil, secondary relays would be more economical; otherwise the series relays are less expensive. By means of a specially treated wooden rod, the relay operates a tripping switch, closing a separate tripping circuit, usually 125 or 250 volts direct current. Series relays are essentially the same as secondary relays except in the coil winding and insulation.

2. One which functions at a predetermined value of the current to cause the disconnection of the motor from the line.—NEMA.

OVERLOAD RELEASE.—A rheostat attachment consisting of an electro-magnet, the coil of which is connected in series with the motor armature circuit and two contacts normally closed and connected in series with the low voltage release. The overload relay magnet has a pivoted armature carrying an insulating wedge at its end. When the motor armature current exceeds a predetermined value, the overload relay magnet armature rises and forces the insulating wedge between the contacts, thereby opening the low voltage release circuit and allowing the operating arm to return to the off position.

OVERLOAD STORAGE BATTERY SWITCH.—An automatic switch controlling the discharge of a storage battery, cutting the battery out of the circuit when the rate of discharge becomes too great.

OVER MAXIMAL CONTRACTION.—In electro-therapeutics, the further contraction of a motor nerve which occurs upon increased excitation after it has been subjected to apparent utmost stimulation.

OVERRUNNING OF INCANDESCENT LAMPS.—Applying a voltage above the normal to an incandescent lamp system, thereby increasing the luminosity or brightness, but at the same time shortening the life of the lamps.

OVERSHOOTING.—A phenomenon of momentary excessive brightness in the filament of a tungsten incandescent lamp when first turned on after having been out of service for a considerable period.

OVER-SPEED LIMIT DEVICE.—A device which functions on machine overspeed.—NEMA.

OVER-SPEED SLOW DOWN RELAY.—An elevator safety device consisting of a voltage relay so connected that an overspeeding of the elevator in either direction will cause the relay to act and thus automatically retard the speed. This relay is set to act at a speed below that at which the overspeed governor is set.

OVERTONE CURRENTS.—Alternating electric currents having higher frequencies than the fundamental frequency, being an even or odd multiple of the fundamental frequency.

OVERTONES.—In sound waves, certain higher harmonics associated with the first harmonic or fundamental tone. These overtones may be compared to the succession of shades by which one color of the spectrum passes almost imperceptibly into another, even while not interfering with the eye's sensation of seven colors. In one kind of instrument, such as the piano, one set is intensified and in another, such as the violin, another set; and it is this fact that gives the characteristic difference between a piano and a violin note, although the "fundamentals" may be the same in both. Thus in a musical note the ear finds three things: the loudness of the note, its pitch or tone and its timbre or quality.

OVERTRAVEL LIMIT SWITCHES.—Elevator safety switches which act to stop the car in case of the failure of the regular terminal stop limits.

OVERTYPE DYNAMO.—A dynamo in which the armature is placed above the field magnet coils and yoke.

OVERTYPE FIELD MAGNET.—A field magnet employed in an overtype dynamo in which the armature is placed above the field magnet coils and yoke.

OVER-VOLTAGE.—In electrolysis, oxygen and hydrogen are evolved very easily on platinum-black electrodes by the passage of a current at a minimum voltage. When some other metal is used as the electrodes, a greater voltage is required. The difference between these values is known as the "over voltage" of hydrogen or oxygen on that particular metal. The over voltages of hydrogen on metals varies from .1 volt on the noble metals to .7 volt for zinc. This voltage influences the deposition of metals from acid solutions.

OVER VOLTAGE RELAY.—A relay usually of the circuit closing type and similar to secondary overload relays, but having pressure instead of current windings.

OVER WOUND SERIES MOTOR.—A series motor provided with exceptionally strong series winding.

OXIDATION.—In chemistry, the act of combining with oxygen, or subjecting to the action of oxygen or of an oxidizing agent.

OXIDATION REACTION.—The reaction which takes place at the anode in an electrolytic cell when the current is passed.

OXIDE FILAMENT LAMP.—An incandescent lamp, like the Nernst, which employs refractory metallic oxides of the rare earths, also lime, magnesia, etc., for incandescence. They are insulators in the cold state, but become conductors when heated.

OXIDE FILM ARRESTER.—A lightning arrester consisting essentially of a number of cells with a gap in series between line and ground. The cells are held together under moderate pressure and are arranged in sections or stacks, according to the voltage and kind of circuit. The cells are disc shape, about 7½ in. in diameter and ⅝ in. thick. In operation when a lightning voltage sparks over the gap, it is impressed on the cells and breaks down the insulating coating on the metal plates.

OXIDE OF IRON.—Ferric oxide, prepared from ferrous sulphate or green copperas by the action of great heat. The more calcined portions are graded to form the varieties of crocus, the softer portions are termed rouge, both being used for polishing.

OXY-ACETYLENE WELDING.—A method of uniting the metal pieces by means of a torch flame of appropriate temperature with the addition of metal of the same composition. The joint thus obtained is called autogenous. The torch used is an instrument in which the flames are produced and projected on the metallic parts to be welded. The flame produced by the torch is of unusually high temperature. With the oxy-acetylene torch the metals can be welded without adding metal to the weld. The temperature of the oxy-acetylene flame is approximately 6,300° F.

OXYGEN.—In chemistry, the vital or life giving element in the atmosphere. Its presence is essential to combustion and it enters into combination with the carbon in fuel to produce heat in furnaces. In union with metals it forms oxides. Oxygen does not itself burn, but it is the greatest supporter of combustion known, and nearly all other chemical elements combine with it under evolution of heat.

OXY-HYDROGEN FLAME.—An intensely hot flame produced by the combustion of hydrogen or of coal gas in oxygen gas. The temperature of this flame is sufficient to melt very refractory substances, while certain infusible bodies such as lime can be brought by this flame to a brilliant incandesence; often called limelight. The oxy-hydrogen flame was first used in gas welding. Its temperature is approximately 4,000° F. The two gases furnished in steel cylinders, are allowed to mix with a considerable excess of hydrogen in a small chamber leading to the mixing jet.

OYSTER FITTING.—A fitting used for incandescent lamps in water tight compartments on ships.

OZITE.—A product of the distillation of petroleum, mixed with fibrous material to form an insulating covering for electrical conductors.

OZOKERITE.—A waxlike, resinous mixture of natural paraffins, used for insulating electric conductors.

OZONE.—A faint blue gas with characteristic smell produced when a silent electric discharge is passed through the air, changing the oxygen into ozone. Ozone is always formed when a frictional electric machine of the old plate type is worked with an air discharge. Ozone is used commercially for bleaching, purifying and sterilizing, especially in the sterilization of water.

OZONIZER.—An apparatus for generating ozone. It consists usually of two conducting surfaces insulated from each other and separated at such a distance that when oppositely charged a "silent discharge" will take place between them. The oxygen of the air under the electric influence recombines into ozone which contains three atoms.

P

P.—1. Symbol for power, measured in watts or kilowatts.
2. Symbol for steam pressure.

Pa.—Apparent power measured in kilovolt amperes (kva.).

PACINOTTI ARMATURE.—A form of ring armature invented by Pacinotti, consisting essentially of a toothed iron wheel carrying its inductors in the depressions between the teeth.

PACKFONG.—A Chinese alloy, containing about forty parts of copper, twenty-five of zinc, and thirty-two of nickel; also called white copper.

PACKING.—In microphone operation, effect of abnormal pressure on the carbon particles due to sound waves striking the diaphragm resulting in reduction in resistance.

PACKING OF TELEPHONE TRANSMITTER.—A trouble arising in granular carbon or dust transmitters from the gradual settling of the carbon particles until they form a compact mass between the diaphragm and the back electrode, seriously impairing the efficiency of the instrument.

PAD.—A device for reducing the amplitude of a radio wave without introducing appreciable distortion.

PAGE EFFECT.—A faint metallic sound which may be detected when a bar of iron is suddenly magnetized or demagnetized. Named after its discoverer. Also called magnetic tick.

PAINT.—A thick liquid which is used to give substances a superficial coating. It is made of a dry coloring material mixed with a liquid vehicle. It is used largely to give decorative color effects to structures, also, to preserve them from the action of the atmosphere and other corroding agencies. The dry coloring material of which the paint is made is called a pigment.

PAIRING.—Building up a member or part of an airplane with a false piece to give it a stream line.

PALLADIUM.—A metal of the platinum group distinguished for its exceptional power of absorbing gases, or power of occlusion.

PALLADIUM ALLOYS.—Non-magnetic alloys in which palladium is the chief ingredient, employed in the manufacture of non-magnetic watch springs.

PALM RULE.—If the palm of the right hand be held facing or against the lines of force, and the thumb in the direction of the motion, then the fingers will point in the direction of the induced current. In electro-magnetic induction, a rule for direction of induced current.

PANCAKE.—To stall an airplane.

PANCAKE COIL.—1. A flat coil of wire adjusted to the surface of an armature.
2. A spirally wound flat coil of wire. Used in some radio receiving sets. Also called spiderweb coil.

PANEL.—A section of the wings of an airplane.

PANEL DIAL SYSTEM.—An automatic telephone system comprising: a, vertical flat panels in which are mounted contacts of the multiple banks over which selection occurs; b, brushes of the selecting mechanisms raised and lowered by motor driven apparatus; c, dial pulses received and stored by controlling mechanisms which govern the subsequent operations necessary in establishing a telephone connection.

PANEL FEEDER.—A feeder leading to a bus bar connected with a switchboard panel.

PANEL FUSE.—A safety fuse carried on a panel board.

PAN-TELEPHONE.—A highly sensitive microphone capable of reproducing sound vibrations at a great distance.

PANTOGRAPH TROLLEY.—A form of trolley employed in high speed electric traction. A broad contact shoe, formed of a conducting material which does not wear the wire is supported by jointed elbows resembling a pantograph carried on springs. The trolley is raised and lowered by compressed air.

PAPER CABLE.—An electric cable insulated by wrappings of specially prepared paper.

PAPER CONDENSER.—A condenser having a dielectric composed of paper. For ignition service, especially on automobiles or motor boats, paper condensers should never be used, as this type is virtually an unreliable makeshift specified by the manufacturer because of its cheapness. Replace a paper condenser with a mica condenser.

PAPER FILAMENT.—An early type of incandescent lamp filament made of carbonized paper.

PAPER INSULATION.—An insulation often employed for electric light, power, and telephone cables, consisting of specially prepared tough paper, loosely laid on or crinkled, so as to form a dielectric of both paper and air. The paper covered conductor is encased in a lead sheathing, and so long as this sheathing remains intact good results are obtained.

PAPIER MACHE.—A material made from paper pulp mixed with other substances. It is used for the mold in stereotyping, and in electrical work as an insulating material for low voltages, or as a secondary insulator to back up a primary insulator such as mica.

PARA RUBBER.—The best grade of india rubber for electrical purposes, and the grade generally specified for insulation work. It is derived from the Amazon Valley in South America, and gets its name from the city of Para, in Brazil, from which it is exported.

PARABOLIC REFLECTOR. — A concave mirror having a surface such as would be generated by the revolution of the arc of a parabola. It reflects light in parallel rays.

PARAFFIN.—A colorless or white, waxy substance obtained by dry distillation from wood, coal, peat, petroleum, etc., largely used in electrical work for its moisture proof and insulating properties. Dielectric constant 2 to 2.5. It has low radio frequency losses.

PARAFFINED WIRE.—An insulated electric wire provided with a final coating of paraffin.

PARALLAX.—An apparent displacement of an object caused by actual change in the position of the point of observation.

PARALLAX ERROR.—An error which may occur in the reading of an index or needle indication upon a scale, if the eye be not in exact relation to the pointer.

PARALLEL CONNECTED TRANSFORMERS.—Transformers in a system of electric distribution having all their primary coils connected across the mains in parallel. In paralleling transformers, it is essential that the terminals have the same polarity at a given instant, and the transformers should have practically identical characteristics. If a transformer which has 2 per cent regulation be connected in parallel with one which has 3 per cent regulation, at no load the transformers will give exactly the same voltage at the secondary terminals, but at full load one will have a secondary pressure of, say, 98 volts, while the other has 97 volts. The result is that the transformer giving only 97 volts will be subject to a reverse pressure of one volt from its mate. This will not cause a current to flow backward through the secondary winding of the low voltage transformer, but it will disturb the phase relations and lower the power factor and efficiency of the combination. In such a case it is much better to work the secondary circuits of the two transformers separately.

PARALLEL CONNECTION.—A method of connecting up an electric system in which all the positive poles, or terminals, are joined to one conductor, and all the negative poles to the other; multiple connection.

PARALLEL FORCES.—In mechanics, forces which act in directions parallel with one another.

PARALLEL MODULATION.—Heising or constant current modulation.

PARALLEL RESONANCE.—In a circuit containing inductance and capacity in parallel, the condition when the inductance and capacity are in such proportion as to produce resonance at the frequency of the main circuit.

PARALLEL RUNNING OF ALTERNATORS.—The joining up of two or more alternators in parallel. When it becomes necessary to run more than one alternator to carry the load, before they can be connected in parallel they must be synchronized; that is, the alternating cycles must be in step with each other, otherwise one machine will be short circuited through the other and serious results will follow. In other words the speed, phase and voltage of each machine must be the same before connecting in parallel. Synchronizing is accomplished in several ways, as by dark, and brilliant lamp methods.

PARALLEL SERIES CONNECTION.—The arrangement of receptive devices, such as lamps, in an electric circuit in a number of series connected groups, these groups, in turn, being connected in parallel; multiple series connection.

PARALLEL TREE SYSTEM.—In early installations of electric lamps a parallel system of distribution in which a pair of mains was extended through the district with branches reaching out in either direction from them, so that the plan of the system resembled a tree with spreading branches.

PARALLEL WINDING.—A method of armature winding, usually known as lap winding, in which adjacent coils are connected in series instead of the connections progressing in a "wave" around and around the core. Lap winding is characterized by having as many circuits through the armature from positive to negative brushes, as the machine has poles, the current dividing equally between these parallel circuits.

PARALLEL WIRE STRETCHER.—A form of lineman's wire clamp for gripping a wire and bringing it to the proper tension.

PARALLELING OF DYNAMOS.—1. Two or more dynamos joined in parallel. In order to put an additional dynamo in parallel with those already working, it is necessary to run the new dynamo up to full speed, and, when it excites, regulate the pressure by means of a hand regulator until the voltmeter connected to the terminals of the machines registers one or two volts more than the voltmeter connected to the lamp circuit, and then close the switch. The load upon the machine can then be adjusted to correspond with that upon the other machines by means of the hand regulator.

2. For a shunt dynamo, there is little danger in overloading the armature in making the connection, hence the pressure need not be accurately adjusted. It is, in fact, common practice in central stations to judge the voltage of the new dynamo merely by the appearance of its pilot lamp.

3. Since compound dynamos may be regarded as a combination of the shunt and series wound machines, and as no special difficulties are encountered in running these latter in series, analogy at once leads to the conclusion that compound dynamos under similar circumstances may be coupled together with equal facility.

PARALLELOGRAM. — A quadrilateral which has its opposite sides parallel.

PARALLELOGRAM OF FORCES.—A method of finding the resultant of any two uniform forces, by drawing a parallelogram whose adjacent sides represent the two component forces, the concurrent diagonal of which represents the resultant.

PARAMAGNET. — A paramagnetic substance; a substance, such as iron, which readily becomes magnetic.

PARAMAGNETIC.—A term introduced by Faraday to denote a substance which acted like iron in regard to a magnetic field; a substance more susceptible to magnetism than air. Paramagnetic substances concentrate the lines of force on them. The most powerfully paramagnetic bodies are iron, nickel and cobalt. Since convergence or divergence of magnetic lines is the physical cause of what are usually called poles, the polarity of paramagnetic bodies is in the direction of the external inducing field.

PARAMAGNETISM.—The magnetism possessed by paramagnetic bodies; ferromagnetism.

PARASITES.—In radio, a name sometimes given to static disturbances.

PARASITIC CURRENTS.—Useless local currents that are liable to arise in the core of an armature and waste energy by generating heat. They are usually known as eddy or Foucault currents, and it is to obviate them that armature cores are laminated.

PARCHMENTIZED FILAMENT.—A variety of incandescent lamp filament made from cotton thread which is first subjected to a parchmentizing process by passing it slowly through a solution of sulphuric acid and water, and then carbonized.

PARTIAL CONTACT.—A contact between two electric circuits such as to produce a partial fault in the circuits. Distinguish between partial and intermittent contact.

PARTIAL EARTH.—A partial fault in an electric circuit due to a partial earth connection.

PARTIAL FAULT.—Any fault in an electric circuit which interferes with the proper working of the circuit without causing its complete interruption.

PARTIAL FRACTIONS.—Fractions whose sum may be reduced to the original fraction.

PARTIAL SHORT CIRCUITS IN ARMATURES.—Usually due to the presence of moisture in the windings. To remedy the fault the armature should be taken out and exposed to a moderate heat, or subjected to a current equal to that ordinarily given by the dynamo.

PARTIALLY CLOSED SLOT WINDING.—In winding a.c. motors with partially closed slots, the coils are usually uninsulated, except for the cotton covering on the individual wires. They are all of one kind when they come to the winder, that is, there is no difference between plain and phase coils, as in the case of the open slot windings; but, according to the service requ'rements, the design may call for the winder to differentiate between the plain and phase coils by one of the following methods:

1. Tape those coils that start and end a group.

2. Tape all coils, with extra taping on the phase coils.

3. Tape no coils, but place insulating material (usually treated cloth), between the ends of the phase coils.

4. Place insulating material between the ends of all coils and a double thickness between phase coils.

PARTIALLY DISTRIBUTED WINDING.—An a.c. winding in which the coil slots do not occupy all the circumference of the armature, that is, the core teeth are not continuous.

PARTIALLY OVERLAPPING ARMATURE WINDING.—A method of winding armatures, in which some of the coils are made to overlap one another, while others are laid on separately.

PARTITION INSULATOR.—A sleeve insulator used to run a circuit through a partition.

PARTY LINE.—A telephone line connecting a central office with more than one station or subscriber, as distinguished from a private line. The party line is available for small private telephone systems, connecting a number of neighboring houses with one another or with stores or places of business.

PARTZ GRAVITY CELL.—A primary cell having electrodes of zinc and carbon in sulphate of magnesia and a chromic solution, the liquids being kept separate by their difference in weight.

PASSIVE STATE.—A term applied to the condition of a substance which remains unattacked when exposed to the action of an acid which would ordinarily corrode it; as when cast iron is not acted on by strong nitric acid.

PASTE.—The mixture of lead oxide or spongy lead and other substances which is put into grids.

PASTE JOINT.—In an incandescent lamp, a method of joining the filament to the leading in wires by the use of a carbonaceous cement which is afterward carbonized by sending a strong current through it.

PASTING.—A process of preparing lead plates for storage cells, in which the grids are coated with lead oxide and sulphuric acid; the red oxide of lead, or minium being usually employed for the positive plates, and the yellow oxide, or litharge, for the negative plates.

PATINA.—A green semi-transparent crust consisting of basic copper carbonate which appears on the surface of copper and bronze when exposed for a long time to the air. The effect is obtained artificially by immersing copper articles in a bath of acetic acid.

PATROL ALARM BOX.—A signal box from which an alarm may be sent by a police, or fire patrol.

PAWLOWSKI VALVE.—An electrolytic rectifier employing a solid electrolyte. It consists of a copper plate which has been coated with a crystalline layer of carefully prepared copper hemisulphide, prepared by melting sulphur and copper together out of contact with air. The prepared plate is placed in contact with an aluminum sheet and the combination is then formed by submitting it to an alternating pressure until sparking, which at first occurs, ceases.

PAY AS YOU ENTER CAR.—A model of electric street car construction introduced to simplify the loading and unloading of passengers and the collection of fares. The platforms are lengthened to allow of an entrance and an exit. The passenger enters at the front entrance, deposits his fare in the receiver, and alights from the front or from another exit. On some cars, entrance and exit is from a door at the center of the car.

PAYING OUT.—In submarine cable laying, the regulated delivery of the cable into the water from the stern of the cable ship.

P.B.X.—In telephony, abbreviation for private branch exchange.

P. C.—Abbreviation for primary current.

PEA LAMP.—A diminutive type of incandescent lamp.

PEAK LOAD.—In a power station, the maximum load which has to be carried by the station at any time of day or night as shown by the highest point of the load curve.

PEAK VOLT METER.—A type of volt meter which indicates the maximum value of an alternating current.

PEAKED TRANSFORMER.—In radio, an audio frequency transformer designed to obtain resonance at a certain frequency by proper proportion of inductance and distributed capacity.

PEAKED WAVE.—A pointed maximum value of an alternating current wave.

PEANUT TUBE.—A very small three element radio tube designed for use on small portable receivers.

PEAR PUSH.—A pear shaped wooden terminal of a pendant cord containing a push-button for making an electrical contact.

P.E.C. AMPLIFIER.—A photo electric cell amplifier.

PEDESTAL OF ARMATURE.—A support for carrying the bearings of an armature.

PEG SWITCH.—A switch that is operated by the insertion or withdrawal of a peg; also called a pin switch.

PEG SWITCHBOARD.—A switchboard provided with peg switches.

PELLET AND OXIDE FILM ARRESTERS; ADAPTATION.—The pellet type of arrester is generally used to protect small circuits, small banks of transformers, and other electrical machinery where the cost will not warrant the larger and more expensive arrester The oxide film lightning arrester is used for all important stations for protecting large banks of transformers, and for protecting circuits where trouble from lightning would be very dangerous and expensive.

PELLET ARRESTER.—A lightning arrester whose essential elements are a number of small pills about ¼ in. in diameter, made of lead peroxide. These are coated with litharge powder which forms a film around the pill. These litharge coated pills or pellets are placed in a porcelain tube and assembled in good electrical contact with metal electrodes at each end of the column. Between the line lead and the pellet column is one or more series gaps which separate the pellets from the line under normal conditions, but which allow a discharge to take place when the voltage reaches a sufficiently high value above normal voltage.

PELTIER EFFECT.—A current flowing across the junction of two dissimilar metals, causing either an absorption or liberation of heat, depending on the direction of the current, at a rate proportional to the first power of the current.

PELTIER'S CROSS.—A contact of two unlike metals at right angles for the purpose of exhibiting the Peltier effect.

PEN CARRIAGE.—In an electric chronograph, the device for carrying the pen or stylus which traces the record upon the paper strip.

PEN, ELECTRIC.—A stylus, operated by an electric motor, for making perforations in paper corresponding to a design or writing, so that the paper may afterwards be used as a stencil for manifold copying.

PENCIL MICROPHONE.—An early form of microphone devised by Hughes, and usually called by his name. It consisted of a thin carbon pencil supported loosely between two blocks of carbon fixed to a sounding board. When connected with a battery and a telephone receiver, it served to greatly intensify sound.

PENCILING.—In cable jointing, the insulation around each conductor should be "pencilled" back. This is done much in the same way as sharpening a lead pencil. It is important that the pencilling be smooth and even.

PENDANT CORD.—A flexible cord containing a pair of insulated conductors, employed for suspending incandescent lamps, or for making electrical connection with other movable electric devices.

PENDANT PULL SWITCH.—A switch which is opened and closed by a pendant pull.

PENDANT SOCKET.—A lamp socket for light electrolier or ceiling lamps, provided with a pendant or hanging chain for turning on or extinguishing the light.

PENDULUM ANNUNCIATOR.—An annunciator in which the index consists of a pendulum or upright arm which is caused to swing by the electric current; a **swinging annunciator.**

PENDULUM, ELECTRIC.—1. A pith ball suspended by a silk thread from an insulated support, for the purpose of illustrating electrical repulsion.

2. A pendulum operated by an electromagnet, and so adjusted as to open and close a circuit by its swing.

PENDULUM MYOGRAPH. — An electric pendulum for measuring the contraction and relaxation of muscular tissues.

PENDULUM SIGNALER. — A pendulum which transmits signals by making and breaking an electric circuit by its swings.

PENETRATING EFFECTS OF DISCHARGE.—A discharge of electricity under very high pressure has the power of piercing glass and other insulators. Although the dielectric strength of glass is very great, electricity from a powerful induction coil has pierced glass several inches thick. Two curious effects were observed by Lullin; when a piece of cardboard is perforated by a spark: a, there is a slight burr raised on each side; b, the hole is found to be nearer the negative point, if the two electrodes be not exactly opposite each other. A sheet of glass may be easily pierced by a spark from a battery of Leyden jars.

PENTANE STANDARD.—A standard of illumination employing a lamp with a specially constructed burner consuming a mixture of 7 parts of pentane gas and 20 parts of air at the rate of a half cu. ft. per hour.

PENTODE.—In radio, a five element tube. Plain English instead of Greek (pente, five) is much more desirable.

PENTODE WORKING. — In synchronous multiplex telegraphy, the simultaneous transmission of five messages over the same wire.

PENUMBRA.—1. A region of partial and varying shadow surrounding the total shadow, or umbra, cast by an opaque body, when the source of light is a luminous body with greater or less area.

2. During an eclipse the moon's half shadow which envelopes all places where the eclipse is partial.

PERCENTAGE.—The rate per hundred; from the Latin per centum meaning by the hundred, that is a certain part of every hundred. Thus 23 per cent means 23 out of every hundred. To illustrate, 23 per cent of one dollar, or 100 cents =23/100 of 100=23 cents. Symbol: %. 23% is read 23 per cent and in calculating is written as .23. Note carefully how to express less than one per cent. Example.—Express ¼ of 1% as a decimal.

$$\tfrac{1}{4} \text{ of } 1\% = \tfrac{1}{4} \text{ of } 1/100 = 1/400 = .0025$$

PERCUSSIVE WELDING.—A form of resistance welding in which the electric current is suddenly discharged across the contact area to be welded, and a hammer blow applied at the same time or immediately following the electrical discharge.

PERFORATED ARMATURE.—1. An armature having a perforated core to admit of ventilation.

2. An armature having perforations in its core for the winding of the coils.

PERFORATED CORE DISCS.—Discs for building up a laminated armature core, having perforations to admit the windings.

PERFORATOR.—A part of the apparatus employed in automatic telegraphy, which prepares the message for transmission by punching holes, corresponding to the signals of the Morse code, in a paper ribbon.

PERIMETER.—The length of the boundary line of any plane figure.

PERIOD.—The time of one cycle of the alternating current.

PERIOD OF COMMUTATION.—The time required for commutation, or the angle through which the armature must turn to commute the current in one coil. It depends upon the width of the brushes. This fixes the angle through which the armature must revolve to commute the current in one coil.

PERIOD OF OPEN CIRCUIT OSCILLATION.—The time required for one complete to and fro motion of an oscillation set up in an open circuit by electric resonance.

PERIODIC CHARGE METHOD.—A method of wet storage in which the batteries are given charges periodically, and is used where it is not practicable to arrange for the trickle charge method. The method is as follows:

1. Give a charge until all the cells are gassing.

2. Store in a dry, clean location and keep the temperature above freezing and below 110 degrees F.

3. Once every two months remove filling plugs, add distilled or other approved water to the proper level, replace and tighten vent plugs and charge until all the cells are gassing.

4. Before putting battery into service, add approved water and charge until all the cells are gassing.

PERIODIC CURRENT.—An oscillating current, the values of which recur for equal increments of time.

PERIODIC DUTY.—A requirement of service which demands operation for alternate periods of load and rest in which the load conditions are well defined and recurrent as to magnitude, duration and character.—NEMA.

PERIODICITY.—A name sometimes used for frequency; the latter term is preferable.

PERIPOLAR ZONE.—In electro-therapeutics, the parts of a patient's body just outside of the immediate region of the electrodes that are being applied to it.

PERISTALTIC.—A term applied by Lord Kelvin to the kind of electrostatic induction that takes place between conductors enclosed within the same insulation, as in a submarine cable.

PERMALLOY.—In radio, an alloy used in the cores of audio frequency transformers. It has great permeability and is composed of iron and nickel.

PERMANENCY.—The property possessed by electric conductors of retaining their conductivity unchanged for an indefinite time.

PERMANENT CURRENTS. — 1. In the Wheatstone automatic telegraph, electric currents continuously applied to the line while signaling.

2. Currents employed in double current telegraph working.

3. A constant current strength sometimes maintained on the line in telephone working.

PERMANENT INDUCED CHARGE.—A permanent electric charge produced in a body by induction.

PERMANENT INTENSITY OF MAGNETIZATION.—The intensity of the magnetism permanently retained in magnetized steel.

PERMANENT MAGNET.—A magnet consisting of hard steel which possesses coercive force, or retentivity, in a high degree, and is, therefore, said to retain its magnetism permanently; used in the construction of magnetos.

PERMANENT MAGNET INSTRUMENT.—An indicating instrument employing a permanent magnet to produce its magnetic field.

PERMEABILITY.—The ratio between the number of lines of force per unit area passing through a magnetizable substance, and the magnetizing force which produces them. In other words, it is the ratio of flux density to magnetizing force. If B=the magnetic flux density and H the magnetizing force, then

$$\text{permeability} = B \div H$$

For non-magnetic materials, B is very near unity, for iron, etc., its value varies greatly and depends on the magnetization, decreasing as the latter increases. The permeability of any piece of material increases with the increase of cross section and decreases with the increase of length.

PERMEABILITY BRIDGE. — An instrument, involving the principle of the Christie or so called Wheatstone bridge, designed for measuring magnetic permeability.

PERMEABILITY CURVES.—Graphic curves showing the relation between magnetic density and permeability in magnetic substances.

PERMEAMETER.—An apparatus for measuring magnetic permeability by the traction method, in which a spring balance indicates the pull required to detach the sample of iron which is being tested from the magnetic mass to which it is caused to adhere.

PERMEANCE.—The reciprocal of magnetic reluctance, just as electric conductance is the reciprocal of electric resistance.

PERMEATION.—A term used in magnetism for the entrance of magnetic flux into the mass of a magnetizable substance.

PERMITTANCE OR PERMITTIVITY. — A word used by Heaviside to denote specific inductive capacity.

PERSISTENCE OF FORCE.—A term sometimes used for conservation of energy. Objectionable.

PERSISTENCE OF VISION.—The electrochemical process taking place in the nerves and the brain, as a result of a stimulus on the retina, which persists for a brief time after the stimulus has been removed.

Persistence lasts for about one tenth of a second; so if a series of stimuli be applied to the eye at that interval the result will be, not a broken, but a continuous reaction. It is this defect in vision that makes possible motion pictures and television, since the illusion of motion is produced by sending a series of pictures, each of which is a still, at a very rapid rate.

PERSISTENT WAVES.—In radio, a name sometimes given to continuous waves.

PETTICOAT INSULATOR.—A name given to the common forms of line wire glass insulators which have one, two or three deep flanges or petticoats of glass around the base for the purpose of increasing the surface distance from the line to the pin. Porcelain insulators for high voltage transmission are of the petticoat type.

P. f.—Abbreviation for power factor.

PHANTOM AERIAL.—An artificial aerial.

PHANTOM ANTENNA.—An artificial antenna.

PHANTOM CIRCUIT.—A superposed circuit, each side of which consists of the two conductors of a two wire circuit in paralle'

PHANTOPLEX CIRCUIT.—In telegraphy, a superposed circuit operated by alternating current over a simplex, duplex or quadruplex circuit operated from direct current sources.

PHASE.—1. The angle turned through by a generating element of an alternator reckoned from a given instant. Phase is usually measured in degrees from the initial position of zero generation.

2. Any position on an a.c. or pressure curve as indicated by some reference position. Usually the phase position is defined by specifying the number of electrical degrees between the phase and the reference position.

PHASE ANGLE.—The angle expressing the phase relation in an alternating current.

PHASF CONVERTER.—A phase changer.

PHASE DIAGRAM.—A diagram which graphically represents the magnitude and relative phases of electric currents.

PHASE DIFFERENCE.—The angle between the phases of two alternating current quantities of the same frequency as measured in degrees.

PHASE DIFFERENCE METER.—A synchronism indicator.

PHASE DISPLACEMENT.—A change of phase of an alternating pressure or current.

PHASE DISTORTION.—A radio wave distortion due to change in phase between voltage and current at certain frequencies.

PHASE FAILURE PROTECTION.—The effect of a device operative upon the failure of power in one wire of a polyphase circuit, to cause and maintain the interruption of power in all of the circuit. —NEMA.

PHASE FAILURE PROTECTIVE RELAY.—An elevator safety device usually a polyphase, shunt wound relay with a control circuit contact to maintain the control circuit of the elevator controller so long as the phases are all alive. The failure of any phase causes the relay to open the controller circuit and thus disconnect the motor from the supply lines.

PHASE INDICATOR.—An instrument intended for "phasing out" particularly in making relay connections or other connections where a current of a specific phase should be selected in regard to a particular voltage connection.

It operates on the principle that a suitably pivoted iron vane, when placed in a rotating field and magnetized by alternating currents, will assume a position depending on the phase difference between the current magnetizing the vane, and the voltage producing the rotating field.

PHASE LAG.—In an a.c. circuit, when the current reaches a maximum or zero value at a time later than the corresponding values of the pressure, the current is said to be out of phase with the pressure and to lag behind the pressure.

PHASE LEAD.—In an a.c. circuit, when the current reaches a maximum or zero value at a time earlier than the corresponding values of the pressure, the current is said to be out of phase with the pressure and to lead the pressure.

PHASE METER.—A synchronism indicator.

PHASE OPPOSITION.—The condition which obtains when the current and voltage of an alternating current have a phase difference of 180°.

PHASE REVERSAL PROTECTION.—The effect of a device operative on the reversal of the phase rotation in a polyphase circuit, to cause and maintain the interruption of power in all of the circuit.—NEMA.

PHASE REVERSAL PROTECTIVE RELAY.—Many State electrical codes now require a phase reversal protective relay on all polyphase elevator installations. Frequently the phase failure and phase reversal relays are combined in one device. The reversal of phases immediately opens the controller circuit and prevents the elevator motor being connected to the lines until the relation of the phases is corrected.

PHASE ROTATION RELAY.—One which functions in accordance with the direction of phase rotation.—NEMA.

PHASE SPLITTING.—In a single phase motor, producing temporarily a substitute for a two phase current so as to obtain a make shift or bastard rotating field in starting by "doctoring" the single phase.

When the motor has come to speed, the makeshift second phase is cut out and the motor then runs on the single phase or true phase delivered by the external circuit. There are several methods of splitting the phase as by providing in addition to the main single phase or running winding: a, starting winding, or b, shading coils. Practically all small single phase induction motors are started by means of a split phase starting winding.

PHASE SPREAD.—The space occupied by each single phase winding. For a two phase winding the phase spread is (180÷2) or 90 degrees. For a three phase winding it is (180÷3) or 60 degrees. In a single phase winding, the phase spread is theoretically 180 degrees. Nothing is gained however by winding all the slots of a single phase machine. In practice only about 75 per cent of the available slot space is utilized making the phase spread for a single phase winding about 135 electrical degrees.

PHASE TRANSFORMATION.—The use of a transformer for changing a system of polyphase currents into another system differing in phase, or for transforming single phase into polyphase currents.

PHASE TRANSFORMER. — A polyphase transformer whose secondary voltage differs in phase from its primary voltage. An induction regulator may be used as a "phase transformer" and the phase of the secondary voltage may be set at any desired angle to that of the primary by turning the rotor.

PHASE WOUND.—The type of armature winding of an external resistance or slip ring motor. The commonly used terms wound rotor and phase wound, for an external resistance motor are objectionable, because they do not fully classify. For instance, the terms are commonly though questionably applied to internal resistance motors and external resistance motors. The term slip ring fully defines the motor as to type and leaves nothing to the imagination.

PHASED.—A term sometimes used to denote synchronism of current and voltage.

PHASING CURRENT.—An instantaneous current which passes through two alternators before they come into step when they are switched into parallel.

PHASING OUT.—The process of checking the connections of an a.c. machine.

PHASING TRANSFORMER.—A transformer for changing the phase of electric currents; one that effects phase transformation.

PHILOSOPHER'S EGG. — An ellipsoidal vacuum chamber containing two vertical electrodes, a discharge between which resembles a luminous egg.

PHONAUTOGRAPH.—A device for registering speech, in which a stylus mounted upon a diaphragm is caused to vibrate by the sound waves so as to transfer the spoken message by corresponding marks upon a rotating cylinder.

PHONE.—1 A contraction commonly used for telephone

2. A contraction for the act of telephoning.

3. The receiver in phonoplex telegraphy.

PHONIC WHEEL.—In a synchronous multiplex telegraph system, a type wheel rotated by timed electric impulses transmitted over the line.

PHONO-FILM.—A talking motion picture system introduced by De Forest in 1923.

PHONOGRAPH.—An apparatus, invented by Edison, by which permanent records of sound are impressed upon wax cylinders, and afterwards reproduced at will from the record. In place of wax cylinders, discs made of moulded material are the prevailing type. Sound frequencies are formed by undulations cut by the recording needle in a spiral groove on the surface of the disc. Records are usually made on both sides of the disc.

PHONOGRAPH ADAPTER.—A vacuum tube socket to permit the output of a phonograph pickup to be connected to the tube's grid circuit.

PHONOGRAPH AMPLIFIER.—In radio, an audio frequency amplifier having for its signal source a phonograph pick up.

PHONOGRAPH PICKUP.—A device which converts the vibrations of a phonograph needle in traversing a phonograph record into audio frequency currents for reproduction through a radio set.

PHONOGRAPHIC RECORD.—The sheet of tin foil or wax bearing the impression of the record made in a phonograph; a phonogram.

PHONOPLEX TELEGRAPHY.—A system of telegraphy in which pulsatory currents are superposed upon the regular Morse currents to operate a form of telephone receiver, and thus allow of double transmission without interference.

PHONOSCOPE.—An instrument for observing or exhibiting the motions or properties of sounding bodies.

PHONOZENOGRAPH.—A device operating by a telephone in conjunction with a Christie or so called Wheatstone bridge for determining the point from which a sound comes.

PHOSPHOR BRONZE.—An alloy of copper, tin and 2 to 5% of phosphorus with small percentages of zinc, iron and lead. The metal is of a reddish brown color, which after annealing and tempering acquires great resiliency which makes it useful for springs. As an electric conductor, it is much stronger than pure copper, but of inferior conductivity. It is very durable and is often employed for parts of machinery exposed to shocks. Phosphor bronze resists corrosion to a considerable extent, and is, therefore, used for parts that are exposed to the action of salt water.

PHOSPHORESCENCE, ELECTRIC.—Phosphorescence produced in a body by a static discharge of electricity.

PHOSPHORESCENT GLOW.—Luminous phenomena following an electric discharge through a vacuum tube. Before exhaustion of the tube the sparks pass without any unusual effects. As the air is exhausted the sparks become less sharply defined, and widen out until the entire volume of the tube is occupied. At a certain degree of vacuum the light breaks up into a set of patches of light of a cup-like form, which vibrate to and fro between darker spaces. Various effects may be obtained by introducing different gases, such as oxygen, nitrogen, etc., into the tube. In hydrogen gas, the tint of the electric discharge is bluish, except where the tube is narrow, where a crimson tint may be seen. The light of discharges in a vacuum is rich in those rays which produce phosphorescence and flourescence.

PHOSPHOROSCOPE.—An instrument for determining the phosphorescence or flourescence of a substance.

PHOSPHORUS.—An elementary substance of a yellowish color and semi-transparent resembling fine wax. It burns in common air with great rapidity, and in oxygen gas with the greatest vehemence. Even at the common temperature, it combines with oxygen, undergoing a slow combustion and emitting a luminous vapor.

PHOT.—An illumination unit equal to one lumen per sq. cm. One phot=1,000 milliphots=10,000 lux=929 foot candles. 1 foot candle=1.0764 milliphot.

PHOTOACTIVE.—The property of certain substances of being affected by light; for instance, a photograph film.

PHOTO-ELECTRIC CELL.—A device which varies in electrical resistance in proportion to the amount of light falling upon it. Manufacturers of photo-electric cells used for sound pictures make use of the fact that when light falls upon the surface of a metal, electrons are emitted from its surface. Although all metals emit electrons when subjected to light, only a few of them are affected by ordinary or visible light. The number of electrons emitted is directly proportional to the amount of light falling on the surface of the metal.

PHOTO-CHEMICAL EFFECTS.—Chemical changes produced by the action of light.

PHOTO-CHEMICAL SPECTRUM. — The spectrum of the ultra-violet rays of light which, though invisible to the eye, accompany luminous radiation and may be detected by photographic means.

PHOTO-CHEMISTRY. — That branch of chemistry which treats of the action of light in producing chemical effects.

PHOTO-CHRONOGRAPH. — An electric chronograph provided with a photographic apparatus for taking instantaneous pictures of a moving object, such as a heavenly body, at regular intervals of time.

PHOTO-CONDUCTIVE CELL.—A type of photo-electric cell usually having selenium for its active material. The effect of light striking the active material is to reduce its resistance.

PHOTO-ELECTRIC.—Descriptive of the effect which light has on electric circuits, through a device controlled by light.

PHOTO-ELECTRIC ALARM.—An alarm operated by a selenium cell by which a bell is rung when the cell is exposed to the action of light.

PHOTO-EMISSIVE CELL.—A form of photo-electric cell which contains a cathode material acted upon by visible light or other forms of radiant energy, the material then emitting electrons in proportion to the amount of flux and the wave-length of the radiation. The emission is solely a result of the radiant energy without the assistance of local heat.

PHOTO-ENGRAVING.—A name applied to each of many processes, in which the action of light on a sensitized surface is made to change the nature or condition of the substance of the plate or its coating, so that it may be made to afford a printing surface corresponding to the original from which the photographic image is derived.

PHOTOGRAPHIC METER. — An electric meter employing photography to obtain its record.

PHOTOMETER.—An instrument for measuring the intensity of light, and, especially, for comparing the relative illuminating powers of different sources of light. Its operation is based on the fact that a translucent spot in the center of a white screen will have the same appearance as the rest of the screen when the illumination on the two sides is equal.

PHOTOMETER SCREEN.—A paper disc, often containing a grease spot in the center, placed between the two lights to be compared by a photometer, and adjusted along a graduated scale; a photometer disc.

PHOTOMETRIC METHOD.—In this method of measuring the radio frequency power delivered by a transmitter, a lamp filament heated to incandescence provides the resistive load. The d.c. or a.c. power required to heat a similar lamp to the same brightness, is a measure of the radio frequency power dissipated in the load. This method is useful for the measurement of power up to a few kilowatts.

PHOTOMETRIC UNIT.—A unit of light measurement, such as the lumen hour for quantity of light; the lumen for flux of light; the candle and hefner for intensity of light; the candle per sq. cm., or sq. ft. for brightness; and the lux for illumination.

PHOTO-MICROGRAPHY.—The act of photographing microscopic objects which have first been enlarged by the microscope. The use of artificial light is necessary.

PHOTON.—A positively charged extremely small particle.

PHOTOPHONE.—An instrument for transmitting sounds along a beam of light reflected between mirrors, and converging upon a selenium cell. The reflecting mirror is thrown into vibrations by the sound waves and the beam of light consequently falls with varying intensity upon a receiver of selenium, connected in circuit with a small battery and a telephone receiver in which the sounds are reproduced by the variations of the current. Tellurium possesses similar properties and carbon also is sensitive to light.

PHOTOPHORE.—A form of endoscope employing a small incandescent lamp for examining the internal cavities of the human body.

PHOTOSPHERE. — The luminous envelope of incandescent matter surrounding the sun.

PHOTO - TELEGRAPHY. — Telegraphic transmission by means of light, as with a heliograph or a photophone.

PHOTO-VOLTAGE.—Electric pressure generated by the action of light.

PHOTO-VOLTAIC CELL.—A form of primary cell having a lead and a cuprous oxide element immersed in an electrolyte. In operation, the effect of light on one of its elements is to produce voltage between its two elements.

PHOTO-VOLTAIC EFFECT.—A change in the electric resistance of a substance, especially of selenium, when exposed to light.

PHYSICAL CHANGE.—Any change occurring in matter without altering its chemical constitution, as distinguished from chemical change.

PHYSICAL UNITS. — Selected physical quantities in terms of which the magnitude of other physical quantities of a like kind may be reckoned or expressed.

PICKING UP GEAR.—In submarine cable operations, the apparatus for bringing a cable to the surface.

PICKLE.—To steep in an acid bath, for the purpose of removing impurities; as, in the following:

1. In boilermaking, the plates are steeped on edge for a period of six hours, in racks within a wooden bath, containing a 5% solution of hydrochloric acid in fresh water. This loosens the mill scale, which is removed by the aid of wire brooms, mechanical brushes and a plentiful supply of water. The cleaned plates are immersed in an alkaline bath of weak quicklime and water, to neu-

tralize remaining acid, and finally washed in fresh water.

2. In iron founding, the castings are placed on racks, and have a 25% solution of sulphuric acid poured over them, by means of a ladle, the acid being collected and used over again. After standing to drip all night, the castings are washed down with a hose and brooms, remaining sand being removed by wire brushes and old files. A better method is to steep for two or three hours in a wooden vat containing ten per cent solution of hydrofluoric acid, which attacks scale and sand, but not iron. A vat may be used three or four times with the same acid.

PICKLES AND DIPS.—While the best polish is secured by grinding and wheel polishing, many articles are best cleaned chemically by immersing them in solutions which dissolve the scale, grease, etc., adhering to them, leaving a clean but rough surface which must be polished afterward.

PICKLE (BLACK) FOR IRON.—Sulphuric acid 66° Baume, 1 part; water, 15 parts. Used chiefly for removing scale from castings and forgings.

PICKLE FOR GERMAN SILVER.—German silver may be cleaned in the bright dip for brass, or in a preliminary pickle of dilute nitric acid and water (12 to 1), followed by a dip of equal parts of sulphuric and nitric acids, and then by rinsing in boiling water and drying in sawdust. Use sawdust that contains no tannin.

PICK UP VOLTAGE (OR CURRENT).—The voltage (or current) at which a magnetic contactor starts to close under conditions of normal operating temperature.—NEMA.

PICO-FARAD.—1. A unit of electro-static capacity. One pico farad$=10^{-12}$ farad, that is $1 \div 1{,}000{,}000{,}000{,}000$ of a farad.

2. A term used by amateurs meaning one millionth of a micro farad, that is, a micro micro farad.

PICTURE FREQUENCY.—In television the number of separate pictures projected per second.

PIEZO ELECTRIC CRYSTALS.—Those possessing the property known as the piezo electric effect.

PIEZO-ELECTRIC SPEAKER. — A radio loud speaker whose operation depends on the property of a crystal of expanding and contracting in accordance with the electric strains to which it is subjected. In operation the variations in the applied signal voltage will cause the crystal to expand and contract and these mechanical vibrations are, by suitable means communicated to a diaphragm.

PIEZO-ELECTRICITY. — Electricity produced by pressure, such as the electric polarity sometimes seen in a crystalline substance. It was discovered by Hauy, that a crystal of calcspar pressed between a man's dry fingers, so as to compress it along the blunt edges of the crystal, became electrical, and remained in this condition for several days. Mica, topaz and fluorspar are said to possess a similar property. Opposite kinds of electricity are produced by pressure on a crystal tourmaline at the opposite ends, and also on other crystals which possess a skew-symmetry or hemihedry in their structure.

PIEZOMETER.—An instrument for measuring flowing water. If a vertical or oblique tube be inserted into a pipe containing water under pressure, the water will rise in the former, and the vertical height which it reaches will be the head producing the pressure at the point where the tube is attached. If the water in the piezometer falls below its proper level, it shows that the pressure in the main pipe has been reduced by an obstruction between the piezometer and the source of water supply. If the water rises above its proper level, the pressure there has been increased by an obstruction beyond the piezometer.

PIG MAGNET.—A type of lifting magnet provided with a central cylindrical pole and a concentric outer pole, with a magnetizing winding inserted in an annular slot or space between the two poles. These magnets are designed to give fields of deep penetration by reason of the powerful magnetizing winding and wide spread poles.

PIG TAIL.—A short length of flexible wire connecting a terminal and a circuit.

PIKE POLE.—A long pole, twelve or sixteen feet in length and tipped with an iron spike, for use in raising telegraph poles.

PILE.—A primary battery consisting, usually, of super-imposed plates; the voltaic pile.

PILOT BRUSH.—An additional commutator brush used for testing the voltage derived from the different commutator segments.

PILOT HOUSE CONTROLLING GEAR.—The appliances in a ship's pilot house for controlling the searchlight.

PILOT LAMP.—1. In a central power station, an incandescent lamp placed upon a dynamo, and connected across its terminals to show the pressure of the terminals by the brightness of its light.

2. In a lamp signal telephone switchboard, a specially conspicuous lamp connected with a group of line lamps in such a way that it remains lighted as long as any one of the lamps in the group is lighted.

PILOT MOTOR.—A small motor designed to start and control a large motor.

PILOT TRANSFORMER.—A small transformer set at any point in an alternating current system to indicate to the central station the pressure at that point.

PILOT WIRES.—In an electric lighting or power system, small wires connecting distant points in the mains with a volt meter at the central station, in order that the pressure at those points may be read at the station.

PIN-JACK.—A type of jack consisting of a small receptacle and a pin contact which is inserted in the receptacle.

PIN PLUG.—A slender metal plug designed to make an electrical connection when inserted between two contact blocks.

PINS.—In pole line construction, wooden pegs with threads cut to fit the glass line insulators.

PINCH EFFECT.—That property of an electric current flowing in a conductor which tends to compress the conductor and reduce its cross sectional area.

PIPE FITTINGS.—Pieces made of brass, cast and malleable iron, used in pipe fitting: a, to alter the direction of a pipe; b, to connect a branch with a main; c, to close an end; d, to connect two pipes of different sizes. There is an undue multiplicity of fittings on the market and the supply house that keeps all of them is indeed hard to find, hence in pipe fitting, it is advisable to use only the simplest fittings, because special or unusual forms are sometimes hard to get and costly.

PIPE POLE.—A pole for overhead wires, consisting of jointed metal pipes or tubes.

PIPE VISE.—A gripping appliance for holding pipes while being threaded or cut. A typical vise consists of a plain or hinged U-shape piece containing the clamp screw, the sides of which form guides for the upper jaws. The upper and lower jaws are provided with a series of rectangular teeth. When the U piece is closed over the pipe, pin inserted, the teeth of both jaws are brought in firm contact with the pipe by screwing down the upper jaw thus holding the pipe firmly.

PIPE WELDING.—The process of joining wrought pipe by welding instead of by the use of screwed fitting. Various kinds of standard fittings have been designed for welded joints. Standard dimensions have been adopted for each fitting. The fittings consist of elbows, tees, offsets, reducers, crosses, manifolds, saddles, swage nipples, etc. These fittings are now available the same as ordinary screw fittings, in sizes 1 in. to 20 in. (standard thickness). One manufacturer who makes these fittings calls them "tube turns." All stock sizes furnished with ends beveled 45 degrees for welding unless otherwise specified.

PIPETTE.—A small graduated glass tube for transferring measured quantities of liquids from one vessel to another.

PISTON SPEED.—The total distance traveled by the piston of an engine in one minute—not the actual velocity at any given instant of time.

PISTON SPEED CALCULATION.—Apply the following rule: Multiply twice the number of revolutions per minute by the stroke of the engine in inches and divide the product by 12 to reduce to feet. Thus, an engine having a stroke of 6 inches and running 500 revolutions per minute is said to have a piston speed of

$$\frac{2\times6\times500}{12}=500 \text{ feet per minute.}$$

PITCH LINE.—A circle drawn through the middle of the length of the conductors wound upon an armature for the purpose of measuring the pitch of the windings.

PITCH OF POLES.—In an alternator, the distance between the center of one pole piece to the center of the opposite pole piece.

PITCH OF PROPELLER.—In marine propulsion, the distance the propeller would move forward (or backward) in one revolution if there were no slip. In the case of a screw advancing through a nut, each revolution will produce a forward travel equal to the pitch of the screw. With a propeller, considering the water as the nut, the pitch is the distance it would advance each revolution. However, in practice, there is always more or less slip.

PITCH OF WINDING.—In armature winding the angular distance between the sides of a coil, usually measured as the number of the slot in which each side of the coil is wound. Thus, a pitch of 1-6 means that the first coil is wound in slots 1 and 6. This would also be stated as a pitch of 5. Usually the pitch of the coil is made just a little less than the pole pitch of the machine, in order to shorten the end connections of the coils from slot to slot. However, if the pitch be made too small, trouble will be encountered in commutation. Pitch is sometimes called **spread.** In addition to pitch of the coils, there is also the **commutator pitch.**

PITCH RATIO.—In marine propeller propulsion, the ratio of the pitch of the propeller to its diameter. Thus in a 20 ×30 propeller the pitch ratio=30÷20= 1.5. It should be remembered in stating the dimensions of a propeller that the diameter is given first and then the pitch. Thus a 20×30 propeller means one of 20 ins. diameter and 30 ins. pitch. Light hulls which drive easily may be fitted with propellers of reasonably high pitch, while hydroplanes and extremely light racing boats frequently use ratios as high as 1.75 and 2. In general practice a ratio higher than 1.5 will produce abnormal slip and should be avoided. A safe rule is the heavier the hull, the lower the pitch ratio. Installations have been made on extremely heavy scows and canal boats where a ratio as low as .45 has been used and satisfactory results obtained.

PITCHBLENDE ORE.—Radium ore. The deposits at La Bine Point in Northwest Canada are a valuable source of radium.

PITCHOMETER.—A device used to measure the pitch of propellers.

PITH.—A light spongy cellular tissue which occupies the center of the stem in certain plants.

PITH BALL ELECTROSCOPE.—An instrument consisting of a pair of pith balls suspended by cotton threads from an insulated conductor; when approached by a rubbed glass rod the balls fly apart, thus exhibiting the repulsion existing between similarly electrified bodies.

PITH BALLS.—Small pellets cut from pith for use in experiments in static electricity with the pith ball electroscope.

PITTING.—A defect in steam boilers due to corrosion consisting of a series of holes often running into each other in lines and patches, eaten into the surface of the iron to a depth sometimes of one-quarter of an inch. Pitting is the more dangerous form of corrosion, and the dangers are increased when its existence is hidden beneath a coating of scale.

PIVOT SUSPENSION.—A method of supporting the indicating needle of an electric measuring instrument in which the needle has a jewel at its center resting upon a sharp pivot, as distinguished from **fiber suspension.**

PIVOTAL TROLLEY.—A trolley base pivoted so that the trolley pole may readily be turned about to reverse the direction of the car.

PLAIN AERIAL.—A direct coupled aerial.

PLAIN ANTENNA TRANSMITTER.—A radio spark gap transmitter whose spark gap is in series in the antenna circuit.

PLANE ANGLE.—An angle included between two lines.

PLANE GEOMETRY.—That branch of geometry that treats only of the relations of points, lines, angles, triangles and other figures in a plane.

PLANE OF MAXIMUM INDUCTION.—In a dynamo, a plane passing through the armature axis and lying 90° in advance of the neutral plane, being the position of maximum induction in a distorted field. This refers to a bi-polar machine. Of course the angle of advance depends upon the number of poles.

PLANE OF POLARIZATION.—In plane polarized light, the plane perpendicular to the direction of the vibration of the light waves.

PLANES.—The main supporting surfaces of an airplane.

PLANIMETER.—An instrument used for measuring areas, as in indicator diagrams. It consists of two hinged levers, with points at the ends; one of which is secured to the paper, while the other, having attached to it a graduated wheel, is traced around the outline of the figure; the circuit being completed, the area is read from a graduated wheel, a vernier being provided so the area may be read to three decimal places. For a diagram, the area is divided by the length, which gives the average height or mean pressure.

PLANT ELECTRICITY.—Electricity exhibited in vegetable life; such as differences of voltage existing in various parts of a tree.

PLANTE TYPE STORAGE CELL.—A secondary cell in which the lead is chemically attacked and finally converted into lead peroxide, probably after it has gone through several intermediate changes. The plates are all formed as positive plates first and then all that are intended for negative plates are reversed, the peroxide being changed into sponge lead. The surfaces of the plates are finely sub-divided, the following methods being those most common: scoring, grooving, casting, laminating, pressing and by the use of a lead wool.

PLATE.—1. In a radio vacuum tube, the element that attracts electrons from the filament. The positive element.

2. In a storage battery, the combination of grid and paste properly "formed." Positives are reddish brown and negatives slate gray.

PLATE BATTERY.—In radio, the B battery, that is, the one used to furnish current for the plate of a vacuum tube. The purpose of this battery is to keep the plate voltage positive with respect to the filament so that the electrons will be attracted sufficiently to the plate.

PLATE BY-PASS CONDENSER.—In radio, a condenser in the plate-filament circuit of a vacuum tube for the purpose of bypassing high frequency current.

PLATE CIRCUIT.—In a radio vacuum tube the circuit connected to the plate.

PLATE COIL.—In radio, an inductance coil forming part of the plate circuit.

PLATE CONDENSER AERIAL.—One having a counterpoise.

PLATE CONSUMPTION.—In radio, the voltages usually impressed on the plate of a vacuum tube, that is the B battery voltage 22½ or 45 volts; an amplifier tube 90 volts and power tube up to 135 volts. Detector tube plate current .3 to 1½ milliamperes amperes up to 7.4 and power amplifier up to 55 milliamperes.

PLATE CURRENT.—The current passing between the plate and heated filament of a vacuum tube.

PLATE CURRENT CUT OFF.—In a vacuum tube, the degree of negative grid bias at which the flow of electrons from the filament to the plate ceases.

PLATE DETECTOR.—A radio vacuum tube detector whose operation is based on the principle of plate current detection.

PLATE MODULATION.—Heising modulation.

PLATE RESISTANCE OF TUBE.—In a radio tube, the opposition to flow of alternating current between the plate and filament.

PLATE WINDING.—In radio hook ups, that winding of a transformer which is connected in the plate circuit of a tube.

PLATED.—Covered with a coating of metal as by electro-plating.

PLATING.—1. The process of covering an object with a coating of metal, as in electro-plating.

2. The art of coating stronger or baser metals with a film of a more valuable one, such as silver, gold, or nickel; either by electro-deposition or otherwise.

PLATING BALANCE.—A balance from which an article to be electro-plated is suspended so that when the article accumulates deposited metal up to a certain weight the balance tips and automatically stops the operation.

PLATING BATH.—In electro-plating, the acid solution, containing a salt of the metal to be deposited, held in a vat or trough which is fitted with terminals for the passage of an electric current through the solution. The action of electrolysis in this liquid causes metal to be freed from the anode and deposited upon the cathode which is the object to be plated.

PLATING DYNAMO.—A dynamo which supplies the electric current for electro-plating. Since it is not economical to transmit low voltage heavy amperage current a long distance, the current is usually generated in the electro-plating plant. Accordingly, a special type dynamo is used either belted to any power source or direct connected to a motor. Both shunt and compound wound dynamos may be used either self-excited or separately excited. The so-called "separately excited shunt wound dynamo" is simply a dynamo in which the entire field current is furnished from outside. Strictly speaking, it is not shunt wound, but the above expression has come into common use, probably in contrast with the term "separately excited compound wound." Except in the smaller sizes, separate excitation produces superior plating characteristics. On account of the very heavy current output electro-plating dynamos usually have two commutators.

PLATINIZING.—To coat a surface with finely divided platinum to provide a conducting surface.

PLATINOID.—An alloy of copper, zinc, nickel and tungsten, having a temperature coefficient less than half that of German silver, often employed for resistance wires in resistance boxes. The addition of tungsten imparts greater density, and when polished the alloy has the appearance of silver. The resistance of platinoid ranges from about thirty to thirty-six microhms between the opposite faces of a cubic centimeter of the alloy, this being about one and one-half times the resistance of German silver.

PLATINUM.—A somewhat rare, silvery white metal, specific gravity 21.5 nearly the heaviest known, while it melts at about 3190° F. Platinum is very ductile, is not dissolved by any acid and is very difficult to oxidize. Coefficient of expansion .00000479 per degree F. Electrical conductivity approximately 14.4 (silver =100).

PLATINUM BLACK.—A dull black powder of finely divided platinum having in a high degree the power of absorbing oxygen.

PLATINUM FUSE.—A slender strip or wire of platinum used for firing a blast when heated to incandescence by an electric current.

PLATINUM LAMP.—An incandescent lamp having a platinum filament.

PLATINUM PLATING.—Depositing a coating of platinum upon an object by electro-plating.

PLATINUM SILVER.—An alloy composed of one-third platinum and two-thirds silver, possessing high specific resistance.

PLATINUM STANDARD LIGHT.—A standard of light proposed by Violle; being that which is emitted by a square centimeter of molten platinum at the temperature of solidification: the violle.

PLATINUM VOLTAMETER.—A voltameter having electrodes of platinum in dilute sulphuric acid.

PLATY METER.—An instrument, consisting essentially of a pair of cylindrical condensers with their inner coatings connected, for the purpose of measuring the capacity of condensers, or the specific inductive capacity of dielectrics.

PLENUM.—Any condition of fullness; a pressure of air, the opposite to vacuum. The plenum method of ventilation is a system for ventilating buildings by forcing in fresh air, the plenum or fullness created by its incoming, causing an outward flow of foul air.

PLOW.—In a conduit trolley system, the contact that is pushed along the underground trolley wire in the conduit for the purpose of deriving current for the car motors

PLOW, ELECTRIC.—A plow driven by electricity, used in agricultural operations on a large scale.

PLOW STEEL WIRE.—Denotes a very high quality of wire originally used in the manufacture of steel rope, sometimes used for electric conductors.

PLUCKER TUBE.—A form of vacuum tube specially designed to exhibit the stratification of luminous rays, and the effects produced in the neighborhood of the negative electrode.

PLUG.—1. A terminal, consisting of a metal tip and sleeve, insulated from each other, and connected to a flexible cord, for inserting into a spring jack in a telephone switchboard, and making the desired connection.

2. A metal key with insulated handle for inserting between contact blocks to complete a circuit, as in a resistance box.

3. A fitting for closing the end of a pipe or a fitting having a male thread. Plugs are made of cast iron, malleable iron and brass. Usually a square head or four side counter-sunk is used for the small sizes and a hexagon head for the larger sizes. A special form of plug suitable for closing large openings is known as the bull plug.

PLUG CUT OUT.—A form of safety fuse block provided with a fuse plug.

PLUG FUSE.—An enclosed fuse with screw connections. It consists of a cylindrical porcelain body, in which the fuse strip is placed. One end of the strip is soldered to the screw shell which surrounds the body and which forms one of the contacts. The other end of the strip is soldered to the center contact in the bottom. The top cover is spun in place on the body and is fitted with a mica window by which it is possible to tell at once when a fuse on the circuit has blown, as the blowing discolors the window. These plugs screw into the receptacles on the fuse block, and, whenever a fuse blows, a new plug must be inserted. Standard plug fuses are intended for the protection of circuits having a maximum current of 30 amperes.

PLUG-IN COILS.—Interchangeable coils which can be plugged into sockets such as are used in radio short wave receivers.

PLUG-IN TRANSFORMER. — An interchangeable radio frequency transformer which can be plugged into a socket.

PLUG KEY.—A plug resembling a key.

PLUG RESISTANCES. — The resistance coils of a resistance box provided with contacts and plugs.

PLUG RHEOSTAT.—A resistance box in which the coils terminate in brass blocks which are reamed out to fit the shape of brass plugs with insulated handles. By inserting or withdrawing the plugs the resistances can be varied.

PLUG SLEEVE.—A tube of brass which encases the tip conductor of a telephone switchboard plug and forms the second contact part.

PLUG SWITCH.—A switch containing contact blocks separated from each other by just sufficient space to admit the plugs which complete the circuits.

PLUG SWITCHBOARD.—A switchboard such as a telephone switchboard, which makes its connections by the insertion of plugs.

PLUMBAGO.—Graphite or "blacklead"; used for crucibles and lubricating and also to coat insulating surfaces as gutta-percha. It is the composition with which the interior of pencils is filled.

PLUNGE BATTERY.—A number of primary cells so arranged that one or both elements may be withdrawn from the electrolyte. A familiar cell of this type is the Grenet bichromate cell.

PLUNGER.—A solid cylindrical body which fits accurately or approximately the chamber within which it reciprocates. It differs from a piston in that it is longer than its stroke. A plunger is guided by a stuffing box, either internal or external, while a piston is guided by the cylinder walls. Used in dashpots, and in many mechanical movements; also in a plunger pump. The word plunger is very frequently used, erroneously, for piston even by those who ought to know better. Many pumps are built with pistons—not plungers.

PLUNGER DOOR CONTACT.—A form of burglar alarm switch which operates by the movement of the door. Made for open and closed circuit alarm systems.

PLUNGER FLOOR CONTACT.—An electric floor contact operating on the principle of a plunger and pushed by the foot.

PLUNGER SWITCH.—A form of circuit breaker employed in high tension work. It consists of a metal plug drawn in and out of a split tube by a lever mechanism while immersed in oil.

PLUNGER TYPE AMMETER.—A form of current indicating instrument consisting of a series coil and a soft iron plunger forming a solenoid, the plunger is so suspended that the magnetic pull due to the current flowing through the coil is balanced by gravity. In order to adapt the instrument to alternating current the plunger should be laminated to avoid eddy currents. An objection to the plunger type ammeter is that they are large and expensive because the coil carries all the current.

PLUS CHARGE.—A positive charge. The kind of electric charge which is developed on glass by rubbing it with silk, as distinguished from a minus or negative charge such as is produced on resinous bodies by friction with flannel or fur.

PLUS POLE.—The positive pole of a magnet. It is the pole which, if the magnet were suspended, would tend to point to the north. It is also called the **north, north-seeking, N, marked, blue** and **boreal pole.**

PNEUMATIC CELL.—A form of bichromate primary cell arranged to permit a jet of air to be blown through the electrolyte to aid in its diffusion and depolarization.

PNEUMATIC PERFORATOR.—In automatic telegraphy, a perforator operated by compressed air.

PNEUMATIC RODDING.—A method of passing a wire through a conduit by applying air suction at the farther end, which draws a wooden cylinder or "dart" through the duct followed by the wire which is attached to it.

PNEUMATIC SYSTEM OF WATER SUPPLY.—A combined water and air power pump which pumps into a pressure tank, the air pressure being equivalent to head necessary to force the water to the highest outlet. The drive is usually electric and automatic devices are provided to maintain the proper amount of water and air to meet service conditions.

POCKET RELAY.—A small sized telegraphic relay.

POCKETS.—Spaces left in walls, ceilings, etc., to permit electrical connections to be made in a system of inside wiring.

POGGENDORFF CELL.—A bichromate cell first invented by Poggendorff. The electrolyte consists of dilute sulphuric acid to which has been added bichromate of potash to prevent polarization; the bichromate combining with the hydrogen as it is liberated from the sulphuric acid. The elements are plates of zinc and carbon, there being usually three plates of zinc and four of carbon to each cell. Cells of this type are usually arranged as a plunge battery, the cells being connected in series, and the plates suspended from a cross bar so that by a windlass arrangement, all the plates can be raised out of the solution when not in use.

POHL COMMUTATOR.—A double pole, double throw switch used in galvanometer testing. It has a base with six depressions which are filled with mercury. A handle carries six prong contacts which dip into the depressions and by rocking it from one side to the other the double throw movement is obtained.

POINT.—A name given to a stationary contact button on a switch to designate the number of paths. Carefully distinguish from "way."

POINT DISCHARGE.—The discharge of static electricity from the tip of a pointed conductor which takes place when electricity of high voltage accumulates at such a point, and by electrifying the surrounding air causes an escape of electricity by means of the charged air particles.

POINT LIGHTING.—A name sometimes used for spot lighting in television.

POINTS OF COMPASS.—The 32 points or rhumbs into which the compass card of the mariner's compass is divided, corresponding to supposed divisions of the horizon, of which North, South, East and West are called the cardinal points. For the first quadrant the points are: N, N by E, NNE, NE by N, NE, NE by E, ENE, E by N, E. The others follow in similar

POINT OF IGNITION.—The moment at which the charge in a gas engine cylinder is ignited with reference to the operating cycle. It occurs before the piston reaches the end of the compression stroke, the exact point or amount of advance depending (for best results) on the speed of the engine, etc.
order.

POINTS OF LIGHTNING RODS.—Tips of copper forming the upper extremity of lightning rods.

POINTS RELATING TO COMMUTATORS.—1. The number of commutator segments depends on the scheme of winding and on the number of sections in the armature winding.

2. Increasing the number of bars diminishes tne tendency to spark, and lessens the fluctuations of the current.

3. The surface of a commutator should always be kept free of carbon and copper dust. A commutator can best be cleaned by rubbing a kerosene soaked flannel cloth over its surface.

4. Flats on a commutator cause sparking.

5. An untrue commutator is indicated when the machine is slowed down, by a visible eccentricity, or by holding the hand, or a stick, in the case of a high tension machine, against the surface while revolving, when any irregularity or eccentricity will be apparent by the vibration or movement of the stick. The only remedy for an untrue commutator is to re-turn it in the lathe.

POINTS RELATING TO HOT BEARINGS.—1. Use good oil.

2. See that oil cups or reservoirs are full and all oil passages clear.

3. In self-oiling and splash systems where the oil is used over again, it should be kept in clean condition by frequent straining.

4. Keep bearings clean and properly adjusted.

5. Maintain bearings in good alignment.

6. Avoid tight belts.

7. Examine the air gap or clearance between armature and pole faces and see that they are uniform.

POINTED CONDUCTORS.—When a pointed conductor receives a static charge the electricity escapes from the point: this is the operating principle of the electric windmill.

POLAR.—1. Pertaining to magnetic poles.

2. In geometry, proceeding from a fixed point of radiation.

3. In geography, of or pertaining to either of the poles of the earth; whether the geographical or magnetic poles.

POLAR BORE.—The hollow space between the pole pieces of a dynamo within which the armature rotates.

POLAR DUPLEX TELEGRAPH SYSTEM.—One in which each station is provided with two batteries or dynamos, which are arranged in such a manner that the direction of the current in the line depends on whether the key is in its raised or depressed position. As in the case of the differential method, the current divides at the relay, which instead of being of the differential type is known as a polarized relay.

POLAR PITCH.—In a dynamo or motor, the armature circumference divided by the number of poles.

POLAR RELAY.—In telegraphy a relay which operates when the direction of the current changes. Instead of having a common soft iron armature it has one which is permanently magnetized.

POLAR SURFACES.—The surfaces of the poles of a magnet about which magnetic fields exist.

POLAR ZONE.—In electro-therapeutics, the parts of a patient's body in the immediate region of the electrodes applied to it.

POLARISCOPE.—An optical instrument for examining substances in polarized light; it is employed to identify minerals, precious stones, or to investigate rock structures.

POLARITY.—1. As applied to electric circuits, it indicates which terminal is positive and which negative.

2. As applied to magnets, it indicates which pole is N and which S.

POLARITY-DIRECTIONAL RELAY. — One which functions by reason of a change of the direction of polarity.

POLARITY INDICATOR.—Any device for indicating the presence and direction of magnetic flux, also called pole indicator.

POLARITY OF ELECTRO-MAGNETS.—If a wire be wound around a magnet in a right handed helix, the end at which the current flows into the helix is the south pole. If the wire be wound around an ordinary screw, and the current flows around the helix in the direction from the head of the screw to the point, the head of the screw is the south pole.

POLARITY OF A TRANSFORMER.—A designation of the relation of the high voltage and low voltage leads with respect to each other.

POLARIZATION.—In a primary cell, the effect of increasing the internal resistance and diminishing the current strength, produced by the accumulation of hydrogen bubbles on the negative plate.

POLARIZATION CURRENT.—In electrotherapeutics, a constant current which produces a condition of electrotonus in a nerve through which it passes.

POLARIZATION EFFECTS.—In a primary cell, polarization: a, weakens the current by the increased resistance which it offers to the flow, for bubbles of gas are bad conductors; b, weakens the current by setting up an opposing pressure.

POLARIZATION FAULT CURRENT. — A counter current set up at a break in a submarine cable by the action of a testing or other current.

POLARIZATION OF ARMATURE.—In dynamo operation, the induced current flowing in the armature winding, converts the armature into an electro-magnet, setting up a field across or at right angles to the field of the machine. This cross magnetization of the armature tends to distort the field produced by the field magnets, the effect being known as armature reaction.

POLARIZATION OF DRY CELLS.—The generation of current in dry cells produces a condition known as "polarization," or the collection of hydrogen on the electrode attached to the positive lead wire. This condition may be remedied, that is, the cell may be "depolarized," only by leaving it for a period on open circuit, or disconnected. A polarized cell will show a low current register on the ammeter, but may be restored more or less after resting.

POLARIZATION PHOTOMETER.—A photometer in which the light of the more intense of the two sources under comparison is polarized.

POLARIZED ANNUNCIATOR.—An annunciator, or indicator, operated by an electro-magnet having a permanently magnetized armature.

POLARIZED ARMATURE.—A steel armature for an electro-magnet in a polarized telegraphic relay, being itself a permanent magnet, or having its magnetism maintained by a permanent magnet.

POLARIZED BELL.—An electric bell operated by an electro-magnet having a polarized, or permanently magnetized armature.

POLARIZED CELL.—A primary cell which has become inactive from polarization The film of hydrogen bubbles due to polarization affects the strength of the current of the cell in two ways: a, weakens the current by the increased resistance which it offers to the flow, for bubbles of gas are bad conductors; b, weakens the current by setting up an opposing pressure.

POLARIZED INK WRITER.—In telegraphy, an ink recording instrument operated by an electro-magnet having a permanently magnetized armature.

POLARIZED RELAY.—In telegraphy, a relay provided with a permanently magnetized steel armature which responds at a distant station to the action of a pole changer at the home station, being attracted by the electro-magnet when the current flows in one direction, and repelled when the current is reversed; a polar relay.

POLARIZED SOUNDER.—In telegraphy, a sounder operated by an electro-magnet having a permanently magnetized armature.

POLARIZING SPECTRO-PHOTOMETER.—A spectro-photometer provided with a polariscope.

POLE.—1. A conductor or lead of a circuit acted upon by a switch.

2. As applied to a terminal of an electric circuit, whether positive or negative.

3. As applied to the ends of a magnet whether N or S; being the two regions where the magnetism is the strongest.

POLE ARMATURE.—An armature carrying its windings upon projecting poles arranged radially upon its surface, or extending inward from a circular frame.

POLE CHANGER.—In duplex telegraphy, a transmitter which sends signals by reversing the direction of the current in the circuit; a reverser or pole changing key.

POLE CHANGING INDUCTION MOTOR.—An a.c. motor with taps brought out from the field winding to a pole changing double throw switch which permits two running speeds, one double the other. Practical difficulties limit the attainable efficient speeds to two, usually in the ratio of one to two. This limitation and the increased cost of building the motor restrict its use. A squirrel cage armature is often used.

POLE CHANGING SWITCH.—1. A switch for reversing the direction of the current in a circuit, also called polarity switch and depolarizing switch.

2. In ignition, a switch used to reverse the current in the primary circuit periodically to keep the breaker contacts clean.

POLE CLEARANCE.—In a generator or motor, the distance between the tips of the pole pieces of adjacent field magnets.

POLE CLIMBERS.—A device consisting of spurs properly supported and braced for attachment to a lineman's shoes to assist him in climbing a pole supporting telegraph or other electric wires.

POLE COUNTER.—A tally register for counting poles in a telegraph or other pole line system.

POLE GUY.—A rod, wire, or other appliance for stiffening a telegraph pole.

POLE HOOD.—In overhead cable construction, a sheet iron cover placed over a pole top terminal.

POLE LOCATION AT CORNERS. — In transmission line construction, locate corner poles so as to obtain good guying facilities. Corner poles should be "set in" to give the proper rake where conditions are favorable. In open wire lines use a single pole corner where the pull is less than 40 feet. Where the pull on a single pole would be 40 feet or greater, in general make the corner on two poles. Where a two pole corner is impracticable a single pole corner with special cross arm construction may be used.

POLE PIECES.—The steel end portions of a dynamo or motor field magnet, which are bored out so as to form the armature chamber within which the armature rotates; also called pole shoes.

POLE PLATFORM.—In overhead cable construction, a small platform, protected by railings, erected upon a terminal pole below a cable box to afford safe standing room for workmen.

POLE PRESERVATION.—There are several processes which may be successfully employed for the preservation of poles or other exposed timber. The best known of these are the creosoting, burnettizing, kyanizing, carbolizing, and vulcanizing processes.

POLE ROOF.—A metal cover sometimes furnished for the top of a wooden pole.

POLE SHIFTING MOTOR.—An adjustable speed d.c. motor in which the field magnet cores are shifted radially by means of a hand wheel and gears. This permits change in length of air gaps with resulting change in reluctance and speed.

POLE SPACINGS.—In catenary construction with wood poles, pole spacings as high as 180 feet may be used but 150 feet is common practice for tangents. For steel bridge construction spacings as great as 300 feet, on tangents are in use.

POLE STRENGTH. — A magnet's pole strength can be estimated by measuring the force with which it attracts or repels another pole, tht force being equal to the product of the two polar strengths. If M represents the strength of one pole and M^1 the strength of the other similarly magnetized, the force of their repulsion will be M times M^1. This force f varies inversely as the square of the distance, and may be expressed by the following formula:

$$f = \frac{M\,M^1}{d^2}$$

where d equals the distance between the poles.

POLE SUPPLY.—Poles for transmission lines come in car load lots. When ordering poles a schedule should be attached to the order covering the shipment to be made, delivery points, and the required date at each delivery point. Pole storage yards should be provided at delivery points and the poles should be hauled from these yards to the stake, either by the company's forces or a teaming contractor, depending on which is more economical.

POLE TOP TERMINAL.—In overhead cable construction, a variety of cable head consisting of a circular cast iron box placed at the top of a pole.

POLES FOR POLE LINES.—For lines of low and moderate voltage, poles are used to support the conductors. To meet the varied conditions several types of poles are used. They may be classed with respect to materials, as: a, wooden; b, steel; c, concrete. Wooden poles are mostly used.

POLES IN THERAPEUTICS.—The electrode where the current enters the patient is the positive pole and where the current leaves the patient, the negative pole.

POLES OF MAGNETIC VERTICITY.—The magnetic poles of the earth; being points where the dipping needle would stand vertical.

POLLING.—1. Planks temporarily supported against the sides of excavations to prevent caving in.

2. In copper refining, an operation in which a large pole of green birch or oak is thrust down to the bottom of the furnace containing the molten copper. Violent boiling ensues, consequent on the liberation of oxygen from dissolved oxides of copper. Frequent assays are taken, and when the specimen shows by its long silky fracture that the poling process has been sufficiently prolonged, the copper is ladled off.

POLISHING BOB.—A rapidly rotating disc carrying emery powder upon its periphery, for polishing metal objects preparatory to electro-plating.

POLISHING MOP.—A rapidly rotating disc of soft material, for polishing metal surfaces preparatory to electro-plating.

POLYGON.—A closed plane figure bounded by three or more straight lines called sides. Polygons bounded by a greater number of sides than four are designated only by the number of sides.

POLYHEDRON.—A solid bounded by plane faces especially more than four.

POLYPHASE.—Having more than one phase, or period of alternation; multiphase.

POLYPHASE ALTERNATOR.—One which delivers two or more alternating currents differing in phase by a definite amount. The polyphase currents are employed rather for power purposes than for lighting, but such systems are often installed for both services. For lighting purposes, the phases are isolated in separate circuits, that is, each is used as a single phase current. For driving motors the circuits are combined. For power service they are combined on account of the difficulty encountered in starting a motor with single phase current.

POLYPHASE ARMATURE.—An armature so wound and connected up as to produce polyphase currents.

POLYPHASE ARMATURE WINDINGS.—Methods of combining groups of coils, such as the star grouping and mesh grouping, in order to produce polyphase currents.

POLYPHASE ASYNCHRONOUS MOTOR.—An asynchronous induction motor driven by polyphase currents; a multiphase induction motor.

POLYPHASE CHOKING COIL.—A choking coil introduced into a polyphase system.

POLYPHASE CURRENTS.—Groups of alternating currents which differ in phase in a fixed proportion. If two separate sets of coils be placed on the armature of an alternator, one a little in advance of the other, two alternate currents of equal strength and frequency are obtained. These may be made to differ in phase in any desired degree by changing the positions of the two sets of coils. There are several ways of combining the circuits which receive the currents of the various phases. For instance, the windings may be divided into four separate coils, each having one end joined to a common junction, and the four outer ends joined to four line wires.

POLYPHASE INDUCTION MOTOR.—An asynchronous motor arranged to operate on a three phase rotating magnetic field. The motor consists of: a, armature; b, field magnets; there being no electrical connection between the two. Operation depends on: a, the production of a rotating magnetic field; b, induction of eddy currents in the armature; c, reaction between the rotating magnetic field and the eddy currents.

POLYPHASE INDUCTION REGULATOR.—A voltage regulator in which the excitation is produced by the combined action of shunt windings connected across the separate phases of the system. The magnetizing flux produced has a practically constant value, but does not have a constant direction. The magnetic field is a rotating one, not an alternating one, as in the single phase type. All of the slots on the circumference of a polyphase regulator armature are filled with the windings of the various phases symmetrically arranged, and the secondary or series winding is similarly arranged on the inside circumference of the stationary core.

POLYPHASE MOTOR.—A motor driven by polyphase currents; a multiphase motor.

POLYPHASE MOTOR DATA.—The following will be found helpful in selection:

1. Squirrel cage, constant speed (¼

to 50 h.p.). Adaptation: Light group and individual drives requiring constant speed. No sliding electrical contacts. Used in textile mills, etc., where inflammable dust or gases are encountered.

2. Wound rotor, constant speed (½ to 50 h.p.). Adaptation: Used with large group or individual drives requiring high starting torque and low starting current. Used on heavy planers, plunger pumps, applications using fly wheels, etc.

3. Wound rotor, varying speed (½ to 50 h.p.). Adaptation: By means of secondary control, 50% speed variation. Used on pumps, compressors, fans, etc. Same motor as used for constant speed. Varying speed obtained by secondary control.

POLYPHASE ROTATING CONVERTER.—The combination of a polyphase synchronous motor and a dynamo. On the d.c. side of the armature is a commutator and on the a.c. side, slip rings. On the d.c. side it operates as a dynamo and on the a.c. side, as a synchronous motor. The advantage of polyphase converters (compared to single phase) is the saving in copper on the transmission line. The armature is similar to that of an alternator with either delta or Y connections. In construction, the machine is built similar to a dynamo with the addition of suitable collector or slip rings connected to the armature windings at points having the proper phase relations.

POLYPHASE ROTATING MAGNETIC FIELD.—In 1885, Professor Ferraris of Turin discovered that a rotating field could be produced from stationary coils by means of polyphase currents. This is the basis of operation of polyphase induction motors. Walmsley attributes the first production of rotating fields to Walter Bailey in 1879, who exhibited a model at a meeting of the Physical Society of London, but very little was done, it is stated, until Ferraris took up the subject.

POLYPHASE SYNCHRONOUS MOTOR.—A synchronous motor driven by polyphase currents. Any single or polyphase alternator will operate as a synchronous motor when supplied with current at the same pressure frequency and wave shape as it produces as an alternator, the essential condition, in the case of a single phase machine, being that it be speeded up to so called synchronism before being put in the circuit. In construction, synchronous motors are almost identical with the corresponding alternator, and consist essentially of two elements: a, an armature; b, a field, either of which may revolve. The field is separately excited with direct current.

POLYPHASE SYSTEM.—A system of electric conductors distributing two or more single phase alternating currents succeeding one another in a definite relation, and differing in phase in a fixed proportion; two phase and three phase systems are usually employed. There is a great variety of polyphase systems, the choice depending on the various service requirements.

POLYPHASE TRANSFORMER.—A combination in one unit of several single phase transformers with separate electric circuits but having certain magnetic circuits in common. In polyphase transformers there are two or more magnetic circuits through the core, and the fluxes in the various circuits are displaced in phase. There are two types: a, core; b, shell.

POLYPHOTE LAMP.—A regulator for an arc lamp suitable for maintaining a number of lamps in series circuit with the dynamo. The regulating electro-magnets are energized by a shunt circuit around the electrodes of the lamp. This term not generally used in America.

PONY INSULATOR.—A small variety of glass insulator.

PONY RELAY.—A type of telegraph relay.

POP SAFETY VALVE.—A valve designed to open very suddenly, like a cork popping out of a bottle, to prevent further increase of pressure in a steam boiler and to remain open until the pressure is reduced a pre-determined amount. Candidates for steam engineer's license should know why a pop safety valve pops. The construction is such that as soon as the valve begins to open an excess area of the disc is presented to the escaping steam, hence it suddenly opens widely.

PORCELAIN.—A hard, opaque solid, manufactured from kaolin mixed with quartz and with a fusible silicate. It has a high insulating strength and resists entrance of moisture or water. It has the objection of being brittle. Many plugs using porcelain insulation have the porcelain in two or more parts, so as to avoid the troubles arising from uneven temperatures. Heat is liable to break a single long piece of porcelain.

PORCELAIN INSULATOR.—An insulator made of glazed porcelains, instead of glass, largely used in England and Europe because, though more costly, it does not condense moisture from the air.

PORCELAIN TUBE.—An insulating tube of porcelain for carrying an electric conductor through a wall.

POROUS CELL.—A two fluid primary cell containing a cup of porous material which separates the two solutions sufficiently to retard polarization without interfering with the passage of the current; the Daniell cell is an example of porous cell.

POROUS INSULATION.—Insulation effected by a porous insulating material.

PORRET'S PHENOMENON.—1. The undulating motion of the sarcous substance from the positive toward the negative pole when an electric current is passed through a living muscular fibre.

2. An increase in the diameter of a nerve fibre in the neighborhood of the positive pole when traversed by an electric current.

PORTABLE APPLIANCE.—An appliance capable of being readily moved when necessary or convenient for it to be detached from its source of current by means of a flexible cord and attachment plug.

PORTABLE IGNITING DEVICE. — 1. A movable device for exploding a mine or blast.

2. An electric gas lighter suitable for carrying about.

PORTATIVE FORCE OF MAGNET.—The power which a magnet has of carrying a weight by the force of attraction; the tractive force, or lifting power of a magnet.

PORTLAND CEMENT.—A calcined compound of chalk and clay, subsequently ground to fine powder. It possesses the valuable property of hardening under water.

PORTRAIT, ELECTRIC.—A portrait, or other picture, produced upon a sheet of paper by an electric discharge sent through an overlaying sheet of gold leaf containing the design.

POSITION LIGHT SIGNAL.—Railway signal lights which indicate by their position, thus: a, vertical, proceed; b, oblique, slow down prepared to stop at the next signal; c, horizontal, stop.

It consists of nine lamps set around a cast iron hub bolted to a mast, and wired so that it can light three lamps in any one position. The lamps are 12 volt tungsten filament lamps and through the reflectors and lenses give a range of vision, in bright sunlight, of half to three quarters of a mile. The lamps are located on an 18 in. radius about the central lamp and the hoods and lenses project through a background attached to the pipe support by brackets. The wires leading to each lamp pass down the pipe supports to a central terminal box and from there, by flexible conduit down the mast to the source of current supply.

POSITIVE CHARGE.—A charge of so called vitreous electricity, or that developed by rubbing glass with silk.

POSITIVE ELECTRICITY.—The kind of electricity developed by rubbing glass with silk; vitreous electricity. This term expresses the condition of the point of an electrified body having the higher energy from which it flows to a lower level, just as a current of steam is impelled through pipes by the generating pressure at the steam boiler. The sign which denotes this phase of electric excitement is +.

POSITIVE ELEMENT.—In a primary cell, the electrode (usually of zinc) from which the current flows to the negative element. Accordingly it must be evident that the terminal of the positive element is negative.

POSITIVE GRID BIAS.—In a radio tube, maintaining the grid positive with respect to the center of the filament in an a.c. tube, or the negative end of the filament in a d.c. tube.

POSITIVE ION.—A cation.

POSITIVE LEAD.—In valve gears, the amount by which the steam part is open to admission when the piston is at the beginning of the stroke.

POSITIVE PLATE OF PRIMARY CELL.—The positive element in a primary cell. It should be noted that its terminal is negative.

POSITIVE POLE.—1. The north seeking or plus (+) pole of a magnet.

2. The terminal of an electric generator out of which the current is assumed to pass into the external circuit.

3. The pole of an electro-receptive device connected with the positive pole of a source.

POSITIVE RAYS.—Streams of positive ions traveling at high speed from the anode of a partially evacuated tube. Canal rays.

POSITIVE ROTATION.—Left handed or counter clockwise rotation. A rotary motion in a direction opposite to the movement of the hands of a clock as seen when one reads the time. A right to left rotation.

POSITRON.—A positive electron. In Cambridge, England, Dr. P. M. S. Blackett, working with G. Occhialni, has verified the discovery of a positive electron tentatively announced by Dr. Carl D. Anderson, September 1932.

POST OFFICE.—A designation for the types of electrical apparatus employed by the British Post Office in its telegraph system.

POST OFFICE BRIDGE.—A compact form of the so called Wheatstone bridge for ordinary resistance measurements. Not suitable for measuring very low or very high resistance. It consists of a number of conical short circuiting plugs, which when in place between the contact blocks, effectively short circuit the resistance connected between the blocks.

POSTULATE.—A self-evident statement claimed as basis of argument, especially regarding a geometrical construction.

POTASH BRUSH.—A brush for cleaning metal surfaces by applying a caustic, preparatory to electro-plating.

POTASSIUM BICHROMATE.—A red crystalline solid, soluble in water, poisonous. When mixed with sulphuric acid it is used as a depolarizer in primary cells of the Poggendorff type requiring a liquid depolarizer, such as the Grenet and Fuller cells.

POTASSIUM CHLORATE.—A white solid crystalline substance, soluble in water. It is used as an oxidizing agent, in testing for poisons, in the preparation of aniline black dye, in fireworks, for matches, etc. It may be prepared by the electrolysis of potassium chloride solutions, using a copper or iron cathode and a platinum anode.

POTASSIUM CYANIDE.—A white crystalline solid, very soluble in water, very poisonous. It is a powerful reducing agent, so that when heated with metallic oxides it reduces many of them, and hence is used in blowpipe analysis. Its aqueous solution dissolves platinum and its dilute aqueous solution with access of air dissolves gold. It is used in preparing the solutions used in electro-plating silver and gold, as it dissolves many cyanides which are insoluble in water.

POTASSIUM HYDRATE.—Caustic potash. Found in commerce in various degrees of purity either in sticks or cakes. Pure caustic potash is used in electro-plating as an addition to zinc and gold baths, and the impure commercial article is used to free objects from grease

POTASSIUM HYDRIDE CELL.—A type of photo-electric cell.

POTASSIUM NITRATE.—Also called saltpeter and niter. A white solid crystalline substance, very soluble in water, occurring naturally in rich soils and in spring and river waters. It is made on a large scale by the double decomposition between potassium chloride and sodium nitrate. It is used in the preparation of explosives, as a food preservative, in electro-plating as a desilvering pickle, and for producing a matt luster upon gold and gilding.

POTASSIUM SULPHIDE.—Forms a hard greenish yellow to pale brown mass with conchoidal fracture. It readily absorbs moisture which causes it to deliquesce and smell of sulphuretted hydrogen. It is employed in electro-plating for coloring copper and silver black.

POTENTIAL.—Electrical pressure which determines the flow of current through a given resistance or impedance. The term pressure or voltage should be used rather than potential.

POTENTIAL ENERGY.—The capacity for performing work by virtue of position. For instance, water stored in an elevated tank has capacity for performing work equal to its weight × head.

POTENTIAL TRANSFORMER.—An instrument transformer.

POTENTIOMETER.—A device for measuring the pressure difference by either totally or partly balancing the unknown against a variable pressure difference, the value of which is known by reference to a voltage standard. There are numerous types of potentiometers, some adapted to high resistance measurements, others for low resistance. The intermediate resistance potentiometer is a type having resistance intermediately between the high and low resistance types. One type uses a slide wire in place of a series of standardized resistances.

POTENTIOMETER VOLT METER.—A volt meter made upon the principle of a potentiometer.

POT HEAD TERMINAL.—In underground construction a method of terminating the lead armor. The pot head is soldered to the lead covering and is filled with pitch. The pot head serves to localize stray currents that might prove disastrous to the cable and by thoroughly grounding the lead covering these stray currents are effectively dissipated.

POULSEN ARC.—A form of oscillator for radio transmission. It has a rotating carbon element and a water cooled copper element and due to the instability of the arc it maintains continuous oscillations.

POUND CALORIE.—The quantity of heat required to raise the temperature of one pound of water one degree C. One pound calorie=1.8 B.T.U.=.4536 calorie.

POUNDS PER MILE OHM.—The weight in pounds of a conductor a mile long and of such uniform cross section as to offer a resistance of one ohm; a standard employed in conductivity tests of telegraph and telephone wires.

POUNDAL.—An absolute unit of force suggested by some writers to introduce the absolute system into English weights and measures. It is defined as: that force which acting on the mass whose weight is one pound at London will in one second produce a velocity of one foot per second. Prof. Perry, in his "Calculus for Engineers," page 26, says, "One might as well talk Choctaw in the shops as to speak about so many poundals of force and so many footpounds of work."

POWDER TRANSMITTER.—A form of telephone transmitter employing granulated carbon as the varying resistance medium; a carbon dust transmitter.

POWER.—The rate at which work is done; it is usually expressed as the number of foot pounds done in one minute, that is

$$\text{power} = \frac{\text{foot pounds}}{\text{minutes}}$$

The result thus obtained simply gives the foot pounds per minute, but this is usually reduced to horse power by dividing by 33,000, that is

$$\text{horse power} = \frac{\text{ft. lbs. per min.}}{33{,}000}$$

Why spend unnecessary time in calculating the horse power of an engine by the old formula

$$\text{h.p.} = \frac{2\ \text{PLAN}}{33{,}000}$$

when it can be done in a fraction of the time by the formula

$$\text{h.p. } .000004\ D^2\ \text{LNP}$$

For full explanation see Audel's Mechanics Guide I, page 82.

POWER ABSORBED IN CIRCUITS.—In any part of a circuit, the power expended is proportional to the resistance of that part. Hence, the resistance of circuits must be kept low. To accomplish this copper of high conductivity must be used, but the size of the wire, on account of the high price of the metal must be small. The transmission of current to any considerable distance is not economical, if the reduction of waste is obtained merely by increasing the conductivity of the leads. To transmit electrical energy economically to distant points, the current must be comparatively small, traversing a thin wire, and the electric pressure high.

POWER AMPLIFICATION.—The ratio of a.c. power output to a.c. power input. The apparatus used consists of powerful vacuum tubes and special transformers giving extra audio amplification and adapted to heavy duty loud speakers as for auditoriums.

POWER CONDENSER.—A radio transmitting circuit condenser.

POWER-DIRECTIONAL RELAY.—Any relay which functions in conformance with direction of power. This includes both uni-directional relays with single throw contacts and duo-directional relays with double throw contacts. The reason this name is preferred to "reverse power" is that the device is frequently used to function under normal direction of power. Furthermore, in some cases the normal condition of the system may permit power to flow in either direction. Relays for use in either a.c. or d.c. circuits are to be classed as "power directional relays."

POWER FACTOR.—1. In an alternating current circuit, the number of watts indicated by a watt meter, divided by the apparent watts, the latter being the watts as measured by a volt meter and ammeter.

2. The multiplier used with the apparent watts to determine how much of the power supplied is available.

3. That quantity by which the apparent watts must be multiplied in order to give the true power. That is, true power=apparent watts×power factor.

4. Numerically, the cosine of the angle of phase difference between current and pressure.

POWER FACTOR CORRECTION.—There are two kinds of corrective device used to correct the power factor (that is, to synchronize current and voltage): a, synchronous condenser; b, static condenser. The choice between these two types depends on the conditions in the industrial plant. The substitution of a few comparatively large synchronous motors in place of induction motors, where conditions are suitable, often is the most economical method of improving the power factor. The usual application is met best, by the simple squirrel cage induction motor, but it is common practice to obtain the desired power factor for the plant, by installing a few synchronous units, or static condensers, whichever be better adapted to local conditions.

POWER FACTOR METER.—A meter which indicates the phase relationship between pressure and current, and is therefore sometimes called phase indicator. There are two types: a, watt meter; b, disc, or rotating field. In the watt meter type, the phase relation between the pressure and the current fluxes is such that on a non-inductive load the torque is zero. In the disc or rotating field type there are two pressure coils, placed at right angles to each other, one being connected through a resistance, and the other through an inductance so as to "split" the phase and get the equivalent of a rotating magnetic field.

POWER FACTOR OF INDUCTION MOTORS. — Careful investigations have shown that the power factor of industrial plants using induction motor drive with units of various sizes will average between 60 and 80 per cent. With plants supplying current to underloaded motors having inherently high lagging current values, a combined factor as low as 50 per cent may be expected. Since standard alternators are seldom designed to carry their rated kilowatt load at less than 80 per cent power factor, the net available output is, therefore, considerably increased.

POWER GRID DETECTOR.—A radio power detector whose operation is based on method of grid current detection.

POWER GRID GLOW TUBE.—A radio tube of the hot filament grid glow type.

POWER IN ALTERNATING CIRCUIT.—The product of the corresponding instantaneous current and pressure multiplied by the cosine of the angle of lag.

POWER PACK RADIO TROUBLES.—Generally indicated in the plate voltage and current readings obtained by analysis of the tube sockets of the radio supplied by the power pack, and such an analysis should precede any power plant tests.

POWER PENTODE.—A five element power radio tube.

POWER PUMP.—A machine for the transfer of liquid or gases from one location to another and driven by any prime mover either direct connected or geared, as by belt, chain or toothed gears. Briefly, any pump having a shaft to which the motive power is applied is a power pump. A power pump is essentially a constant speed machine. An exception is the direct connected marine pump whose speed is governed by the main engine.

POWER PUMP DRIVE.—The reciprocating pump, because of the necessarily low speed at which it must operate, requires a high velocity reduction between the power unit and pump, especially in the case of electric motors. Accordingly some form of gearing which constitutes the "drive" or transmission must be interposed between the two machines. The various types of drive are:

1. Belt: a, single reduction; b, double reduction.
2. Toothed gear.
3. Combined belt and toothed gear.
4. Chain.

Belt drives are simple, flexible, inexpensive and quiet.

POWER PUMP, ELECTRIC.—The so called electric power pump is simply a power pump with electric drive. For best results the motor should be of proper type and size.

POWER RELAY.—One which functions at a predetermined value of watts. It may be either an over-power relay or an under-power relay.—NEMA.

POWER REQUIRED TO DRIVE CRANES.—This is determined by allowing a certain friction percentage over the power required to move the dead load.

On hoist motions 33 1/3% is allowed for friction of the moving parts, thus giving a motor of 1/3 greater capacity than if friction were neglected. For bridge and trolley motions, a journal friction of the track wheel axles of 10% of the total weight of the crane and load is allowed. There is then added an allowance of 33 1/3% of the horse power required to drive the crane and load plus the track wheel axle friction, to cover friction of the gearing.

POWER STATION.—A term usually applied to any building containing an installation of machinery for the conversion of energy from one form into another form. There are several general classes of power station: a, central stations; b, substations; c, isolated plants.

It must be evident that the general type of central station to be adapted to a given case, that is to say, the general character of the machinery to be installed depends upon the kind of natural energy available for conversion into electrical energy, and the character of the electrical energy required by the consumers.

The general tendency is toward larger stations, and the interlocking of the systems located in different localities.

The reasons for this is because the investment cost per kw. generated decreases as the size of the station increases, also by taking advantage of the interconnection of stations the most efficient means of generation of power may be employed, as, by steam, water or gas engine power.

POWER STATIONS CLASSIFIED.—Power stations may be classified:

1. With respect to their function, as: a, generating stations; b, distributing stations; c, converting stations.
2. With respect to the kind of power used in generating the electric current, as: a, steam electric; b, hydro-electric; c, gas electric, etc.
3. With respect to the distribution of power, as: a, generation and distribution voltages the same; b, generation voltage lower than distribution voltage; c, distribution at several voltages, one of which is the same as the generation voltage.
4. With respect to the kind of current supplied, as: a, direct; b, alternating; c, direct and alternating.

POWER SWITCHBOARD.—A large frame panel or assembly of panels on which are mounted (on the face or back or both) switching, measuring, control and protective devices (with buses and connections).—NEMA.

POWER TRANSFORMER.—The first element of an eliminator or so called power pack. It consists of a multi-tap transformer so that when the primary is connected to the house lighting circuit suitable voltage may be obtained from the secondary for operating the rectifier tube.

POWER TRANSMISSION.—When the electric current has to be transmitted long distances for either lighting or power purposes, economy is attainable only by reducing the weight of the copper conductors. This can be accomplished only by the use of the high voltage currents obtainable from alternators. Again, where the consumers are located within a radius of two miles from the central station, thereby requiring a transmission voltage of 550 volts or less, dynamos may be employed with greater economy. Alternating current possesses serious disadvantages for certain important applications. Direct current is required for certain kinds of electrolytic work, such as electro-plating, the electrical separation of metals, etc., also the charging of storage batteries for electric automobiles. Sometimes the central station must be equipped with suitable apparatus for supplying both direct and alternating current. Thus, it is evident that the character of a central station will be governed to a great extent by the class of services to be supplied. An exception to this is where the entire output has to be transmitted a long distance to the point of utilization. In such cases a copper economy demands the use of high tension alternating current, and its distribution to consumers may be made directly by means of step down transformers mounted near by or within the consumers' premises, or it may be transformed into low voltage alternating current by a conveniently located sub-station.

POWER TUBE.—A radio vacuum tube designed to amplify a large signal voltage without distortion.

POWER UNIT.—In radio, apparatus for obtaining the proper current from the lighting supply for use in radio sets. It comprises: a, transformer; b, rectifier; c, filter, and d, voltage controller. The transformer increases or reduces the voltage to that required for the tubes. The rectifier changes the a.c. to d.c. The filter smooths out the pulsations and the voltage controller furnishes the various voltages required for the set.

POWER WIRE.—In the monocyclic a.c. system, the third wire employed as an auxiliary and for starting the motor.

PRACTICAL SYSTEM OF UNITS.—The units which have been adopted for practical use owing to the c.g.s. unit being in many cases inconveniently large or small. Each is a decimal multiple or sub-multiple of the corresponding c.g.s. unit.

PREFIX.—A code signal preceding a telegraphic message in order to signify the special character of the message.

PRE-IGNITION.—In a gas engine, ignition of the charge before the ignition arc or spark occurs. Usually caused by carbon in the cylinder, which was rendered red hot during the previous power stroke.

PREPAYMENT METER.—An instrument for regulating, measuring and indicating electrical supply, especially in residences of uncertain tenancy, such as tenements. A designated coin deposited in the slot will permit a certain amount of current supply to pass. The prepayment meter requires elaborate mechanism to respond when the proper coin is deposited, and to be proof against tampering.

PRE-RELEASE.—In valve motion, the opening of the steam port to exhaust before the piston has completed its stroke. If the steam were confined in the cylinder until the piston had reached the end of its stroke, there would not be time for it to escape without creating considerable back pressure. The proper point for pre-release depends on the piston speed, and the quantity of steam to be discharged. Mechanical pre-release depends upon the amount of positive or negative exhaust lap given the valve.

PRE-RELEASE LINE.—On a steam indicator card a rapidly decreasing forward pressure line showing the steam pressure from the point where exhaust begins to the end of the stroke.

PRE - SELECTIVE THEATRE SWITCHBOARD.—A type which allows the operator to set up the lighting for a second scene or act, while the first scene lighting is being used. It is well adapted for use in vaudeville theatres, because in this service, it is not expedient to set up the lighting for more than one scene in advance, owing to the nature of the program.

PRE-SELECTOR.—In radio, a band selector circuit.

PRESERVATION OF TIMBER.—Best effected by using well seasoned timber and keeping it well ventilated. Large posts should be bored longitudinally, with a transverse hole at top and bottom, while a space should be left around all built into masonry. All woodwork in contact with outside masonry, should have the back painted and no chance allowed for lodgment of moisture. Posts to be put in the ground should be dipped in coal tar, or else have the buried parts charred. Timber kept constantly submerged will keep indefinitely, but all exposed to intermittent wetting should be creosoted. Of artificial processes, creosoting, as described for railway sleepers is admitted to be equal to any, and better than others as regards baffling the teredo.

PRESS BLOCK.—In armature winding, a pair of blocks shaped to fit into each other so as to give a final form to a form wound coil when pressed between them.

PRESS BUTTON.—A push button; a spring contact to close the circuit in operating an electric bell.

PRESS MESSAGE.—A telegraphic message designed for a newspaper; a despatch for the daily press.

PRESSED STEEL. — Steel plate bent or pressed by means of dies into channel or other sectional forms, giving great strength with a minimum weight of metal.

PRESSEL.—A push button contact set in a pear shaped handle at the end of a flexible cord, for conveniently ringing a bell or lighting an electric lamp.

PRESSPAHN.—A name sometimes given to fullerboard, a useful material for insulating armature slots. It is mechanically tough and has high disruptive strength.

PRESSURE (POTENTIAL) AND CURRENT TRANSFORMERS.—A type (also called instrument transformer) suitable for use with measuring instruments in which the conditions of current, pressure and phase in the primary or high voltage circuit are represented with acceptable accuracy in the secondary or low voltage circuit. Where extreme accuracy is required, it is recommended that separate instrument transformers be used to supply energy to instruments or meters, and that tripping transformers be used in connection with trip coils of protective devices. The construction of both tripping and instrument transformers may be classified as air insulated and oil insulated.

PRESSURE, ELECTRIC. — Voltage. The words pressure or voltage should always be used instead of such cumbersome expressions as electromotive force or difference of potential. According to Hobart: "The expression electromotive force although sanctioned by usage, and having a perfectly definite connotation, is not scientifically accurate, as electromotive force is not a force in the accepted meaning of the word. The real nature of electromotive force is involved in that of electricity, but it must be conceived as acting on electricity and not on the bodies in which the electricity resides. The expression is used in two distinct senses. It is primarily something which resides in certain regions of activity, such as voltaic cells, conductors moving relatively to magnetic fields, or the rubbing surfaces of dielectrics. It appertains, in fact, to the seat of energy conversion, and is one of the two elements whose product represents the electrical energy generated, the other being the electric displacement produced." The term is clearly objectionable for the reasons just given and should be discontinued.

PRESSURE GAUGE.—A dial instrument for registering the pressure of a fluid or liquid confined within a pipe or chamber. The usual pattern operates by the tendency of a bent oval tube to straighten itself under pressure. Mercurial columns are used for accurate measurements or for testing mechanical gauges. Inverted syphons containing oil or water are used to measure air pressures, such instruments being often known as piezometers.

PRESSURE MANOMETER (AEROSTAT).—An instrument whose indications depend on the excess of pressure inside the envelope over the atmospheric pressure at a standard reference point.

PRESSURE OR POTENTIAL TRANSFORMER.—Names sometimes used for instrument transformer.

PRESSURE PANEL.—In a central power station, a switchboard panel provided with a device for indicating the mean electric pressure of that station.

PRICKING.—A method of locating a wire in a cable by pricking through the insulation with a brad awl connected in circuit with a grounded battery.

PRIMARY AMPERE TURNS.—The ampere turns in the primary coil of a transformer or induction coil.

PRIMARY AND SECONDARY OF INDUCTION MOTOR.—Considering the motor as a species of transformer, because the motor acts in many respects like a transformer, some writers call the field winding, the primary and the armature, the secondary.

PRIMARY AND SECONDARY WINDINGS.—Terms used to distinguish transformer windings in regard to energy flow, the primary being that which receives the energy from the supply circuit and the secondary that which receives the energy by electro-magnetic induction from the primary.—NEMA.

PRIMARY CELL.—A device for producing an electric current chemically. The incorrect use of the word battery for cell should be avoided. A primary cell consists of two elements of dissimilar metals placed in an electrolyte or exciting fluid contained in a jar. The fact that if a plate of metal be placed in a liquid, there is a difference of electrical condition produced between them of such sort that the metal either takes a lower or higher electrical pressure than the liquid, according to the nature of the metal and the liquid. If two different metals be placed in one electrolytic liquid, then there is a difference of state produced between them, so that, if joined by wire outside the liquid, a current of electricity will traverse the wire. This current proceeds in the liquid from the metal which is most acted upon chemically to that which is least acted upon. An important point to be noted is that the polarity of each plate is different from that of its terminal. For instance, with zinc and copper electrodes the zinc terminal is negative but the zinc plate submerged in the electrolyte is positive. There are many types of primary cells grouped into two general classes: a, single fluid; b, two fluid.

PRIMARY CELL ACTION.—If two different metals be placed in one electrolytic liquid, then there is a difference of state produced between them, so that, if joined by wire outside the liquid, a current of electricity will traverse the wire. This current proceeds in the liquid from the metal which is most acted upon chemically to that which is least acted upon.

PRIMARY CIRCUIT.—In a secondary induction coil or transformer the coil which receives current from the source.

PRIMARY CLOCK.—A master clock.

PRIMARY COIL.—A type of induction coil consisting of a long iron core wound with a considerable length of a low resistance insulated copper wire. It works on the principle of self-induction and is used largely on low tension ignition circuits giving "momentum" to the current at break with resulting arc which ignites the charge.

PRIMARY CURRENT.—1. The current in the primary of a transformer.

PRIMARY CUT OUT.—A safety cut out included in the circuit of the primary coil of a transformer.

PRIMARY ELECTRONS.—In a radio vacuum tube minute particles of negative electricity emitted direct from the hot filament as distinguished from secondary electrons or those which become detached from the plate by the impact of the primary electrons.

PRIMARY EMISSION.—In a vacuum tube, emission of electrons due to heating the filament.

PRIMARY IMPEDANCE.—The impedance existing in the circuit of a primary coil.

PRIMARY INDUCTION COIL.—A single winding coil having: a, an air core, or b, an iron core consisting of a bundle of iron wires. The operation of primary coils depends on self-induction, or the action of the current upon itself during variations of current. An important application of iron core primary coils is on low tension or make and break ignition circuits.

PRIMARY OF INDUCTION MOTOR.—The field coils of an induction motor, usually the fixed part, or stator.

PRIMARY LUMINOUS STANDARD.—In photometry, a standard by which the unit of light is established and from which the values of other standards are derived.

PRIMARY PHOTO-ELECTRIC CURRENT.—Current in a photo-cell due to electron emission from the photo-sensitive film, that is, from the cathode.

PRIMARY RAYS.—1. Alpha, beta and gamma rays.

2. X-rays generated at the focal point of the tube.

PRIMARY RELAY.—This type is sometimes called a series relay as it has the current coils connected directly in series with the line, both on high and low tension circuits.

PRIMARY TUNING INDUCTANCE.—In radio a variable inductance in the antenna circuit of a transmitter.

PRIMARY WINDING.—The coil through which current from the source flows to a transformer. In a lighting transformer the primary coil receives high tension current; in an ignition transformer, low tension current.

PRIME CONDUCTOR.—In the cylinder electrical machine, an elongated metal cylinder, with rounded ends, supported upon a glass stand, having one end provided with a metallic comb, and the other with a rod terminating in a brass knob. The prime conductor collects the charge as follows: The charge on the rotor acts inductively on the long insulated conductor, repelling a plus charge to the far end and leaving the nearer end negatively charged. A negatively electrified wind is emitted by the row of points toward the positive charge upon the rotor, which is thereby neutralized.

PRIME FACTOR.—One which cannot be separated into factors.

PRIME MOVER.—An apparatus or mechanism whereby motion and force are received directly from some natural source of energy, and transmitted into some form of motion by means of which the power may be conveniently applied. The sources of energy are: muscular energy, as the power exerted by men and animals, the man or animal constituting the prime mover; gravity, exemplified in the driving of a clock, by the falling of its weights, or in the operation of a water wheel by the weight of falling water; motion of fluids, as in a windmill; heat, as in a steam engine and boiler, whereby the heat of the fuel is converted into the motion of the crank shaft; chemical energy, as in the firing of a gun, or the generation of electricity in a primary battery.

PRIMING.—In steam boiler operation a condition due to forcing which causes a lifting of the water level and mixing of the water, in the form of spray, with the steam.

PRINCIPAL FOCUS.—That point where all the rays parallel with the principal axis meet after reflection, as for instance, the rays from a source of light at an infinite distance from a mirror.

PRINTING TELEGRAPH.—An automatic telegraphic machine which prints the message, as it is received, upon an uncoiling tape or strip of paper. The Morse alphabet or common Roman type is employed.

PRISM.—1. A transparent body with, usually, three rectangular plane faces or sides, and two equal and parallel triangular ends or bases; used in experiments on refraction, dispersion, etc. Prisms of different forms are often named from the figure of their bases; as a triangular prism, a quadrangular prism, a rhombic prism.

2. In optics, etc., a piece of transparent refracting material in the form of a prism, usually with three equal rectangular faces and of triangular cross section.

PRISMATIC COMPASS.—A form of compass used in surveying, provided with a metal frame and a stretched horse hair for a sight vane, opposite which is a right angled prism with an eye hole and slit.

PRIVATE AUTOMATIC EXCHANGE.—An automatic telephone exchange designed to serve one business organization with means of outside communication, that is, it has no connection with a central exchange.

PRIVATE BRANCH EXCHANGE.—A small telephone switchboard adapted to offices, apartment houses, etc. It is connected to extension sets in the building and to the central exchange, thus avoiding the complication and expense of installation. It affords inter-communication between the extension sets and also between these sets and the central office. An operator on the premises is required to make connections with the central exchange. Abbreviated **P.B.X.**

PRIVATE LINE.—A telephone line connecting a central station with a single subscriber, or a subscriber with only one other, as distinguished from a party line.

PROBE, ELECTRIC.—A surgical instrument for locating a bullet or other metallic matter in the human body by closing an electric circuit when the probe makes contact with the foreign substance and operating a signal bell.

PROBLEM.—A proposition in which some operation or construction is required, also the demonstration showing how the task is to be accomplished.

PROCESS PRESSURES.—Steam at pressures from 10 to 125 lbs. per sq. in. as used in industrial, chemical and textile manufacture and in many non-industrial processes, such as sterilizing in hospitals, cooking in hotels, drying in lumber kilns, etc., etc.

PRODUCER GAS.—The gas formed by a gas producer being the product of an incomplete or retarded combustion of the fuel. This is effected by burning the latter in a bed, several feet in thickness, within the generator or producer proper. The heated gases and flame from the portion nearest the air supply, where combustion is more or less rapid and complete, have to pass through the remainder of the bed, distilling gases from the latter in their transit.

PRODUCTION OF ELECTRIC CURRENT.—The necessary voltage required to cause a flow of electricity may be obtained: a, chemically as by primary battery; b, mechanically as with a dynamo or alternator; c, thermally as with a thermopile.

PROGRESSIVE WAVE WINDING. — An armature winding in which the front and back pitches are such that in tracing the course of the winding through as many coils as there are pairs of poles, a segment is reached in advance of the one from which the start was made.

PROJECTION ARMATURE. — A slotted armature having recesses of sufficient depth to leave projections upon its surface after all the windings are laid on.

PROJECTION GALVANOMETER.—A galvanometer constructed so as to be used with a projection lantern so that its scale and pointer may be projected upon a screen.

PROJECTION LAMP. — A focusing arc lamp provided with a mechanism such that the carbons are fed toward each other as they wear away so as always to maintain the arc at the exact focus of the reflector which projects the light. Projection lamps are used for searchlights in theaters; for photo-engraving purposes and in motion picture and television apparatus.

PRONE PRESSURE METHOD.—An approved method of resuscitation from electric shock.

PRONY BRAKE.—A device for making brake horse power tests. It consists of a friction band which may be placed around the fly wheel or a pulley fixed on the crank shaft, and attached to a lever bearing upon the platform of a weighing scale. A brake used for testing purposes should be self-adjusting to a certain extent, so as to maintain automatically, a constant resistance at the rim of the wheel. For comparatively small engines, various forms of rope brake, satisfy this requirement very well. In such cases, a weight is hung to one end of the rope and a spring scale to the other end. The wheel should be provided with interior flanges, holding water for keeping the rim cool. For very high speeds, some form of water friction brake should be employed, as they have the advantage of being self-cooling.

PRONY BRAKE FORMULA.—The delivered or brake horse power is calculated from the following formula:

$$H.\ P. = \frac{2\ \pi\ R\ N\ W}{33{,}000}$$

in which

W = unbalanced weight in pounds, acting on lever arm at distance R;

R = length of lever arm in feet from centre of shaft;

N = number of revolutions per minute.

H. P. = horse power.

Soft woods are preferred to hard woods for brake blocks. The rubbing surface should be well lubricated with a heavy grease.

PROOF PLANE.—A small metal disc with an insulated handle, used to collect electricity by contact with a charged body, for purposes of testing or experimenting.

PROPELLER.—A device having two or more oblique blades for propelling boats of all sizes. A propeller is virtually a section of a screw. The angle of the blades determines the pitch of the thread and the water corresponds to the nut through which the screw travels. There are numerous types of propeller, designed to meet the varied conditions of service, and they may be classed:

1. With respect to the pitch as: a, true screw (constant pitch); b, variable pitch.
2. With respect to the number of blades, as: a, two blade; b, three blade; c, four blade.
3. With respect to the shape of the blades, as: a, weedless; b, elliptical; c, round; d, straight tip.
4. With respect to construction, as: a, solid; b, built up; c, reversible.

PROPELLER FOR AIRPLANES.—A type of propeller having two long blades made of laminated wood. Black walnut is considered the most desirable wood but maple and birch are also used. Black walnut and spruce are often used in alternate layers. After the laminations are glued together the assembly is roughed out by hand with different forms of draw knife, but in some of the larger shops special routing machines capable of routing several propellers at one time are used, thus saving considerable time and reducing the expense proportionately. In operation the oblique blade surfaces push back a column of air, the resistance of which gives a forward thrust to the propeller shaft. Since the outer end of the propeller travels faster than points nearer the center the pitch angle changes, increasing from the end to the hub. The nearer the ratio of pitch to diameter approaches 1, the more efficient is the blade. The propeller surface should be very smooth especially near the outer end where the speed is greatest, otherwise there will be considerable "skin friction." The propeller should be perfectly balanced and the surface areas of both ends equal.

PROPELLING DRAG.—In a motor, when current flows through the armature winding it sets up a magnetic field which distorts the field produced by the field magnets. This results in a force upon the wires tending to cause rotation, that is, a drag which propels or rotates the armature. In a dynamo this force opposes the motion.

PROPER FRACTION.—One whose numerator is less than its denominator.

PROPERTIES OF STEAM.—These consist of temperature, total heat, latent heat, volume, weight, etc., and are given for various pressures in tabulated form, the tabulation being known as a steam table. The present accepted standard is the table by Marks and Davis as given in Audel's Engineers and Mechanics Guide. Vol. 1, page 40.

PROPORTION.—An equality of ratios, that is, when two ratios are equal the four terms form a proportion. A proportion is expressed by putting the sign = or : : between the ratios. The antecedents are the first and third terms; consequents the second and fourth terms; extremes, the first and fourth terms; means, the second and third terms.

PROPORTIONAL COILS. — In electrical measurement, resistance coils of known resistances, usually in tens, hundreds or thousands of ohms, connected in a box in such a way as to form a bridge, as in the "dial" and "post-office" patterns of the Christie or so called Wheatstone bridge.

PROPORTIONATE ARMS.—In electrical measurement, the arms of known resistance of a so called Wheatstone bridge; the ratio arms.

PROSTRATION, ELECTRIC. — Physical prostration with symptoms resembling those of sunstroke, sometimes occasioned by too great exposure to the rays of an intense arc light. The skin is sometimes affected to such a degree as to come off after a few days. The throat, forehead, and face suffer pains, and the eyes are irritated. These effects only follow exposure to very intense sources of light, or for very long times.

PROTECTED MACHINE.—One in which the armature, field coils and other live parts are protected mechanically from accidental or careless contact, while free ventilation is not materially obstructed. —NEMA.

PROTECTED SERIES GAP.—In a lightning arrester a series gap protected from rain and other precipitation by a roof or cover.

PROTECTING BATTERY.—A battery connected to a faulty submarine cable for the purpose of sending a negative current through the fault to prevent corrosion.

PROTECTION OF METALS, ELECTRIC.— A method of preventing the corrosion of a metal, as the copper sheathing of a ship's bottom, by placing another metal, as zinc, in connection with it, so that the zinc, acting as the positive element of a voltaic battery, suffers the corrosion, and saves the copper.

PROTECTIVE CHARACTERISTICS OF LIGHTNING ARRESTERS.—The protective ability of a lightning arrester depends upon the voltage to which it allows the surge to go and the time during which it permits such voltage to be maintained.

PROTECTIVE RELAY.—A type used to protect circuits from abnormal conditions of voltage, or current, which would be undesirable or dangerous to the circuit and apparatus contained therein. They act in combination with automatic circuit breakers, operating when their predetermined setting has been reached, energizing the trip coil of the circuit breaker and opening the circuit.

PROTECTIVE SHEATH.—A sheet of copper, connected to ground, introduced between the primary and secondary coils of a transformer to prevent any possible electrical connection between the two windings.

PROTECTIVE THROW. — The protection given to metals by a magnetic field, producing the power of concentrating lines of magnetic force while exposed to chemical action.

PROTECTOR, ELECTRIC.—A device for guarding the human body from destructive or injurious electric shocks. In one system, Delany's, the wrists and ankles are encircled by conducting bands, which, by wires running along the arms, back and legs, are connected. A discharge, it is assumed, received by the hands will thus be short circuited around the body and its vital organs.

PROTON.—The smallest quantity of electricity which can exist in the free state.

Its charge is 4.774×10^{-10} negative electrostatic units. The quantity of positive electricity on the proton is numerically equal to the quantity of negative electricity on the electron. Its mass as determined by Rutherford is practically identical with that of the neutral atom of hydrogen, that is 1.66×10^{-24} grammes or 1.007 on the oxygen scale.

PRUSSIC ACID.—Hydrocyanic acid. An extremely poisonous acid. It exists in nature in a state of combination in certain vegetables and fruits, especially in the kernels of stone fruits, such as plum, apricot, cherry, etc. In electro-plating, it is employed in the preparation of gold immersion baths, and for the decomposition of the potassa in old silver baths. Symbol HCN.

PSYCHROMETER.—A sling psychrometer.

PUBLIC ADDRESS SYSTEM.—In radio, a heavy duty loud speaker system with amplification to a degree that an ordinary voice can be heard plainly in any part of a large auditorium.

PUBLIC SUPPLY INSTRUMENTS.—Meters for recording the amount of electricity furnished to consumers.

PUDDLING.—The process by which wrought iron is manufactured from cast iron, the material being known as forge pig. When the pig iron is melted most of the silicon, carbon, phosphorus, and other impurities are separated from the iron. The temperature is kept below the melting point of wrought iron. Accordingly small particles of wrought iron freed from the excess of carbon in a semi-plastic state form a spongy mass which is divided by the puddler into lumps of about 200 lbs. each. The spongy pasty mass is removed from the furnace to the shingling hammer, where the slag is beaten out of it. After this operation with the same original heat, it is passed through the rolls, forming puddled bar, which is also known from its contained impurities, as muck bar.

PULL.—An electric contact maker which closes a circuit by a pull, sometimes used in place of a push button; a pull contact.

PULL IN TORQUE.—The maximum constant torque at which a synchronous motor will start and bring up to speed its load with full voltage.

PULL OUT TORQUE.—The maximum sustained torque which a synchronous motor will develop at synchronous speed for one minute, with rated voltage applied at rated frequency and with normal excitation.

PULL OVER.—A trolley hanger designed to suspend the trolley wire in proper position and at the right tension in making a curve; a pull off.

PULL UP TORQUE.—Minimum torque of a motor developed during acceleration with full voltage.

PULLING IN CABLES.—In this operation special precaution should be taken to avoid sharp bending of the cable and thus prevent injury to the lead sheathing. If the cable be light and of small diameter, the distance not over 300 feet, and the run fairly straight, the cable can usually be pulled in a conduit by hand; but often other means must be provided so as to secure sufficient power.

PULLING WIRES.—In house wiring, when pulling wires through floors, partitions, etc., by means of a snake, it is necessary that some one be at each end so that one may feed the wires in and the other pull them out. The wires should be gently pulled so no damage may be done to the plastered ceiling. If, in pulling the snake, the wires get stuck, the snake and the wires should be pulled back and forth as the wires may be caught against a plaster clinker. This operation will break off clinkers. Sometimes a whole house may be fished without taking up any floors, but it may be necessary to take off base boards and flooring to drop down to the meter board or switch outlets. Sometimes it is necessary to use two snakes on long runs and hook them underneath the ceiling. In this case the ends of the snakes should be connected to a bell and battery so the bell will ring when the ends touch each other.

PULSATING CURRENT.—A periodic current, the values of which are always positive or always negative.

PULSATING GALVANIC SINUSOIDAL CURRENT.—In electro-therapeutics, a current in which only one-half of each oscillation produced by the penetrator is employed, consequently the frequency of the voltage change is only one-half as great with the oscillatory wave, and the intensity of the impressed voltage is changed 170 times per second, while the peak voltage is on for only 1/1,360th of a second, with a rest period of 3/1,360ths of a second. The rapid pulsation of this current eliminates all possibility of irritation by chemical action on the skin, still causing greater nerve stimulation, so deeper penetration and greater action of muscle and various organs may be obtained with less current, each pulsation acting as a sudden interruption of the galvanic current. The pulsating galvanic sinusoidal is especially indicated in intestinal stasis, constipation and splanchnoptosis, as well as other condition-where deep massage is indicated. This current is rapidly replacing the galvanic sinusoidal and super-imposed wave currents.

PULSATING RINGING CURRENT.—A telephone current for ringing, having succeeding impulses separated by intervals approximately equal to those of the impulses.

PULSATING WAVE.—In periodically varying motion, a wave in which one half has a greater value than the other; as distinguished from an alternating wave in which the positive and negative values are equal.

PULSATORY CURRENT.—A continuous current, constant in direction, but periodically varying in intensity so as to progress in a series of throbbings or pulsations, instead of with uniform strength.

PULSATORY PRESSURE.—A pressure subject to periodic changes in value, so as to produce a pulsatory current.

PULSE, ELECTRIC.—A throbbing of electric current.

PUMP LOG CONDUIT.—In underground cable laying, a cheap and simple form of conduit composed of creosoted wood tubes.

PUMPING OF ALTERNATOR.—A pulsating action in an alternator intended to run in step with another in parallel, when the synchronism is not exact.

PUNCHED CLIP SWITCH.—A clip switch having the clips punched from sheet metal.

PUNCHING BEAR.—A portable press, operated either by screw gear or a small hydraulic ram, for punching holes in erection or other field work.

PUNCTURE VOLTAGE.—A pressure which represents the strength of a dielectric, that is the highest voltage it will stand before failure.

PUNNING.—Packing earth tightly about the foot of a newly erected telegraph pole.

PUP JACK.—A tip jack.

PUPILLARY PHOTOMETER.—A form of photometer which compares the brilliancy of lights by noting the degree of contraction produced by them upon the pupil of the eye.

PUPIN COILS.—In telephone lines, induction coils connected at intervals to balance capacity

PURE INDUCTANCE.—An ideal conception of a circuit containing inductance, but neither capacity nor resistance. Such circuit is impossible as all circuits contain resistance.

PURE RESISTANCE.—Resistance in a non-reactive circuit.

PURE SPECTRUM.—A spectrum of light with sharp and distinct lines, free from the blurring commonly seen when the colors overlap.

PURE TONE OR NOTE.—A sound due to waves of a single frequency without harmonics.

PUSH BOX.—A box containing the contacts and springs for the operation of a push button.

PUSH BUTTON.—An acorn or cylindrically shaped part which is pressed by the finger to move the contact of a switch.

PUSH BUTTON OPERATION OF ELEVATORS.—In a full automatic installation, buttons are mounted in the car corresponding to each floor. Buttons are also mounted at each landing. Pressure of a button starts the car, which then continues to run after the button has been released, and stops automatically at the floor corresponding to the button pushed.

PUSH BUTTON SOCKET.—A wall socket fitted with a push button.

PUSH BUTTON SWITCH.—A small switch operated by a push button for controlling one or more lights.

PUSH PULL AMPLIFICATION.—In radio, a method of generating more power for the loud speaker than is usually obtained by audio amplifiers. In the last stage two tubes are thus employed and so connected that they are used alternately on the two halves of each a.f. cycle. In push pull operation the grid of one tube is most negative when the grid of the other tube is least negative; therefore, as the plate current of one tube increases, the plate current of the other tube decreases. To describe this action the word push pull was coined. The action is similar to the operation of a hand car, where one operator pushes on the cross bar as the other pulls, and vice versa. A push pull parallel stage is one in which two or more push pull circuits are used in parallel.

PUSH PULL MICROPHONE. — A radio acoustic device whose operation depends on two elements acting 180° out of phase.

PUSH PULL TRANSFORMER.—A radio transformer designed for a push pull amplification circuit.

PUSHER.—A rear drive airplane; one that is pushed instead of pulled through the air.

PYKNOMETER.—An instrument for determining the specific gravity of solids, consisting essentially of a glass bottle with a long tubular neck combined with a thermometer; a specific gravity bottle.

PYLON.—Any V-shaped construction from the point of which wires are taken.

PYRITES.—A mineral, usually whitish or yellow with a bright luster; any one of the metallic sulphides: as, of iron or copper.

PYRO-ELECTRIC CRYSTAL.—A crystalline body which gives electrical effects when heated or cooled. The best example is tourmaline.

PYRO-ELECTRICITY.—In certain crystalline bodies, electricity produced by unequally heating or cooling them. A heated crystal of tourmaline suspended by a silk fibre may be attracted and repelled by electrified bodies, or by a second heated tourmaline crystal. If a crystal be broken up, each fragment is found to possess also an analogous and an antilogous pole. Many other crystals besides tourmaline are pyro-electric. When a natural hexagonal prism of quartz is heated, its six edges are found to be positively and negatively electrified in alternate order.

PYROGRAVURE.—Burning a design upon wood or other substance with a tool heated by electricity.

PYROMAGNETIC DYNAMO.—A machine which generates electricity from heat by the operation of pyromagnetism; thermo-magnetic dynamo

PYROMAGNETIC MOTOR.—A motor operated by pyromagnetism which causes an armature to be attracted and released by the influence of heat upon its magnetic properties.

PYROMETER, ELECTRIC.—An instrument for measuring temperature by the thermal effect of the heat. There are several types as follows:

1. **Resistance pyrometer.**—Temperature is indicated by the effect of heat upon a platinum wire. The resistance of the wire is measured before and after heating and from the increase in resistance the temperature is calculated.

2. **Thermo-electric pyrometer.**—A type which works on the principle of the thermo couple. By heating the junction of two dissimilar metals a voltage will be set up which will deflect a galvanometer joined in series in the circuit. A well known type consists of a junction of platinum wire and a wire composed of an alloy of platinum and rhodium in a fire-clay tube closed at one end, and an opposite junction of the wires kept at the temperature of the atmosphere and joined to a galvanometer. Such a junction can measure temperatures up to 3227° F., the melting point of platinum.

3. **Optical pyrometer.**—A type whose operation is based on Wiens law that for all black bodies a definite relation exists between color and temperature. A simple pyrometer based on this law consists of a sighting tube through which the heated body is observed, and across it is stretched a glow lamp filament capable of being raised to various degrees of incandescence by means of a current passed through it. In use, the current is varied until the color of the filament appears identical with that of the glowing body behind it, the temperature being then deduced from the ammeter reading.

4. **Radiation pyrometer.**—A type whose operation is based on the Stefan-Boltzmann law that the heat radiated from a glowing black body is proportional to the fourth power of its absolute temperature.

Q

Q.—Symbol for: 1. Quantity of electricity; ampere-hour; coulomb.

2. Quantity of cooling water for condensers.

3. Center of lap circle on the Bilgram diagram.

QUAD.—In telegraphy, an abbreviation for quadruplex.

QUADRANT.—1. A name used at one time for the henry, because expressed by 10^9 centimeters, which is a length equal to a quadrant of the earth's surface.

2. The quarter of a circle or of its circumference; a sector, arc or angle of 90°.

3. An instrument for measuring the

altitude of the sun, consisting of a graduated arc of 90°, with a movable radius for measuring angles on it.

4. On some reverse gears, two circular strips of iron for guiding the reverse lever and having notches so that the lever can be "latched" in full gear or in any intermediate position corresponding to the expansion ratio desired.

QUADRANT ELECTROSCOPE.—A device for indicating the electric condition of a conductor, consisting of a wooden standard carrying a graduated quadrant or half circle, in the center of which is attached an index of straw terminating in a pith ball. When the whole is electrified the pith ball is repelled from the upright and flies out at an angle indicated on a graduated scale or quadrant behind it.

QUADRANT OF INDUCTANCE.—One henry of inductance; obsolete.

QUADRANTAL DEVIATION.—A deviation or error in a ship's compass due to the induced magnetism in the iron of the vessel by the action of the earth's horizontal force, it changes sign in every quadrant; quadrantal error.

QUADRATIC EQUATION.—One which contains the square of the unknown quantity but no higher power.

QUADRATURE.—A quarter of a cycle phase difference. If the angle of lag or of lead between two sets of alternating current waves be 90°, or a quarter circle, the waves are said to be in quadrature with each other.

QUADRODE.—A four element vacuum tube.

QUADRUPLE EXPANSION ENGINE.—A four stage expansion engine, adapted to steam pressures of 200 lbs. or more. For economy, the temperature range (rather than the power) should be divided into equal stages. The cylinders of a quadruple expansion engine are called: a, high pressure; b, 1st intermediate; c, 2nd intermediate; d, low pressure. A quadruple expansion engine is desirable when the total number of expansions are high enough to result in a degree of economy such as will offset the cost and complication of four stage working.

QUADRUPLEX BALANCE.—In quadruplex telegraphy, obtaining a resistance balance between the artificial line and the main line, and a static balance in which the condenser of the artificial line has a capacity equal to that of the main line.

QUADRUPLEX CIRCUIT.—The circuit employed in quadruplex telegraphy.

QUADRUPLEX TELEGRAPH SYSTEM.—One which permits the simultaneous sending of two messages in either direction over a single wire.

Theoretically it consists of an arrangement of two duplex systems, which differ from each other so greatly in their principles of operation that they are capable of being used in combination. The sending apparatus consists of a reversing key and a variable current key (or equivalent), and the receiving apparatus consists of a neutral relay and a polar relay, batteries and connections.

QUADRUPLEX TRANSMISSION.—The simultaneous transmission of four telegraph or telephone messages over one wire, two from each end.

QUALITATIVE ANALYSIS.—The process of determining the nature of an unknown element or compound, or of a mixture of these.

QUANTUM THEORY.—The theory of emission which states that energy is radiated intermittently in amounts called quanta, the value of which depends on the vibration frequency of the radiators and a universal constant.

QUARTER PERIOD.—The time taken to execute one quarter of a cycle of a periodic motion.

QUARTER PHASE.—A term sometimes used for two phase because in a two phase alternating current system the two voltages are 90 degrees or one-quarter of a cycle apart.

QUARTER TWIST BELT.—A method of driving two shafts at right angles to each other and in different planes. The pulleys must be set so that a plumb line from the center of the face of the upper pulley, on the side where the belt leaves it, will touch the center of the face of the lower pulley on the side where the belt leaves it. The direction of rotation must be such that the twisted belt is always "going on" to the upper pulley.

QUARTZ.—A mineral which is not only a good insulator but desirable as a piezoelectric crystal. Has been used as an oscillator and master oscillator or frequency indicator in radio transmitting stations.

QUARTZ FIBRE.—A fine thread produced by rapidly drawing out a piece of quartz when fused in the oxyhydrogen flame. This fibre can be made more slender than any natural fibre, and because of its strength and elasticity is used for delicate suspension in sensitive galvanometers, electrometers, etc.

QUARTZ LAMP.—A mercury vapor lamp which uses in place of a glass container a tube of quartz. Higher temperatures can be maintained than with glass, hence stronger currents may be used.

QUARTZ RESONATOR.—A radio device whose operation is based on the piezo-electric effect.

QUARTZ THREAD.—Quartz fibre.

QUEGA.—A prefix to a unit of measurement to denote one quintillion times that unit; as, for example, quegohm.

QUENCHED GAP.—A device used in a radio telegraph transmitting circuit consisting of a series multi-gap. The gaps are formed by a number of copper discs separated by micanite or other insulating material.

QUENCHED SPARK TRANSMITTER.—A radio telegraph transmitter which employs a quenched spark gap.

QUICK ACTING AUTOMATIC AIR BRAKE.—This type of automatic air brake is the same as the plain automatic but with the additional feature that the triple valve is so modified that when a relatively quick reduction in brake pipe pressure is made, it also opens a direct communication from the brake pipe through the triple valve to the brake cylinder. The object of this arrangement is to reduce the time from the movement of the brake valve handle until a full brake application is obtained on the entire train, and to increase the total braking power obtainable by such operation (called an emergency application of the brakes), about 20 per cent over the maximum obtainable during ordinary operations (called service applications of the brake).

QUICK BREAK SWITCH.—One having an auxiliary blade pivoted to the main blade and provided with a stiff spring so that in opening, the auxiliary blade is snapped quickly out of contact, thus breaking the circuit so as to reduce arcing.

QUICK LIME.—Lime burnt and unslaked; calcium oxide; prepared by burning limestone or marble in kilns to drive off the carbonic acid.

QUICKING.—A process in electro-plating with silver, employed to secure a perfect adhesion of the metal; it consists in covering the article to be plated with a thin coating of mercury by dipping it in a solution of a mercury salt; also termed quickening.

QUICKING LIQUID OR SOLUTION.—A solution of nitrate of mercury, or of some other salt of mercury, into which articles are dipped preparatory to silver plating in order to secure perfect adhesion of the metal.

QUICKSILVER.—The metal mercury; so called from its resemblance to liquid silver; it is so called on account of its fluidity at normal temperatures.

R

R—Symbol for 1. Resistance.

2. Ratio of expansion.

3. Radius.

RACEWAY.—In house wiring, a metal casing for wires which provides a box-like covering which fits snugly over the wires and protects them from injury. Also called moulding. As compared with wooden moulding, the metal moulding takes up less room and has a better appearance.

RACKING OF ARMATURE CONDUCTORS.—A drag sometimes sustained by the coils of a dynamo or motor armature while in operation.

RAD.—A unit of time flux of light equal to a lumen per second; a lumen second.

RADIAL BRUSH.—A form of commutator brush in which a block of carbon moving freely in a socket is held directly against the surface of the commutator by a flat spring.

RADIAL FLOW.—A turbine is said to have radial flow when the water flows inwardly from the circumference of the wheel to its center, or outwardly in the reverse direction.

RADIAL VALVE GEAR.—One in which the motion of the valve is taken from some point in a vibrating rod, one end of which moves in a closed curve, while a third point on the rod moves in a straight line or open curve, that is, the construction is such as to obtain from some reciprocating or revolving piece of the engine, an arrangement of mechanism a point in which shall describe an oval curve, and by altering the direction of the axes of this curve, to produce variable cut off and reversal.

RADIAN.—The unit of angular velocity, being the angle which at a distance equal to the radius from the center, is subtended by an arc equal to the radius. This unit angle=180÷π degrees=57.3°.

RADIAN PER SECOND.—The unit of angular velocity of a moving body constantly changing its direction; the angle swept over per second by a rotating body.

RADIANT FLUX.—The rate of energy radiation; expressed in watts or ergs per second.

RADIANT HEAT.—Heat waves passing through space with the velocity of light, and giving the sensation of heat only when absorbed by the body through which they are passing.

RADIANT MATTER.—Matter found to exist in the extremely rarefied gas of high vacua in a fourth state, which exhibits extraordinary properties not known to the solid, liquid, or gaseous conditions; **ultra gaseous matter.**

RADIANT RAYS.—In physics, rays which go in all directions, yet act in the most efficient manner when striking a surface exactly at a right angle to their line of movement.

RADIATING SYSTEM.—The antenna circuit of a radio transmitting station.

RADIATION.—1. The transmission of energy by ether vibrations.

2. The radiant expulsion of charged particles of matter at high velocity, such as the alpha, beta and gamma rays emitted by radio-active substances.

RADIATION, ELECTRIC.—Electric or electro-magnetic waves, a series of electric disturbances or waves set up in the surrounding medium by discharges from a condenser. They are also known as Hertzian waves from Hertz, a German scientist who first produced them by sparks from an induction coil.

RADIATION OF HEAT.—1. Throwing out of heat in rays; the opposite process of absorption. All bodies possess the property of radiating heat. The heat rays proceed in straight lines, and the intensity of the heat radiated decreases in the inverse ratio of the square of the distance.

2. Repeated tests have shown that the amount of heat given off by ordinary cast iron radiators per sq. ft. of heating surface per hour per degree difference in temperature between the steam or water in the radiator and the air surrounding same to be about 1.6 B.t.u. Taking this as a basis a steam radiator under 5 lbs. pressure, corresponding to 228°, which is surrounded by air at 70°, will give off

$$(228°-70°)\times 1.6=253 \text{ B.t.u.}$$

commonly taken as

250 B.t.u.

per sq. ft. of heating surface per hour. With hot water at an average temperature of 160°, the heat given off is

$$(160-70)\times 1.6=144 \text{ B.t.u.}$$

commonly taken as

150 B.t.u.

per sq. ft. of heating surface per hour.

RADIATION OF MAGNETIC FLUX.—Lines of magnetic force projected radially from the positive pole of a magnet.

RADIATOR.—A device of tubular or honeycomb construction for cooling the jacket water of a gas engine; used especially on automobiles.

RADIATOR, ELECTRIC.—An electric heater in which the heating effect of an electric current passing through resistance coils is utilized for the purpose of warming cars and buildings.

RADICAL.—1. In chemistry, a group of atoms which reacts as if it were a single atom; also known as compound radical.

2. An ion, one of the products of electrolysis, consisting of a portion of matter carrying a definite electric charge.

RADIO.—1. Dr. Lee de Forest says: Radio is simply a cause and an effect. The cause is the radio transmitter. It makes an electro-magnetic splash that sets up radio waves. These waves travel through space in all directions. The effect is the setting up of delicate currents in the aerial or loop. These delicate currents are detected and converted into audible sounds by means of the radio receiving set. Imagine a boy operating a paddle at one end of a pond of still water. Ripples are set up in the water. They travel farther and farther away from the paddle, getting weaker as they move along until they reach a piece of wood which bobs up and down as it rides the waves. Put a bell on the piece of wood, in order that it will ring with the action of the waves. This illustrates the mechanical parallel of radio communication.

2. According to Marconi: Radio waves go to outer space. In his inaugural address at the second meeting of the Ital-

ian Society for the Advancement of Science September 11, 1930, Senator Guglielmo Marconi expressed belief that radio waves may travel long distances, even millions of miles beyond the earth's atmospheric layer. He said that he did not see any reason why, as some scientists maintain, waves produced on the earth should not travel such a distance, since light and heat waves reach the earth from the sun, penetrating the atmospheric layer. He referred to observations of such scientists as Stormer and Pedersen and commented that the former had said that electrified particles derived from the sun and under the magnetic influence of the earth acted as a reflector of electric waves from the earth after they had passed the so called Kennelly-Heaviside layer.

3. Dr. Albert Einstein discards the theory of the ether usually presented by writers in an attempt to explain radio transmission. Dr. Einstein derides radio's ethereal medium as fiction, calling it a makeshift fabricated to explain something for which scientists have not had the correct explanation. Einstein believes it is an electro-magnetic phenomenon; so did Charles Proteus Steinmetz.

4. Steinmetz, shortly before his death, said: "There are no ether waves." He explained that radio and light waves are merely properties of an alternating electro-magnetic field of force which extends through space. Scientists, he contended, need no idea of ether. They can think better in the terms of electro-magnetic waves.

RADIO-ACTIVE SUBSTANCES.—A class of substances, such as uranium, thorium, radium, and their compounds, which possess the property of spontaneously and continuously emitting radiations capable of passing through substances opaque to ordinary light. Three different types of such radiations have been distinguished, known as **alpha, beta** and **gamma rays.**

RADIO-ACTIVITY. — That property of a substance by which it spontaneously emits rays which affect a sensitive photographic plate, excites phosphoresence in certain substances, and ionizes the surrounding air, that is to say, breaks up the molecules of the air into atoms which become electrical conductors.

RADIO AUDITION.—In receiving sets, the high frequency impulses having been rectified and reduced to audible limits by the detector, in the simplest hook up, it is only necessary to add telephone head receivers, to change these impulses to sound waves so they can be heard. For more volume, instead of telephone head receivers, the circuit should contain one or more amplifiers and a loud speaker.

RADIO BEACON.—A fixed transmitter which sends special signals to allow ships, air planes or other movable receivers to determine their bearings with reference to the fixed transmitter.

RADIO BEARING.—The angle formed by the fixed line of a moving receiver on an aircraft or vessel and the direction of the incoming radio wave.

RADIO BROADCASTING.—Starting with the microphone, sounds received by it pass through an amplifier, modulator and oscillator to the antenna.

RADIO CHANNEL.—1. A band of frequencies within which a transmitter is allowed to operate.

2. A band of frequencies of sufficient range to permit transmitting without causing interference by oscillations of frequencies outside of the band.

RADIO COMPASS.—A device with which bearings can be taken in dense fog, snow storms and over distances greatly beyond the horizon with an accuracy equal to that obtained with visible sights, thus eliminating one of the greatest hazards to navigation. In construction, the coil is enclosed within a circular housing in a manner such that it is free to rotate even under the most severe conditions of the wind and sea. This is of value in northern latitudes, where, during the winter months, the ship's superstructure is generally covered with ice. The housing also protects the coil from mechanical damage. The coil and housing with its stem are mounted on the upper deck. At the lower end of the shaft there is attached a pair of sight wires which travel over a compass card or azimuth circle by means of which the angle between the station upon which the bearing is taken and magnetic North, true North, or the ship's direction (depending on the type of installation) can be read directly. The sight wires are not rigidly fastened to the shaft but are connected thereto through a simple mechanical device which automatically corrects for variations in the direction of the incoming radio waves caused by the influence of the ship's hull and rigging. This device is called the automatic compensator. The radio beacon sends out characteristic radio signals by which the operator of the radio compass may take bearings. Such beacons are under the supervision of the U. S. Bureau of Lighthouses, the sole purpose of which is to maintain aids to navigation.

RADIO COMPASS RECEIVER.—A device located directly beneath the compass which utilizes a circuit specially designed to give maximum sensitivity and selectivity. The receiver contains seven large tubes, so operated that they are equivalent to four stages of radio frequency amplification, a detector and two stages of special design audio frequency amplification. The receiver is designed to operate over a wave length range of from approximately 550 to 1,050 meters. Tuning is accomplished by a one dial wave selector.

RADIO COMPASS VISUAL INDICATOR.—A method of obtaining a bearing by means of a visual indicator, consisting in observing the change in brilliancy in the glow of a gaseous conductor lamp.

RADIO CONTROL.—A radio wave indicator.

RADIO DETECTION.—The process of converting the high frequency waves received from the aerial into pulsating unidirectional current so as to make the transmitted signals audible in the telephone receiver. The part of the apparatus that converts the current is called a detector. A detector is essential because the human ear is not responsive to vibrations above a few thousand per second. The detector changes the incoming radio frequency currents to audio frequency currents. The simplest form of detector is known as the crystal detector. Galena, silicon and carborundum are the names of three of the crystals used. Vacuum tube detectors are now used in place of crystal detectors.

RADIODONTIA.—Radioscopic examination of the alveoli and roots of the teeth.

RADIO ELEMENT.—An element possessing radio activity.

RADIO FATHOMETER.—A marine depth indicator.

RADIO FREQUENCY.—The term applied to currents pulsating at a frequency too high to be heard by the human ear. Used to identify the currents in the antenna circuit. The frequencies of radio waves in transmission through space.

RADIO FREQUENCY ALTERNATOR.—A machine which generates alternating current at radio frequency.

RADIO FREQUENCY AMPLIFICATION.—The process of increasing the voltage or power of a signal at radio frequency.

RADIO FREQUENCY AMPLIFIER.—The assembly and hook up of vacuum tubes, couplers, condensers, etc., used to increase the voltage or power of signals at radio frequency.

RADIO FREQUENCY CHOKE.—An inductance coil with air core designed to present high impedance at high frequencies.

RADIO FREQUENCY SIGNALS.—In radio the incoming signals picked up by the aerial and flowing into the receiver, corresponding to the radio frequency signals coming out from the transmitter to the antenna.

RADIO FREQUENCY TRANSFORMER.—One designed to operate at radio frequency. It usually has an air core; however, some have a small amount of iron in the core.

RADIOGRAM.—A radio telegram, that is, a message sent by radio telegraph in code.

RADIOGRAPH.—A picture taken upon a photographic plate by means of X-rays. In taking a radiograph replace the fluorescent screen of the fluoroscope by a suitable photographic plate, give it the proper exposure and develop as in photography. The length of exposure will depend upon the character of the object radiographed, the quality of the X-ray tube, and the current strength employed.

RADIO INSTRUMENTS.—1. A volt meter should draw as small a current as is possible if it is to be left in circuit to show the voltage across the filament of a vacuum tube whenever it is in operation. Unless the volt meter draw a small current, it cannot be placed across the vacuum tube filaments for the moment of adjustment of the rheostat, and then be removed from the circuit, without causing the filaments to have excessive voltage when the volt meter switch is opened.

2. Inefficient ammeters are undesirable for filament adjustment, since they have a relatively high voltage drop and the A battery must be replaced, or recharged, much sooner.

3. A vacuum tube set taking from three to five volts for filaments can be served better by a combination filament volt meter and plate battery tester than by a filament ammeter.

4. Double range ammeters are particularly good for double duty rectifiers. The minus common of the ammeter is connected to the minus (anode) of the rectifier. Two other terminals are supplied, one for 0-5 amperes for A battery charging, and the other 0-1 ampere for B battery charging. The usual number of plus terminals for 2, 6, 12, 22.5, 45, and 90 volt batteries should be supplied on the rectifier as usual. Other double ranges are supplied such as: 0-1.5 and 0-7.5, also 0-2 and 0-10 amperes.

5. Milli-ammeters range from 0-10 to 0-100, and are for use in plate circuits of vacuum tubes, and for other purposes where a few volts drop is not harmful. The 0-10 milli-ammeter may have its terminals connected to a standard plug and thence inserted into any jack in-

tended for head phones or loud speaker, so as to measure the vacuum tube plate current in that circuit. The voltage drop in the milli-ammeter is much less than that in any head phone or loud speaker, and hence this drop is no detriment for such uses.

RADIOMETER.—An apparatus invented by Sir William Crookes which demonstrates the power of light. A set of metal vanes, blackened on one side and bright on the other, is fixed on a vertical axis, capable of free revolution, within a glass bulb from which the air is exhausted. Radiant heat received by the vanes causes them to rotate at a speed depending upon the intensity of the radiation.

RADIO-MICROMETER.—An extremely sensitive instrument for measuring faint heat radiations, consisting essentially of a closed circuit containing a bismuth-antimony junction suspended between the poles of a powerful magnet.

RADIOPHARE.—A radio "lighthouse" having a radio telegraphic transmitter as an aid to navigation to determine a ship's position.

RADIOPHONE.—A radio telephone.

RADIO RANGE.—A stationary transmitter whose special signals enable an airplane, air ship, etc., to determine its course. Also called radio beacon.

RADIO RECEIVER.—Apparatus usually in a neat and compact cabinet, comprising a detector with audio and radio amplifiers and able to produce audible sounds from modulated wave signals.

RADIO RECEIVER CIRCUITS.—Any electrical circuit used in connection with the reception of radio is a receiving circuit. The more important receiving circuits using vacuum tubes and named according to the principles of operation are: a, regenerative; b, super feed back; c, tuned frequency; d, reflex; e, inverse duplex; f, neutrodyne; g, heterodyne; h, autodyne; i, super-heterodyne; j, super-heterodyne with second harmonic oscillator; k, short wave; l, ultra-short wave.

RADIO RECEPTION.—The detection, rectification and amplification of incoming signals.

RADIO RELAY STATION.—One which receives signals and transmits them to a more remote station.

RADIOSCOPE.—A fluoroscope.

RADIOSCOPY.—An examination, as of a part of the human body, by the use of the X-ray in connection with a fluorescent screen without employing photography.

RADIO SELECTION.—When several transmitting stations are broadcasting at the same time it is necessary to provide means for cutting out or making the apparatus non-responsive to all stations except the one it is desired to hear. This function is called selection and is accomplished by a process called tuning. In tuning, the selector knob should be turned to the exact number corresponding to the station desired and the volume regulated by the volume control knob. The ignorant practice of turning on too much power with the volume control knob and then softening the volume with the selector knob wastes current, overloads the tubes and is accordingly very objectionable.

RADIO SET LIGHTNING ARRESTER.—The preferred location of the lightning arrester is outside the building at the point where the lead in wire enters the building. One terminal of the arrester is connected to the aerial and the other to ground. The lightning arrester interposes a very small air gap between the aerial and the ground and across which any sudden high voltage impressed on the aerial as happens during a thunder storm will readily discharge across the gap without injuring the radio apparatus.

RADIOSTAT.—A stenode radiostat.

RADIO TELEGRAPHY.—A system of telegraphy in which messages are transmitted by means of electro-magnetic waves set up by an instrument for generating oscillations at the sending station, passing through free space, and received by a delicate detecting instrument at the receiving station. The surging of electric charges at the spark gap of the transmitting instrument causes the current to ascend the sending mast and flow out into the ether in the form of electro-magnetic waves; the aerial conductor at the receiving station obstructs a portion of these waves which are led into the receiving instrument by which signals are sounded. A transmitter key controls the duration of the sparks at the spark gap, hence the waves are sent out in groups corresponding to the dots and dashes of the Morse code.

RADIO TELEPHONY.—The transmission to a distance, of articulate speech through space, without wires, by means of electro-magnetic waves. The success of this system depends upon an oscillation detector of such a character that it is capable of varying the current through a telephone receiver to exactly correspond with the variations of air pressure produced by the voice upon a telephone transmitter at the sending station.

RADIO THERAPY.—The employment of radio active substances in treating physical disorders.

RADIOTHORIUM.—A radio active substance which is supposed to emit the same rays as radium. It is a disintegration product of thorium.

RADIO TRANSMITTER.—Apparatus for production of radio frequency power with amplifying, modulating and oscillating circuits and all necessary parts from microphone to antenna.

RADIO TROUBLES.—1. All tubes fail to light. Caused by: a, a battery discharged; b, open rheostat; c, poor battery connection; d, broken lead in battery cable; e, poor switch; f, burned out tubes; g, open primary of power transformer (a.c. set); h, open in a.c. lead cord; i, fuse blown.

RADIO TROUBLES.—2. Part of tubes fail to light. Caused by: a, open rheostat; b, dead tube; c, open in power secondary; d, poor socket contact.

RADIO TROUBLES.—3. No reception (set dead). Caused by: a, B supply dead or defective; b, B batteries down, open in power secondary, defective rectifier tube, shorted power supply condenser, open choke in power unit, defective resistor in power unit, open in plate cable lead; c, A battery connections reversed; d, open primary of radio frequency transformer; e, open primary of audio frequency transformer; f, shorted grid condenser; g, open or shorted speaker cord; h, shorted by pass condenser; i, defective tube; j, open or shorted speaker choke; k, open circuit in wiring; l, short circuit in wiring; m, tube prongs not making contact in socket; n, grid resistors open; o, short between aerial and ground leads; p, shorted lightning arrester.

RADIO TROUBLES.—4. Weak reception. Caused by: a, defective tube; b, A or B voltages low; c, corroded battery connections; d, partially shorted audio transformer; e, partially shorted radio frequency transformer; f, open radio frequency transformer secondary; g, leaky audio transformer; h, set out of synchronization; i, poor grid resistors; j, partially shorted power transformer primary; k, partially shorted power transformer secondary; l, poor rectifier; m, poor lightning arrester; n, incorrect eliminator resistor values; o, poor aerial insulation; p, poor ground; q, poor socket contacts; r, defective grid condenser; s, high resistance wiring connection; t, speaker weak; u, speaker out of adjustment.

RADIO TROUBLES.—5. Noisy reception. Caused by: a, a.c. plug loose; b, swinging antenna, grounding; c, poor lightning arrester; d, defective ground connection; e, defective by pass condenser f, defective tube; g, variable condenser shorted; h, variable condenser dirty; i. defective grid leak; j. defective resistors; k, loose connection in wiring; l, loose contacts in socket; m. defective filter condensers; punctured; n, defective audio transformer; grounded, o, defective eliminator resistors; p, grid resistor open; q, poor battery connections; r, defective B batteries; s, speaker cord shorted, partially; t, speaker cord tips loose; u, speaker unit defective; v, dirty switch contacts; w, volume control worn.

RADIO TROUBLES.—6. Distortion. Caused by: a, defective A or B power supply or overloaded; b, speaker out of adjustment; c, poor tube; d, incorrect type of tubes; e, incorrect battery voltages; f, C battery disconnected; g, incorrect C voltage; h, set out of synchronization; i, open biasing resistor; j, shorted biasing resistor; k, poor rectifier tube or elements; l, high regeneration; m, reaction between radio and audio frequency elements; n, inter-action between transformers; o, acoustic coupling between speaker and set; p, poor by pass condensers; q, reactive coupling in power leads.

RADIO TROUBLES 7.—Hums or continuous whistle. Caused by: a, defective tube; b, speaker too close to set; c, defective power supply; d, shorts in wiring; e, reaction between wiring; f. open grid circuit; g, low detector voltage;h, grounded audio transformer; i, open antenna choke; j, partially open power transformer secondary; k, open filament balancing resistances; l, shorted filter choke; m, open primary circuit; n, a.c. plug in wrong position; o, cooked winding of power transformer; p, ground binding posts not making good ground contact; q, grounded choke; r, grounded speaker jack; s, grounded resistors; t, open grid circuits; u, open or shorted or grounded by pass condensers; v, open resistor; w, open leads in cable.

RADIO TROUBLES 8.—Intermittent reception. Caused by: a, poor tube; b, loose connections; c, poor lightning arrester; d, defective grid leak; e, open in grid circuit resistors; f, corroded connections; g, poor aerial insulation; h, poor grounds; i, swinging ground or aerial; j, weak A battery; k, defective rectifier tube or elements; l, open biasing resistor.

RADIO TROUBLES 9. — Overheating Caused by: a, shorted power transformer primary; b, shorted power secondary circuit.

RADIO TROUBLES 10.—Continued oscillation. Caused by: a, defective tube; b, poor ground connection; c, grid resistor shorted; d, excess radio frequency plate voltage; e, open grid circuit; f, antenna lead too close to set; g, reaction or poor shielding; h, poor radio frequency by pass condensers.

RADIO TUNING.—It is found that in a circuit containing inductance and capacity, certain combinations of these give much greater response than others to a given wave length. Hence, if each broadcasting station have a different wave length, the receiving set can be tuned to respond to any selected station by adjusting the relative amounts of inductance and capacity. When the strength of the signals from the selected station is greatest, the circuit is in tune or in resonance with the incoming wave length, or frequency, and then only a very small impulse is required. Accordingly, in tuning, first turn the selector knob to the point of resonancy, then regulate volume by the volume control knob, not by the selector knob.

RADIO WAVES.—Electro-magnetic waves.

RADION.—One of the particles of which alpha or beta rays are composed.

RADIOTRON.—A trade name for radio vacuum tubes made by RCA.

RADIUM. — A metallic element, atomic weight 226.4. Extracted in very minute quantities from pitchblende. It possesses radioactivity to a greater degree than any other known substance. It is fluorescent and imparts this quality to other substances; causes gases to become conductors of electricity; discharges electrified bodies and affects a photographic plate through opaque substances. It emits three kinds of rays: alpha, beta and gamma, also a radioactive gas or emanation, radon (niton), and causes burns of the skin when applied too long without a proper shield.

RADIUS OF GYRATION.—In physics, the distance of the center of gyration of any figure from its axis of rotation, that is, the distance from its axis of rotation, of that point at which, if all the moving matter were collected, it would obtain equal angular velocity from, and sustain equal resistance to, the force that gives the rotary motion. More plainly termed the center of inertia.

RADIUS RODS.—1. On a self-propelled vehicle a device designed to prevent any forward or aft movement of the rear axle, which on account of the flexible action of the springs, may be caused by an obstruction in the road.

2. On a link motion reverse gear one or two rods attached by pivot to the reverse lever and the link either at the middle point or end of the link. It should be noted that when the rods are pivoted at the end of the link (called end suspension) the slip of the block is less than when pivoted at the center. Radius rods are also called reach rods. For graphical explanation of this see Audel's Engineers and Mechanics Guide No. 1, Page 330.

RADON.—Radium emanation.

RAIL BOND TEST.—One of the best methods of finding the resistance of a bonded joint is to use two milli-volt meters and determine the number of feet of rail equivalent to the bonded joint. A duplex milli-volt meter is preferable to two separate instruments.

RAIL BONDING.—In electric traction, a method of reducing the electrical resistance of rail joints by attaching bonds. As rail lengths of 30 or 60 feet are used, there will be 88 to 176 joints per mile, and the resistance of these joints being in series the total resistance per mile of track will be considerable. In order to overcome this, adjacent rails are "bonded," that is, joined by stranded copper bonds. They are fastened by drilling holes in the rails and compressing the ends, or terminals, of these copper straps in them.

RAILWAY CONTROL METHODS. — The control on an electric car provides for the correct application of power in starting, for operation "forward" or "backward" for opening the power circuits in order to slow down or stop, and for the protection of the equipment. In the resistance method, the resistor is provided with taps so that the amount of resistance in the circuit may be gradually reduced from the maximum at the instant of starting until it is finally all cut out of circuit and the motors are receiving full voltage. The various connections are made through a controller. The use of field control motors increases the equipment efficiency in starting by reducing the resistance loss.

RAILWAY CROSSING.—The intersection of two tracks consisting of four frogs, one for each rail intersection, connected together and provided with arms at the four corners for attachment of the main rails. A third rail, known as easer rail or simply easer, is usually provided outside the running rails for reinforcement and to supply a bearing for the overhanging portion of hollowed out treads of wheels. The easer rails may be continuous throughout the crossing, or as is frequently the case for the smaller angles, of a length only sufficient to protect the immediate intersections. When the angle at which the tracks intersect is other than 90° the two frogs at the acute angle intersections are called end frogs, and at the obtuse angle intersections, center frogs.

RAILWAY, ELECTRIC.—A traction system upon rails in which electricity is employed as the motive power. In street railway service, the cars usually carry motors which are driven by current derived from the line through trolleys or, when the conductor is carried underground, connection is made by contact plows through a slot between the rails. In heavy railway service, the current is obtained from a third rail by a contact shoe or from an overhead line by "pantograph" or "bow" trolleys to motors carried by electric locomotives.

RAILWAY FROG.—A device which is introduced at the intersection of two running rails to permit the flanges of wheels moving along one of them to pass across the other. Classified as: a, rigid; b, spring rail; c, sliding. They are also classed as: a, turn out; b, crossing.

RAILWAY MOTORS.—Except in a few instances, city and interurban electric railways employ d.c. motors of the series type supported by the truck transom and axle, geared to the axle and entirely or partially enclosed for protection against water and dirt. The commutating pole series motor is now the standard for d.c. railways.

RAILWAY SIGNALS.—Means of conveying to a train information necessary to the motorman or engineman in order that he may drive the train with safety.

RAILWAY SWITCH.—A device for diverting rolling stock from one track to another. There are several kinds of switch, classified as: a, split; b, three throw; c, derailing.

RAILWAY SWITCH STAND.—A device used to operate the junction to two tracks. Classed as: a, horizontal throw; b, vertical throw; c, non-automatic; d, automatic.

RAKE OF POLES.—In transmission line construction where practicable, corner and dead end guyed poles should be raked by "setting in" the butts by an amount not exceeding 1 foot for every 20 feet of pole length. Conditions in towns and cities may require that all poles be set vertically.

RANGE BEACON.—A radio range.

RAPID SINUSOIDAL CURRENT.—In electro-therapeutics, a current having 3,600 cycles per minute. This current is obtained from the ungrounded secondary of the transformer and hence is earth free. It may be safely used in hydrotherapy. In view of the fact that the direction of the current is constantly reversing polarity, no chemical effects are obtained, but it is widely used for massage and promoting muscular tone. It acts favorably, due to its exercising effect, in removing the sequelæ of fibrositis, but for this purpose it should be given at a point just below that necessary to produce contractibility. Neiswanger prefers it in the treatment of peripheral nerve atonicity. Waggoner uses it for massaging adhesions and deposits. Mild treatments stimulate, but heavy dosages will produce sedation through inhibition. Caution. It is of the utmost importance when using Kantbern pads that these electrodes be thoroughly saturated with a sodium chloride or sodium bicarbonate solution before starting treatment.

RAPID SINUSOIDAL WAVE SUSTAINED PEAK CURRENT.—In electro-therapeutics, a current similar to the rapid sinusoidal wave with exception of the sustained peak effect. It will satisfy the physician's need for a very strong push and pull effect, without polarity, for the combined tonic effect on nerve and muscles. In cases of intestinal stasis and where prolapsed colon exists and a more powerful stimulant is required to stir up the sluggish musculature into action, this current can be relied upon. However, much better results can be obtained by employing the oscillatory wave sustained peak, which embodies all of the good principles of this form of wave, with many additional refinements.

RAT TAIL.—A radio multi-wire lead in.

RATCHET PENDANT BURNER.—A gas burner which is lighted by means of an electric spark coil operated by a pendant pull.

RATED BREAK DOWN TORQUE.—For a.c. motors the maximum torque which the motor will carry, with rated voltage and frequency applied to the motor, without an abrupt drop in speed.—NEMA.

RATED LOAD.—The horse power output for motors, kilowatt output for dynamos, and kilo-volt ampere output for alternators.—NEMA.

RATED LOCKED ROTOR CURRENT.—For squirrel cage induction or other internally short circuited motors, the current taken from the line with the rotor locked and with rated voltage and frequency applied to the motor.—NEMA.

RATED PULL UP TORQUE.—For a.c. motors, the minimum torque developed by the motor during the period of acceleration from rest to full speed with rated voltage and frequency applied to the motor.—NEMA.

RATED STARTING OR STATIC TORQUE.—For a.c. motors, the minimum locked rotor torque for all angular positions of the rotor with rated voltage and frequency applied to the motor.—NEMA.

RATED VOLTAGE OF CIRCUIT BREAKERS.—The maximum voltage in r.m.s. volts between any two wires of any circuit to which the breaker should be connected. When referred to the breaker, it is a function of its insulation strength and of the safety factor desired.

RATING.—Of a machine, apparatus or device, an arbitrary designation of an operating limit. A rating is arbitrary in the sense that it must necessarily be established by definite fixed standards and cannot, therefore, indicate the safe operating limit under all conditions that may occur in service.—NEMA.

RATING OF ALTERNATORS.—These machines are rated at the load they are capable of carrying continuously without exceeding their temperature guarantees. The rating shall be expressed in kva. available at the terminals at .8 power factor. The corresponding kilowatts should also be stated. Standard voltages are 240, 480, 600 and 2,400 and standard frequencies are 25 and 60 cycles per second. The standard excitation voltage for field windings shall be 125 volts d.c. Standard general purpose alternators shall operate successfully at power factors at least as low as .8.

RATIO.—The relation of one number to another of the same kind. Thus the ratio of 12 to 23 is expressed as 12:23 or 12÷23. Terms of a ratio—The numbers compared; antecedent, the first term; consequent, the second term; couplet, the antecedent and consequent together.

RATIO ARMS.—The proportionate arms of a Christie or so called Wheatstone bridge, the two arms whose ratios are known; also called bridge arms.

RATIO OF CONVERSION.—There is always a certain approximate ratio between the alternating and direct current voltage of any given synchronous converter, and the alternating current voltage is the smaller of the two. The ratio varies with the number of phases for which the converter is designed. For a d.c. voltage of 1, the a.c. voltage will be single phase, .707; two phase, .707; three phase, .615; six phase double delta, .615; six phase diametrical, .707.

RATIO OF TRANSFORMER.—1. In a step up transformer, the quotient of the number of secondary turns divided by the number of primary turns. In a step down transformer, the quotient of the number of primary turns divided by the number of secondary turns.

2. The turn ratio, that is, the ratio of the number of turns in the full high voltage winding to that in the full low voltage winding.—NEMA.

RAWHIDE GEARS.—Pinions and wheels made of hard leather built up in several thicknesses, through which the teeth are cut. They are used to a considerable extent for high speed driving, especially as a first gear of an electric motor; being durable, elastic and noiseless.

RAY.—A beam of light thrown by a luminous body, light emitted in a given direction from any source.

RAY, ELECTRIC.—A fish, sometimes called the torpedo, having an organ in the back of its head by which it is able to give an electric shock.

RAYLEIGH DISC.—A sound wave indicator consisting of a light metal disc, the vibrations of which when suspended in the path of sound waves, indicate the air pressure produced by the waves.

REACH RODS.—Radius rods.

REACTANCE.—Reaction. A term used to express certain effects of the a.c. other than that due to the ohmic resistance of the circuit. Thus, inductance reactance means the reaction due to the spurious resistance of inductance expressed in ohms; similarly, capacity reactance, means the reaction due to capacity, expressed in ohms.

REACTANCE COIL.—1. A choking coil, a coil of insulated wire of low resistance wound on a laminated core and joined in series with an a.c. circuit to prevent too large a current. A coreless reactance coil consisting of a spiral of a few turns of insulated wire is used to force a lightning discharge through an arrester.

REACTANCE FACTOR.—In an alternating current circuit, the quotient of the spurious resistance divided by the ohmic resistance.

REACTION.—In electro-therapeutics, the spasmodic contractions in the tissues of the body which occur upon application of an electric current.

REACTION BRUSH HOLDER.—A commutator brush holder in which the movement of the brush is constrained in one direction by the surface of a part rigidly secured to the brush spindle, and is further constrained by a spring controlled arm, the pressure of which is capable of ready adjustment.

REACTION OF EXHAUSTION.—In electro-therapeutics, an exhausted state of the tissues of the body undergoing electrical treatment, such that they fail to respond until the strength of the current is increased.

REACTIVE CIRCUIT.—A circuit containing inductance or capacity or both in such proportion that the circuit is non-resonant.

REACTIVE DROP.—In a reactive circuit a drop in voltage due to spurious resistance.

REACTIVE FACTOR.—The ratio of the wattless volt-amperes to the total amperes in an electric circuit.

REACTIVE LOAD.—A load which is either inductive or capacitive, that is, one in which the current is not in phase with the voltage.

REACTIVE VOLT-AMPERES.—A power value equal to the square root of the difference between the square of the apparent power and the square of the power. The reactive volt-amperes when both current and voltage are sinusoidal, is equal to the volt-amperes times the sine of the angle which expresses the phase difference between current and voltage.

REACTOR.—An induction or capacity unit, as an induction coil or a condenser.

READILY ACCESSIBLE.—Capable of being reached quickly, for operation, renewal or inspection, without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, chairs, etc.

READING MICROSCOPE.—A microscope mounted upon an instrument for making exact measurements in order to enable the observer to read minute divisions of the scale.

REAGENT.—A chemical that reacts upon a compound; a substance used to effect chemical changes upon a compound for discovering its constituent parts and determining its percentage composition; thus, iodine added to a solution containing starch turns it a beautiful blue; and on adding common salt to a gold and silver alloy, dissolved in nitric acid, the silver is at once precipitated as chloride and its quantity readily ascertained.

REAL CABLE.—In duplex submarine cable working, the cable proper as distinguished from the artificial or false cable.

REAL COMPONENT.—A name sometimes given to the active component.

REAL CUT OFF.—In valve gears, the sum of the apparent cut off plus the percentage of clearance. For instance, if the apparent cut off (that is, the point of the stroke at which steam is cut off by the valve) be one half, or 50% and the clearance be 10% then the real cut off is $10+50=60\%$ of the stroke.

REAL IMAGE.—In optics, one that can be projected on a surface as on film in a camera.

REAL SLIP.—In marine propeller propulsion, the velocity (relative to water at rest) of the water projected sternward.

REAUMUR THERMOMETER.—A thermometer having its scale divided into 80 degrees between the freezing and boiling points of water, the freezing point being taken as zero. One degree Fahrenheit is equal to 4/9 of a Reaumur degree. The Reaumur thermometer is used for scientific purposes in the countries of Eastern Europe.

RECALESCENCE.—A sudden check in the process of cooling a bar of iron or steel from a white heat, when the metal glows more brightly for a short while upon reaching a certain temperature, and then continues cooling. On bringing a piece of iron to a white heat and letting it cool in a dark room, it will cool regularly, the colors fading to a dull red as the temperature falls. When a certain point is reached, about 1000° F., not only is the rate of cooling retarded, but the iron bursts out into a glow as if reheated, before fading again. This recalescence is occasioned by molecular changes in the metal, as iron is magnetic below the point of recalescence; non magnetic above that point.

RECEIVER.—1. A radio term generally used for a radio receiving set.

2. In telephony, the instrument which is applied to the ear in receiving a message.

3. In automatic telegraphy, a special recording machine which registers messages as received.

4. A chamber between the cylinders of compound engines into which the steam from the high pressure cylinder escapes, and from which it is admitted to the low pressure cylinder. On triple expansion engines, there are two receivers, and on quadruple expansion engines, three. In any multi-stage expansion engine when the sequence of cranks is 180°, receivers are not necessary.

RECEPTACLE.—A socket in which a plug is pushed in or screwed to complete a connection for an outlet.

RECEPTIVE DEVICES.—Electro-receptive devices; any instrument or appliance which receives electrical energy to utilize it, or transform it or measure it.

RECIPROCAL.—In mathematics, the quotient arising by dividing unity by the number whose reciprocal is required.

RECIPROCATING FIELD.—In a split phase motor the field provided by the main single phase winding as distinguished from the oscillating field produced in starting by the starting device.

RECIPROCATING MOTOR.—An early type of motor whose armature acted with a reciprocating instead of rotary motion.

RECOIL CIRCUIT.—That portion of a circuit lying in the alternative path of a disruptive discharge.

RECOIL OR DISRUPTIVE DISCHARGE.—A sudden reaction which occurs simultaneously with a disruptive discharge, like the "kick" of a gun.

RECONNECTING.—Making changes in the hook up of armature and field windings to adapt the machine to changes in: a, voltage; b, frequency; c, phase; d, speed; e, rotation. There are some changes in the windings of an a.c. motor that can easily be made by a repairman, and also some which should not be attempted. Complicated changes should not be attempted except by men of experience.

RECONNECTING A.C. WINDINGS FOR FREQUENCY CHANGES.—For the same number of poles a change in frequency will cause the speed to vary directly as the frequency. In order to maintain the speed constant in making a frequency change, the voltage on the motor should be varied in the same proportion as the frequency is changed. A change in frequency may be regarded the same as a voltage change because the voltage changes with the frequency. Increase in frequency usually causes the machine to run a little cooler, and decrease, a little warmer. A change in frequency should be offset by a change in voltage in the same direction and amount; thus, if a motor be operated at 110 volts on 60 cycles, it should be operated at 5/6 of 110=92 volts on 50 cycles. In making a frequency change if the speed is to remain the same, the number of poles must be changed in the same ratio as the frequency, or approximately so.

RECONNECTING A.C. WINDINGS FOR PHASE CHANGES.—The change most frequently desired is from two to three phases, or from three to two phases. Consult a reference table. See Audel's New Electric Library, Vol. V, page 2204.

RECONNECTING A.C. WINDINGS FOR SPEED CHANGES.—The speed of an induction motor may be changed by regrouping the field coils for a different number of coil groups. In this connection it should be noted that an increase in the number of poles will decrease the speed, whereas, a decrease in the number of poles will increase the speed. Practically all reconnections involving pole changes give only a fair operating performance.

RECONNECTING A.C. WINDINGS FOR VOLTAGE CHANGES.—Nearly all commercial motors are arranged so that they can be reconnected for two voltages. To make these changes, the polar groups are connected in series for the higher voltage and in parallel for the lower voltage. In changing to higher voltages it should be noted that motors as manufactured are provided with insulation good for 550 volts or for 2,500 volts. The capacity of the insulation should accordingly be considered and no change be made beyond the capacity of the insulation. In making a voltage change, the voltage per coil or per turn must be approximately the same after reconnection as before.

RECORDER.—In telegraphy, an instrument for automatically recording a message as received.

RECORDER SIGNALS.—Telegraphic signals registered upon the paper ribbon in a siphon, or other recorder.

RECORDING AMMETER.—An ammeter that automatically records the number of amperes passing through a circuit.

RECORDING COMPASS.—A variety of mariner's compass designed to record a ship's direction and to give a warning signal when the vessel deviates from its course.

RECORDING DEMAND METER.—A meter which gives the load time curve of an installation or system. The demand interval may be of any specified length, and the demand periods may be taken as beginning at specified times of the day or may be timed so as to include the maximum average load occurring in any period of the chosen duration. Curve drawing or graphic recording instruments are obtainable in many varieties and makes.

RECORDING DRUM.—1. In an electric chronograph, a rotating cylinder or drum upon which the stylus makes the record.

2. On a steam engine indicator, a rotating cylinder around which is placed a piece of paper or "card" on which is traced a diagram by the indicator pencil showing accurately the pressure varia-

tion in the engine cylinder during one revolution.

RECORDING LAMP.—In sound picture, variable density method of recording, the lamp whose intensity is varied at sound frequencies.

RECORDING VOLT METER.—A form of voltmeter designed to register the voltage measured by it. The leverage of a glass pen provided with an ink reservoir is connected by a spring to the movable part of the volt meter. The movement of the pen as the voltage changes traces a record upon a sheet of paper fed forward by a rotating cylinder.

RECORDING WATT METER.—A watt-hour meter, a form of watt meter designed to register the watt-hours expended during a period of time. It is used to record the amount of electric power furnished to a consumer by a central station.

RECOVERY OF CONDENSER.—The return of the dielectric of a condenser to its neutral condition after being subjected to the strain of an electric charge.

RECTANGLE.—A rectangle is a parallelogram having its angles right angles.

RECTIFICATION.—In radio, converting alternating current into direct current by means of a vacuum tube of the rectifier type.

RECTIFICATION OF ALCOHOL, ELECTRIC.—A method of purifying alcohol by passing a current of electricity through it between zinc electrodes; the water present is decomposed, the hydrogen combining with the alcohol and the oxygen with the zinc.

RECTIFIED CURRENTS.—Alternating currents which have been acted upon by a rectifying commutator and changed into direct pulsating currents.

RECTIFIED SIGNALS. — Radio signals which have passed through a detector system. In this process the alternating current waves are converted to direct current and the radio frequency to audio frequency.

RECTIFIER.—A device for converting alternating current into pulsating current. The various kinds of rectifiers may be classed as: a, mechanical; b, electromagnetic; c, electrolytic; d. mercury vapor, or mercury arc.

RECTIFYING COMMUTATOR.—A form of commutator for obtaining direct pulsating currents from alternating currents; also called rectifier.

RECTIFYING VALVE.—A radio vacuum tube rectifier.

RECTIGON RECTIFIER.—An argon gas bulb rectifier as constructed by the Westinghouse Co. The rectigon outfit consists essentially of a transformer for converting the voltage to the proper value, and a bulb for rectifying. The bulb is a glass envelope, containing an anode and a cathode in the shape of a filament, surrounded by an atmosphere of pure argon. Leads to the anode and cathode are sealed through the glass walls of the bulbs. For convenience of installation, the filament leads are connected to the terminals of a screw base.

RECTILINEAR.—Descriptive of any figure composed wholly of points and straight lines.

RECTILINEAR CURRENT.—An electric current passing along a straight conductor.

RED BRASS.—Standard red brass is an alloy composed of 85% copper, 5% tin, 5% lead and 5% zinc. Also known as red composition and ounce metal.

RED CANDLE.—A standard candle screened by red glass for use in connection with a photometer.

RED POLE.—The north seeking pole of a magnet or magnetic needle, also known as the N, plus, positive, marked or boreal pole.

REDUCED BATTERY. — In quadruplex telegraphy, the short end or smaller portion of the divided battery.

REDUCED DEFLECTION METHOD.—A method of electrical measurement based upon observing reduced deflection of the galvanometer needle as the current strength lessens.

REDUCED VOLTAGE TAP.—A tap on a transformer with which the unit may not be operated at full capacity without exceeding the specified temperature rise.—NEMA.

REDUCING COUPLING.—A joint designed to make electrical connection between the ends of two conductors differing in size.

REDUCING OR ENLARGING FITTINGS.—In pipe fitting the term reducer originated from the trade custom of always giving the larger size of a run of a fitting first, and as applied, it means a reducing or enlarging coupling having female threads at both ends, as distinguished from a bushing which has both male and female threads.

The function of a bushing is to connect the male end of a pipe to a fitting of larger size. It consists of a hollow plug with male and female threads to suit the different diameters. A bushing may be regarded as either a reducing or an enlarging fitting. As generally manufactured, bushings 2½ inches and smaller reducing one size are malleable iron; reducing two or more sizes are cast iron, all above 2½ inches are cast iron except brass bushings, which may be obtained in sizes from ¼ to 4 inches. Bushings are listed by the pipe size of the male thread, thus a "¼ bushing" joins a ¼ fitting to a ⅛ pipe. It is better however, in ordering, to avoid mistakes to specify both threads, calling for instance, the bushing just mentioned a ¼ × ⅛ bushing. The regular pattern bushing has a hexagon nut at the female end for screwing the bushing into the fitting.

REDUCTEUR FOR AMMETER.—A resistance coil connected in parallel with the coils of an ammeter to act as a shunt to reduce the current entering the ammeter.

REDUCTEUR FOR VOLT METER.—A resistance coil connected in series with the coils of a volt meter for the purpose of diminishing the currents in a fixed proportion, and thereby increasing the range of the volt meter.

REDUCTION.—1. The reaction which takes place at the cathode in an electrolytic cell when the current is passed.

2. Changing terms of a problem into other terms of equivalent value to make it easier to solve.

REDUCTION GEARING.—A gearing by which the driver is connected with the shaft of the driven gear (or pulley) so that there shall be a reduction in r.p.m. in amount depending upon the ratio between the driver and driven elements.

REED INDICATOR.—A frequency meter of the vibrating reed type.

REED INTERRUPTER.—A device for automatically making and breaking a circuit by a vibrating reed; a tuning fork interrupter.

REED LOUD SPEAKER.—One employing a vibrating reed which converts the signal current variations into vibrations of a radiating diaphragm.

REEL INSULATOR.—A reel shaped insulator employed with certain signal systems.

RE-ENTRANT ARMATURE WINDING.—An armature winding in which both ends re-enter or lead back to the starting point.

RE-EVAPORATION.—Vaporization of condensate; an erroneously called loss in steam engine operation which occurs near the point of pre-release. In the operation of a steam engine, the walls are alternately heated and cooled during each revolution, because of the variable temperatures of the steam in passing through the cylinder. Since these changes occur so rapidly, it is impossible for the metal of the cylinder to change its temperature in like manner. Accordingly, the metal is heated to some intermediate temperature, less than that of the incoming steam and greater than that of the outgoing steam. During expansion after cut off, the temperature of the steam falls and becomes less than that of the metal. This results in re-evaporation of part of the condensate formed while the steam was at a higher pressure than the metal.

While this re-evaporation effects a small gain by elevating the expansion line, it is more than offset by the heat taken from the metal, that is, the resultant effect is a loss and this is the reason re-evaporation is called a loss. The term **loss by re-evaporation** is used so frequently by writers that no doubt a wrong impression is conveyed to most readers. It should be distinctly understood that re-evaporation causes a gain by increasing the area of the indicator card; **it is the cost of obtaining this gain** (i.e., robbing the cylinder metal of heat) **that offsets this gain by a greater loss.**

REFINING, ELECTRIC.—The application of electro-metallurgy in the refining of metals, especially copper, by electrolysis.

REFLECTING GALVANOMETER. — The mirror galvanometer. An instrument for exact determinations, having a small magnetic needle fixed to a very light mirror and suspended inside a coil of wire by means of a silk or quartz fiber, the movements of the needle being indicated by reflection upon the mirror. In one method, the deflections are read by means of a small telescope through which the reflected divisions of a scale are seen on the mirror as it moves; in another, a beam of light is thrown on the mirror and reflected to a suitable scale where the movements of the needle are indicated and magnified.

REFLECTION.—1. The change of direction experienced by a ray of light or of other radiant energy, when it strikes a surface and is thrown back or reflected.

2. In radio, the turning back of radio waves from a surface.

REFLECTION ALTERNATOR.—A high frequency high power alternator whose output is four or more times that initially produced.

REFLECTOR.—A polished surface of reflecting material designed to reflect light with increased illuminating power.

REFLECTOR BRACKET.—A street lamp bracket provided with supports for two insulators and a reflector.

REFLEX ANGLE.—An angle greater than a straight angle.

REFLEX CIRCUIT.—One in which the amplifier tubes are made to function as both radio and audio-frequency amplifiers simultaneously. The reflex idea is one of many which aim to extract the maximum use of a tube or a group of tubes. Briefly, the incoming wave is passed through radio frequency amplification, is then rectified by the detector, and then passed again through the same tubes as used for the radio frequency amplification, but which now function as audio frequency amplifiers. The current is guided through this tortuous path by inductances and condensers which, if proper values be used, are supposed to keep the current to this path. Reflexing may be accomplished in a number of different ways. In some cases all the tubes are made to work twice. In other cases only a part of the tubes are used for dual amplification.

REFRACTION.—1. The change of direction which a ray of light undergoes upon entering obliquely a medium of different density from that through which it has been passing.

2. The change in direction of the flow of an electric current when it passes from one medium to another of different conductivity or of other differing electric qualities.

3. In radio, a change in direction of radio waves in traveling through a non-homogeneous medium.

REFRACTIVE INDEX.—When a ray of light passes obliquely from one medium into another of different density, the ratio between the sines of the incident and refracted angles is known as the refractive index or index of refraction of the second medium with respect to the first.

REFRACTORIES.—For lining electric furnaces there are three kinds of refractory materials employed: acid in which the chief constituent is silica; basic consisting of lime, magnesia, bauxite and dolomite; and neutral such as fire clay, chromite and carbon.

REGENERATED CELL.—1. A primary cell which has been depolarized after polarization.

2. A storage cell which has been recharged after exhaustion.

REGENERATION.—1. Restoring a primary cell to activity after it has become polarized.

2. In radio, increasing amplification in a vacuum tube by returning part of the out put to the grid to be re-amplified.

REGENERATIVE BRAKING.—In electric traction, running the motors as dynamos with load to offer braking resistance.

REGENERATIVE CONTROL.—A method of control of electric cranes having shunt motor drive for the hoisting motion. In this method, speed regulation over a fairly wide range is obtained by inserting resistance in the motor field circuit. By this means considerable variation of speed in lifting and lowering may be obtained without the necessity of having variable speed gear in the hoisting train, and when lowering, the shunt motor, if overhauled by a load, becomes a dynamo and feeds current back to the circuit, thus automatically controlling the speed of lowering. This system has been in use to a limited extent.

REGENERATIVE COUPLING. — A radio hook up for producing regeneration by coupling the tube plate circuit to the grid circuit.

REGENERATIVE RECEIVING SET.—A set in which an electron tube is so connected that part of the plate circuit power is fed back to the grid circuit (by a tickler or through the tube capacity), thus building up great amplification.

REGIONAL MAGNETIC DISTURBANCES.—Disturbances in the earth's magnetism confined to limited areas or special regions.

REGISTER, ELECTRIC.—Any mechanism for making a permanent record by the aid of electricity.

REGISTERING DECLINOMETER.—A declinometer which automatically records variations in the earth's magnetic declination.

REGISTERING ELECTROMETER. — An electrometer which automatically records the voltage it measures.

REGNAULT'S LAW.—Regnault determined by experiment, that the specific heat at constant pressure is constant for any gas.

REGULATING COMPOUND DYNAMOS.—A carefully compounded dynamo will, when run at the speed for which it was designed, regulate itself perfectly, and maintain a constant voltage across its terminals under any variation of load within its range. In practice, however, it is not always possible to work a dynamo under these exact conditions, and, moreover, in the case of large machines, the effect of temperature upon the resistance of the machine has an appreciable effect upon the voltage. Means for regulating the latter are desirable. The voltage may be varied to a certain extent by suitably adjusting the governor of the driving engine, increasing or decreasing the speed; but in many cases this is not very desirable or possible, and a much better method of obtaining the desired variation of voltage is to insert a variable resistance or hand regulator in the shunt circuit of the machine, the resistance of the shunt being suitably proportioned to give the requisite margin for regulation.

REGULATING OVER-COMPOUNDED DYNAMOS.—It is sometimes desirable, as in central light and power stations, to have a dynamo which will maintain a constant pressure at a point some distance from the machine. In this case the dynamo is over-compounded, or the series coils are wound with a greater number of turns, in order to raise the pressure at the terminals of the machine as the load increases, and thus compensate for the fall of pressure in the mains. As it is well to vary the degree of over-compounding, the series coils of such dynamos are usually so proportioned as to give from 10 per cent to 20 per cent of over-compounding, and a strip or ribbon of German silver or copper is arranged as a shunt to the series coils.

REGULATING RELAY.—A type used to control the condition of a main circuit through control devices operated by a secondary circuit. They are used as feeder circuit or generator regulators, and differ from protective relays in that they have differentially arranged contacts, that is, arranged for contact on either side of a central or normal position.

REGULATING SHUNT DYNAMOS.—In regulating a shunt dynamo, the resistances of the field magnet shunt windings and of the regulator coils are so proportioned, that when no load is on the dynamo, and all the coils of the regulator are in circuit with the shunt, the machine generates the normal pressure required at the lamps. As more and more lamps are switched on, the voltage at the lamps has a tendency to decrease, and therefore the pressure at the machine must be raised in proportion. This is effected by moving the lever of the regulator, so that fewer resistance coils are included in the shunt circuit; the resistance of the latter being thus decreased, the exciting current and voltage of the machine is increased correspondingly.

REGULATING SOCKET.—An incandescent lamp socket containing a resistance coil controlled by the key, for the purpose of regulating the brilliancy of the light.

REGULATING WIRES.—In pole line construction, adjusting the tension of wires, or regulating the proper sag between the poles.

REGULATION.—1. This term applies to the relative change of pressure (or current) with changing load. In the transformer, regulation is inherent, that is, it automatically tends to maintain constant voltage (or current).

2. The percentage increase in the secondary voltage as the load is decreased from its normal value to zero.

3. With reference to a machine or apparatus in regard to some characteristic quantity (such as terminal voltage, current or speed), the ratio of the deviation of that quantity from its normal value at rated load to the normal rated load value.

REGULATION OF A TRANSFORMER.—1. The drop in voltage from no-load to full-load. This is usually specified in percentage of full load voltage and varies with the power factor of the load. The regulation in distributing transformers varies from approximately 2%.

2. The difference between the no-load and the rated load values of the secondary, terminal voltage expressed in percent of the rated load secondary voltage, with the primary impressed terminal voltage adjusted to such a value that the transformer delivers rated kva. output at a specified power factor and at rated secondary voltage.—NEMA.

REGULATOR.—1. In storage battery practice employing a shunt wound booster, a device provided to automatically vary the magnitude and direction of the current in the shunt winding according to the load. This "regulator" consists essentially of a carbon resistance composed of piles of carbon discs in which the pressure may be varied, and a pressure producing coil and plunger.

2. Any automatic or hand device for regulating a dynamo or motor; especially an electro-magnetic device actuated by solenoids placed in the main circuit for automatic regulation.

REGULATOR ADJUSTMENT.—With field regulators on shunt and compound machines, sometimes too much resistance is cut in to permit the necessary strength of exciting current passing through the field windings. The field coils of series machines are sometimes provided with short circuiting switches or resistances arranged to shunt the current across the field coils. If too much of the current be shunted across, the switch should be opened, or if there be a regulator, it should be so adjusted that it will pass enough current through the field windings to excite the machine.

REGULINE.—In electro-metallurgy, a term applied to metallic deposits which have all the characteristics of the pure metal.

REHEATER.—A reheating receiver used on multi-stage expansion engines to vaporize the condensate and in some instances also to super-heat the exhaust from one stage before admission into the next stage. According to Marks, adequate reheating involves superheating the steam in the receivers from 30° to 100° F. With the latter amount, Marks has shown that the efficiency of the compound engine may be increased 6 to 8 per cent. Good reheating makes low pressure jackets unnecessary. As a rule, not nearly enough reheating surface is installed. With moderately superheated steam in both cylinders, the steam consumption is about constant for the range from ½ load to 1¼ load.

RE-IGNITION.—In radio arc transmission, the formation of a reverse arc.

REINARTZ CIRCUIT.—A radio regenerative circuit with capacity and inductive feed back introduced by John L. Reinartz.

REJUVENATION LUMINESCENCE. — Restoring luminescence to a substance which has exhausted its capacity for spontaneous glowing.

RELATIONS OF TEMPERATURE, VOLUME AND PRESSURE.—In conformity with the laws of permanent gases, the mutual relations of the temperature, volume, and pressure of a gas in the cylinder of an engine vary according to the conditions which obtain at heating.

1. If the temperature of the gas be kept constant, an increase of volume results in a decrease of pressure (Boyle's Law).

2. If the pressure of the gas be kept constant, an increase of temperature results in an increase of volume. (Gay-Lussac's Law.)

3. If the volume of the gas be kept constant, an increase of temperature results in an increase of pressure (Gay-Lussac's, Regnault's, and Joule's Laws).

RELATIVE INCLINOMETER.—An instrument which indicates the inclination of an air craft with reference to apparent gravity, that is, to the resultant of the acceleration of the air craft and that due to gravity.

RELATIVE INDUCTIVITY.—The specific inductive capacity of a substance. It is measured by the ratio of the capacity of a condenser which has its plates separated by that substance to the capacity of the same condenser when its plates are separated by dry air.

RELATIVITY.—Einstein's theory of the "fusing of time and space in one unitary concept."—Sellars.

RELAY.—1. A device having two separate circuits and so constructed that a weak current in one of the circuits controls a strong current in the other circuit. An electrical multiplier.

2. A device which opens or closes an auxiliary circuit under pre-determined electrical conditions in the main circuit. The object of a relay is generally to act as a sort of electrical multiplier, that is to say, it enables a comparatively weak current to bring into operation a much stronger current.

RELAY AMPLIFIER.—A name sometimes used for a telephone repeater.

RELAY BELL.—An electric bell which is rung by the action of a relay magnet which introduces a local battery into the circuit.

RELAY CLASSIFICATION. — There are many types of relays, and they may be classed:

1. With respect to the nature of the service performed, as: a, protective; b, regulative; c, communicative.
2. With respect to the operating current, as: a, alternating current; b, direct current.
3. With respect to the manner of performing their function, as: a, circuit opening; b, circuit closing.
4. With respect to the operating current circuit, as: a, primary; b, secondary.
5. With respect to the abnormal conditions which caused them to operate, as: a, overload; b, underload; c, over voltage; d, low voltage: e, reverse energy; f, reverse phase.
6. With respect to the time consumed in performing their function, as: a, instantaneous (so-called); b, definite time limit; c, inverse time limit.
7. With respect to the character of its action, as: a, selective; b, differential.
8. With respect to whether it act directly or indirectly on the circuit breaker, as: a, main; b, auxiliary.

RELAY CONTACT.—An electro-magnetic mechanism which completes a local circuit when a current is passed through it.

RELAY MAGNET.—The permanently magnetized steel armature of a polarized relay.

RELAY PROTECTIVE PRINCIPLES.—In the development of relays to meet the various requirements of protection for the circuits and apparatus, there are a number of protection principles upon which their design depends. These principles are: a, over current; b, inverse time; c, definite time; d, directional; e, differential; f, ground or residual; g, over current with under voltage; h, thermal.

RELAY SELECTION. — The information here given will be helpful in selecting relays to meet the requirements of modern power house and sub-station layouts.

1. **Single pole relays** are used on single phase and on balanced three phase circuits.
2. **Double pole relays** are used on ungrounded three phase and on quarter phase.
3. **Triple pole relays** are used on three phase grounded neutral and interconnected quarter phase.
4. **Circuit closing relays** are recommended in all cases where a constant source of direct current is available for operating trip coils.
5. **Reverse current relays** of instantaneous or time limit types are often connected to the secondaries of current and of pressure transformers to indicate by lamp or bell any trouble that may occur in the generator circuit.

RELIEF LAMP.—1. A series incandescent lamp provided with an automatic cut out which short circuits the lamp the moment it breaks.

2. A lamp reserved for immediate substitution for a broken lamp.

RELIEF VALVE.—A valve similar to a safety valve which opens at a predetermined pressure. Used to relieve steam cylinders from excess of condensate and to relieve condensers in case of flooding.

RELIEVO.—An electro or die with the design raised above the surface; a carving in relief, as distinguished from an intaglio.

RELUCTANCE.—Magnetic resistance, that is, the resistance offered to the magnetic flux by the substance magnetized, being the ratio of the magnetic pressure to the magnetic flux. It is measured in oersteds. The reluctance is directly proportional to the length of the circuit, and inversely proportional to its cross sectional area. In calculating reluctance use the equation reluctance$=$length in cm.$\div$permeability$\times$cross section in sq. cm.

RELUCTIVITY.—The resistance per unit of length and unit cross section that a substance offers to being magnetized; specific magnetic resistance.

REMAGNETIZER.—A powerful coil used to remagnetize the magnets of magnetos.

REMANENCE.—Residual magnetism.

REMANENT FLUX.—Residual magnetism, the magnetism which is retained by iron or steel after it has been magnetized and the magnetizing force has ceased to act upon it.

REMOTE CONTROL.—1. A method of operating high voltage machines at a distant point for safety. For instance switches may be operated mechanically through a system of links and bell cranks, or electrically and in some cases by compressed air. Remote control should be employed for pressures above 1,100 volts. Red and green lamps are used as indicating devices with electrically operated switches; red for closed and green for open. Motor operated switches are used for exceptionally heavy work where the kilowatt rupturing capacity is greater than that for which the other types are suitable.

2. In radio, an electric method of tuning a receiver from a distant point.

REMOTE CONTROL OIL SWITCHES.—A method of operation for high tension circuits, in which the parts which carry the high pressure current are located at some distance from the switchboard in order that they may be operated with safety. They are made for either hand or power operation. For hand operation, the mechanism between the operating lever and switch proper, consists simply of a system of links and bell cranks. Various shapes of bell crank are used, to permit change in direction or position of the force applied to operate the switch.

REMOTE CONTROL SWITCHBOARD.—One which has the main current carrying parts at some distance from the operating board, the control being effected by mechanical devices or by electric motors or solenoids.

REMOTE ELECTRICAL CONTROL SWITCHBOARD. — A type of switchboard for heavy duty requiring electrically operated apparatus, or where the distance between the board and switching devices makes the application of hand operated apparatus undesirable.

REMOTE MANUAL CONTROL SWITCHBOARD.—A type of switchboard upon which only the lighter pieces of apparatus are mounted. The main circuit breakers and their associated apparatus are supported upon suitable frame work at a reasonable distance from the panel board. The oil circuit breakers or other switching devices are operated by means of suitable operating rods and links attached to a handle or handles on the front of the panels.

REMOVING COILS.—In a.c. motor winding, in case it becomes necessary to remove a coil before the winding has been treated, and baked, proceed in the reverse order, step by step, from the original winding operation, considering the coil to be removed as the last one inserted, under the throw. Should a coil have to be removed from a winding that has been treated and baked, it will be necessary to heat the winding in order to soften the varnish. Saturating the part to be opened with paraffine helps to soften the varnish. The coils should be removed while the winding is hot. For raising the wires out of the slot use a piece of thin fibre sharpened to the general shape of a screw driver. Metal tools will injure the cotton covering on the wires, and will necessitate taping the wires, which usually overcrowds the slot.

RENEWABLE CARTRIDGE FUSE.—A type of cartridge fuse having a screw cap at each end and arranged so that the fusible element is easily renewed.

REPEATER.—1. In telegraphy, an arrangement of electrical instruments and apparatus for repeating a message coming over one line to go forward over another line by the aid of a separate battery. An automatic type repeats in either direction without requiring the turning of a switch. By means of repeaters, the reception and re-transmission of a message by the operator at an intermediate office on a long line is dispensed with.

REPEATING COIL.—In telephone work, a special form of induction coil designed to connect a grounded line with a metallic line.

REPEATING RELAY.—A relay employed in a telegraphic repeater to take a message from one wire and transmit it automatically to another wire.

REPEATING SOUNDER.—A telegraphic sounder which assists in repeating a message into another line.

REPEATING TELEGRAPHIC STATION.—In a long telegraph line, an intermediate station in which messages are received from one wire and re-transmitted automatically into another by means of telegraphic repeaters.

REPETEND.—A figure or set of figures continually repeated.

REPLENISHER.—A form of static influence machine designed to maintain constant the voltage of the needle of the quadrant electrometer.

REPRODUCER.—A name sometimes given to a radio loud speaker.

REPULSION, ELECTRIC.—The action of a force by which two similarly charged bodies tend to repel each other.

REPULSION ELECTROMETER.—An instrument which measures differences of electrostatic pressure by employing the principle of electric repulsion.

REPULSION INDUCTION MOTOR.—An a.c. motor operating by the combined principles of repulsion and induction. Sometimes called a squirrel cage repulsion motor. In this motor is obtained the desirable starting characteristics of the repulsion motor and the constant speed characteristics of the induction motor. It is obviously impossible to combine the two types of motor and obtain only the desirable characteristics of each. The field has the same type of winding as is used in the repulsion start induction motor. The armature has two separate and independent windings: a, squirrel cage winding; b, commutated winding. The repulsion induction motor is especially suitable for such applications as household refrigerators, water systems, garage air pumps, gasoline pumps, compressors and similar applications.

REPULSION, MAGNETIC.—The action of a force by which two magnetic poles of the same kind repel each other.

REPULSION MOTOR.—A single phase a.c. motor operating on the principle that a copper ring placed in an alternating magnetic field tends either to move out of the field, that is, it is repelled by the field (hence the name repulsion motor), or to return so as to set itself edgeways to the magnetic lines. There are several types of motors which operate entirely or partly on the repulsion principle and they may be classified as: a, straight repulsion; b, compensated repulsion; c, repulsion start induction; d, repulsion induction. For a very extended explanation of why this type of motor is called repulsion motor, see Audel's New Electric Library, Vol. V, Chapter 61.

REPULSION MOTOR PRINCIPLES.—1. The approach or recession of a copper ring from a magnet pole will induce currents alternating in direction.

2. The approach or recession of a copper ring from a magnet pole is respectively equivalent to an increase, or decrease in the number of lines of force which pass through the ring.

3. Lenz' Law. The approach or reces-

sion of a copper ring from a magnet pole induces a current in the ring in such direction as to set up a magnetic field which opposes the motion which produces it.

4. A copper ring is repelled from a magnet pole when the number of lines of force passing through the ring is increasing.

5. A copper ring is attracted to a magnet pole when the number of lines of force passing through the ring is decreasing.

6. When the plane of a pivoted copper ring is at right angles to the axis of an a.c. magnet there is no tendency for the ring to turn.

7. When a pivoted copper ring is placed in the field of an a.c. magnet, there are four positions in which no torque is produced.

8. When the plane of a pivoted copper ring at rest is oblique to the axis of an a.c. magnet, torque is produced by repulsion and attraction alternately, no useful torque; ring vibrates.

9. If a pivoted copper ring be brought up to synchronous speed in an a.c. field, rotation is produced by repulsion and attraction alternately.

10. When a pivoted copper ring is placed in the field of an a.c. magnet obliquely, it tends to set itself edgeways to the magnetic lines, while the flux is increasing (or decreasing).

11. The current induced in a non-inductive metal ring placed in an a.c field will be 90° later in phase than the primary flux.

12. Theoretically the maximum torque occurs if the primary flux and current in the ring differ in phase by 180°.

13. Practically maximum torque occurs when the primary flux and current in the ring differ in phase by about 135°.

These principles are illustrated with elementary diagrams in Audel's New Electric Library, Vol. IV, Chap. V.

REPULSION START INDUCTION MOTOR.—A type of a.c. commutator motor designed to start as a repulsion motor and run as an induction motor. It should be carefully distinguished from the repulsion induction motor. It has a single phase distributed field winding with the axis of the brushes displaced from the axis of the field winding. The armature has an insulated winding. The current induced in the armature or rotor is carried by the brushes and commutator resulting in high starting torque. When nearly synchronous speed is attained the commutator is short circuited so that the armature is then similar in its functions to a squirrel cage armature. The efficiency and maximum running torque are usually less than those of a cage wound induction motor built of the same parts. Since this motor has low starting current, the fractional horse power sizes may be operated from lighting circuits when used to drive frequently starting devices. Some applications of this motor are air compressors, water systems, gasoline pumps, household refrigerators, meat choppers, etc.

RES.—Abbreviation for resistance, or resistor.

RESERVE CELL SWITCH.—A switch connected with a storage battery for the purpose of maintaining a constant rate of discharge by introducing reserve cells.

RESERVOIR CONDENSER.—One connected across the output of a power unit filter.

RESIDUAL CHARGE.—In a condenser, a small charge which permeates or soaks into the dielectric during charge and which after discharge appears as a small secondary discharge or continuation of the main discharge.

RESIDUAL DISCHARGE.—A discharge from a condenser after the first or initial discharge has taken place. The residual discharge is due to the absorption current which penetrated the dielectric during charge.

RESIDUAL MAGNETISM.—The magnetism that remains in a piece of iron or steel when the magnetizing force is removed; as after the current stops flowing through the winding of an electro-magnet. Residual magnetism in iron is of great importance in the working of the self-exciting dynamo, and is, indeed, the essential principle of this class of machine.

RESIDUAL MAGNETISM INSUFFICIENT.—This occurs chiefly in a new dynamo. To remedy, excite with storage battery or other current source, being careful to connect for correct polarity. A few primary cells will suffice for a shunt or compound machine.

RESILIENCE.—The act or quality of elasticity as understood by physicists; the property of springing back or recoiling upon removal of a pressure, as with a spring. Without special qualifications the term is understood to mean the work given out by a spring, or piece, strained similarly to a spring, after being strained to the extreme limit within which it may be strained again and again, without rupture or receiving permanent set.

RESIN.—A class of vegetable products obtained from the sap of certain trees, especially the residue from distillation of pitch. Resin in its various forms is a dielectric, and is useful for insulating purposes, also spelled rosin.

2. Pine amber resin is the best flux for soldering for electrical work because

it does not cause corrosion. A corrosive flux, such as zinc chloride solution (killed spirits) should be strictly excluded from any electrical work.

RESINOUS ELECTRICITY.—The kind of electricity produced upon a resinous substance such as sealing wax, resin, shellac, rubber or amber when rubbed with wool or fur, as distinguished from vitreous electricity produced by rubbing glass with silk. Resinous electricity is also called negative electricity.

RESISTANCE.—1. The opposition offered by a substance or body to the passage through it of an electric current which converts electric energy into heat. Resistance is the reciprocal of conductance. —NEMA.

2. Silver is taken as the standard, with the percentage of 100, and the conductivity of all other metals is expressed in hundredths of the conductivity of silver. The practical unit of electrical resistance is the ohm.

3. In physics, the quality of not yielding to force or external pressure; that power of a body which acts in opposition to the impulse or pressure of another, or which resists the effect of another power; as, the resistance of the air to a body passing through it; the resistance of a target to a projectile.

RESISTANCE BOX.—A box containing sets of standard resistances consisting of spools of insulated wire having low conductivity and small temperature coefficient. The ends of the coils are joined to the section of the bar between the plugs. The insertion of a plug cuts out a coil. In using, care should be taken to put the plugs in which a slight twist so that there shall be no resistance introduced by poor contact.

RESISTANCE BRIDGE.—A name sometimes given the Christie or so called Wheatstone Bridge.

RESISTANCE COEFFICIENT OR FACTOR.—The specific resistance of a substance. It may be taken as the electric resistance of a piece of that substance 1 cm. in length and 1 sq. cm. cross section, at a temperature of 32° F. or 0° C.

RESISTANCE COIL.—A coil of wire of German silver or similar alloy, having a known electrical resistance, employed in a resistance box or rheostat.

RESISTANCE COLUMN.—A resistance obtained by introducing variable lengths of a column of mercury into a circuit.

RESISTANCE COUPLING.—In radio, a method of coupling in which a resistance is connected in common to two circuits.

RESISTANCE DROP.—The loss in voltage of a current due to resistance, as in flowing in a circuit, or across a resistor.

RESISTANCE FEED BACK.—In radio, a method of feed back through a resistance coupling.

RESISTANCE IN ARMATURE STARTING METHOD.—A method of starting an external resistance or slip ring motor. The squirrel cage armature winding is not short circuited by copper end rings, but connected in Y grouping and the three free ends connected to three slip rings, leads going from the brushes to three external resistances, arranged as a triplex rheostat having three arms rigidly connected so that the three resistances may be varied simultaneously and in equal amounts, in starting, the external resistances being progressively cut out as the motor comes to speed.

RESISTANCE IN FIELD STARTING METHOD.—For starting an induction motor, variable resistances are inserted in the circuits leading to the field magnets and mechanically arranged so that the resistances are varied simultaneously for each phase in equal amounts. These starting resistances are enclosed in a box similar to a d.c. motor rheostat. A better method is to use an auto-transformer or compensator.

RESISTANCE LOSS.—A loss usually called the I^2R loss.

RESISTANCE MEASURING METHODS.—The following are the methods by which resistances may be measured: a, direct deflection; b, substitution; c, fall of potential; d, differential galvanometer; e, drop; f, volt meter; g, Christie or so called Wheatstone bridge.

RESISTANCE OF LEAKAGE.—In telegraphy, a resistance in the circuit due to a leak in the line.

RESISTANCE OF VOLTAIC ARC.—A resistance which an electric arc offers to the current, causing a drop of voltage in the neighborhood of the crater.

RESISTANCE SLIDE.—The sliding contact of a rheostat which cuts in or out of circuit the several resistance coils.

RESISTANCE STANDARDS.—It is not convenient ordinarily to use the standard column of mercury in testing, and instead, secondary standards are made up and standardized with a great degree of precision. These secondary standards are made of wire. The material generally used being manganin or platinoid. Silver is taken as the standard, with the percentage of 100, and the conductivity of all other metals is expressed in hundredths of the conductivity of silver.

RESISTANCE TEMPERATURE COEFFICIENT.—In a metal, the ratio of increase in specific resistance, or resistivity, corresponding to an increase in temperature of one degree.

RESISTANCE TESTS.—There are various methods by which an unknown resistance may be measured, as by the:

1. Direct deflection method.
2. Method of substitution.
3. Fall of potential method.
4. Differential galvanometer method.
5. Drop method.
6. Volt meter method.
7. Christie or so called Wheatstone bridge method.

RESISTANCE THERMOMETER, ELECTRIC.—A thermometer which depends for its action upon the changes of electrical resistance in a metal under variations in temperature.

RESISTANCE WELDING.—A method in which the heat for welding is obtained by passing an electric current through the pieces to be welded.

RESISTANCE WIRE.—A wire composed of some special alloy, usually German silver, employed in making resistance coils. A frequent composition of German silver for this purpose is as follows: 50 parts by weight of copper, 30 parts zinc, and 20 parts nickel.

RESISTIVITY.—The resistance of a centimeter cube of a substance to a flow of electric current between opposite sides; specific resistance.

RESISTOR.—1. An aggregation of one or more units possessing the property of electrical resistance. Resistors are used in electric circuits for the purpose of operation, protection or control.—NEMA.
2. Any electrical resistance unit, usually non-adjustable.

RESISTOR MATERIAL.—For small motors resistors are ordinarily made of a special wire wound on porcelain or asbestos tubing or some form of suitable base and then covered with cement. For intermediate sizes, ribbon resistor material or very fine cast iron grids are used, and for the heavy sizes heavier cast iron grids are used almost exclusively. For very large motors these grids are parallel, to obtain the necessary current carrying capacity.

RESOLUTION OF A FORCE.—In physics, the process of discovering the magnitude and direction of two or more forces so that their resultant is identical with the force which is being resolved. It is the antithesis of composition of forces, for instead of finding the single force which is the resultant of several, it finds out the various components of a given resultant.

RESOLVENT.—Anything which has power to reduce something else to a state of solution.

RESONANCE.—A phenomenon observed in alternating current circuits when capacity and inductance are present together in such proportion that they neutralize each other, making the spurious resistance of the circuit zero. An abnormal rise of current or voltage occurs in a part of the circuit, much in excess of the values supplied by the generating source. An electrical circuit is said to be in resonance with an impressed pressure, when the natural period of the circuit is equal to the period of the impressed pressure.

RESONANCE FREQUENCY.—In a reactive circuit, that frequency which causes inductance and capacity to neutralize each other, thus giving the maximum current flow. When this condition obtains, the current is in phase with the voltage. The fundamental frequency.

RESONANCE OR VIBRATING REED SYNCHRONOUS INDICATOR.—A type of synchronous indicator operating on the same principle as the resonance type of frequency indicator.

RESONANCE TRANSFORMER.—In radio, any loose coupled tuning inductance having a primary and secondary each with a variable condenser in the circuit. Tuning the secondary circuit brings it in resonance with the primary, thus enabling signals to be heard with greatest volume.

RESONANT CAPACITY.—The capacity of an a.c. circuit which tends to produce electrical resonance.

RESONANT CIRCUIT. — An alternating current circuit in which the current is in phase with the voltage.

RESONANT CONTROL.—A method of control for street lighting which uses the existing power conductors as the control circuit. The control currents are transmitted over the lines just like power currents. The frequency of the control currents used is sufficiently higher than the power frequency to make it easy to separate the control currents from the power currents. Special relays employing tuned circuits are provided at points where control is desired. These relays are connected across the 110 volt mains which feed the individual street light or group of lights. The relays respond only to currents having the particular frequency for which they are tuned. Sufficient energy is fed through the power system to the control relays to operate them by the direct electromagnetic pull of the control currents themselves without the use of vacuum tubes, amplifiers or rectifiers of any kind. This avoids complication and delicacy in the control units and also avoids using parts requiring periodic replacement. Two control frequencies are used, one to turn the lights on and one to turn them off.

RESONANT INDUCTANCE.—The inductance of an alternating current circuit which tends to produce electrical resonance.

RESTORED CELL.—A recharged cell.

RESTORING COIL.—An electro-magnetic coil for operating a self-restoring telephone switchboard drop.

RESULTANT INDUCTION.—A magnetic induction which is the resultant of various forces tending to produce induction.

RESULTANT MAGNETIC FIELD.—A line, whose direction may be determined by the "parallelogram of forces," indicating the resultant of the magnetic forces in a magnetic field.

RESULTANT REACTANCE.—The sum of all the reactances existing in an electric circuit.

RESUSCITATION FROM SHOCK.—Revival from apparent death. In the case of electric shock, treatment by approved methods such as the Prone Pressure Method.

RETAINING WEDGES.—On slotted armatures, a method of preventing armature inductors being thrown out of the core slots by centrifugal force by means of strips or wedges inserted between the projecting tops of the teeth.

RETARD OF SPARK.—An adjustment of a gas engine ignition gear which causes the spark to occur later as the piston approaches the end of the compression stroke.

RETARDANCE.—In a telephone circuit, a quantity equal to the total capacity of the line multiplied by the total ohmic resistance.

RETARDATION.—1. The tendency of electro-magnetic inertia, or self-induction, to prevent an electric current beginning or ceasing instantaneously in a circuit.

2. In telegraphy, the delay in the transmission of signals over long lines, especially in submarine cables, due to the electrostatic capacity of the line.

3. In mechanics, a decrease of velocity or speed of movement on the part of anything, either from internal causes or from being hindered in its free progress.

RETARDATION COIL.—1. In a telephone circuit, an induction coil having an iron core to slow down the rise of currents at certain frequencies at closing of circuit.

2. In wire communication, a discriminating inductance coil which chokes the flow of alternating current while allowing the easy flow of direct current.

3. In differential duplex telegraphy, a coil employed to retard and diminish the condenser charge and discharge to conform more closely to the actual conditions in the main line.

RETARDER.—In a steam boiler, a spirally curved lath of metal placed in the fire tubes to check the speed of the gases, and cause them to part with more of their heat.

RETARDING DISC.—In a watt meter a copper or aluminum disc attached to the armature shaft to reduce the speed of the armature.

RETENTIVITY.—The power to hold residual magnetism, as shown by a magnetizable substance in its resistance to magnetization or demagnetization. Not all magnetic substances can become magnets permanently. Steel, lodestone and nickel permanently retain the greater part of the magnetism imparted to them. Steel is magnetized with more difficulty than iron but retains the magnetism better than the latter. The power of resisting magnetism is called coercive force.

RETORT CARBON.—An impure carbon deposited in coal gas retorts, formerly employed for the manufacture of arc lamp carbons.

RETROGRESSIVE WAVE WINDING.—An armature winding such that in tracing the winding through as many coils as there are pairs of poles, the first segment of the commutator is not encountered or passed over.

RETURN CALL ANNUNCIATOR.—An annunciator drop in an answering call box, which indicates that a call has properly reached the station.

RETURN CIRCUIT.—That portion of an electric circuit through which the current is assumed to return to its starting point.

RETURN CURRENT.—In telegraphy, the current flowing back to the sending station to be discharged to earth.

RETURN GROUND.—The ground return. The earth or ground used as a return in an electric circuit employing only one wire, the terminal being connected to water or gas pipes or to iron rods driven into the ground.

RETURN SHOCK.—1. A shock, due to electrostatic induction, which may be felt in the neighborhood of a charged conductor when suddenly discharged; the return charge.

2. On the same principle, a violent shock sometimes experienced at a considerable distance from the place where a discharge of lightning occurs, caused by inductive action of the cloud upon bodies within its range.

RETURN WIRE.—That conductor in an electric circuit through which the current returns to its starting point.

RE-TURNING A COMMUTATOR.—Dynamo and motor commutators should be returned with a sharp pointed tool driven with very fine feed. A broad nosed tool should not be used, as it is liable to burr over the segments. After turning, the commutator should be lightly filed with a dead smooth file and finally polished with coarse and fine sandpaper. Do not use emery paper for this operation.

REVERSAL OF RESIDUAL MAGNETISM.—If a dynamo become reversed by a reversal of its field magnetism due to lightning, short circuit or otherwise, the residual magnetism should be reversed by a current from another dynamo, or from a battery; but if this be not convenient, the connections between the machine and the line should be crossed so that the original positive terminal of the dynamo will be connected to the negative terminal of the line and vice versa.

REVERSALS.—In duplex and quadruplex telegraphy, changes in the polarity of the battery which produces changes in the direction of the current and in the magnetism of the relays.

REVERSE CURRENT CIRCUIT BREAKER.—A discriminating cut out which opens a circuit to prevent flow of current in a reverse direction. Used especially on automobile battery charging systems.

REVERSE CURRENT RELAY.—A discriminating cut out.

REVERSE ENERGY RELAY.—A type whose chief object is to protect the generator. When so used, the overload adjustment is set at the maximum value to give overload protection only at the maximum carrying capacity of the generator and a sensitive reverse protection to prevent a return of energy from the line.

REVERSE INDUCED CURRENT.—An instantaneous secondary current which opposes the primary current the moment a circuit is closed.

REVERSE LEVER.—In valve gears, a lever connected to a link motion, radial or other gear for reversing the direction of rotation of the engine.

REVERSE PHASE RELAY.—A type used chiefly to prevent damage in case of reversal of leads in reconnecting wiring to two or three phase motors.

REVERSE PRESSURE CELLS.—A type of cell used as a control for storage battery plants. A reverse pressure cell consists of unformed lead plates immersed in the ordinary electrolyte of dilute sulphuric acid. As they have no active material, they possess no capacity, but are capable of setting up an opposing pressure of about 2 volts each to the discharging current flowing through them, thereby cutting down the total voltage of the battery, so that the net voltage across the line depends on the number of reverse current cells in series in the battery circuit. As the voltage of the battery falls during discharge the reverse pressure cells are cut out, successively, thus keeping the external or line voltage constant.

REVERSED FIELD MAGNETISM.—This is sometimes caused by the nearness of other dynamos, but is generally due to reversed connections of the field coils. Under such conditions the field coils tend to produce a polarity opposed to the magnetization to which they owe their current, and therefore the machine will refuse to excite until the field connections are reversed, or a current is sent from another dynamo or a battery through the field coils in a direction to produce the correct polarity in the pole pieces.

REVERSED SERIES FIELD.—In a dynamo a "bucking" series winding, the object of which is to limit the maximum output of the machine.

REVERSER.—1. On electric cars, a control which reverses the direction of current in the motor fields or armatures by interchanging the connections. This reversal of current in the field or armatures with relation to the armature or field current reverses the direction of running.

2. In telegraphy, a key for sending signals by reversing the current. This is done by shifting the line and the ground wire simultaneously from one pole of a battery to the opposite pole; a term sometimes used for pole changer.

REVERSIBLE BOOSTER.—One capable of increasing or decreasing the line voltage of a circuit.

REVERSIBLE BRIDGE.—A form of Christie or so called Wheatstone bridge which permits of a reversal of the proportionate arms for purposes of testing the resistance of the coils.

REVERSIBLE HEAT.—1. The heat exhibited in the Peltier effect at the junction of dissimilar metals.

2. The so called Peltier effect, in which if an electric current flow across the junction of two metals, heat is either absorbed or given off according to the direction of the current flow.

REVERSIBLE MOTOR.—1. An electric motor so adjusted that its direction of rotation may be reversed, as in electric traction.

2. A motor designed to act as a dynamo when reversed.

REVERSING CYLINDER.—1. In an electric street car controller, a cylinder operated by a small reversing handle, and provided with contacts for reversing the connections of the field coils of the motors so that they will run in the opposite direction.

2. On large locomotives and large marine engines, a cylinder used as a power unit to reverse the valve gear, the object being to reduce the manual effort required.

REVERSING DYNAMOS.—The direction of rotation of ordinary series, shunt, or compound bipolar dynamos may be reversed by simply reversing the brushes without changing any of the connections, then changing the point of contact of the brush tips 180°. In multipolar dynamos, a similar change, amounting to 90° for a four pole machine, and 45° for an eight pole machine, will reverse their direction of rotation. It will be understood that under these conditions, the original direction of the current and the polarity of the field magnets will remain unchanged.

REVERSING GEAR.—In valve motion, various types of gears such as link motion, radial gears, etc., for reversing the rotation of a steam engine.

REVERSING METHODS.—Since railway cars are required to run either forward or backward, reverse control for the motor is necessary. A series motor is reversed by reversing the current in the field or armature—not both. Commutating pole motors require that the armature and commutating pole windings be connected so that the relative directions of current through them shall always be the same. It is further desirable that both the commutating and main field windings shall always be on the ground side of the armature on account of the reduced voltage strains on the field coil insulation. In order to secure these features, the commuting pole winding is permanently connected to the negative armature brush and the main field winding is reversed between the negative terminal of the commutating pole winding and the ground.

REVERSING POLYPHASE INDUCTION MOTORS.—For a two phase four wire machine, interchange the connections of the two leads on either phase. For a two phase three wire motor, interchange the two outside leads.

For a three phase machine, interchange the connections of any two leads.

REVERSING SPLIT PHASE MOTORS.—A single phase motor will operate equally well in either direction, and the direction in which it will start depends upon the direction in which the resultant magnetic field tends to rotate. To reverse, reverse either winding with respect to the other, but not both.

REVERSING SWITCH.—1. In telegraphy, a switch placed in the field magnet circuit of a dynamo for changing the direction of the current.

2. Any switch for reversing the direction of an electric current.

REVOLVING ARMATURE ALTERNATOR.—A type having its parts arranged in a manner similar to a dynamo, that is, the armature is mounted on a shaft so it can revolve while the field magnets are attached to a circular frame and arranged radially around the armature. It is used on machines of small size because the pressure generated is comparatively low and the current transmitted by the brushes small, no difficulty being experienced in collecting such a current.

REVOLVING FIELD ALTERNATOR. — A type in which the field magnets are connected radially to a shaft so that they can revolve, surrounded by the armature windings which are attached to the stationary frame of the machine. This type is desirable for medium and large size machines because of superior insulating methods and absence of collector rings.

R.f.—Symbol for radio frequency.

RHEOCHORD.—In electro-therapeutics, a form of rheostat used for regulating the strength of the current.

RHEOMETER.—An instrument for measuring the velocity of the blood current.

RHEOPHORE.—The cord conducting an electric current.

RHEOSTAT.—A variable resistance mounted on a base or placed in a box and so arranged that the amount of resistance may be varied by moving a lever: a, along the resistance, or b, across a series of contacts which connect with the resistance at various points along its length.

RHEOSTAT ARM.—In a Christie or so called Wheatstone bridge, the third arm of known resistance other than the two proportionate or ratio arms.

RHEOSTAT FOR SERIES MOTOR.—In this type a resistance is inserted in series with the armature, the no voltage release is connected in series with the motor and the line, therefore its strength varies with the changes of current in the armature and field coils. The disadvantage of this type of rheostat is that if the no voltage release magnet winding should burn out, the motor will refuse to start, unless a wire or jumper be bridged across the terminals of the magnet.

RHEOSTAT FOR SHUNT AND COMPOUND MOTORS.—This type of starter is similar to the series wound motor starting rheostat, except in the connections to the field circuit. The shunt field coils receive their current from the line through the no voltage release magnet.

RHEOSTAT PANEL.—A switchboard panel containing connections with rheostat circuits.

RHEOSTATS AND SPEED REGULATORS.—A rheostat is designed to start a motor; if it be used as a speed regulator by leaving the lever in an intermediate position, it will burn out. A speed regulator will carry the current in any position.

RHEOSTATIC CONTROL.—A method of elevator control by variable resistance. The typical d.c. elevator motor for speeds 200 to 400 f.p.m. is compound wound, the series field being frequently shorted out at full speed; starts with a resistance by-passed around the armature, this resistance being increased in value, then shorted out as the elevator comes up to speed and finally inserts resistance into the field to reach top speed. The motor in this case has a range of speed by field of about 700 to 850 r.p.m. Dynamic braking is applied to retard the elevator before the mechanical brake is applied.

RHEOSTATIC CONTROLLER.—In electric traction, a type of hand controller designed to control one or more motors by means of resistance only. They are not equipped for series parallel connection and therefore have a limited application. Also known as type "R" controller.

RHEOSTATIC CRANE BRAKE.—It consists of a controller provided with several positions on the lowering side, called brake points. In these positions the controller alters the connections of the motor to those of a series dynamo, so that it generates current when driven by the descending load, the energy being absorbed by the controller resistance. The speed of lowering is regulated by varying the resistance.

RHEOTOME.—An interrupter for making and breaking an electric current.

RHEOTOMETER.—A form of combination rheostat and Christie bridge.

RHIGOLENE.—An extremely volatile fluid obtained in the distillation of petroleum, sometimes used in the process of flashing incandescent lamp filaments.

RHODIUM.—A rare metal resembling palladium, found in platinum ores. It is silver gray and only fuses in the oxyhydrogen blowpipe, being also insoluble in acids when in the mass. It is sometimes used in an alloy for tipping pen points, but chiefly with platinum, in making the thermo couple of the Le Chatelier pyrometer.

RHUMBS.—The points of a mariner's compass, usually the four cardinal points N., S., E., W., and the four points intermediate between them NE., SE., SW., NW. The term is sometimes broadly used for all of the 32 points.

RHUMKORFF COIL.—A secondary coil with magnetic vibrator (for interrupting the current in the primary circuit), a condenser and a variable spark gap in the secondary circuit. This coil is a type generally used in the laboratory. The name Rhumkorff was formerly very widely applied to any induction coil.

RIB.—Airplane framework members transverse to the spars.

RIBBON COIL.—A coil having windings of insulated metal ribbons laid on flat, in place of wires.

RIBBON COPPER.—A copper conductor in the form of a ribbon or strip.

RIBBON CORE.—A laminated ring armature core built up of iron strips or ribbons; a tangentially laminated core.

RIBBON FILAMENT.—A type of incandescent lamp filament as distinguished from the commonly used wire filament (of incandescent lamps) a filament consisting of a flat ribbon of tungsten, either flat to present a smooth surface to certain optical devices, or crimped, saw tooth fashion, to obtain the benefit of multiple reflections between the surfaces of the crimped sections in raising the brightness of the filament for any given power consumption.

RIBBON VIBRATOR.—A make and break mechanism in which a strip of steel is caused to vibrate between the attractions of a spring and an electro-magnet.

RIDING CUT OFF.—A variable cut off valve gear having a main valve and a cut off valve. Both valves are placed in one steam chest, the back of the main valve being used as a seat for the cut off valve, that is, the cut off valve "rides" on the main valve, hence the name riding cut off. Cut off by a riding valve may be varied in three ways, as by: a, variable angular advance; b, variable lap; c, variable travel.

RIGHT HAND RULE.—A rule to determine the direction of magnetic field around a conductor carrying a current, viz.: **The thumb of the right hand is placed along the conductor, pointing in the direction in which the current is flowing, then, if the fingers be partly closed, the finger tips will point in the direction of the magnetic whirls.**

RIGHT HAND RULE FOR SOLENOID.—**If a solenoid be grasped in the right hand so that the fingers point in the direction in which the current is flowing in the wires, the thumb extended will point in the direction of the north pole.** This is an important rule and should be remembered.

RIGHT HANDED ARMATURE WINDING.—An armature winding in which the coils are laid on in a direction corresponding to the movement of the hands of a clock when the machine is viewed from the commutator end.

RIGHT HANDED ROTATION.—A clockwise rotation. The movement of a rotating body from left to right following the direction of the hands of a clock when one is looking at its face.

RIGHT LINE.—Straight line.

RIGHT TRIANGLES, PROPERTIES.—The square of the hypotenuse is equal to the sum of the squares of the other two sides. From which

$$\text{hypotenuse}^2 = \text{base}^2 + \text{altitude}^2$$

$$\text{base}^2 = \text{hypotenuse}^2 - \text{altitude}^2$$

$$\text{altitude}^2 = \text{hypotenuse}^2 - \text{base}^2$$

In working impedance problems, it is not the square of any of the quantities which the sides of the triangle are used to represent that is required, but the quantities themselves, that is, the sides. Hence extracting the square root in the equations:

$$\text{hypotenuse} = \sqrt{\text{base}^2 + \text{altitude}^2}$$

$$\text{base} = \sqrt{\text{hypotenuse}^2 - \text{altitude}^2}$$

$$\text{altitude} = \sqrt{\text{hypotenuse}^2 - \text{base}^2}$$

RIGID CONDUIT.—A wrought pipe raceway for wires but differing from ordinary wrought used for other purposes. It comes in lengths of 10 ft. or less, and must never be used in sizes smaller than one-half inch pipe or nominal size. It has threaded joints and is installed with pipe tools such as used in making joints on steam pipe. Galvanized conduit is recommended for use where the conduit is subject to rough usage and where the utmost in rust prevention is desired. It is especially recommended for use in street work, in concrete or masonry construction.

RIGID TOWERS.—Structures of this type commonly called transmission towers are the largest and heaviest structures made for transmission line supports, and as would be implied by the designation given them, they are intended to have strength to carry loads coming upon them, either in the direction of the line or at right angles to this direction. They are usually designed to take a combination of loads in both directions. These towers are built in triangular, rectangular, and square types, depending upon the particular conditions under which the structure is to be used.

RING ARMATURE.—An armature, like the Gramme armature, whose coils are wound upon a core in the form of an iron ring.

RING CLUTCH.—A ring shaped clutch for holding the carbon rod of an arc lamp, and feeding downward to maintain the arc.

RING CONNECTED ARMATURE.—In a polyphase system, a dynamo armature connected into the system by the ring connection.

RING CONNECTION.—In an interlinked polyphase system of alternating currents a method of connecting apparatus into the system by joining the circuits of the machine together in closed circuit, and connecting the points of connection of adjacent circuits to the lines of the system; in a three phase system this is known as the **delta (Δ) connection.**

RING CORE.—An armature core in the shape of a ring.

RING CURRENT.—In a three phase system, the current flowing between adjacent conductors.

RING MAIN.—In a system of electrical distribution, a main in the form of a ring.

RING OFF DROP.—In a telephone switchboard, a drop which falls when a subscriber "rings off" by hanging up his receiver.

RING OFF SIGNAL.—A signal given at the switchboard of a telephone station when a subscriber hangs up his receiver at the end of his conversation.

RING WINDING.—An early method of armature winding in which coils are wound around an iron ring. The coils are wound on separately, the wire being carried over the outside of the ring, then through the center opening and again around the outside, this operation being repeated until the winding for that individual section is completed. The adjacent coil is then wound in the same way, the ends of each being brought out to the commutator side of the armature. This winding is well suited to the generation of small currents at high voltage, as for series arc lighting, because the numerous coils can be very well insulated; but is objectionable because those inductors which lie on the inner side of the iron ring, being screened from practically all the lines of force, do not generate any current. Only about half of the winding is effective, the rest or "dead wire," adding its resistance to the circuit, thus decreasing the efficiency of the machine. Numerous attempts have been made to utilize this part of the winding by making the pole pieces extend around the ring in such a manner that lines of force will pass to the inside of the ring, also by arranging an additional pole piece on the inside of the armature, but mechanical considerations have shown these methods to be impractical. Because of this and other reasons it has been discontinued, drum winding is now the prevailing type.

RINGS, ELECTRIC.—Nobili's rings or metallochromes. A phenomenon which may be observed when a solution of lead is subjected to electrolysis. If the anode be a plate of polished metal placed horizontally in the liquid beneath a platinum wire as a cathode, a deposit occurs of symmetrical rings of varying thickness exhibiting the colors of the rainbow.

RINGING.—In cable jointing, a line scribed around the sheath to indicate the length of sheath to be removed.

RIPPLE CURRENT.—A pulsating current of which the constant component is large relative to the sum of the amplitudes of the harmonic components.

RIPPLE FILTER.—A low pass radio filter.

RIPPLE VOLTAGE.—A voltage which varies very slightly periodically.

RISERS.—1. In indoor wiring, conductors rising vertically from one floor to another; vertical mains.

2. In a water tube boiler, the up flow pipes.

3. In steam heating, the vertical pipes carrying the steam to the radiators.

RITCHIE PHOTOMETER.—A form of photometer in which the lights are fixed at the ends of a bar, and the illuminations of the screen are viewed at right angles to the line of the lights, the screen, instead of the lights, being moved to equalize the illuminations.

RIVETED RAIL BOND.—A rail bond formed of a length of wire or cable with copper terminals which are riveted into the rails, across the joint.

R. M. A.—Abbreviation for Radio Manufacturer's Association.

R.m.s.—Abbreviation for root mean square.

ROARING ARC.—A voltaic arc which gives off a roaring sound when the carbons are too near together; a noisy arc.

ROCKING SWITCH.—A switch which changes contacts by movement about an axis; a throw over switch.

ROD CLAMP.—A clamp for securing the upper carbon of an arc lamp in its carbon rod.

ROD CLUTCH.—A clutch for gripping the carbon rod of an arc lamp, and controlling its downward movement in feeding forward the positive carbon.

RODDING A CONDUIT.—The process of drawing a cable through a conduit by first pushing through a series of interlocking rods and then pulling out the rods, the cable being attached to the end of the rods.

ROEBLING GAUGE. — Washburn and Moen's wire gauge.

ROENTGEN RAYS.—A peculiar form of radiation usually known as X-rays, discovered by Prof. Roentgen in 1895. In experimenting with Crookes tubes he found that if the cathode rays from the negative terminal were focused upon a platinum reflector, a type of invisible radiation resulted, having remarkable properties. These rays have great penetrating power, passing freely through aluminum, zinc, wood, paper and flesh, but being stopped by platinum, lead, bone, etc. They affect photographic plates and excite phosphorescence in certain substances, strongly ionizing the air through which they pass. By means of these rays, in connection with a photographic plate, shadow-like pictures may be taken of the interior of opaque bodies. On this account, Roentgen rays are employed in medicine and surgery to locate foreign bodies and determine unusual conditions in the human body.

ROENTGEN TUBE.—An X-ray tube. A form of Crookes tube developed by Roentgen in 1895 in his experiments with cathode rays. It consists of an exhausted glass chamber fitted with electrodes so that the cathode rays from the negative terminal are focused upon a platinum reflector, from which a still more penetrating kind of radiation emanates, known as Roentgen or X-rays.

ROENTGENOGRAM.—A shadow picture made by Roentgen rays on a sensitized film. Also called **roentgraph.**

ROENTGENOTHERAPY.—The treatment of disease by means of Roentgen rays.

ROGET'S SPIRAL.—An experiment to show the attraction of parallel currents; a spiral of copper wire is hung from a binding screw so that its lower end just tips in a mercury cup. When a current is passed through the circuit thus formed, the coils of the spiral attract one another and contract, raising the tip from the mercury surface and breaking the circuit; the circuit being broken, the coils relax, the circuit is again completed through the mercury, and the performance repeated.

ROLL.—To turn about the longitudinal axis of an airpane.

ROMAN NOTATION.—In this method numbers are expressed by means of letters. It is so called because it was used by the ancient Romans. The ridiculous custom of using the Roman notation for chapter numbers, years of copyright, sections, etc., should be discontinued.

ROOF BRACKET OR STANDARD.—In overhead wiring, a form of bracket provided with insulators for carrying wires over a roof.

ROOF TRUSS.—A set of tension and compression pieces so arranged as to support the weight of the roof.

ROOFING POLES.—In transmission line construction, the roofing operation consists in forming a roof in the top of the pole, by making two 45° cuts on opposite sides of the end of the pole.

ROOT MEAN SQUARE.—The square root of the mean value of the square of a variable quantity. This function is particularly used in a.c. measurements, especially those of current and voltage. The mean value of these quantities being zero, the most readily measured function of them is the mean square value. Instruments for measuring the mean square usually have their scales marked to indicate the root mean square. When the value of an a.c. or voltage is mentioned without qualification, it is usually to be understood to mean the root mean square value. The root mean square (r.m.s.) value is generally called the virtual value.

ROPE LAY CABLE.—A single conductor cable composed of a central core surrounded by one or more layers of helically-laid groups of wires. This kind of cable differs from concentric lay cable in that the main strands are themselves stranded.

ROSETTE.—A small two-piece insulator in which connection is made between wiring and drop cords attached to the wiring. Rosettes are made of porcelain in two parts called the base and the cap. Although rosettes may be obtained either fused or unfused, the fused type is seldom used.

ROTARY CONDENSER.—An unusual name for a synchronous condenser, that is, a synchronous motor used as a condenser.

ROTARY CONVERTER.—The synchronous or rotary converter consists of a synchronous motor and a dynamo combined in one machine. It resembles a dynamo with an unusually large commutator and an auxiliary set of collector rings. On the collector ring side it operates as a synchronous motor, while on the commutator side as a dynamo. Also called **synchronous converter.**

ROTARY CONVERTER SUBSTATION.—In an electric traction system employing a.c., a substation to reduce high voltage a.c. to low voltage a.c., and then to convert it into d.c. at proper voltage to feed into the trolley line.

ROTARY DIAL SYSTEM.—An automatic telephone system, comprising: a, brushes of the selecting mechanisms moved in a circular arc by a rotating member; b, selecting mechanisms driven by power apparatus; c, dial pulses received and stored by controlling mechanisms which govern the subsequent operations necessary in establishing a telephone connection.

ROTARY DISCHARGER.—A toothed motor driven disc used in a radio transmitter.

In operation, sparks occur between the teeth.

ROTARY ELECTROTYPE.—In printing, a form of electrotype with an arched or convex surface for fitting into the cylindrical surface of a rotary press.

ROTARY FIELD.—An electro-magnetic field produced by a combination of alternating currents differing in phase, such that a suitably wound armature if placed in the field will rotate because of induced currents. The action of the induction motor depends upon the creation of a rotary field.

ROTARY FIELD INSTRUMENT.—A form of induction instrument arranged similar to those of watt meters, the necessary split phase being produced by dividing the current into two circuits, one inductive and the other non-inductive, or a definite proportion of that current.

ROTARY FIELD MOTOR.—A term sometimes applied to types of a.c. motor whose operation depends upon a rotating magnetic field.

ROTARY MAGNETISM.—The magnetism existing in a rotary magnetic field.

ROTARY OR ROTATING CURRENTS.—Alternating currents displaced in phase relative to each other, so as to produce a rotating magnetic field, as when two alternating currents are displaced in phase by 90 degrees or three currents by 120 degrees.

ROTARY PHASE CONVERTER.—A machine which changes alternating current of one or more phases into alternating current of a different number of phases, but of the same frequency. On the collector ring side, it operates as a synchronous motor, while on the commutator side as a dynamo.

ROTARY PUMP.—One which has a circular motion; a pump whose piston or pistons partake of the nature of cams, rotating upon an axis and being in contact at one or more points with the walls of the enclosing chamber. A rotary pump differs from a centrifugal in that the latter, by means of a fan or impeller, imparts velocity to a stream of fluid, while the rotary pump continuously scoops the fluid from out of its chamber.

ROTARY SPARK GAP.—In radio spark transmission, a device for timing condenser discharge consisting of a disc with teeth which rotate between two spark points.

ROTARY SWITCH.—A multi-circuit switch having one contact on a pivoted arm and the other contacts placed radially around the pivot so that the contact arm may be rotated to touch any of the other contacts.

ROTATING BRUSHES.—Metal discs sometimes caused to rotate about the commutator of a dynamo armature to draw off the current in place of the usual commutator brushes.

ROTATING FIELD SYNCHRONISM INDICATOR.—An instrument whose operation depends on the production of a rotating field by the currents of the metered circuits in angularly placed coils, one for each phase in the case of a polyphase indicator. In this field is provided a movable iron vane or armature, magnetized by a stationary coil whose current is in phase with the voltage of one phase of the circuit. As the iron vane is attracted or repelled by the rotating field, it takes up a position where the zero of the rotating field occurs at the same instant as the zero of its own field. In the single phase meter the positions of voltage and current coils are interchanged and the rotating field is produced by means of a split phase winding, connected to the voltage circuit.

ROTATING MAGNETIC FIELD.—The resultant magnetic field produced by a system of coils symmetrically placed and supplied with polyphase currents. A rotating magnetic field can, of course, be produced by spinning a horse shoe magnet around its longitudinal axis, but with polyphase currents, the rotation of the field can be produced without any movement of the mechanical parts of the electro magnets. It should be understood that the term "rotating field" does not signify that part of the apparatus which revolves, it refers to the magnetic lines of force set up by the field magnets without regard to whether the latter be the stationary or rotating member.

ROTATING RADIO BEACON.—In aviation, a beacon having a rotating directive antenna, giving characteristic signals when passing through north and through east, giving to the pilot a basis for finding a course in degrees from north.

ROTATOR.—In photometry, a device operated by an electric motor for rotating an incandescent lamp about a vertical axis in order to obtain the mean horizontal candle power, as the light given by the lamp varies in different planes.

ROTOMETER.—In submarine cable operations, an instrument attached to a cable laying drum or sheave to measure the length of the cable as it passes over the drum.

ROTOR.—In a dynamo, or other machine, the part which rotates. A term which should only be used when there is any doubt as to which part is armature and which commutator.

ROTOR AND PHASE ROTATION.—Alternators driven counter-clockwise (clockwise is standard) will alternate without change in connections, but the phases will follow the sequence of 3, 2, 1, instead of sequence, 1, 2, 3, etc. Synchronous motors, synchronous condensers, induction motors and synchronous converters may be operated with reversed rotation by so transposing connections that the phase sequence of the polyphase supply is applied to the terminals in reversed order, for example, 3, 2, 1.

ROTOR AND STATOR.—In some types of a.c. motor the function of the two parts is not well defined and where there is any chance of misunderstanding, the terms stator and rotor should be used. For instance, the rotor of a self-starting synchronous motor acts as an armature in starting (currents being induced in the squirrel cage bars), and as a field in running when the exciting current is turned on. Where there is no doubt as to function, the terms armature and field should be used.

ROTOR SLOTS.—Openings punched in the circumference of the rotor, or rotating part of an induction motor, for the reception of the windings. The number of slots in the rotor per pole per phase must be prime to that of the stator in order to avoid dead points at starting, and to insure smooth running.

ROTTEN STONE.—A name given to the residuum of naturally decomposed impure limestone, and also sometimes applied to a sort of infusorial earth known as "tripoli." It is sometimes employed in packings and in insulation compounds.

ROUND CONDUCTOR.—Either a solid or stranded conductor of which the cross section is substantially circular.

ROUND WIRE GAUGE.—A form of wire gauge, such as the American and Birmingham wire gauges, consisting of a circular metal disc with graduated notches cut around the circumference.

ROUNDING.—In cable jointing shaping the conductor strands to the form of a circle. The operation is easily done by means of a special claw plier tool, although ordinary gas pliers are generally used. The belt of insulation left over the conductor protects the strands from the teeth of the pliers. After shaping, this insulation is removed, exposing the conductor.

R.p.m.—Abbreviation for revolutions per minute.

R.p.s.—Abbreviation for revolutions per second.

R. Q.—A signal used in submarine telegraphy to ask for the repetition of any doubtful portion of a message.

RUBBER.—As applied to insulation, rubber is used in many ways. In the form of a thin plastic mass it may be laid over a wire and then vulcanized. It may be used as tape for direct insulation or for making joints. As vulcanite or ebonite it may be used as plates, tubes, rods, switch handles, etc.

RUBBER COVERED WIRE.—A conductor for interior wiring consisting of a tinned copper wire with a rubber covering, protected by an outside braiding of cotton saturated with a preservative compound.

RUBBER INSULATOR.—A form of line wire insulator made of india rubber, and containing an iron hook, often used on the under side of cross arms, especially on roof fixtures.

RUBBER OF ELECTRIC MACHINE.—In a frictional machine, a cushion of leather which presses against the rotating disc or cylinder.

RUBBER SOLUTION.—India rubber or caoutchouc dissolved in benzine or bisulphide of carbon, forming a cement for securing insulating tape, etc., on electrical apparatus.

RUBBER SUBSTITUTE.—Any manufactured compound designed to take the place of india rubber by providing similar properties at less cost of production. They are sometimes used to mix with pure rubber for reducing the cost without injurying the efficiency.

RUBBER TAPE.—A specially prepared insulating, adhesive tape impregnated or coated with india rubber.

RUBBING CONTACT KEY.—A key which makes an electrical contact by rubbing between contact parts.

RUDDER.—In airplane operation, a hinged surface giving lateral control, the same as a ship's rudder.

RUHMKORFF'S COIL.—A form of induction coil perfected by Ruhmkorff: it consists of two insulated coils: one, the primary, having few turns of comparatively coarse wire, and the other, the secondary, with many turns of fine wire, wound upon a hollow cylinder enclosing a core of soft iron wires; the primary is joined to a battery, and includes an interrupter and commutator.

RUHMKORFF'S COMMUTATOR.—A current reverser designed to reverse the direction of the battery current sent through the primary of a Ruhmkorff's coil.

RULES FOR DIRECTION OF INDUCED CURRENT.—There are a number of rules to quickly determine the direction of an induced current when the direction of the lines of force, and motion of the inductor are known. They are: a, Fleming's rule; b, right hand rules; c, Ampere's rule; d, palm rule; e, Lenz' law.

RUMBLE.—A rotating cask or box in which small articles are polished, preparatory to electro-plating, by the friction against one another as the rumble turns.

RUMFORD'S PHOTOMETER.—The shadow photometer devised by Rumford. It consists of a ground glass screen in front of which is fixed an opaque rod, shadows of which are thrown on the screen by the two lights to be compared. When the lights are adjusted so that the intensities of their shadows are the same, the intensities of the lights are proportional to the square of their distances from the screen.

RUN DOWN CELL.—A cell that has become inactive through polarization or exhaustion.

RUNNING BOARD.—In pole line construction, a device sometimes employed for heavy work; it consists of a board to which the wires are fastened and which is drawn by horses away from the reels from pole to pole, the wires being passed over the cross arms and fastened to the insulators by linemen stationed upon each pole.

RUNNING FIT.—That fit in practical mechanics where one part will run in another when lubricated, the amount of difference between the male and the female part depending upon the class of the work. Thus, for a 2-inch shaft, the hole would be bored from .0015 to .0035 inch larger, the latter size giving a very easy fit.

RUNNING OVER.—In steam engineering, an engine is said to run over when the valve is so set that the top of the fly wheel turns in a direction away from the cylinder.

RUNNING UNDER.—In steam engineering, an engine is said to run under when the valve is so set that the bottom of the fly wheel rim turns in a direction away from the cylinder.

RUSSIA IRON.—A special kind of sheet iron manufactured in Russia and used for lagging engines, boilers, etc. It is made by a secret process, which produces an iron that has a very hard and highly polished surface, thus rendering it easy to keep clean. A similar material is produced elsewhere under the name of planished iron.

RUST JOINT.—A joint employed by engineers where it is necessary to withstand high water pressure, the joint being filled with a paste which oxidizes the iron, the whole rusting together and hardening into a solid mass. A good recipe is 80 lbs. cast iron borings or filings, 1 lb. sal ammoniac, 2 lbs. flowers of sulphur, mixed to a paste with water.

RUTHERFORD ATOM.—One as conceived by Rutherford, consisting of a central dense nucleus containing a positive charge surrounded at distances relatively great compared with its diameter by planetary electrons. The positive charge on the nucleus of an atom determining the atomic number of the element to which the atom belongs.

S

S.—Symbol for: 1. South pole of magnet.
2. Length of stroke of engine piston (usually in inches).
3. Second.

SADDLE BRACKET.—A bracket erected upon the top of a telegraph pole for supporting the insulator for the saddle wire.

SADDLE WIRE.—A line wire carried by a saddle bracket upon the top of a telegraph pole.

S.A.E.—Abbreviation for Society of Automotive Engineers.

S.A.E. STANDARD SCREW THREADS.—The standard automobile threads. These threads should only be used on high tensile strength steel as intended. The thread is too fine for softer material as for instance tire lug bolts which have often been stripped by greenhorns using their last ounce of strength in screwing up the nuts.

SAFE CARRYING CAPACITY OF WIRES.—The maximum current strength that a conductor can safely carry without dangerous heating.

SAFE WORKING BOILER PRESSURE.—The highest pressure considered safe to carry on a steam boiler consistent with the factor of safety employed in its design, and with respect to old boilers, its condition, as determined by the inspectors.

SAFETY ENCLOSED SWITCHBOARD.—A dead front switchboard with an enclosure on the back and sides. The front may be either detachable or fixed.—NEMA.

SAFETY FACTOR.—Properly called factor of safety.

SAFETY GAP.—A device employed on gap arresters, permitting a discharge to ground in case of an abnormal voltage or surge during a thunder storm.

SAFETY LAMP.—An incandescent lamp specially designed for use in mines and similar places where there is danger of firedamp or other explosive conditions.

SAFETY SPARK GAP.—In high tension (jump spark) ignition an auxiliary gap shunted across the secondary winding to limit the voltage. It may be compared to the safety valve on a steam boiler. The safety gap is slightly longer than the spark plug gap. As long as the wires to the spark plug are connected, the safety gap is inactive, but if the spark plug wire should come loose, then the safety gap becomes active by a spark jumping across its gap instead of trying to jump from the end of the loose wire to the engine.

SAFETY VALVE.—A circular valve seated on the top of a steam boiler, and weighted to such an extent, that when the pressure of the steam exceeds a certain point, the valve is lifted from its seating and allows the steam to escape. The load on a safety valve necessary to balance a given pressure may be obtained: a, directly with a spring; or b, by a lever held down by either a weight or a spring.

SAFETY VALVE AREA.—To meet the marine requirements the area should be determined from the following formula:

$$a = .2074\ (W \div P)$$

Where a=area of safety valve in sq. ins. of grate surface.
W=lbs. of water evaporated per sq. ft. of grate surface per hr.
P=absolute pressure per sq. in.=working gauge pressure+15.

When this calculation results in an odd size of safety valve, use next larger standard size.

SAFETY VALVE PROBLEM.—The simple equation from which any lever safety valve problem can be solved is

$$Sv = Vv + Gg + Bb$$

in which
S=total pressure due to the steam tending to raise the valve;
V=weight of valve and spindle;
G=weight of lever;
B=weight of ball.
The distances at which these forces act are:
v=distance from fulcrum to center of the valve;
g=distance from fulcrum to center of gravity of the lever;
b=distance from fulcrum to the ball.
The weights are measured in pounds, and the distances in inches.
The weight of the lever is considered as acting at its center of gravity g, distance from the fulcrum.
With the general equation here given any safety valve problem can be solved by substituting the given values and solving the equation for the unknown letter. The practice of some of the officials connected with the U. S. Department of Commerce, steamboat inspection service, of requiring applicants for engineer's license to memorize the so called Roper's rules is ridiculous and should not be tolerated. Equations should be derived by the process of reasoning not by learning rules parrot fashion.

SAG OF BELT.—In the location of shafts that are to be connected with each other by belts, as between an engine and a dynamo, care should be taken to secure a proper distance, one from the other. This distance should be such as to allow of a gentle sag to the belt when in motion. A general rule may be stated thus: Where narrow belts are to be run over small pulleys, 15 feet is a good average, the belt having a sag of 1½ to 2 inches. For larger belts working on large pulleys, the distance should be 25 to 30 feet, the belts working well with a sag of 4 to 5 inches.

SAGNAC RAYS.—Secondary rays.

SAINT ELMO'S FIRE.—A name given by sailors to a form of glow electric discharge sometimes appearing under certain weather conditions at sea as a pale blue flame at the tops of the masts or the tips of the spars.

SAL AMMONIAC.—Ammonium chloride. A substance chiefly obtained by distillation of the ammoniacal liquor of gas works, neutralization with hydrochloric acid, and concentration of the liquid by evaporation until crystals are formed. The chloride is very soluble in water, and is used to a great extent as the electrolyte in open circuit primary cells. In electro-plating it serves as a conducting salt for many baths

SALIENT POLES.—The poles of a dynamo or motor field magnet occurring at the ends of the pole pieces, as distinguished from consequent poles.

SALT.—In chemistry, the neutral compound formed by the union of an acid and a base; thus, sulphuric acid and iron form the salt of sulphate of iron or green vitriol.

SALTED CARBON.—An arc lamp carbon impregnated with metallic salts such as calcium or magnesium, for use in the flaming arc lamp.

SAND BARREL SETTING.—In pole line construction in loose or sandy soil, a barrel filled with earth used as a base into which the butt of the pole is set.

SAND BENDING.—The process of bending lead or other pipes after having first filled them with sand and plugged the ends.

SAND BOX.—In electric traction, a box of sand carried by a car for the purpose of sprinkling it along the track in order to prevent slipping of the wheels.

SANDY DEPOSIT.—In electro-plating, a deposit of a granular character which results when the electric current is too strong.

SASH LINES.—In pole line construction ropes employed to raise telegraph poles of such size and weight as to require the use of a derrick.

SATURATED FLUX.—Lines of magnetic force sufficient to produce in a magnet a state of saturation.

SATURATED SOLUTION.—A liquid which holds in solution all that it can dissolve of a substance at a given temperature.

SATURATION.—The degree of magnetic force which can be permanently imparted to the core of a magnet; magnetic saturation.

SATURATION OF COIL.—In ignition, the electrical state of a coil when the current in a primary coil, or in the primary winding of a secondary coil reaches full strength due to the impressed voltage so that at "break" the coil will produce the maximum arc or spark respectively. When the coil has reached this state it is said to be built up.

SAVING DUE TO CONDENSING.—"It is held in the popular mind that the economy of condensing is, in round numbers, 25%. This percentage usually relates to simple engines and it refers to the economy as measured by the difference in the coal consumption produced by a condenser." The evidence of some of Barrus' test shows that "this belief is not well founded except in special cases." "If the feed water be heated by the exhaust steam of the non-condensing engine to a temperature of 100°, which is that of the ordinary hot well, to a temperature of 210°, the non-condensing engine can be credited with about 11% less coal consumption, which should be considered in determining condenser economy." The average of a number of Barrus' tests gives a saving produced by condensing of 22.3%. "If we allow for the steam or power used by an economical condenser, it would be seen that the net economy of condensing is at best, not much over 20%, based on steam consumption. If furthermore, we allow for the difference produced by heating the feed water to the extent above mentioned the saving of fuel would be reduced to about 10%."—Barrus.

SAW, ELECTRIC.—1. A platinum wire heated to incandescence by the electric current for the purpose of cutting certain substances.

2. A circular, or other saw run by electric power.

S. C.—Abbreviation for secondary current.

SCALAR.—In physics, a quantity which has magnitude, or magnitude and sign only, without direction, such as density, mass, energy, etc., as distinguished from a vector quantity.

SCAN FREQUENCY.—In television the oscillations per second of the scanning beam.

SCANNING.—In television, running over the elements of the image in sequence, instead of endeavoring to transmit all of the elementary signals simultaneously. There are two methods of scanning, known as: a, beam; b, direct.

SCANNING DISC.—In television, a disc pierced with a series of small holes or apertures arranged in the form of a spiral; and, as the disc rotates, the apertures trace across the image one after the other in a series of parallel lines. The frame limits the size of the image and prevents more than one aperture being in the image at one time Light, passing through an aperture a-it travels across the image, falls in the light sensitive cell and generates a picture current proportional to the brightness of the image from point to point along steps taken one after the other across the image.

SCANNING DRUM.—In television, the equivalent of a scanning disc, but having the shape of a hollow cylinder.

SCAVENGING.—In internal combustion engines, the expulsion of burnt gases from the cylinder after explosion, the operation being sometimes assisted by a jet of fresh air. A scavenging effect is produced in four cycle engines, by means of a long exhaust pipe, the momentum of the gases producing a partial vacuum in the cylinder. If the exhaust and admission valves be placed diametrically opposite each other, on the sides of the clearing space, the same effect may be produced, the process being aided by holding open the mechanically operated exhaust valve until the piston has begun its charging stroke.

S.C.C.—Abbreviation for single cotton covered.

S.C.E.—Abbreviation for single cotton over enamel.

SCHISIOPHONE.—An automatic hammer combined with an induction balance for detecting flaws and structural imperfections in iron rails and other metallic products.

SCHOLIUM.—In geometry a remark pertaining to one or more preceding propositions.

SCHUMANN RAYS.—Rays of various wave lengths between 1,850 and 1,230 A.u.

SCIAGRAPH.—A name sometimes given to a radiograph, a photograph obtained by the use of the X-ray.

SCIAGRAPHY.—A term sometimes used for radiography, the science of the use of X-rays.

SCINTILLATING JAR.—A Leyden jar which, instead of having a complete coating of tin foil, has bits of foil distributed upon it so as to leave short spaces between each piece, so that, when discharged, sparks appear at the intervals; a luminous jar.

SCISSEL.—The clippings of metals made in various mechanical operations, as in machine shops, or by sheet metal workers, etc.

SCISSORS BRUSH HOLDER.—A commutator brush holder used for slip rings, and consisting of two arms pivoted together like a pair of scissors. The lower ends of the arms carry the brushes suitably mounted, and the upper ends are drawn together by a spring, which thus exerts pressure on the brushes.

SCOBS.—The dross of metals; raspings of ivory, metals or other hard substances.

SCOOP.—1. A fireman's shovel.

2. A small shovel shaped wooden device with a short handle for bailing a bateau, dory or other small boat.

SCOURING PASTE RECIPE.—The following composition is recommended for scouring woodwork or utensils, taking the place of soap or sand: 1 lb. of soft soap, 1 lb. silver sand, 1 lb. powdered whiting, 1 tablespoonful common salt; all put into a vessel containing 1 quart of boiling water; the whole to be boiled and well stirred for 15 minutes.

SCRATCH BRUSH.—A brush composed of a bundle of stiff wires six or eight inches in length, bound together for the purpose of cleaning metallic objects preparatory to electro-plating.

SCRATCH FILTER. — A discriminating phonograph pick up filter designed to reject high frequencies which cause the phonograph needle to scratch.

SCREEN.—In radio, a metal barrier placed around electrical members of a set to shield each part from external electrical fields. The screen prevents the fields generated by any part interfering with the proper functioning of any other part.

SCREEN GRID.—In a radio vacuum tube, a wire mesh screen interposed between the control grid and the plate, extending over the outside of the plate. It is maintained at a suitable voltage to reduce the electrostatic capacity between the plate and the control grid.

SCREEN GRID PENTODE TUBE.—A five element radio vacuum tube comprising: 1, filament; 2, plate; 3, control grid; 4, screen grid; 5, space charge grid.

SCREEN GRID TUBE.—A radio vacuum tube having the usual elements; filament (or filament and heater) plate, control grid and also a screen grid. The object of the screen grid is to act as a shield around the plate.

SCREEN, MAGNETIC.—When any substance is interposed between a magnetic needle and a magnetizing force the magnetism will act across the intervening substance just as if it did not exist, with the single exception that if the screen consists of iron or steel no outside magnetic force will penetrate it.

This is because the iron being itself magnetic the lines of force seem to be absorbed by it without passing through it.

SCREW CLEAT.—In indoor wiring, a cleat carrying the necessary screws for quickly attaching it to the walls.

SCREW PITCH GAUGE.—A small instrument furnished with a number of thread gauges, usually ranging from 28 to 6 per inch, for ascertaining the pitch or number of threads per inch of any given screw. The various gauges are mounted, like blades on a pocket knife.

SCREW PROPELLER.—A marine propeller.

SCREW THREADS.—A helical groove of sufficient turns cut at the end of a bolt or through the hole in a nut for the purpose of fastening the two pieces together, called a male and female threads respectively; also outside and inside thread respectively. A plus thread projects beyond the diameter of the bolt as on a tap; a minus thread does not project beyond the diameter of the bolt. There are numerous kinds of threads to meet varied requirements. The threads on bolts are straight threads as distinguished from tapered threads used in pipe fitting. Pratt & Whitney's recommend the use of the U. S. standard thread for bolts and nuts and for all screw threads where possible, using the U. S. form, with a greater number of threads per inch if desired, for special work, as in the case of the S.A.E. standard, thus entirely superseding the use of the sharp V and over size makeshifts. The U. S. standard thread is peculiarly adapted for interchangeable work, which is impossible with the sharp V and impracticable with any other known. A joker to be remembered with respect to U. S. and V threads is the difference in number of threads on two sizes:

Size	½	2⅜
U. S. thread	13	4
V thread	12	4½

SEAL.—1. A piece of lead combined with wires used to seal up a meter in order to prevent tampering.

2. In steam engine valve design, the distance the face of the valve over laps the ports in extreme positions, and along the sides. The amount of seal should be sufficient to secure a steam tight joint and to obtain sufficient bearing area to prevent too great pressure per sq. in. on the valve seat.

SEALING GAP.—The distance between the armature and the center of the core of a magnetic contactor when the contacts first touch each other.—NEMA.

SEALING INCANDESCENT LAMPS.—After the air has been sufficiently exhausted, the small tube connecting the bulb to the exhaust tube is fused, drawn out to a thread, and the lamp sealed off. The vacuum is usually tested by means of an induction coil, by fusing two platinum wires into the glass tube leading to the lamp, and connecting these wires to the secondary terminals of the coil. The distance between the ends of the wires inside the tube is so adjusted that when the required degree of vacuum is attained, a spark passes through the air outside the tube in preference to traversing the vacuous space between the platinum points.

SEALING VOLTAGE (OR CURRENT).—The voltage (or current) necessary to seat the armature of a magnetic contactor from the position at which the contacts first touch each other, under conditions of normal operating temperature.—NEMA.

SEALING WAX.—A mixture, as of shellac and turpentine with a pigment, as vermillion or lampblack, that is fluid when heated, but quickly solidifies on cooling; used for making seals.

SEALING WAX ROD.—In rudimentary experiments for illustrating static electricity, a rod of sealing wax is rubbed with wool or flannel and held near suspended pith balls or loose bits of paper to show electrical attraction. Electricity so produced is called resinous, or negative electricity.

SEARCH LIGHT.—A powerful electric lantern containing a focusing arc lamp between a system of reflectors and a lens, for projecting the light to a great distance. In the various forms of arc lamp designed for search lights, the carbons may be either inclined or horizontal, but the arc is always directed toward the reflector and away from the object illuminated. By this arrangement all the projected rays of light are made parallel with each other, and the intensity of the beam of light maintained the same theoretically at any distance from the lamp. It is evident that if the crater of the positive carbon were turned toward the object illuminated all of its rays that did not strike the reflector would be divergent instead of parallel, and would not reach the object to be illuminated. In other words the beam of light composed of parallel rays represents the full illuminating power of the lamp, has greater penetrating qualities, and is the most suitable for picking out objects on land or sea. Again there are many cases such as making landings, picking up tows of barges, etc., where it is very desirable to have the light cover a greater area. This result is obtained by the use of dispersion lenses which disperse or spread out the light radially.

SEAT.—1. A valve seat. The piece whereon a valve rests when closed, and from which it rises on opening, as, in a safety valve or globe valve.

2. In a steam engine, the flat finished piece having steam and exhaust ports and over which the valve travels (to and fro) to secure the proper distribution of the steam.

SECOHM.—A term proposed for the practical unit of self-induction, now called the henry.

SECOND.—1. The unit of time in the c.g.s. system of measurement; it is equal to 1÷86,400 of the mean solar day.

2. A unit of circular measure. One degree=3,600 seconds.

SECOND DETECTOR.—In a radio superheterodyne receiver, a detector which having intermediate frequency voltages impressed upon its grid circuit, produces audio frequency currents.

SECONDARY.—1. A term commonly used for a secondary coil.

2. In an induction motor, that part in which currents are induced by the field coils, the armature.

SECONDARY AMPERE TURNS.—The number of ampere turns in the secondary coil of a transformer or induction coil.

SECONDARY BATTERY. — The proper name for the so called storage battery.

SECONDARY CELL.—The proper name for the so-called storage cell. According to Houston "A storage battery cannot any more properly be said to store electricity than a music box can be said to store sound when mechanical power is applied to wind its driving spring. What the storage battery actually stores is the energy of the charging current."

SECONDARY CLOCK.—In a system of electric time keeping, a subordinate clock whose movement is controlled by the primary, or master clock.

SECONDARY COIL.—A type of induction coil consisting of a long iron wire core upon which is wound primary and secondary windings. It works on the principle of mutual induction. Its main object is to considerably step up the voltage. Used largely in electro-therapeutics and on high tension ignition circuits. In this latter service, the voltage in the secondary winding becomes so high at "break" that current jumps across the air gap of the plug, resulting in a spark which ignites the charge. Distinguish between secondary coil and transformer.

SECONDARY CURRENT.—The current induced in the secondary of a transformer or induction coil.

SECONDARY ELECTRONS.—In a vacuum tube, electrons liberated or knocked off the plate or grid, by the bombardment of the electrons from the hot filament.

SECONDARY EMISSION.—In a vacuum tube, electron flow due to bombardment, that is the liberation or knocking off of electrons from a cold element by rapidly moving primary emitted electrons.

SECONDARY INDUCTION COIL.—A coil having two windings with no circuit connection between them. The operation of a secondary coil is due to mutual induction, in which the magnetic field producing an electric pressure in a circuit is due to the current in a neighboring circuit. The two circuits or coils are known as primary and secondary. The one property of a secondary coil that makes it of great value for most purposes is that the voltage of the induced current may be increased or diminished to any extent depending on the relation between the number of turns in the primary and secondary windings. This relation may be expressed by the following rule: The voltage of the secondary current is (approximately) to the voltage of the primary current as the number of turns of the secondary winding is to the number of turns of the primary winding.

SECONDARY MAIN.—In electric lighting, the main coming from the secondary coil of a transformer or converter, which conveys current to the lamps.

SECONDARY NETWORK.—An interconnected low voltage system in which common mains, fed by a number of distribution transformers located at separate points are used to supply energy to numerous customers.

A secondary network may be single phase, two wire; single phase, three wire; two phase, three wire; two phase, five wire; three phase, three wire, or three phase, four wire.

SECONDARY NEUTRAL GRID.—A well grounded network of neutral conductors formed by connecting together within a given area all the neutral conductors of individual transformer secondaries of the supply system.

SECONDARY OF INDUCTION MOTOR.—That part of an induction motor, usually the rotating part or rotor, in which currents are induced by the field coils.

SECONDARY RELAY.—A type which receives its current supply from the secondary circuits of current transformers. A.c. relays connected to secondary of pressure transformers and relays with both current and pressure windings are included in this class. Secondary relays are more accessible and more easily adjusted than primary relays, as they are always at low voltage, which makes it possible to change the calibration or even the coils without the necessity of shutting down the lines, regardless of their voltage. The current coils are usually wound for 5 amperes and the pressure coils for 110 volts.

SECONDARY ROENTGEN RAYS.—Roentgen rays emitted in all directions by any matter irradiated with Roentgen rays.

SECONDARY SOURCE OF LIGHT.—A luminous source which reflects luminous energy received upon it, or diffuses luminous energy passing through it, as distinguished from a primary source.

SECONDARY VOLTAGE OF WOUND ROTOR MOTORS.—The open circuit voltage at standstill, measured across the slip rings.—NEMA.

SECONDARY WINDING.—In a secondary induction coil, the winding in which induction takes place. In an ignition coil it is the high tension winding; in a house lighting transformer; the low tension winding.

SECRETION CURRENT.—In electro-therapeutics, an electric current produced by stimulating the secretory nerves.

SECTION BOX.—In a system of electric traction, a box containing the switches which control the sectional feeders.

SECTION OR DETECTOR LOCKING.—The control of switches by track sections which may form a part or all of a route and of which the switches protected are a part. Section or detector locking has practically superseded the older form of switch protection, mechanical detector bars, used before track circuits were available for preventing the unlocking and moving of switch points when a car was at the switch.

SECTION SWITCH.—In a trolley system, a switch by means of which a trolley section may be cut out of the line circuit when necessary.

SECTIONAL FEEDER.—A feeder wire employed to supply current to a trolley section.

SECTIONAL PLATING.—A method of electro-plating an article, in which a coating of special thickness is deposited at those points on the surface which are expected to have the greatest wear. In this method a frame is used for holding an article in the bath so that it shall receive a thicker deposit of metal at certain points than at others.

SECTIONAL ROUTE LOCKING.—In railway interlocking equipment, a system in which the switches in one section may be released while those in another section of the same route are still electrically locked, for traffic in a certain direction. This is a question of expeditious handling of traffic and not of safety.

SECTIONAL TROLLEY.—A trolley line made up of sections of wire fed by separate feeders from the power house and joined by section insulators or line breakers.

SECTOR.—The part of a circle included between two radii and the intercepted arc.

SECTOR CABLE.—A multiple conductor cable in which the cross section of each multi-wire conductor is substantially a sector, an ellipse, or a figure intermediate between them.

SECTOR METHOD OF SLIP MEASUREMENT.—A black disc having a number of white sectors (generally the same as the number of poles of the induction motor) is fastened with wax to shaft of the induction motor, and is observed through another disc having an equal number of sector shaped slits (that is a similar disc with the white sectors cut out) and attached to the shaft of a small self-starting synchronous motor, which is fitted with a revolution counter that can be thrown in or out of gear at will; then the slip (in terms of N_r) $= N \div (N_s \div N_r)$, in which: N=number of passages of the sectors; N_s=number of sectors; N_r=number of revolutions recorded by the counter during the period of observation. For large values of slip, the observations may be simplified by using only one sector ($N_s=1$), then N will equal the slip in revolutions.

SECULAR VARIATION.—A variation in the declination of the magnetic needle at the same place on the earth's surface which may be observed during long periods of time.

SEDIMENT.—In a storage battery loosened or worn out particles of active material fallen to the bottom of cells; frequently called "mud." A first class storage cell will have plenty of sediment space.

SEEBECK EFFECT.—A thermo-electric effect discovered by Seebeck. He observed that an electric current was produced in a closed circuit by heating a point of contact of two dissimilar metals. The two metals producing this effect are known as a thermo-electric couple.

SEE SAWING.—A term applied to the state of two parallel connected alternators running out of step, or not synchronously; hunting.

SEF.—Abbreviation for series field winding.

SEGMENT.—The portion of a circle included between a chord and the arc which it subtends.

SEGMENT SWITCH.—A form of switch in which contacts are made by a lever moved over insulated metallic segments in the form of an arc.

SEGMENTS LOOSE OR KNOCKED IN.—On dynamos or motor armatures this fault is due to loose clamping ring. After tightening, re-turn if necessary.

SEGMENTAL CORE DISC.—An armature core disc made up of several segments, instead of being in a single piece. Adapted to large armatures where the central portion consists of a spider or structure resembling a fly wheel. The segmental discs are fastened to the rim of the spider thus saving metal.

SEISMIC PHOTO-CHRONOGRAPH. — An instrument for making a photographic record of disturbances of the earth's crust.

SEISMOGRAPH.—An instrument for measuring and recording the period, extent and duration of earthquakes.

SEIZING.—1. The lashing or securing of two ropes or two parts of a single rope by binding them around with smaller line or yarn.

2. The yarn or cord used in seizing a rope or ropes.

3. Binding or gripping of a moving part in its bearings, when the parts have become incorporated by overheating or lack of lubrication. Steel on steel is very apt to seize, and therefore, it is good practice to face bearings for steel shafts with some other metal, as brass, Babbitt metal, etc.

SELECTIVE ABSORPTION.—Absorption of sound, light, heat, etc., with a discrimination for waves of certain frequencies, other waves passing unabsorbed.

SELECTIVE RADIATION. — Radiations from a body in waves of sound, light, heat or electro-magnetism confined to certain definite frequencies only; also called selective emission.

SELECTIVE SIGNALING.—On a party line telephone circuit, calling one of several subscribers.

SELECTIVITY.—The ability of a radio receiver to be tuned to a particular wave length and exclude all other wave lengths.

SELECTOR.—1. In the automatic or dial telephone system, one of the elements which operates in making a connection. The three essential elements being: a, line finder; b, selector; c, connector. In the step by step system the selector consists of a multiple bank and wipers and a mechanism whereby the shaft can be lifted and rotated step by step. The selector is a one digit switch. The vertical motion is controlled by the dial, and the rotary motion automatically. In a four digit system the essential elements are: a, line finder; b, 1st selector; c, 2nd selector; d, connector.

2. The tuning knob control of a radio set.

SELENIUM.—A rare non-metallic element, closely resembling sulphur in its behavior, and found in conjunction with that substance and with tellurium. The electrical resistance of selenium changes remarkably under the action of light, consequently selenium cells are much employed in certain classes of apparatus.

SELENIUM CELL.—A type of cell extremely sensitive to light. It consists essentially of two copper wires wound without contact on a strip of mica, and having the free ends joined to a circuit including a telephone and battery, the spaces between the turns of wire being filled with annealed selenium. The conductivity varies with the intensity of the light falling on it. This property offers a means of transmitting sound or pictures by wire or radio.

SELENIUM EYE.—A model of the human eye constructed for photo-electrical experiment purposes, having a retina of selenium connected in circuit with a battery and galvanometer.

SELENIUM PHOTOMETER.—A photometer having a screen of selenium standardized with reference to a known illumination, devised in an attempt to measure the visual intensity of a light source.

SELF-CAPACITY.—Circuit capacity, sometimes called distributed capacity. In radio circuits, self-capacity is objectionable.

SELF - COOLING TRANSFORMER. — A transformer which can be sufficiently cooled by contact of its coils with the air, or by merely filling the case with oil, without resorting to a forced circulation.

SELF-EXCITATION.—Magnetizing the field magnets of a dynamo by means of currents generated in its own armature. It is made possible by virtue of residual magnetism in the frame and pole pieces of the machine.

SELF-EXCITED ALTERNATOR. — One whose armature has, in addition to the main winding, another winding connected to a commutator for furnishing direct field-exciting current. The advantage of a direct connected exciter is economy of space. A disadvantage is that the exciter must run at the same speed as the alternator, which is slower than desirable, hence the exciter must be larger for a given output than the gear driven type, because the latter can be run at high speed and accordingly be made proportionally smaller.

SELF-EXCITED DYNAMO. — A dynamo which supplies its field magnets with magnetizing currents generated by its own armature, as distinguished from a separately excited dynamo.

SELF-HETERODYNE RECEPTION. — In radio, usually called autodyne reception.

SELF-INDUCTION.—The property of an electric current by virtue of which it tends to resist any change of value. It is sometimes spoken of as electro-magnetic inertia and is analogous to the mechanical inertia of matter. Self-induction is due to the action of the current upon itself during variations in strength. It becomes especially marked in a coil of wire, in which the adjacent turns act inductively upon each other upon the principle of mutual induction arising between two separate adjacent circuits. Self-induction manifests itself by giving "momentum" to the current so that it cannot be instantly stopped when the circuit is broken, the result being a bright arc at the moment of breaking the circuit. On account of this arc, a primary induction coil is used in low tension or "make and break" ignition systems.

SELF-INDUCTION IN ARMATURE.—An effect produced by action of the induced current upon itself which prevents the instantaneous reversal of the current in the armature coils. That is, the current tends to go on, and in fact does actually continue for a brief time after the brush has been reached.

SELF-INDUCTION PRESSURE.—In an a.c. circuit, that component of the impressed pressure necessary to overcome the spurious resistance due to induction. Also called the **reactance drop**.

SELF-OSCILLATION.—In radio the tendency of the tubes to generate radio frequency oscillations.

SELF-RECORDING MAGNETOMETER.—An instrument for automatically measuring and recording the varying intensity of terrestrial magnetism.

SELF-REGISTERING TACHOMETER. — A registering speed indicator. Plain English is always better than such terms as "tachometer."

SELF-REGULATING DYNAMO.—A dynamo so constructed as to maintain a constant pressure under varying loads.

SELF-REGULATING X-RAY TUBE. — A vacuum tube in which the degree of exhaustion may be automatically regulated.

SELF-RESTORING DROP.—In a telephone switchboard or other annunciator, a drop that is mechanically or electrically self-restoring after falling, so that the operator or attendant is spared the labor of returning by hand.

SELF-STARTER.—A low voltage electric motor for cranking an automobile engine. It is attached on one side of the engine and receives its current from a storage battery. Usually the motor operates on 6 volts but some starters are designed for higher voltages. The average cranking current is from 150 to 300 amperes depending upon the resistance offered by the engine, and the voltage of the starter circuit.

SELF-SUSTAINED OSCILLATION. — In radio receiving sets, the tendency of the tubes to generate radio frequency oscillations.

SELLERS SCREW THREAD.—Known generally as the U. S. standard thread.

SEMAPHORE.—In a railway block system, the apparatus for signaling by means of movable arm discs, lights, etc.

SEMAPHORE SIGNALS.—In railway signaling, a type in which the day indications are given by the positions of a movable arm, and the night indications by colored lights. They may be classed as:

1. Two positions: a, home; b, distant.
2. Three positions: a, upper quadrant; b, lower quadrant.

Two position signal blades are often used in combination on the same signal post to give three indications. The home or top arm gives final authority to the engineman, the distant or lower arm merely repeating the indication of the home signal in advance; its function being purely cautionary.

SEMI-AUTOMATIC SUB-STATION.—One which is started manually and runs until shut down, according to some schedule, by one of a number of different methods. These methods may be a time switch, momentary interruption of a.c. supply, or by an attendant who enters the sub-station for that purpose.

SEMI-CIRCULAR DEVIATION OR ERROR.—The deviation of the magnetic needle of a compass due to the permanent magnetism in an iron or steel ship. This error disappears when the ship is in the magnetic meridian, but twice increases to a maximum and diminishes to zero when the vessel swings through a complete circle.

SEMI-CONDUCTOR.—A name given to substances having only moderate power of transmitting electricity, and which may be said in that respect to stand midway between conductors and insulators.

SEMI-ENCLOSED MACHINE. — One in which the ventilating openings in the frame are protected with wire screen, expanded metal, or perforated covers, the openings in which must not exceed ½ sq. in. in area and must be of such shape as not to permit the passage of a rod larger than ½ in. in diameter.—NEMA.

SEMI-INCANDESCENT LAMP.—A type of electric lamp which combines the principles of arc and incandescent lighting, having two carbon electrodes between which an arc is formed which at the same time produces incandescence.

SEMI-INDIRECT LIGHTING. — In this method a small portion of the light passes directly downward through the unit, lighting the room in a similar manner to the direct lighting system. The major portion of the light, however, is thrown to the ceiling and from there diffused throughout the room.

SEMI-MAGNETIC CONTROLLER. — One having part of its basic functions performed by electro-magnets and part by other means.—NEMA.

SEMI-PERMEABLE SEPTUM.—A porous partition which will separate a solution by permitting the solvent to pass through it, but not the matter held in solution.

SENSIBLE HEAT.—That part of heat which produces a rise in temperature, as shown by the thermometer, as distinguished from latent heat.

SENSITIVE PLANT.—It was discovered by Ritter, that the sensitive plant shuts up when electrified. This property, as has been shown by Burden Sanderson, extends to other vegetable growth, being exhibited by the carnivorous plant, the Venus's flytrap or dionaea.

2. Mimosa pudica, a plant which closes or droops when touched or shaken.

SENSITIVE TELEPHONE.—A telephone of particularly delicate construction, so that it can respond to feeble vibrations.

SENSITIVITY OF GALVANOMETER. — There are four convenient definitions of this characteristic, involving some statement of the electrical conditions required to secure a standard deflection.

1. Current sensitivity.—The current required to give the standard deflection.
2. Megohm sensitivity.—The number of megohms resistance that must be placed in series with the galvanometer in order that from an impressed pressure of one volt there shall result the standard deflection
3. Voltage sensitivity. — The voltage that must be impressed on the circuit made up of the galvanometer coil and the external critical damping resistance, in order that there shall result the standard deflection.
4. Ballistic sensitivity.—The quantity of electricity that must suddenly be discharged through the galvanometer in order that there shall result the standard deflection.

SEPARABLE CORE.—A core, as of an electro-magnet, which may be readily withdrawn from the coils.

SEPARABLE SPARK PLUG.—A type of ignition spark plug in which the insulation core can be removed.

SEPARATE CIRCUIT DYNAMO.—A dynamo in which the field magnet coils are excited by special coils wound upon the armature or upon a separate armature; a separate coil dynamo.

SEPARATE EXCITATION.—The excitation of dynamo field magnets from an external and entirely separate source, usually by a small continuous current dynamo called an "exciter," or by a storage battery.

SEPARATE TOUCH.—A method of magnetizing a steel bar, in which two bar magnets with their opposite poles near together are brought into contact with the middle of the bar and drawn apart toward the ends and back several times, leaving off at the middle. This method is also called divided touch.

SEPARATELY EXCITED ALTERNATOR.—One in which the field magnets are excited from a small dynamo independently driven or driven by the alternator shaft, either direct connected or by belt.

SEPARATELY EXCITED BOOSTER.—A small exciting dynamo. The exciter is provided with a single series coil, through which the station output or a proportional part thereof passes. The armature of the exciter is connected to the exciting coil on the booster, and thence across the mains.

SEPARATELY EXCITED DYNAMO.—One whose field magnets are excited from an external and separate source, as distinguished from a self-exciting dynamo.

SEPARATOR.—In a storage battery an insulator between plates of opposite polarity; usually of wood, rubber or a combination of both. Separators are generally corrugated or ribbed to insure proper distance between plates and to avoid too great displacement of electrolyte. A cheap battery with wood separators is expensive.

SEPTUM.—The porous partition or diaphragm through which two liquids intermix in the phenomenon of osmose.

SERIES A.C. MOTOR.—A type identical with the series d.c. motor, but having all the iron of the magnetic circuit laminated. Sometimes a neutralizing winding is used.

SERIES A.C. MOTOR CHARACTERISTICS.—They are similar to those of the d.c. series motor, the torque being a maximum at starting and decreasing as the speed increases. On account of its powerful starting torque it is particularly desirable for traction service.

SERIES AMPLIFICATION.—In radio, a term that should be used in place of Cascade Amplification. A connection of amplifying tubes (either audio or radio frequency) such that the output of one is introduced as the input of the next, thus obtaining a degree of amplification, depending upon the number so hooked up.

SERIES AND PARALLEL COUPLING OF DYNAMOS.—Since the output of a dynamo is made up of two factors: a, the pressure and b, current, it follows that the output of a machine may be enlarged by increasing either one or the other, or both at the same time. As, however, the systems of distribution in use at the present time involve the maintenance of either a constant current or a constant pressure in a circuit, the methods of coupling dynamos together resolve themselves into two kinds, corresponding to the systems of distribution, viz.: parallel and series connections. In coupling two or more machines in parallel, the pressures of all the machines are kept at a constant value, while the output of the plant is increased in proportion to the current capacities of the machines in circuit. In the series coupling, the current capacity of the plant is kept at a constant value, while the output is increased in proportion to the pressures of the machines in circuit.

SERIES ARC CUT OUT.—A cut out sometimes used in connection with a series arc lamp, providing an alternative path of low resistance, so that when a lamp breaks down from any cause the other lamps in the circuit may not be affected.

SERIES BOOSTER.—An automatic booster which adjusts its voltage to produce the proper ratio of charge or discharge with varying external load, and it also tends to maintain a constant voltage across the line, under all conditions of change in circuit.

SERIES CIRCUIT.—An electric circuit in which all the receptive devices are arranged in succession, as distinguished from a parallel circuit. Cells are said to be in series when the zinc of one is connected to the carbon of the next throughout the battery, lamps are in series when the current passes through each one in turn; any group of electric apparatus is joined in series when the positive pole of one machine is connected to the negative pole of the next.

SERIES D.C. MOTOR.—A motor in which the field magnet coils, consisting of a few turns of thick wire, are connected in series with the armature so that the whole current supplied to the motor passes through the field coils as well as the armature.

SERIES D.C. MOTOR CHARACTERISTICS.—The field strength increases with the current, since the latter flows through the magnet coils. If the motor be run on a constant voltage circuit, with light load, it will run at a very high speed; again, if the motor be loaded heavily, the speed will be much less than before. Series motors should not be employed where the load may be entirely removed because they would attain a dangerous speed. They should not be used for driving by means of belts, because a sudden release of the load due to a mishap to the belt would cause the motor to "run away." Very small series motors may be used with belts since their comparatively large frictional resistance represents an appreciable load, restraining the motor from reaching a dangerous speed. Series motors are used principally for electric railways, trolleys, and electric vehicles, and similar purposes, where an attendant is always at hand to regulate or control the speed.

SERIES DYNAMO.—A dynamo in which the field magnets are wound with a few turns of thick wire joined in series to the armature so that the whole current passes through the coils into the external circuit; the current in passing through the coils of the field magnets energizes the latter, and creates a magnetic field.

SERIES DYNAMOS IN PARALLEL.—This type is seldom so coupled. For this method of coupling the field coil of all the dynamos must be connected in parallel, which lessens the tendency of the voltage of one dynamo to fall below that of the other.

SERIES GAP OF LIGHTNING ARRESTER.—A spark gap connected in series with a lightning arrester which keeps the circuit through the lightning arrester open under normal conditions, but closes the circuit for the lightning discharge by sparking over.

SERIES LIGHTING.—1. A method of lighting with arc lamps in which the lamps are connected in series; the constant current series system.

2. Banks of five 110 volt incandescent lamps connected in series to operate on a 550 volt circuit as in subway and other electric railways, using [illegible] volt currents.

SERIES MULTIPLE.—Series parallel.

SERIES MULTIPLE SWITCHBOARD.—A multiple telephone switchboard in which the line is caused to pass through the spring jacks at the various sections in series.

SERIES PARALLEL CIRCUIT.—An electric circuit containing groups of parallel connected receptive devices, the groups being arranged in the circuit in series; a series multiple circuit.

SERIES PARALLEL CONTROLLER.—When two d.c. motors are used in electric railway work, their armatures are connected in series with each other and an extra resistance which prevents the passage of an excessive current through the armature before the motor starts. As the speed of the car increases, the extra resistance is gradually cut out of circuit and the field winding connections changed from series to parallel by means of a series parallel controller, which finally connects each motor directly across the supply mains, or between the trolley line and the track or ground return.

SERIES PARALLEL DIMMING.—In wiring for lighting, a hook up of lights so that they may be connected in parallel with each other for full brightness and in series with each other for dimming.

SERIES PHASE RESONANCE.—The condition of a circuit having inductance and capacity in series in such proportion that they neutralize each other, so that the current will be in phase with the voltage at the frequency of the impressed a.c.

SERIES STATIC CONDENSER.—A static condenser connected in series with a transmission line to compensate for transmission line reactance.

SERIES SWITCHBOARD.—A multiple telephone switchboard in which connections are made in series.

SERIES TERMINALS.—The terminals of the series winding of a compound dynamo or motor connected with the external circuit.

SERIES TRANSFORMER.—A transformer having its primary in series with the circuit, and its secondary in series with the device which receives the current. They are used largely on a.c. switchboards for operating ammeters and wattmeters.

SERIES WINDING.—1. The winding of a series machine consisting of a few turns of thick insulated wire wound upon the field magnets and connected in series with the armature, so that the whole of the current passes through the coils into the external circuit.

2. In armature construction, a wave winding, that is one in which the coil ends diverge and go to segments widely separated, the winding to a certain extent resembling a wave.

SERRATED.—Toothed or notched along the edge, like a saw. The word is derived from the Latin: serra, a saw.

SERVICE.—In electric distribution, a general term for the branch conductors furnishing electric energy to a consumer.

SERVICE BAND.—A radio channel allotted to a given class of radio service.

SERVICE BLOCK.—In electric distribution a branch block containing safety fuses for connecting service wires to a main.

SERVICE BOX.—In the conduit system of electric distribution, a shallow metallic box placed at points of distribution to consumers. In this box the branch service cables are attached to the main cables and the space filled with an insulating compound and protected by a cover clamped over it. Service boxes are reached by hand holes.

SERVICE CONNECTION.—That portion of the supply conductors which extends from the street main or duct or transformers to the service switch, switches, or switchboard of the building supply.

SERVICE ENTRANCE.—That portion of the service connection where the wires enter a building. There are numerous methods of making service entrance into buildings, and they may be classified as:

1. Tube.
2. Conduit: a, overhead; b, underground.

The essential requirements are: a, dead end insulator to carry the strain; b, a connecting loop projecting downward forming a "drip"; c, extra insulation as porcelain tube where wire passes through building; d, porcelain knob to keep wire away from wall and prevent strain on the switch connection; e, cut cut switch.

SERVICE LINES.—Telephone lines between an exchange and its subscribers.

SERVICE MAIN.—In electric distribution, the wire which leads from the street main into the consumer's premises; the consumer's main, or service wire.

SERVICE RESTORING RELAY.—One type of service restoring relay consists of a small motor driving a drum contactor which, when properly adjusted, will reclose the circuit breaker after it has been tripped by an overload relay. This particular relay will reclose the breaker three times and then lock open, requiring to be reset manually. If the breaker remain closed before the relay locks open, the relay automatically resets itself for another cycle of operation. There are many special types of relays designed for this purpose in connection with automatic substations.

SERVICE TUBE.—An insulating tube by means of which service wires are led into a building.

SERVICE WIRES OR CONDUCTORS.—In a system of electrical distribution, branch wires leading from the mains to a consumer's premises; service conductors.

SERVING.—A spiral wrapping. Generally used in connection with textile insulations.

SERVING MALLET.—A mallet for laying on closely and evenly the coating of jute, paper or other insulating material employed to wrap a cable core before the sheath is applied; a serving tool.

SET ANALYZER.—A testing set for locating faults in radio receivers.

SET COLLAR.—A collar or ring held on a shaft by set screws, which serves to prevent end play on line shafting, or to make longitudinal adjustments of shafts or spindles.

SET SCREW.—A screw with a pointed or cupped end, used to secure a pulley upon a shaft, or for like purposes.

SET SPARK IGNITION.—A system at one time used on some taxicabs, which had no means of advancing the spark, a fixed spark ignition.

SEVEN POINT JACK.—A telephone spring jack provided with seven contact points.

SEXTANT.—An optical instrument for measuring the angular displacement between two distant objects; it consists essentially of a pivoted arm traversing a graduated arc and carrying a small mirror, a second mirror fixed upon the frame so as to be parallel with the first when the arm is at zero, and a small telescope directed towards the second mirror.

SEXTAPLEX TELEGRAPHY.—A system of telegraphy by which six messages may be transmitted simultaneously over the same wire, three in each direction.

S. G.—In submarine telegraphy, a signal prefixed to a message to indicate that the communication relates solely to the company's business.

SHACKLE.—A form of swinging insulator bracket for use upon a telegraph pole where an angle occurs in the line.

SHADING COIL.—In a split phase motor, an auxiliary coil used to split the phase in starting. The usual construction is to surround part of each field pole with a strap of copper which is a closed loop. In operation the flux which threads the shading coil lags in time phase behind the flux in the unshaded part of the pole and the magnetic field tends to move from the unshaded part of the pole toward the shaded part of the pole. The direction of rotation of a motor with a shading coil cannot be reversed by any change in the leads, and the motor has the disadvantage that the shading coil is active when the motor is running at full speed and causes additional loss.

SHADOW BANDS.—During an eclipse, mysterious bands of light and shadow flitting over the surface of the earth just before and just after totality.

SHADOW CONE.—During an eclipse, the funnel shaped part of the shadow directly behind the moon.

SHADOWGRAPH.—1. A term sometimes applied to a radiograph, or an X-ray photograph; a shadowgram.
2. In testing an electric flatiron, records made at short intervals of the ability of the iron to scorch paper to show its power to hold heat.

SHADOW PHOTOMETER.—A type of photometer consisting of an upright ground glass screen having a small vertical rod fixed in front of it; the standard light and the source to be tested are caused to throw two shadows upon the screen, and then are adjusted until the intensities of the shadows are alike, when the distances are measured and the comparative luminosities deduced from the law of inverse squares; the **Rumford photometer.**

SHADOWS, ELECTRIC.—The current of electrified air from a charged pointed conductor will produce a charge upon the surface of any insulating body, such as a plate of ebonite or glass, held a few inches away. If a slip of mica or glass be interposed between the surface against which the wind is directed and the point from whence it comes, an electric shadow will be formed on the surface at the part so screened.

SHALLOW WATER CABLE.—A cable designed to be laid in comparatively shallow water, and hence specially protected against wear upon a rocky bottom by the provision of extra sheathing.

SHARP TUNING.—In radio, tuning with a high degree of selectivity.

SHAVING POLES.—In transmission line construction, poles are shaved with a draw knife, but should be done only when required. Shave only the section of pole or stub which is to extend above the ground or is to be treated.

SHEAR.—The effect of external forces acting so as to cause adjacent sections of a member to slip past each other. When so acted upon, the member is said to be in shear. When shearing takes place with the specimen fixed (held regidly) on one side of the cutter it is called single shear; when fixed on both sides, double shear.

SHEATH.—The final protective coating applied to a cable.

SHED OF INSULATOR.—The petticoat of a line wire insulator.

SHEET BRASS.—Certain compositions of zinc and copper rolled into sheets. The proportion of copper and zinc varies according to the purpose for which the sheet brass is intended. The ordinary yellow brass of commerce, known to the trade as high brass (meaning high in zinc) will vary from 60% copper and 40% zinc up to 75% copper and 25% zinc, according to the physical characteristics the metal must possess to be adapted to the purpose in view. Other varieties are: drawing brass; spinning brass; clock brass; stamping brass; etc.

SHEET LIGHTNING.—A form of lightning seen as a broad flash illuminating a large area of the clouds, and apparently unaccompanied by thunder, probably due to reflection from a distant storm.

SHEET METAL.—The term **sheet** is applied to material (with exception of lead) having a thickness less than No. 12 U. S. gauge. The U. S. government limits the thickness of sheets to No. 10 U. S. gauge. Ordinarily, sheet mills do not roll stock thinner than No. 30 gauge. As distinguished from plate, the term sheet signifies that the manufactured product is made entirely from the material specified. For instance, sheet lead means lead in the form of a sheet, whereas tin plate (erroneously called sheet tin, and sometimes inexcusably just "tin") signifies a sheet of iron or steel coated with tin.

SHEET METAL GAUGE.—1. An instrument employed to measure the thickness of sheets of metal, usually denoting the various thicknesses by a range of successive numbers.
2. A table of gauge sizes corresponding to arbitrarily chosen numbers. Numerous gauges for sheet metal and wire have been in use which leads in many cases to confusion. An act of Congress March 3, 1893, legalized a gauge to be used by the custom house departments for sheet iron and sheet steel, the gauge being known as the U. S. standard sheet metal gauge. This gauge is used by about forty-five sheet metal manufacturers.

SHEET TIN.—In metals, sheet iron coated with tin. The practice of confusing sheet tin with tin plate (ignorantly called just "tin") should be avoided by the well informed plumber. At ordinary temperatures tin can be beaten and rolled into thin leaves known as sheet tin. It comes in weights of from 1 lb. to 20 lbs. per sq. ft.

SHELL OF ARC LAMP.—A term sometimes applied to the frame of an arc lamp.

SHELL TRANSFORMER.—A type in which the core is in the form of a shell, being built around and through the coils. A shell transformer has, as a rule, fewer turns and a higher voltage per turn than the core type.

SHELLAC.—A commercial form of a resinous substance found upon certain tropical trees, and prepared for the market in thin shells; when dissolved in alcohol it forms shellac varnish, which is useful in electrical work for its insulating properties

SHF.—Abbreviation for shunt field winding.

SHIELD.—On radio receivers, a conducting metallic plate surrounding a part to prevent interference of external fields. These fields will produce electric currents or charges on any other conductors in the neighborhood. The higher the frequency of the alternating currents the more widespread will be the fields surrounding their conductors. In the radio frequency part of a receiver, every coil, every condenser and almost every wire will be surrounded by an extensive field. These fields tend to interfere with the proper working of the set. Copper, aluminum and brass are the best metals for use as shields, their relative values being in the order named.

SHIELDED IGNITION WIRING.—A method of shielding ignition wires of air craft with flexible braided steel mesh which is grounded to the engine so that the ignition system will not cause interference with the radio set.

SHIELDED POLE INDUCTION INSTRUMENT.—An a.c. indicating instrument. It consists essentially of a disc or sometimes a drum and a laminated magnet. Covering some two-thirds of the pole faces are two copper plates or shields, and a permanent magnet. In operation eddy currents are induced in the two copper plates or shields, which attract those in the disc, producing in consequence a torque against the opposing action of a spring. A magnet damps the oscillations.

SHIFTING ZERO.—1. An irregular displacement of the true zero of a scale, which sometimes leads to error in electrical measurement.

2. In a mirror galvanometer, any irregular deflection of the spot of light from the zero of the scale, due to imperfect adjustment or other fault.

SHIMS.—Pieces of sheet metal used to adjust a bearing. In adjusting they are placed between the brasses on each side of the crank (or shaft) in sufficient number to take up any lost motion. Used especially on main and crank pin bearings.

SHIP DYNAMOMETER.—A dynamometer used on a cable ship to determine the strain put upon a cable in the process of paying out.

SHIP TO SHORE TELEPHONE.—A system in which the message is transmitted by wire to a radio station located on or near the coast, thence to the ship by radio.

SHIPPING MEASURE.—

1 Register ton	=	100 cu. ft.
1 U. S. shipping ton	=	40 cu. ft.
	=	32.14 U.S. bu.
	=	31.14 imp. bu.
1 British shipping ton	=	42 cu. ft.
	=	32.70 imp. bu.
	=	33.75 U.S. bu.

SHOCK, ELECTRIC.—A painful and sometimes dangerous shock to the human system produced by a discharge through the body of static or current electricity, especially when of high voltage. The effect experienced by the discharge of electricity with high pressure difference through the animal system is that of a sharp and painful shock; pain and violent muscular contraction accompany it. The voltage is the main element of shock, amperage has also some direct influence. The condition of the body after death by electric shock corresponds exactly with that found after death by asphyxia. The electric shock paralyzes or destroys the nerve center which controls the respiratory movements; the passage of venous blood into the arterial system causes contraction of the arterioles, and finally stoppage of the heart exactly as in death by drowning or suffocation. There is, therefore, always hope of resuscitation, except when the respiratory nerve centre has been destroyed.

SHOE.—In the third rail system of electric traction, cast iron rubbing shoes carried on insulated spring supports, by means of which electric contact is made with the third rail.

SHOE PLUG.—A variety of telephone switchboard plug with sliding contact.

SHOLES.—In erecting, wedges, etc., under the heels of shores.

SHORT.—A contraction sometimes used among repair men for short circuit.

SHORT AND LONG COIL GALVANOMETER.—A distinction as to the type of coil winding for a galvanometer. A short coil galvanometer has a coil consisting of a few turns of heavy wire; a long coil galvanometer is wound with a large number of turns of fine wire. With either type and a given current the total magnetizing force which deflects the needle is the same, but with a short coil, it is produced by a large current circulating around a few turns, instead of a small current circulating around thousands of turns as in the long coil. The short coil is used to measure amperes and the long coil volts.

SHORT ARC SYSTEM.—An electric lighting system employing short arcs between the carbons.

SHORT CIRCUIT.—1. A connection of low resistance joining two parts of an electric circuit so as to offer an alternative path for the current when it becomes necessary to cut out that part of the main circuit intercepted by the shunt.

2. A fault in an electric circuit or apparatus due usually to imperfect insulation, such that the current follows a by-path and inflicts damage or is wasted.

SHORT CIRCUITS BETWEEN ADJACENT COILS.—Dynamos and motors having large armatures wound with compressed and stranded bars and connectors are particularly susceptible to this fault, a slight blow generally forcing one or more of the strands into contact with the adjacent bars. Locate the faulty coil by the torque method.

SHORT CIRCUIT BETWEEN INDUCTOR AND ARMATURE CORE.—To remedy, unwind the defective coil, reinsulate the core and rewind, using new magnet wire.

SHORT CIRCUITS BETWEEN SECTIONS THROUGH BINDING WIRES. — This fault is the result of a loose winding, and is caused by the insulation upon which the binding wires are wound giving way, thus bringing coils at different pressures together. Locate fault by inspection. To remedy, it will be necessary to unwind and rewind on new binding wires, on bands of mica or vulcanized fibre, soldering at intervals to obviate flying asunder.

SHORT CIRCUITS IN ARMATURE WINDING.—These are caused by: a, insulation damaged on wires while winding, leaving weak spot which under heat and vibration breaks down; b, careless handling weakens insulation causing it to break down; c, chafing of insulation due to vibration; d, overheating, which chars and weakens insulation so that it breaks down.

SHORT CIRCUITS IN THE COMMUTATOR.—These are caused by:

1. Solder getting down behind commutator and bridging commutator segments.
2. Carbon dust packing into the undercutting of commutator and bridging segments.
3. When a slight short occurs, current starts to flow through short, causing heat. With this condition mica becomes black and conducts current. Heavier current causes more heat until finally short is sufficiently heavy to conduct enough current to burn out coil. Commutator shorts result in heating the armature and sparking at the brushes. To remedy, the insulation between the segments should be carefully examined. and any metallic dust, filings, or burrs cleaned or scraped out. When the commutator is insulated with asbestos or pasteboard (as is often the case in dynamos of European make), short circuits very frequently occur through the insulation absorbing moisture or oil, which is subsequently carbonized by the sparking at the brushes. Expel all moisture from the commutator insulation by means of heat, and scrape out all metallic dust which may be embedded in the surface of the insulation. If this do not effect a cure, it will be necessary to dig out the insulation, as far as possible, with a sharp tool. and drive in new insulation.

SHORT CIRCUIT IN DYNAMO.—In a series or compound dynamo a short circuit or heavy load will overload the machine and cause the fuses to blow. A shunt machine will not excite under these circumstances, for the reason that practically the whole of the current generated in the armature passes direct to the external circuit, and the difference of pressure between the shunt terminals is practically zero. Most liable parts to be short circuited are the terminals, brush holders, commutator, armature coils and field coils.

SHORT CIRCUIT (OR BREAK) IN FIELD MAGNET CIRCUIT.—Either of these faults is liable to give rise to sparking at the commutator. If one of the coils be short circuited, the fact will be indicated by the faulty coil remaining cool while the perfect coil is overheated. The fault may arise through some of the connections to the coils making contact with the frame of the machine or with each other. To ascertain this, examine all the connections, and test with a battery and galvanometer. A total break in one or more of the field coils may readily be detected by means of the battery and galvanometer.

SHORT CIRCUIT IN INDIVIDUAL COILS.—In dynamos and motors, this fault is indicated by excessive heating. The faulty coil if not burnt out, can generally be located by the baked appearance of the varnish or insulation, and by its excessive temperature over the rest of the coils.

SHORT CIRCUIT KEY.—A key by means of which an electrical instrument, such as a galvanometer, may be cut out of a circuit.

SHORT CIRCUITING PLUG.—A plug by means of which a short circuit is effected.

SHORT CLOSED CIRCUIT.—A series circuit having some of its receptive devices disconnected, as distinguished from a long closed circuit.

SHORT CUT OFF.—In steam engine valve gears, any cut off shorter than can be made with a simple gear without requiring abnormal proportions. The simple D valve driven by eccentric (without any expansion gear) can be designed to cut off as early as ½ stroke. Any cut off earlier than this may be regarded as short cut off.

SHORT DIVISION.—A method of division in which the continued subtraction is effected mentally, the quotient alone being set down without any working. Evidently this method is suitable only for small divisors, as 8÷2, 1,272÷12.

SHORT END OF BATTERY.—In quadruplex telegraphy, the smaller portion of the divided battery.

SHORT NEGATIVE IMPULSE.—In electrotherapeutics, reducing the time during which the current is negative, also reduces the time during which irritation may take place; and, therefore, the users of the oscillatory current report that this type of current produces the desired effect without irritation. This type of current was considered the most efficient current by some of the pioneer investigators of the action of electric currents in therapeutics.

SHORT SHUNT DYNAMO.—A compound wound dynamo in which one terminal of the shunt field coil is connected between the armature and the series coil, as distinguished from long shunt in which the terminals of the shunt coil are connected to the outside terminals of the machine.

SHORT WAVE.—1. Any wave of a length between 10 and 80 meters. Short waves permit broadcasting to much greater distances than with the longer waves regularly used, and in order to extend the broadcasting range some of the leading stations simultaneously transmit their programs on long and short waves.

2. A disadvantage experienced in the use of short waves lies in the way in which the received field strength varies in accordance with the time of day; the season of the year, and the distribution of light and darkness over the path of the transmission. The effect of such variations may be greatly reduced by the provision in the receiving system of an automatic volume control which adjusts the amplification in accordance with the strength of the received signal. Even when this is done, however, it is necessary when reliable communication over long periods is desired, to employ several frequencies suitably chosen for each particular case.

SHORT WAVE FREQUENCY RANGE.—In short wave radio sets, on account of the very great difference in frequency in the range of short waves it would not be practical to provide a tuning system for the full range that would be satisfactory, hence the receiver is designed for the particular wave band desired or is provided with removable coils, called plug in coils, or condensers or both. These can be changed for each of the many narrow wave bands into which popular short wave transmission is now divided. These are, the 160 meter, 80 meter, 40 meter and 20 meter amateur bands and the broadcast short wave bands at 50, 25 and 20 meters.

SHORT WAVE RECEIVERS.—These usually consist of a stage of radio frequency amplification followed by a regenerative detector, either with or without one or two stages of ordinary transformer coupled audio frequency amplification. The use of a stage of tuned screen grid radio frequency amplification increases the sensitivity greatly. The nature of the power supply and of the audio amplifier system is of little consideration. The success of the receiver depends mostly upon the apparatus that precedes the audio amplifier.

SHORT WAVE RECEIVER SHIELDING.—The short wave receiver must be shielded against hand capacities and between the relative stages. For shielding against hand capacities, a plain aluminum panel, for mounting the condensers and control dials, is sufficient. It is not imperative that the balance of the circuit be placed in an aluminum container although it is quite advantageous for mechanical reasons.

SHORT WAVE RECEPTION.—In radio, the requirements of receivers for short waves differ from those for ordinary receivers on account of the high frequency of the short waves. With short waves, the inductance and capacity effects between wires and coils are very marked. In short wave radio receiver sets, all wires from grids and plates of tubes should be kept short and well separated. Unless care be exercised in wiring the variable condensers, troublesome hand capacity effects are liable to result. The wire from the grid of the tube to the tuning coil and condenser should always be connected to the stator plates of the tuning condenser, and the rotor plates should go to the grid return circuit.

SHORT WAVE VACUUM TUBES.—Vacuum tubes intended for very short waves retain the feature of an external anode cooled by a circulated liquid, but must be specially designed in order that the following difficulties may be avoided: a, heating effects caused by high frequency losses in dielectrics; b, heating effects caused by the very large high frequency currents which are encountered and high value of the high frequency resistance, due to skin effect; c, external insulation difficulties due to the ease with which the air breaks down at very high frequencies; d, the demand for low electrode capacity.

SHORTENING CONDENSER.—In radio, a variable condenser connected in series with the aerial to shorten the wave length.

SHOT EFFECT.—In a radio vacuum tube, a tube noise audible in the audio output, due to slight variation in the ratio of electron emission.

SHOWER BATH, ELECTRIC.—In electrotherapeutics, a shower bath of slightly alkaline water by means of which an electric current is conveyed to a patient who is supported on a metallic stool connected with a terminal of the circuit.

SHROUD.—Such terms as "shroud," can, etc., are low-brow slang expressions for a radio receiver shield.

SHUNT.—1. In an electric circuit, a branch conductor joining the main circuit at two points and forming a parallel or derived circuit, so that the current is divided, a part passing through the branch and a part through the main circuit.

2. To introduce a shunt into an electric circuit.

SHUNT A.C. MOTOR.—This type has inherently many properties which render it unsuitable for practical use, and accordingly is of little importance. Owing to the many turns of the field winding there is large inductance in the shunt field circuit. The inductance of the armature is small as compared with that of the field; accordingly, the two currents differ considerably in phase. The phase difference between the field and armature currents and the corresponding relation between the respective fluxes results in a weak torque. It is necessary to use laminated construction in the field circuit to avoid eddy currents, which otherwise would be excessive.

SHUNT AND COMPOUND DYNAMOS IN PARALLEL.—It is not practicable to run a compound dynamo and a shunt dynamo in parallel, for, unless the field rheostat of the shunt machine be adjusted continually, the compound dynamo will take more than its share of the load.

SHUNT BELL OR "SHORT CIRCUIT" BELL.—A type in which the current, during operation, is not broken, but as the magnet attracts the armature, the current is shunted or short circuited, and thus being offered a path of very little resistance as compared with that of the magnet winding, most of the current flows through the short circuit. Since this reduces the magnetism to such a small amount that the attraction of the magnet becomes less than the pull of the hammer spring, the hammer swings back to its initial position.

SHUNT BOOSTER.—In a storage battery system, a shunt dynamo, having its armature circuit in series with the line from the main dynamo to the battery. It acts to increase the voltage applied to the battery so that the charging current will flow into the latter. It is not adapted to circuits where there are sudden fluctuations that are great compared with the capacity of the dynamo.

SHUNT BOX.—A resistance box containing coils of known resistances employed with a galvanometer so that only a definite fraction of the current shall pass through the instrument; a shunt rheostat.

SHUNT BREAKING RESISTANCE.—A resistance introduced into the field rheostat of a shunt dynamo when a large part of the load is suddenly removed, to prevent the increase in voltage endangering the devices still in the circuit.

SHUNT CIRCUIT.—A shunt; a by-path provided in an electric circuit so that only a portion of the current shall pass through it. A shunt is employed with dynamos, motors and electrical instruments for deflecting a small part of the current where the entire current strength is not required.

SHUNT COIL.—A coil joined in parallel as a shunt to an electric circuit.

SHUNT DYNAMO.—A machine having a field winding consisting of many turns of fine wire connected in parallel, or as a shunt, to the external circuit, and so connected to the armature brushes as to obtain a portion of the armature current for maintaining the field. In operation, two paths are presented to the current as it leaves the armature, between which it divides in the inverse ratio of the resistance. One part of the current flows through the magnetizing coils, and the other portion through the external circuit. In all well designed shunt dynamos, the resistance of the shunt circuit is always very great, as compared with the resistance of the armature and external circuit, the strength of the current flowing in the shunt coils being very small even in the largest machines. Shunt dynamos are used for constant voltage circuits, as in incandescent lighting. The voltage at the dynamo remains practically unchanged, and the current varies according to the load. There is a certain maximum load current that the shunt dynamo is capable of supplying at constant voltage; beyond this, the voltage will decrease, the machine finally demagnetizing itself, and ceasing to generate current.

SHUNT DYNAMOS IN PARALLEL.—1. To make this connection, the positive and negative terminals of each machine are connected respectively to two massive insulated copper bars, called omnibus bars, through double pole switches and pole fuses.

2. A better method consists in connecting both the shunt coils in series with one another, so that they form one long shunt between the two main conductors.

SHUNT FOR AMMETER.—A shunt of low resistance and small temperature coefficient introduced into the circuit of an ammeter in order that the current flowing in the moving coil of the instrument may be proportional to that in the main circuit. The shunt consists of two heavy terminal blocks of copper or brass between which are brazed thin sheets of resistance metal such as manganin or constantan, offering a large radiating surface to the air.

SHUNT FOR GALVANOMETER.—A shunt having a small temperature coefficient of resistivity employed to increase the range of a galvanometer. When the resistance of the galvanometer circuit is not too small, an ordinary resistance box may be used. The Ayrton or universal shunt is designed for use with any galvanometer by inserting plugs between different terminals, the coils being so arranged that their relative multiplying powers are always the same, whatever the actual resistance of the galvanometer may be.

SHUNT LAMP.—A type of series arc lamp in which the length of the arc is maintained by means of a solenoid consisting of many turns of fine wire connected in shunt with the arc, and acting against a spring.

SHUNT LAW.—The currents in two parallel circuits are inversely proportional to their resistances.

SHUNT MOTOR CHARACTERISTICS.—Weakening the field of a shunt motor as by putting resistance in series with the magnet winding and decreasing current through it, will cause it to increase its speed. Weakening the field reduces the reverse pressure. This causes an increase in current through the armature and a pulling effort is produced more than that which is required for the load. The motor accelerates until the reverse pressure is increased to cut down the current again to that required to propel the load. To properly start a shunt motor the field coils must be fully excited, using a variable resistance for the armature circuit.

SHUNT MOTOR OPERATING PRECAUTIONS.—Because of the large amount of self-induction in the shunt windings, it is important to note: a, that in switching on the field magnet, the current may take an appreciable time to grow to its normal value, and b, that in switching off, especially with quick break switches, high voltages are induced in the windings, which may break down the insulation. Sometimes in order that the rise of voltage may not injure the insulation when the shunt is opened, a special form of main switch is sometimes used which, before breaking from the supply, puts a non-inductive resistance across the shunt of the motor.

SHUNT WINDING.—The winding of a shunt machine consisting of a large number of turns of fine insulated copper wire, which is wound round the field magnets and connected to the brushes, so as to form a shunt or "by pass" to the brushes and external circuit. The object of using a shunt winding for field magnets of dynamos is that the machine may more readily excite its own fields at starting, and that the current may be produced before the rotating armature has fully taken up its speed.

SHUNT WOUND ROTARY CONVERTER.—This type is satisfactory for sub-stations in large cities and similar installations where, due to the larger number of car units demanding power, the load is more nearly constant.

SHUNTED BALLISTIC GALVANOMETER.—A ballistic galvanometer having a shunt so that when a current is applied it divides inversely in proportion to the resistance of the two paths, one through the galvanometer and the other through the shunt.

SHUNTING AIR GAP.—An air gap surrounding an electrical instrument to protect it from injury from a disruptive discharge.

SHUNTING METHOD OF CONTROL.—A method of making the transition from series to parallel connection of electric railway motors. This method has an operating advantage as compared to the open circuit method in that only one-half of the torque is dropped during the transition instead of all torque being lost. Series paralleling by this method is used with most platform controllers of the K type, which also employ the method of series resistors, and with unit switch control except where automatic operation is required or the current handled is comparatively large.

SHUTTER DROP.—A device for displaying a number, name or symbol in a telephone or other annunciator for indicating the source of a call. The shutter is released by the action of an electromagnet, and is manually restoring or self-restoring according as it is designed to be restored by hand or automatically when the answer is made.

SHUTTING DOWN A MACHINE.—In stopping a dynamo, the load should first be gradually reduced, if possible, by easing down the engine; then when the machine is supplying little or no current, the main switch should be opened.

When the volt meter almost indicates zero, the brushes should be raised from contact with the commutator. This prevents the brushes being damaged in the event of the engine making a backward motion, which it often does, particularly in the case of a gas engine.

SHUTTING DOWN A PARALLEL CONNECTED COMPOUND DYNAMO.—The load is first reduced to a few amperes, as in the case of shunt dynamos, either by slowing down the engine, or by cutting resistance into the shunt circuit by means of the hand regulator, and then opening the switch. Previous to this, however, it is advisable to increase the voltage at the bus bars to a slight extent, as while slowing down the engine the load upon the outgoing dynamo is transferred to the other dynamo armatures, and the current in their series coils not being increased in proportion, the voltage at the bus bars is consequently reduced somewhat.

SHUTTLE ARMATURE.—A form of armature of the drum type with a two part commutator, and wound with a single coil in two longitudinal grooves in a shuttle shaped core. The coil has a large number of turns, wound in two slots spaced 180° apart. It was originally used on Siemens' armature and is now used on magnetos.

SIDE BANDS.—In radio, all the frequencies due to modulation of a carrier wave, both above and below the frequency of the carrier wave.

SIDE BAR MOTOR SUSPENSION.—A method of suspending a motor on a car truck by employing two parallel bars fixed at right angles to the shaft and resting upon a frame carried by the truck.

SIDE BRACKET.—A form of bracket for supporting a single insulator upon the side of a pole or building.

SIDE CIRCUIT.—A two wire circuit forming one side of a phantom circuit.

SIDE COMMUTATOR. — A commutator carried on the side of a dynamo armature.

SIDE FLASH.—A lateral discharge in the form of a bright flash taking place from a conductor in which a current due to a static discharge is passing.

SIDE FREQUENCY.—In radio a modulated carrier frequency with a single additional frequency.

SIDE PLAY.—Provision for longitudinal movement as, of a shaft in its bearings, or of a working part on the shaft; it is advisable and necessary, so as to permit the parts to adjust themselves while running. On converters, in order that the brushes may not wear grooves in the commutator and collector rings, the armature should have a slight reciprocating motion parallel with the shaft. To obtain this motion the larger machines are provided with an automatic, magnetic end play device. Current for its operation is obtained from the d.c. side of the converter. A condenser is connected across the make and break to facilitate the opening and closing of the circuit. Small machines having comparatively light armatures are equipped with a mechanical end play device.

SIDE POLE TROLLEY SYSTEM.—A system of line construction for trolley railways in which the trolley wires are supported by poles set along the side of the street, as distinguished from a center pole system.

SIDE SLIP.—In airplane operation, to fall, due to excessive bank or roll.

SIDE TELEGRAPH REPEATER.—A telegraph repeater working branch lines.

SIDES OF THREE WIRE SYSTEM.—The positive and negative wires in the three wire system of electric distribution.

SIDEREAL.—In navigation, of or pertaining to the fixed stars. Sidereal time is measured by the apparent diurnal motion over the stars, the sidereal day being measured by the apparent passage over the meridian of the first point of Aries, or first point of right ascension.

SIEMENS ARMATURE.—An early form of dynamo armature devised by Ernest Werner Von Siemens, a German electrical engineer, brother of Sir William Siemens, in 1856. The armature is commonly known as the shuttle armature. A single coil of wire is wound in an H shaped groove formed in a bobbin shaped core.

SIEMENS DIFFERENTIAL VOLTAMETER.—A form of gas voltameter invented by Siemens for measuring the resistance of the platinum coil used in his pyrometer.

SIEMENS DYNAMOMETER.—An instrument for measuring amperes, volts and watts. It consists of two coils on a common axis but set in planes at right angles to each other in such a way that a torque is produced between the two coils which measures the product of their currents. This torque is measured by twisting a spiral spring through a measured angle of such degree that the coils shall resume their original relative positions. When constructed as a volt meter, both coils are wound with a large number of turns of fine wire, making the instrument sensitive to small currents. Then by connecting a high resistance in series with the instrument, it can be connected across the terminals of a circuit whose voltage is to be measured. When constructed as a watt meter, one coil is wound so as to carry the main current and the other made with many turns of fine wire of high resistance suitable for connecting across the circuit.

SIEMENS ELECTRO-PYROMETER.—An instrument for measuring high temperatures consisting essentially of a fine platinum wire wound on a cylinder of porcelain or fire clay, and the whole enclosed in an iron tube.

SIEMENS-HALSKE CELL.—A variety of Daniell cell employing a zinc-copper couple, the zinc being supported in a bell shaped inner jar upon a mass of paper pulp moistened with dilute sulphuric acid.

SIGHTING PENDANT.—A vertical wire on center line and forward of the control car of an airship used as a mark in steering to assist in determining wind direction.

SIGN FLASHER.—A device used for giving flashing and changeable effects to electric light signs. The mechanism may be constructed to flash a sign by spelling the words out, one letter at a time, flashing border lights around a window, changing colors in glass signs, or in fact in any way to attract the eye. There is a great variety of flashers. They are classed as: a, simple on and off; b, high speed; c, speller; d, script; e, chaser; f, combination; g, control or master; h, thermal.

SIGNS.—+ (plus) and — (minus) for positive and negative respectively. These signs are descriptive of polarity.

SIGNAL ELEVATOR OPERATION.—A system of elevator control in which the elevator is started by the operator, but where the stopping is brought about as the result of pressing one of the signal buttons. In addition to the stopping buttons on the landings, which serve for a bank of several cars, and which when pressed cause the first car of the bank approaching in the proper direction to stop, buttons are mounted in each car also, one for each floor served, which when pressed set up stop calls, or stop impulses for that car alone, the car stopping at those floors in proper order regardless of the order in which the buttons are pressed.

SIGNAL FREQUENCY.—In radio, the frequency of the incoming signal waves arriving at the receiver set.

SIGNAL INDICATIONS.—In railway signals where lights are employed to give the indication, they are of two kinds:

1. Color—in semaphore or color light signals: a, green, proceed; b, yellow, slow down prepared to stop; c, red, stop.
2. Position—in position light signals: a, vertical, proceed; b, oblique, slow down, prepared to stop at the next signal; c, horizontal, stop.

SIGNAL LAMPS FOR SWITCHBOARDS.—In many telephone exchanges, small incandescent electric lamps used for calling signals. These lamps are superior to drops in that they need not be "restored," the light being extinguished so soon as the proper connections are completed, and also from the fact that they occupy less room on the panel, a consideration of importance in the construction and operation of multiple switchboards of large capacity.

SIGNAL OVERLAP CONTROL.—In automatic block train signals, a form of signal control essential to maintain the proper spacing of trains running on a close interval. It provides for overlapping the line control of a signal into the block section beyond the immediate or home block into which the signal governs train movement.

SIGNAL RELAY.—An auxiliary relay which operates an audible or visible signal.—NEMA.

SIGNAL WAVE.—In radio, the wave which transmits the effect to be conveyed.

SIGNALING PRINCIPLE.—In railway signal systems, the signal apparatus, controlling circuits, etc., must be so designed, installed and maintained that, so far as may be fairly practicable, the derangement of any part, or failure of a part to perform its function, will react safely in its effect upon train movement. This means that operations must rather be prevented at a time when they would be safe, than left free, by derangement, to be performed under unsafe conditions.

SIGNALING RELAY.—A device employed in telephone and telegraph work for opening or closing a local circuit according to certain electrical conditions in the main circuit, and acting to transmit signals from the main to a secondary circuit.

SIGNIFICANT FIGURE.—Any figure except a cipher.

SILENT DISCHARGE.—A discharge of electricity which takes place from the tip of a pointed conductor when the charge has accumulated there with so great density as to electrify the surrounding air. The particles of air fly off by repulsion and convey a part of the charge with them. It is usually known as a convective discharge and acts silently in contrast with the noise of a disruptive discharge.

SILEX.—In chemistry, an oxide of silicon. It occurs nearly pure in quartz rock, chalcedony, flint, and in various other more or less impure forms; it constitutes an important part of the earth's crust; also called silica.

SILICON.—A non-metallic element, widely diffused through nature, forming in various compounds most of the rocks constituting the earth's crust. A small quantity added to copper deprives it of oxygen, improving it for telegraph or telephone wire. In cast iron, it increases hardness, and with cast steel, a small percentage favors the expulsion of gases and promotes sound castings free from blow holes. In its most usual form as silica or silicon dioxide, it forms the ruby, the quartz of the mountain, and the sand of the seashore.

SILICON BRONZE.—An alloy of copper and silicon, with or without tin. Silicon gives to copper great strength and toughness; used for telegraph and telephone wires, principally in German and Austrian cities.

SILK ENAMEL WIRE.—A wire covered with one or more servings of white tram silk. Combining the high dielectric of the enamel with the protection from abrasion afforded by the silk servings, it offers the utmost degree of insulation with but little sacrifice of winding space. It is used in the finer classes of instruments, magnetos, armatures of small motors and a great variety of other equipment. It can often be substituted for double silk covered wire with resulting increase in the number of turns, or size of conductor, and consequent improvement in the efficiency of the winding as well as reduction in its cost.

SILOXICON.—A very refractory compound of silicon, carbon and oxygen prepared in the electric furnace.

SILVER.—A precious metal of a white lustrous appearance. It is the best conductor of electricity and is taken as a standard with which all other conductors are compared. As compared with copper the relative conductivity is in the ratio of 100 to 75 (silver=100).

SILVER BATH.—A bath for silver plating containing a solution of a silver salt, usually cyanide of silver formed by the union of silver and prussic acid.

SILVER CHLORIDE.—A heavy white powder which by exposure to light becomes finally black. It is practically insoluble in water, but dissolves easily in liquid ammonia and in potassium cyanide solution. In electro-plating it is employed in the preparation of baths for silver plating. It is also used for silvering by boiling, and in the pastes for silvering by friction.

SILVER CHLORIDE CELL.—A form of primary cell specially adapted for electric testing, consisting of a zinc silver couple in an electrolyte of sal ammoniac.

SILVER PALLADIUM ALLOY.—A non-magnetic alloy of silver and palladium sometimes used for the delicate parts of a watch to prevent magnetization.

SILVER PLATING.—Electro-plating articles composed of a base metal with a coating of silver by immersing them in a silver bath opposite sheets of silver which form the anodes of the electrolytic cell, the articles to be plated being the cathodes; when the electric current passes, the silver of the anodes is decomposed and is deposited upon the cathodes in a uniform layer.

SILVER PLATING SOLUTION.—The best solution for silver plating is the double cyanide of silver and potassium solution. The single cyanide of silver is prepared by adding a solution of cyanide of potassium to a solution of nitrate of silver until a precipitate ceases to form. The double cyanide of silver and potassium is prepared by dissolving an equivalent of silver cyanide (134 parts) in a solution containing an equivalent of cyanide of potassium (65 parts). The silver plating solution is made up with distilled water, the proportion by weight of silver per gallon of water varying from ½ ounce to 5 ounces or more.

SILVER VOLTAMETER.—An instrument for determining the value of an electric current by the weight of silver deposited in the process of electrolysis performed by the current through an anode of pure silver in a solution of silver nitrate.

SILVERED PLUMBAGO.—Powdered graphite combined with silver sometimes applied to a mould in order to give it a conducting surface preparatory to electrotyping.

SIMPLE ARC.—An arc produced by a lamp having but two carbons.

SIMPLE FRACTION.—One expressed by a numerator and denominator (each being a whole number) as distinguished from a decimal fraction.

SIMPLE HARMONIC CURRENT.—Simple sinusoidal current.

SIMPLE HARMONIC MOTION.—A type of oscillatory motion deriving its name from its very general occurrence in the vibrations of bodies emitting musical sounds when the amplitude is not too great. It is completely defined by the two conditions: a, the acceleration of the moving mass is proportional to its displacement; b, the acceleration is always acting toward the position of rest. The oscillations of a pendulum is an example of simple harmonic motion.

SIMPLE IMMERSION.—A method of obtaining a metallic coating upon an article by simply dipping the article in a bath of melted metal.

SIMPLE SINUSOIDAL CURRENT.—An alternating current, the instantaneous values of which are equal to the products of a constant, and the sine of an angle having values varying linearly with time. Also called simple harmonic current.

SIMPLE TONE.—In radio, a tone corresponding to waves of a single frequency without harmonics.

SIMPLEX TWO-CIRCUIT WINDING.—A form of armature winding having only two paths through the armature, and requiring only two sets of brushes, whatever the number of poles. The pitch is always forward instead of alternately forward and backward as in multiple-circuit winding.

SIMULTANEOUS EQUATIONS.—Two separate equations considered together as representing simultaneous relations between unknown quantities.

SINE CURVE.—A wave like curve used to represent the changes in strength and direction of an alternating current. The current begins at zero, rises to a maximum, decreases again to zero, and increases to a maximum in the opposite direction, tracing a waving line in which the horizontal distances represent time and the vertical distances represent the varying values of voltage. It is called a sine curve because its perpendicular at any point is proportional to the sine of the angle corresponding to that point. In practice the sine curve is usually only approximated, being more or less distorted. A distorted wave is due to the properties of the circuit, for instance, the effect of hysteresis in an iron core introduced into a coil is to distort the current wave by adding harmonics so that the ascending and descending portions may not be symmetrical. A peaked wave has a large maximum as compared with its virtual value. A peaked wave is produced by a machine with concentrated winding.

SINE GALVANOMETER.—A type of galvanometer having a vertical coil which may be rotated around a vertical axis, so that it can be made to follow the magnetic needle in its deflections. In the sine galvanometer, the coil is moved so as to follow the needle until it is parallel with the coil. Under these circumstances, the strength of the deflecting current is proportional to sine of angle of deflection. It differs from the tangent galvanometer in that the vertical coil and magnetic needle are mounted upon a standard free to revolve around a vertical axis, with provision for determining the angular position of the coil.

SINE LAW.—A law that the force acting upon a body is directly proportional to the angle of deflection if, a. the controlling force has constant magnitude and direction, and b, the deflecting force is uniform in direction with respect to the body acted upon.

SINE WAVE.—The changes during one cycle of an alternating current corresponding to sine values of the sine curve. If angular degrees corresponding to one revolution of an elementary alternator inductor be laid out on a zero line, the voltage or current, corresponding to any angular position of the inductor is equal to the sine of the angle. Points thus obtained when plotted as ordinates referred to the zero line lie in the sine curve. This is the ideal case but in practice there is always more or less irregularity in the shape of alternating current waves, depending upon the construction of the alternator. Factors which determine the wave form are: a, number of coils per phase per pole; b, shape of pole face; c, eddy currents in the pole pieces; d, air gap.

SINGING ARC.—An arc fed by a direct current which is placed under suitable conditions near an alternating current of small intensity, so that the arc emits a sound corresponding to the oscillations of the alternating current, and the light of the arc produces equal vibrations.

SINGLE AND DOUBLE BREAK SWITCHES.—The distinction is that the one breaks the circuit at one point only, while the other breaks it at two points. If the circuit be opened at two points in series at the same instant, the voltage is divided between the two breaks, and the length to which the current will maintain an arc at either break is reduced to one-half; thus there is less chance of burning the metal of the switch. Another reason for providing two breaks is to avoid using the blade pivot as a conductor, the contact at this point being too poor for good conductivity.

SINGLE BELTING.—Leather belting made in one thickness or ply, such as is used for driving small machines. Horse power transmitted by belt rule: A single belt one inch wide and traveling 1,000 feet per minute will transmit one horse power. This corresponds to a working strain of 33 lbs. per in. of width. Many writers give as safe practice for single belts in good condition a working tension of 45 lbs. per in. of width.

SINGLE BREAK SWITCH.—One which breaks a circuit at a single contact. Suited for light duty.

SINGLE CIRCUIT.—An electric circuit containing no branch circuits, as distinguished from a divided circuit.

SINGLE CIRCUIT TUNER.—A regenerative radio receiver having the grid and aerial circuits conductively coupled.

SINGLE CONTACT CARBON TRANSMITTER.—A form of telephone transmitter depending upon the change of actual resistance of a single button of carbon under varying pressure.

SINGLE CONTACT KEY.—A key for opening and closing a circuit which has only one contact point.

SINGLE CONTROL.—In a radio receiver set, provision for tuning in which all the tuning elements are operated by a single knob.

SINGLE CUP INSULATOR.—A line wire insulator of the simplest form; a single shed insulator.

SINGLE CURB.—A method of submarine telegraphic signaling in which a single weak reverse current is sent immediately after the original signal for the purpose of hastening it through the cable.

SINGLE CURRENT CLOSED CIRCUIT WORKING.—A method of telegraphic working employing a single current, and preserving the batteries at the terminals of the line constantly in circuit.

SINGLE CURRENT OPEN CIRCUIT WORKING.—A method of telegraph working employing a single current, in which no current passes when the circuit is idle.

SINGLE FLUID PRIMARY CELL.—A simple cell having only one solution for its electrolyte, no provision being made to prevent polarization. Complete depolarization may be obtained in single fluid cells by means of a depolarizing solid body, such as oxide of manganese, oxide of copper, or peroxide of lead, in contact with the carbon pole.

SINGLE FLUID THEORY.—A theory suggested by Franklin as a modification of the double fluid theory previously advanced. He proposed that electricity existed in nature as a single fluid showing positive and negative characteristics under varying conditions.

SINGLE FOCUS X-RAY TUBE.—A form of X-ray tube having a single anti-cathode upon which the cathode rays are focused.

SINGLE PEG.—A conducting peg or pin having one contact point for closing a circuit.

SINGLE PHASE.—A term applied to a simple alternating current of uniform frequency as distinguished from polyphase currents; monophase; uniphase.

SINGLE PHASE ALTERNATOR.—A machine having an armature, with single phase winding, field magnets and two collector rings and brushes through which the single phase a.c. generated in the armature passes to the external circuit. As a general rule, when alternators are employed for lighting circuits, the single phase machines are preferable, as they are simpler in construction and do not generate the unbalancing voltages often occurring in polyphase work.

SINGLE PHASE INDUCTION MOTOR.—An asynchronous motor whose operation depends on an oscillating field for starting and a reciprocating field when brought up to speed. In the ordinary single phase motor, the current in the starting winding is usually 25° to 30° ahead of the current in the main winding. Phase difference between the currents in the two windings is obtained by inserting in the starting winding either inductance or capacity or a shading coil. If the motor be connected for one direction of rotation, it may be made to start in the opposite direction by reversing either winding with respect to the other winding. Also called **split phase motor.**

SINGLE PHASE LOCOMOTIVE.—The single phase commutator type railway motor, although it is not as economical or efficient as the d.c. motor, it has the advantages of simplicity and economy of the transmission system, together with the more economical speed control.

SINGLE PHASE OR MONOPHASE CURRENT.—The kind of alternating current generated by an alternator having a single winding on its armature. Two wires, a lead and return, are used as in direct current. The current reverses its direction in a periodic manner, rising from zero to maximum strength, returning to zero, and then going through similar variations in strength in the opposite direction; these changes comprise the cycle which is repeated with great rapidity.

SINGLE PHASE SYNCHRONOUS MOTOR.—An a.c. motor almost identical with the corresponding alternator, and consisting essentially of two elements: a, armature; b, field, either of which may revolve. The field is separately excited with direct current.

SINGLE PHASE SYSTEMS.—There are various arrangements for transmission and distribution classed as single phase systems. Thus, single phase current may be conveyed to the various receiving units by the well known circuit arrangements known as series, parallel, series parallel, parallel series. Again single phase current may be transmitted by two wires and distributed by three wires. This method of treating the neutral wire is only permissible where there is very little unbalancing, that is, where the load is kept practically the same on both sides of the neutral.

SINGLE PHASE TRANSFORMER.—One having only one set of primary and secondary terminals, and in which the fluxes in the one or more magnetic circuits are all in phase.

SINGLE PHASE WINDINGS.—For armatures of single phase machines, various types of winding are used, such as concentrated, distributed, hemitropic, etc.

SINGLE PHASER.—A single phase alternator. A **uniphaser.**

SINGLE PHASING.—In polyphase motor operation, the opening of one leg or wire of a two or three phase circuit, whereupon the remaining leg at once goes or becomes single phase.

SINGLE POLE CUT OUT.—A cut out which acts only on one of the leads or conductors in an electric circuit.

SINGLE POLE SWITCH.—A type of switch designed to control one circuit. Note that the number of points (referring to a single pole switch) is equal to the number of live contacts, not including the pivot contact. That is, one less than the number of external wires.

SINGLE POLE TELEPHONE RECEIVER.—A form of telephone receiver containing a compound magnet composed of several separately magnetized steel bars, presenting one pole only to the diaphragm, as distinguished from a **bipolar receiver.**

SINGLE PULL OVER.—A form of trolley hanger designed to suspend the trolley wire at a curve, provided with a single extension lug for the attachment of a strain wire.

SINGLE RAIL CRANE.—A light workshop crane, which runs on a single rail embedded in the floor. It is maintained in a vertical position by means of wheels running on channel iron hung from or attached to the roof.

SINGLE REDUCTION GEAR.—In a system of gears, a method of reducing the r.p.m. of the driven element without introducing intermediate gears between the driver and driven elements, as an engine belted direct to a dynamo.

SINGLE REFLECTION TUBE.—A simple form of X-ray tube having a single platinum reflector upon which the cathode rays are directed to produce the radiation.

SINGLE SHED INSULATOR.—The simplest form of line wire insulator. It is usually of glass, shaped like an inverted deep cup with a single rim.

SINGLE SLOT WINDING.—A name sometimes given to a concentrated winding.

SINGLE STROKE ELECTRIC BELL.—An electric bell that rings one stroke only when the circuit is closed, as distinguished from a vibrating bell. Such operation is often desirable, as in signaling with a code.

SINGLE THROW SWITCH.—One in which the movement of the blade from the off position to a live contact is limited to one direction.

SINGLE TOUCH MAGNETIZATION.—A method of magnetizing a bar of iron or steel, which consists simply in stroking the bar from the middle to each end with a permanent magnet. Opposite poles of the magnet are used for opposite ends of the bar, the stroking always passing from center to end, the return to the center in all cases being made through the air.

SINGLE UNIT SYSTEM.—An electric system for automobiles which comprises a motor, dynamo, and ignition distributor all in one machine.

SINGLE WIRE SPRING JACK.—A form of spring jack adapted for use in a single wire switchboard.

SINGLE WOUND WIRE.—A conductor wrapped with only one layer of insulation.

SINGLY RE-ENTRANT WINDING.—An armature winding which includes all the conductors in a series circuit before closing on itself.

SINUOUS CURRENT.—An electric current flowing through a spiral conductor.

SINUSOIDAL ALTERNATOR.—An alternator which generates simple harmonic or sinusoidal currents.

SINUSOIDAL CURRENTS. — In electrotherapeutics, currents of the alternating group, which comprise the rapid sinusoidal, the interrupted sinusoidal, rapid sinusoidal wave, and the rapid sinusoidal wave sustained peak, all of which are obtained from the basic current, the rapid sinusoidal and none of which possesses any polar effect, although the negative impulse is 1/120th of a second in duration and produces a certain amount of skin effect. These modalities have been supplied with older types of polysine generators and many clinicians have found distinct fields of use for certain types of these waves.

SIPHON RECORDER.—In submarine telegraphy, a delicate automatic receiving instrument invented by Lord Kelvin. It consists essentially of a fine coil of wire suspended between the poles of a powerful magnet, and carrying a glass siphon one end of which dips into an ink well. As the current enters the coil, oscillations are set up, which, being conveyed to the siphon, cause it to trace upon a paper ribbon an irregular line corresponding to the dots and dashes of the Morse code.

SIPHON WRITING.—The record of a telegraphic message traced upon a paper strip by a siphon recorder.

SIREN.—A signaling device having a perforated rotating disc or discs through which sharp puffs of steam or compressed air are permitted to escape in such rapid succession as to produce a continuous musical note or a loud whistle. One type called fog horn.

SIX AND TWELVE PHASE WINDINGS.—These are required for the operation of rotary converters. The phase difference in a six phase winding is 60 degrees and in a twelve phase winding 30 degrees. A six phase winding can be made out of a three phase winding by disconnecting the three phases from each other, uniting their middle points at a common junction. This will give a star grouping with six terminals. As the phase difference of a twelve phase winding is one-half that of a six phase winding, the twelve phases may be regarded as a star grouping of six pairs crossed at the middle point of each pair, or in mesh grouping for converters they may be arranged as a twelve pointed polygon. They may also be grouped as a combination of mesh and star.

SIX PHASE SYSTEM.—A system of electrical distribution of polyphase currents, consisting of two three phase systems in opposition to each other.

SIXTEENTH BEND.—In pipe fitting, a pipe bend which makes an arc of 22½ degrees and which, therefore, connects pipes which diverge at that angle.

S JOINT.—A method of connecting two surfaces, which are at right angles to each other, by means of a doubly bent strip, somewhat like the letter S reversed.

SKEIN WINDING.—A method of winding a.c. motors in which a skein of wires is looped a number of times through the slots to form one pole. Thus, the total number of turns per pole is a multiple of the number of turns in the skein. When rewinding a skein wound motor the number of times the skein is looped through each slot should be noted, the length of the skein measured and the turns counted.

SKEW ADJUSTMENT OF CARBONS.—A method of adjusting the carbons of an arc lamp in which the positive point is set out of perpendicular with, and slightly in front of, the negative point.

SKEW COIL WINDING.—An a.c. winding having its ends skew shaped. The object being to shape the coils so that all may be of one pattern.

SKEW GEARING.—Cog wheels with teeth placed obliquely, so as to slide into each other and avoid clashing. They serve to transmit motion from one shaft to another when the two form an angle but would not intersect if prolonged. Skew bevel gears have straight teeth which bear on each other along a straight line, but these teeth do not converge or point to a common center, as in the case of ordinary bevel gears; they are, instead inclined to a plane passing through the axis of the gear. A plane through the center of the tooth intersects the axis of the gear instead of passing through the axis, as in ordinary bevel gearing.

SKEW SCALE.—On a galvanometer, an outer scale known as a skew scale from the position of the needle when at zero; its advantage lies in the fact that its range of measurement is double that of the ordinary scale. For a comparatively high reading, the deflection can be read with greater ease, as the pointer is not in the part of the scale where the divisions are close together.

SKIAGRAPH.—An X-ray photograph; a radiograph.

SKID.—In airplane operation, to be carried sideways by centrifugal force when turning to right or left.

SKID FIN AERIAL.—An air plane aerial attached to a wing of the machine.

SKIDDING.—1. In electric traction, the slipping of car wheels along a track instead of rotating properly.

2. In automobiling, the sliding or slipping sideways in turning curves at high speed.

SKIN.—The voltage in a high frequency a.c. circuit producing skin currents.

SKIN CURRENTS.—1. High frequency alternating currents which are confined mainly to the outer surface of the conductor instead of passing uniformly through the cross section of the wire.

2. In the human skin and more especially in the skin of the common eel, there is a voltage exerted from without, inward

SKIN EFFECT.—The tendency of alternating currents to avoid the central portion of solid conductors and to flow or pass mostly through the outer portion. The so called skin effect becomes more pronounced as the frequency is increased. It is due to eddy currents induced in the conductor. It results in an apparent increase of resistance.

SKINDERVIKEN TRANSMITTER BUTTON.—A small carbon grain microphone button.

SKOTOGRAM OR SKOTOGRAPH.—A rarely used term for radiograph, an X-ray photograph.

SLACK CABLE.—In submarine cable laying, an excess of cable length freely paid out to prevent strain upon the cable as it rests upon an uneven bottom.

SLACK CABLE SWITCH.—A safety elevator switch used on a drum type elevator to open the control circuit in case of slack rope caused by the car or counter-weight being caught in the guides.

SLED.—In the conduit system of electric traction, a form of contact plow which, instead of being pushed along the conducting wire, is drawn over the wire after the car.

SLEEVE WIPING.—In cable jointing, slip the lead sleeve into position and dress the end down to fit over the cable. Apply gummed paper about 3 ins. wide on cable and on the sleeve, in order to confine the wiping to the proper joint. Both ends of the sleeve should be soldered to the lead sheath of the cable with a wiped joint.

SLIDE BACK VOLT METER.—A radio vacuum tube volt meter used to measure effective voltage.

SLIDE COUPLER.—A radio inductive coupler having a slide contact on one winding which permits variable turn ratio.

SLIDE RESISTANCE.—A form of rheostat employed in telegraphy in which the coils are arranged in a circle and controlled by a pair of contact arms, each capable of moving over a half circle of contact points.

SLIDE RULE.—A mechanical device for performing the fundamental operations of arithmetic in calculating, such as multiplication, division, involution, etc. A slide rule has four scales designated by the letters A,B,C,D. The two outer scales are stationary, but the two inner scales are on a tongue arranged to slide between the two outer scales.

SLIDE SWITCHBOARD. — A telephone switchboard employing slide contacts.

SLIDE TUNER.—A radio variable induction coil having a sliding contact to vary the amount of inductance.

SLIDE VALVE.—A long rectangular box-like casting designed to secure the proper distribution of steam to and from the cylinder. It is sometimes called the simple D valve, on account of its resemblance to the capital letter D turned with the flat side down next to the seat. In its broad sense the term "slide valve" includes all sliding valves, as distinguished from rotary valves. The slide valve is located in the steam chest, and is moved by the valve gear. This type of valve is satisfactory for use with low and medium steam pressures, but on account of being unbalanced, it is not used to advantage with the higher pressures. Accordingly, it is found on single cylinder engines, on the low pressure cylinder of compound engines, and sometimes on both the intermediate and low pressure cylinders of triple expansion engines. Engines using slide valves, can be constructed with less clearance than when fitted with piston valves; this is an advantage, but is offset by the perfect balance of the piston valve with respect to the steam features.

SLIDE WIRE.—The wire of German silver or platinum alloy used in connection with a scale for the adjustable contact in a slide wire or meter bridge.

SLIDE WIRE BRIDGE.—A form of bridge in which a wire of German silver or platinum alloy is stretched over a graduated scale, the rest of the circuit including thick strips of copper having two gaps in which the known and unknown resistances are introduced. The galvanometer included in the circuit is connected with the wire by a sliding contact which is moved over the scale until a balance is reached and the galvanometer needle rests at zero; a meter bridge or slide balance.

SLIDING BED PLATE.—A dynamo or motor bed plate which is movable within fixed limits for purposes of adjusting the tension of the belt.

SLIDING CONTACT.—1. An electrical contact obtained by a sliding motion of one conductor over another.

2. The contact which exists between two flat surfaces moved over each other, as differentiated from rolling contact in which one part rotates on the other.

SLIDING CONTACT KEY.—In a slide wire bridge, a spring key which, when depressed, causes a knife edge to make contact with the wire.

SLIDING FRICTION.—In mechanics, the friction existing between two bodies in sliding contact with each other.

SLIDING JOINT.—In pipe fitting, an expansion joint.

SLING PSYCHROMETER.—An instrument used in air conditioning. It consists of two accurately graduated mercury thermometers mounted on a metal strip and equipped with a swivel handle or a chain to permit whirling. To observe the wet and dry bulb temperatures of the air, the wet bulb is thoroughly saturated with clean water, preferably distilled. The instrument is then whirled at a rate of 100 or more r.p.m. The whirling should be continued for a half or three-quarters of a minute, then stopped and read quickly, the wet bulb first. Record the wet and dry bulb readings and make, immediately, one or more subsequent observations to check, then consult psychrometric chart.

SLINGS.—In electro-plating, looped pieces of insulated copper wire employed for suspending articles in the plating bath; also called slinging wires.

SLIP.—1. In an induction motor, the difference in speed between the armature and the rotating magnetic field or synchronous speed. This is a vital factor in the operation of an induction motor, since there must be slip in order that the armature inductors shall cut magnetic lines to induce (hence the name "induction" motor) currents therein so as to create a driving torque. Slip varies from about 2 to 5 per cent of synchronous speed depending upon the size of motor.

2. The difference between the actual forward travel of an airplane propeller in one revolution and its pitch.

3. In marine propulsion the slip of the propeller varies considerably. Assuming the propeller used is correct for the installation, normal slip as given by Hyde Windlass Co. is "from 15 to 25%, depending upon the type of boat. In some cases, however, if the hull of the boat be of heavy construction and of bluff lines, a slip of 30% is common." Evidently this refers to gas engine installations, because gas engines usually run at speeds too high for good propeller efficiency. Seaton states that "the slip generally should be about 8 to 10% at full speed in well formed vessels with moderately fine lines; in bluff cargo boats, it rarely exceeds 5%"—this relates to steam rigs, and the wide difference between 30 and 5% slip may be attributed to the better combination of engine speed and propeller dimensions in the case of the steam engine. According to one manufacturer of propeller wheels, "the best results are ob-

tained on motor boats with a slip of from 15 to 25%."

SLIP AND LOAD.—In an induction motor, the greater the load the greater the slip. In other words, if the load increase, the motor will run slower, and the slip will increase. With the increased slip, the induced currents and the driving force will further increase. If the motor be well designed so that the field strength is constant and the lag of the armature currents be small, the driving force developed, or torque, will be proportional to the slip, that is the slip will increase automatically as the load is increased, so that the torque will be proportional to the load.

SLIP FORMULA.—Slip is expressed in terms of synchronism, that is, as a percentage of the speed of the rotating magnetic field.

The slip is obtained from the following formula:

$$\text{Slip (rev. per sec.)} = S_f - S_a$$

or, expressed as a percentage of synchronism, that is, of the synchronous speed.

$$\text{Slip (\%)} = \frac{(S_f - S_a) \times 100}{S_f}$$

where

S_f = synchronous speed, or r.p.m. of the rotating magnetic field;

S_a = speed of the armature.

SLIP MEASUREMENT.—A simple though rough way is to observe simultaneously the speed of the armature and the frequency, calculating the slip from the slip formula. This method is only approximate. For accuracy use the sector method.

SLIP METER.—A device for determining the slip of an induction motor. There are three principal types; the sectored disc, employing a disc with white sectors mounted upon the motor shaft; the vibrating reed consisting of an a.c. electro magnet provided with a steel reed near one of its ends; and the commutator slip meter in which a commutator, with as many segments as the motor has poles, is pressed against the end of the motor shaft.

SLIP OF BLOCK.—In a link motion reverse gear, the sliding of the link on the block which occurs during each stroke. The reason for this is that the center of the block, being pivoted to the valve stem, moves in a straight line, while the ends of the reach rods which guide the link have a circular movement, hence a sidewise motion is given to the link, causing it to slip or slide on the block. In addition to this, slip is occasioned by what might be called "the angularity of the link," that is, the inclined positions which it takes, cause a sliding action. Slip is greater with center suspension than with end suspension; it is greatest in full gear, and least in mid gear.

SLIP RING MOTOR.—An external resistance induction motor. In this motor the starting torque and the starting current are under the control of the operator and may be varied at his will. The slip ring motor accordingly permits the heaviest loads to be started slowly and smoothly with no objectionable line disturbances. It is adapted to variable speed service. Wide variations of speed may be obtained without complicated arrangements.

SLIP RINGS.—Insulated rings mounted upon an alternator shaft to receive direct current for the revolving field. The author objects to the indiscriminate use of the terms slip rings and collector rings. As distinguished from slip rings, collector rings "collect" the alternating currents induced in an alternator of the revolving armature type. Evidently slip rings "collect" nothing but deliver direct current to a revolving field.

SLIP THIMBLE.—In cable laying, an appliance for readily releasing a buoy from its connection with the ship.

SLIPPER SHOE.—A form of third rail contact shoe which extends at right angles from the shoe beam, permitting the use of a top guard over the third rail.

SLOPE.—In a magnetic field, the direction in which the intensity of the field of force diminishes.

SLOT SPACE FACTOR.—In armature winding, the ratio of the sectional area of copper in an armature slot to the sectional area of the slot.

SLOTTED CONDUIT.—In the conduit system of electrical traction, a conduit for carrying the conducting wire, usually placed midway between the tracks and furnished with a continuous slot through which connection is made with the car motors.

SLOTTED CORE ARMATURE.—A type having grooves or slots cut through the core laminae and having the advantage that the "teeth," or metal left between the slots, to protect the inductors, retain them in place against the electrical drag and centrifugal force, and the construction permits a reduction of air gap to a minimum, thus reducing the amount of copper required for the field.

SLOW BURNING CONSTRUCTION.—A type or class of construction suitable for mill buildings, in which heavy hardwood timbers are employed, fitting closely into each other, without crevices for the accumulation of dust, for the passage of air or for affording play to the flames of a fire. Experience has shown that such structures, while being far cheaper than fireproof buildings, resist the flames so much that little more than a superficial charring is likely to occur with ordinary fires.

SLOW BURNING WEATHER PROOF WIRE.—A wire with a covering consisting of a combination of the Underwriters' and weather proof insulations. The fireproof coating comprises a little more than half of the total covering. When the fireproof coating is placed on the outside, the wire is called "slow burning weather proof."

SLOW BURNING WIRE.—One that will not carry fire. The covering consists of layers of cotton or other thread, all the interstices of which are filled with the fireproofing compound, or of material having equivalent fire resisting and insulating properties. The outer layer is braided and specially designed to withstand abrasion. The thickness of insulation must not be less than that required for slow burning weather proof wire and the outer surface must be finished smooth and hard.

SLOW SPEED ALTERNATORS.—One designed to run at a speed slow enough that it may be direct connected to an engine. By slow speed is here understood relatively slow speed, such as the usual speeds of reciprocating engines. Such alternators are of the revolving field type and a little consideration will show that they must have a multiplicity of field magnets to attain the required frequency.

SMASHING POINT.—In incandescent lighting, the point reached when it becomes more economical to install a new lamp than to continue burning a lamp which has passed its useful life. This point can be calculated when the rate at which the candle power falls off, and the watts per candle increase, and the cost of lamp and electrical energy are known.

SMEE CELL.—A voltaic primary originally constructed by Smee in which the negative plate consists of a thin sheet of platinized silver, with an irregular surface tending to prevent the accumulation of hydrogen bubbles and hence retarding polarization. The platinized silver plate is usually attached to a wooden bar, and zinc plates, placed one on each side of it, are kept in position by a metallic cramp passing over the top of the bar. A binding screw, passed through the wooden bar is attached to the silver plate, and a similar binding screw, on the cramp that holds the zincs to the bar. An earthenware containing-vessel is required: the battery is excited by dilute sulphuric acid (7 volumes of water to one of acid). This cell is admirably adapted for electro depositing and general galvanic experiments.

SMELTING.—Separating metals from their ores by the heat of a furnace, accompanied by chemical action. To facilitate the latter, various fluxes are required and sometimes reducing agents.

SMELTING, ELECTRIC.—The working of mineral ores by the use of the electric arc, in which the ore mixed with carbon is placed in a suitable furnace between carbon electrodes of large size, and fused by the arc produced by a current of intense strength.

SMOKE PREVENTION.—In the combustion of fuels, a method whereby the smoke, which consists of finely divided particles of unconsumed carbon or pellicles of carbon containing hydrocarbon gases, may be exposed to the incandescent fuel together with a proper supply of air. Certain devices aid in smoke prevention and some of these are: admission of air above the fire, produced in many cases by the use of a steam jet; coking the fuel previous to its actual admission to the furnace; down-draft furnaces; fire brick arches or checker work placed at the entrance to the combustion chamber; preheating the air supply through the use of hollow furnace walls; the use of automatic stokers for the more uniform firing of the fuel; and the use of mechanical draft.

SNAKE.—In house wiring, a long wire with a hook at one end, used to fish wires through walls, partitions, etc. Snake or fish wires are made of the best steel and tempered in oil. All snakes should have a hook bent at each end, and to do this the wire must first be annealed. The proper method of annealing is to hold the end of the snake in the flame of a torch until it becomes cherry red, then bend into shape, heat again to cherry red color and quickly insert the heated end in a pail of water; this hardens the wire, so that the hook will not pull apart. Snake wire may be obtained in various shapes but the type best adapted for house work is ⅛ inch wide, 1/16 inch thick. The proper way to attach the wires to be pulled into the snake is to just loop them through the hook of the snake and fold them over with pliers. If wires are to be pulled through a long run, they should be taped.

SNAP SWITCH.—One having an automatic spring actuated mechanism within the switch which causes the contacts to open or close with a snap. A snap switch consists essentially of:

1. Stationary contacts with terminal connection.
2. Movable contacts.
3. "Snap" mechanism.

All mounted on a porcelain base and protected by a cover so that only the operating handle projects. There are numerous types of snap switch.

SNAP SWITCH CLASSIFICATION.—There is a large variety of snap switches, and they may be classed as:

1. Single pole	6. Three point
2 Double pole	7. Two circuit
3. Three way	8. Three circuit
4. Four way	9. Electrolier
5. Two point	10. Heating, etc.

SNAP SWITCH CYCLE.—The explanation here given should be helpful to an understanding of the rather complicated mechanism of a snap switch. In operation:

1. Handle is turned increasing tension of spring.
2. When the predetermined tension is reached the movable contacts are released.
3. The force of the spring acting on the released movable contacts causes them to make a quick break.
4. Another turn of the handle actuates the spring to quickly close the switch.

The operation of the standard rotary snap switch is clockwise and non-reciprocating.

SNAPPER.—1. In cable laying, an arrangement consisting of automatic metal jaws used at the end of a sounding line for the purpose of bringing up samples of the sea bottom.

2. In low tension or make and break ignition, a part of the igniter mechanism which causes the rapid separation of the electrodes to produce the arc. It should be noted that to obtain the arc, the break or separation of the contacts must be very rapid. This action cannot be obtained without a spring of sufficient strength.

SNEAK CURRENT.—In a telephone circuit, a comparatively feeble current accidentally introduced through some fault in the line, which, though not strong enough to melt the safety fuse, may accumulate sufficient heat in time to seriously injure a bell or switchboard coil. It is arrested by a protective device known as a heat coil.

SNEAK CURRENT ARRESTER.—A device usually known as a heat coil which depends for its operation on the thermal effect of the current. The heat developed by the passage of a current through a coil of low conductivity melts the coil and the circuit is grounded. Heat coils are employed in telephone exchanges to protect the switchboard circuits against sneak currents.

SNIFTING VALVE.—1. In a condensing steam engine, a back pressure valve on the exhaust, opening to the atmosphere to relieve any excess pressure should the condenser flood.

2. On a locomotive, a relief valve fitted to the steam chest and constructed so as to admit air when the engine is running with closed throttle. This prevents the suction, created by the moving piston, drawing in air and cinders through the exhaust nozzle.

SNIPS.—Small, stout, short lipped shears, used especially for cutting sheet metal and wire.

SNOW SWEEPER, ELECTRIC.—A rotary snow sweeper driven by an electric motor.

SOAKAGE.—1. A term sometimes applied to the small charge of electricity which remains in a Leyden jar or other condenser after it has been discharged.

2. It is also used for the residual magnetism which is retained by a magnet after the magnetizing force has ceased to act upon it.

SOAKING CHARGE.—A low 24 hour rate storage battery charge intended to remove excess sulphate from the plates.

SOAKING OUT.—The gradual discharge which continues for some time after the first rush of escape when a conductor is grounded.

SOAPSTONE.—Steatite, a massive variety of talc. It is often used for switch bases and switchboard panels not requiring finish, as it is superior to slate in insulating properties.

SOCKET.—1. A lamp holder or receptacle consisting of a base with screw threads into which an incandescent lamp is screwed and having terminals for the circuit wires.

2. In radio, a receptacle especially for a vacuum tube, making it easy to replace tubes and impossible to make wrong circuit connections.

SOCKET ADAPTER.—A connecting fitting which enables a tube having one type base to be connected to a socket made for a different type base.

SOCKET EXTENSION.—A device which makes it possible to use a lamp in a reflector which was designed for a lamp of longer light center. If the smaller lamp will not give the distribution of light ordinarily obtainable from the particular equipment, a socket extension, consisting of a female part for accommodating the base of the lamp to be used, and a male part for screwing into the lamp socket, may be used to obtain the normal distribution of light. Socket extensions are available to adapt the 100 watt inside frosted Mazda lamp to equipment designed for the longer clear lamp of the same wattage formerly used.

SOCKET KEY.—A key or switch in the socket of an incandescent electric lamp by means of which the light is turned on or extinguished. It consists of a tap handle which carries a cam which works against a small brass disc, pressing it against a stud on the bottom of the lamp and releasing with a snap action.

SOCKET LAMP.—An incandescent electric lamp mounted upon a socket.

SOCKET PLUG.—The removable portion of an electric coupler.

SOCKET POWER.—Apparatus receiving its current supply from the electric light circuit whether d.c. or a.c. and modifying the current to the proper form for the receiver.

SOCKET POWER SET.—A radio set receiving its current supply from a socket.

SODA ASH.—The trade term for sodium carbonate.

SODA OR SODIUM.—One of the two principal alkaline metals, found nowhere uncombined, but most abundantly diffused as a compound. The chemical manufacture of carbonates, sulphates, and caustic soda is most important. In the Solvay or ammonia process, strong brine is saturated with ammonia and then decomposed by carbon dioxide, forming carbonate of sodium and ammonium chloride or sal-ammoniac, which is used in solution as an electrolyte for primary cells.

SODIUM CARBONATE.—White, crystalline, very soluble in water, forming an alkaline solution. In electro-plating it serves as an addition to copper and brass baths, and the impure product is used to cleanse objects from grease.

SODIUM HYDRATE, OR HYDROXIDE.—Commercially known as caustic soda. It is prepared from the tank liquor of the Leblanc process, or from a sodium carbonate solution, by heating with milk of lime. Calcium carbonate separates out, a weak solution of caustic soda remaining; this is concentrated in iron pans until it has attained the desired consistency or strength, and is then cast in moulds. Caustic soda is used in electroplating for freeing objects from grease. It is largely employed in soap manufacture, the treatment of wood pulp in papermaking, the purification of petroleum, and the preparation of metallic sodium.

SOFT AND HARD COPPER.—In electric wiring, ordinary pure copper is comparatively soft, and a span of any considable weight cannot sustain its own weight. In a gale, the wind pressure greatly increases the stress upon the wire. Owing to refined methods of production, pure copper wire can now be obtained having a breaking strength of 28 to 30 tons per sq. in.

SOFT BRASS.—In metals, brass which has been annealed after drawing and rolling; used for purposes requiring ductility. Annealed brass sheets are designated as light anneal, drawing anneal, soft drawing anneal.

SOFT CARBON.—A term sometimes applied to amorphous carbon as distinguished from graphite or diamond. Charcoal, lampblack and bone black are amorphous forms of carbon.

SOFT COTTON.—Untreated loosely twisted cotton thread.

SOFT IRON.—A general term applied to both wrougnt iron and cast iron which can be shaped with ordinary cutting tools or abraded readily with files. The quality is due to the amount of carbon present and the manner of its combination, and also to the mode of crystallization. Iron which contains practically no carbon, as malleable iron, is very soft, so also is iron which contains the maximum of carbon, as foundry pigs, which may contain as much as 4 or 5 per cent. Carbon when present in the graphitical condition makes a soft iron, but a very much smaller proportion, when in the combined state, yields white iron, which is extremely hard. Iron allowed to cool slowly in sand is soft, while the same iron cooled rapidly against a metallic chill is hard. Soft iron is used for ordinary castings which have to be machined: tough, slippery and hard iron being reserved for special classes of work. Where it is necessary to machine castings of hard iron, grinding or cutting by means of an extremely slow feed is resorted to.

SOFT RAYS.—Those of long wave length and slight penetrability.

SOFT SOLDER.—A solder fusible at comparatively low temperatures. It is composed of lead and tin. Sometimes other metals are added to lower the melting point. Those containing the most lead are the cheapest and have the highest melting point. According to the tin content they may be classed as: a, common or plumber's; b, medium or fine.

Common or plumber's solder consists of one part tin to two parts of lead, and melts at 441° F. It is used by plumbers for ordinary work, and occasionally for electrical work where wiped joints are required, for instance, in large lead covered work. Medium or fine solder consists of equal parts of tin and lead, or half and half, and melts at 370° F. This solder is always used for soldering joints in copper conductors, and for soldering lead sleeves on lead covered wires.

SOFT STEEL.—A tenacious, bending, equal grained alloy of iron; low carbon steel.

SOFT TUBE.—A radio detector vacuum tube exhausted to a low vacuum and in which a small amount of gas remains, causing ionization. Also called gassy tube.

SOIL.—In plumbing, a composition of lampblack and size, which is painted around parts to be soldered, to prevent the adhesion of the melted solder, except to its proper place, and thus give a neat and finished appearance.

SOLAR TELEGRAPH.—The heliograph, an instrument for transmitting signals to distant points by means of a mirror adjusted to reflect the sun's rays in a series of flashes, in accordance with a prearranged code.

SOLDER.—Any fusible alloy used to unite different metal parts. In electrical engineering the solder used is practically always an alloy of tin and lead. As the electrical conductivity of such an alloy is usually about one-seventh that of copper, the best joint between copper conductors is made by bringing the copper surfaces as close together as possible and using a minimum of solder. Common solders consist of equal parts of tin and lead; fine solder, 2 parts tin to 1 part lead; cheap solder 2 parts lead to 1 part tin.

SOLDER EAR.—A trolley ear supporting a trolley wire by being soldered to it.

SOLDERED JOINT.—In wiring for maximum conductivity, joints should be soldered. There are a number of fluxes suitable for various kinds of soldering, but pine amber resin is the best for electrical work as it does not cause corrosion. A corrosive flux, such as zinc chloride solution (killed spirits) should be strictly excluded from any electrical work. The nature of the solder often determines the flux. For soldering copper and brass, use sal-ammoniac as flux.

SOLDERED RAIL BOND.—A rail bond consisting usually of thin strips of annealed copper bent into a V shape for greater flexibility, and soldered direct to some part of the rail by means of flat terminals which are made solid to provide good contact.

SOLDERING.—Briefly the theory of soldering is that: as the solder adheres to and unites with the surface of the copper when the bit is tinned, so will it adhere to and unite the surfaces of the metals to be soldered. The operations to be performed in soldering are: a, cleaning the surface to be soldered; b, heating the bit; c, tinning the bit; d, applying the flux; e, picking up solder; f, applying the bit.

SOLDERING BIT, ELECTRIC.—A bit which is heated by current flowing through a heating unit placed within the bit, the heating unit generating sufficient heat upon the passage of an electric current to heat the bit to a proper temperature.

SOLDERING BOLTS OR BITS.—The erroneously called soldering "iron," or bit consists of a large piece of copper, drawn to a point or edge and fastened to an iron rod having a wooden handle.

SOLDERING FLUX.—A substance applied to a metal to make solder flow readily on its surface. The action of a flux is largely that of cleaning the surface, and of reducing any oxide on the surface to the metallic state. The various fluxes and their use are given in tabular form in the accompanying tables:

For iron, use borax.
For tinned iron, use rosin.
For copper and brass, use sal-ammoniac.
For zinc, use chloride of zinc.
For lead, use tallow or rosin.
For lead and tin, use rosin and sweet oil.

SOLDERING FLUX FOR ELECTRICAL WORK.—For very small wire, rosin should be used to avoid any corrosion. The Underwriters' Code permits the use of a flux composed of chloride of zinc, alcohol, glycerine and water. This preparation is easily applied and remains in place. It permits the solder to flow freely and is not highly corrosive. This flux is made as follows: Zinc chloride, 5 parts; alcohol, 4 parts; glycerine, 3 parts. Anhydrous zinc chloride crystals should be used dissolved in alcohol. The glycerine makes the flux adhesive. To prevent the alcohol igniting, the mixture may be diluted with water.

SOLDERING FURNACE.—A small heating apparatus carried by plumbers and tin men for melting solder and heating their soldering tools.

SOLDERING SUCCESSFULLY.—The essential conditions for successful soldering are: a, clean surfaces; b, correct temperature of bit; c, careful fluxing and tinning. When these conditions are given proper attention the art of soldering without profanity, presents no difficulties.

SOLENOID.—A spiral of conducting wire wound cylindrically so that, when an electric current passes through it, its turns are nearly equivalent to a succession of parallel circular circuits, and it acquires magnetic properties similar to those of a bar magnet. The lines of force must be thought of as closed loops linked with the current. The conductor conveying the current passes through all the loops of force, and these are, so to speak, threaded or slung on the current line of flow. It will be readily inferred that since a solenoid of wire conveying a current attracts and repels by its extremities the poles of a magnet, two such spiral conductors conveying currents should attract and repel each other. This is found to be the case.

The lines of force form continuous closed curves running through the interior of the coil, and issuing from one end and entering into the other end of the coil.

A solenoid has north and south poles, and in fact possesses all the properties of an ordinary permanent magnet, with the important difference that the magnetism is entirely under control, for it is found that under all circumstances the strength of the magnetic field of a solenoid is at every point proportional to the strength of the electric current passing through its coils; if the current be increased, the magnetism is increased in proportion also; and if the current be stopped, all trace of magnetism disappears. The magnetic effect or the magnetizing power of a solenoid is also proportional to the number of turns of wire composing the coil. At first, the presence of an iron core greatly increases the strength of the field; after a time, however, as the strength of the current flowing in the exciting coils is increased, the conductibility of the iron for the lines of force appears to decrease, until a point is eventually reached when the presence of the iron core appears to have no effect in increasing the strength of the field.

SOLENOID AMMETER.—A plunger type instrument.

SOLENOID CORE.—A bar or rod of soft iron placed within the coils of a solenoid for the purpose of intensifying its magnetic properties.

SOLENOID GALVANOMETER.—A galvanometer whose magnetic needle is acted upon by the coils of a solenoid which surround it.

SOLENOID PROPERTIES.—A solenoid has north and south poles, and in fact, possesses all the properties of an ordinary permanent magnet, with the important difference that the magnetism is entirely under control. Since a solenoid carrying a current attracts and repels by its extremities the pole of a magnet, two such solenoids will attract and repel each other.

SOLENOIDAL BLOW OUT.—A magnetic blow out employing a coreless solenoid as an electro-magnet.

SOLENOIDAL DISTRIBUTION OF MAGNETISM.—The distribution of lines of magnetic flux around and in a bar magnet, which, according to Ampere's theory, is identical with the flow of magnetizing force in a solenoid.

SOLID BACK TRANSMITTER.—A modern form of telephone transmitter so called because the back electrode is rigidly supported by the frame of the instrument. The front is very stiff, having the hard rubber mouthpiece screwed into it. The diaphragm of aluminum lies just back of the front with a rubber band snapped over it to provide an insulated cushion seat for the diaphragm. The two electrodes are carbon discs, the space between them being partially filled with carbon granules. The vibrations of the diaphragm are transmitted to the front electrode by a pin which makes a rigid connection between them.

SOLID CARBONS.—Carbons for arc lamps made of uniform density throughout, as distinguished from cored carbons.

SOLID CONDUIT.—A conduit for underground wiring in which the conductors are permanently embedded in insulating material, preventing their removal.

SOLID DEPOLARIZER.—The use of a solid, such as the platinum on the silver electrode of a Smee cell, as a mechanical means of reducing polarization in a primary cell.

SOLID EARTH.—A term sometimes used for dead earth, a fault in an electric circuit due to the complete grounding of the line.

SOLID GEOMETRY.—That branch of geometry which includes all three dimensions of space in its reasoning.

SOLODYNE.—A radio circuit which uses a double vacuum tube and dispenses with the B battery. Also called unidyne.

SOLUBLE ELECTRODES.—In electro-plating, metal electrodes which are dissolved by the electric current for the purpose of depositing the metal upon articles to be plated.

SONIC ALTIMETER.—An instrument for determining the elevation of an air craft. Its operation is based on the time interval for sound waves to reach the earth and return.

S.O.S.—Radio distress signal. The letters S.O.S. are not symbols for words but were selected because the corresponding signals in the International Code are easily recognized.

SOUND ERROR.—In telegraphy, an error made by an operator in reading a message by sound.

SOUND GATE.—In sound picture apparatus, an aperture through which the light that excites the photo cell passes in traversing the sound track.

SOUND PICKUP.—In synchronized sound motion pictures, the combination of photo cell and lens for converting the record on the sound track into electrical impulses.

SOUND PICTURE.—A motion picture with synchronized sound, the latter being produced either by the film method or phonographic method.

SOUND PROPAGATION.—If the atmospheric pressure could be measured at many points along a line in the direction in which the sound is moving, it would be found that the pressure along the line at any one instant varies in a manner similar to that of the alternating current. This variation in pressure has certain definite characteristics, which determine a, loudness; b, pitch; c, tone.

SOUND-RANGING ALTIMETER.—An instrument, the indications of which depend on the measurement of the time required for a sound wave to travel from the air craft to the earth and back.

SOUND TRACK.—That part of a motion picture film on which sound is recorded either by the variable density or variable area method. The sound track is located at the side of the film and occupies a very small portion of the film.

SOUND WAVES.—Waves of vibrating air particles transmitted through the air by the vibrations of a sounding body.

SOUNDER.—In telegraphy, an instrument consisting essentially of an electro-magnet with an armature moving between stops, thereby making two distinct sounds representing the dot and dash of the Morse code, by which the operator can read a message by ear.

SOUNDER RESONATOR.—An open box placed around a telegraph sounder to amplify the sound.

SOUNDING ROD.—A testing device for engine knocks. It consists of a rod of iron or steel. Place the thumb over the end of the rod and then place the ear close to the thumb. Move the other end over the metal of the engine. The closer the rod approaches the noise, the louder it sounds.

SOURCE.—The origin of something supplied as the source of the electric circuit may be a dynamo, alternator, storage battery, etc.

SOUTH MAGNETISM.—The magnetism of the south pole of a magnet which tends to point toward the earth's south magnetic pole. The magnetism of the south seeking pole as distinguished from that of the north seeking pole.

SOUTH POLE OF MAGNET.—That pole of a magnet or magnetic needle which tends to point to the south; also called the austral, blue, negative, south seeking pole or unmarked end.

SOUTH SEEKING POLE OF MAGNET.—The south pole of a magnet.

SOUTHERN LIGHTS.—The aurora australis, the counterpart of the northern lights or aurora borealis, seen in the southern hemisphere in the direction of the south magnetic pole. It exhibits the same characteristics as the northern aurora, showing broad flashes or ribbons of waving light which are undoubtedly due to electrical causes.

S.P.—Abbreviation for single pole.

SPACE CHARGE.—In radio, according to Prof. Taylor, if the space between filament and plate were to be filled with electrons, similar to the droplets of water in a cloud, then this charge would be called a space charge. At any point in space in the vicinity of a negative charge the electric field is such that it tends to repel another negative charge. Thus it is seen that between the filament and plate there is an electric field due to the plate tending to pull electrons to it, while at the same time there is another electric field repelling the electrons away from the plate, due to the space charge. As a result of the repelling action of the field caused by the space charge it is evident that the resultant electric field intensity is less than that produced by the B battery alone, in the space between filament and plate. From the lessened field strength it follows that fewer electrons will move from filament to plate during each second, and consequently smaller current will flow because of it. In general, it can be stated that anything which reduces the intensity of the electric field in any region of space will decrease the current through that space.

SPACE CURRENT.—In a radio tube, the plate filament current.

SPACE FACTOR. — In armature winding, the ratio of the sectional area of the copper in an armature slot to the sectional area of the slot. It varies from .3 to .5. In a magnet core, the ratio of the space occupied by iron to the total cubic content of the core.

SPACE WAVES.—Electro-magnetic waves reflected back to the earth's surface by the Heaviside layer.

SPACED WINDING.—A coil wound with adjacent turns spaced some distance from each other. The object of this spacing is to reduce distributed capacity.

SPACING OF WIRES.—In wiring, the conductors should be so spaced as to lessen the tendency to leakage and to prevent the wires swinging together or against towers.

SPAGHETTI TUBING.—A low brow name for a varnished impregnated cloth tubing used to insulate radio wires.

SPAN CABLE WAY.—In a telpher system, a tightly drawn overhead cable for supporting the car and conveying power to its motor.

SPAN GUARD WIRE.—In a trolley system, a guard wire stretched across the street above the span wire, at right angles to the running guard wire, to further protect the line from the danger of falling wires.

SPAN WIRE HANGERS.—Trolley hangers by means of which the trolley wire is attached to the span wires.

SPAN WIRE SUSPENSION.—In a trolley system, a method of suspending the trolley wire over the center of the tracks by means of steel span wires, stretched across the street from side posts set along the curb.

SPANISH SPOON.—In pole line construction, a long handled shallow ladle-shaped shovel for digging post holes; a spoon shovel.

SPARK.—A discharge of electricity across a gap between two electrodes. The discharge is accompanied by heat and incandescence. Distinguish between spark and arc.

SPARK ADVANCE.—In an internal combustion engine, an advance given to the spark to cause ignition to occur earlier.

SPARK ARRESTER.—Wire netting used to screen the carbons of arc lamps to prevent the scattering of sparks from the arc.

SPARK CHRONOGRAPH.—A form of chronograph in which a continuous tracing made by a stylus is interrupted, at the beginning and end of the event to be measured, by minute perforations made by electric sparks from a Ruhmkorff coil.

SPARK CIRCUIT.—In high tension or jump spark ignition, the circuit between the high tension winding of the secondary coil and the spark plug. Included in this circuit is a distributor (on multi-cylinder engines) and in case of a magneto source, usually an auxiliary or safety spark gap.

SPARK COIL.—In ignition, a secondary coil for obtaining the high voltage necessary to produce the spark. It consists essentially of a core composed of a bundle of soft iron wires surrounded by two separate windings, a primary made up of a comparatively few turns of coarse insulated wire, and a secondary composed of very many turns of fine insulated wire, the two coils being insulated from each other.

SPARK CONDENSER.—1. In telegraphy, one with or without associated non-inductive resistance, connected with a pair of instrument contact points for the purpose of diminishing sparking at these points.

2. In spectroscopy, a form of spark gap having its terminals fused into a glass vessel containing the medium whose spark spectrum is to be observed.

SPARK CONTROL.—In an ignition system the regulation of the ignition spark to suit operating conditions. There are three methods: a, manual, or varying the spark position by hand; b, automatic, as by a governor which varies the spark according to the speed; c, non-variable, or fixed spark.

SPARK DISCHARGE.—A disruptive electric discharge which takes place between two electrodes across a dielectric, accompanied by a spark.

SPARK FREQUENCY.—In radio telegraphy group frequency.

SPARK GAP.—1. In radio spark transmission, the space between electrodes across which a spark discharge takes place. There are numerous types which may be classed as: a, plain; b, rotary; c, synchronous; d, quenched.

2. The distance between the two metallic points in a spark plug. The amount of opening varies from about 1/32 to 1/16 in.

SPARK INTENSIFIER.—In ignition, a spark gap placed in series in the high tension circuit, the effect of which it is claimed will raise the voltage of the high tension circuit sufficient to cause a spark to jump across a carbonized plug.

SPARK MICROMETER.—An electric resonator having a spark gap adjustable by a micrometer screw for the purpose of measuring the length of an electric spark.

SPARK PLUG.—A device for igniting the charge in a gas engine; used in the high tension or jump spark system. A spark plug consists of some insulating material as mica, insulating a central conductor and inserted in a metal shell which carries a second contact and which is screwed into the cylinder.

SPARK RATE.—In radio telegraphy transmission, group frequency.

SPARK RECORDER.—A type of telegraph recording instrument which uses sparks instead of ink on a moving tape.

SPARK TRANSMISSION.—In radio telegraphy, a method of transmission which employs a succession of spark discharges in an oscillating circuit to produce oscillations.

SPARK TRANSMITTER.—A radio transmitter whose radio frequency power is obtained by oscillatory discharge of a condenser through an inductance coil and a spark gap.

SPARK TUBE.—A tube used to test the degree of exhaustion reached in the vacuum of an incandescent lamp bulb. When, upon being connected with an induction coil, a spark ceases to pass within the tube, the vacuum is considered satisfactory.

SPASMODIC GOVERNOR.—A governing device for electric motors which regulates the current applied in proportion to the work required.

S. P. CUT OUT.—Abbreviation for single pole cut out.

SPEAKER.—A radio loud speaker.

SPEAKING GALVANOMETER.—A mirror galvanometer for receiving signals over a submarine cable.

SPEAKING MIRROR PLUG.—A plug for a cable telegraph mirror galvanometer provided with a suspended mirror and magnet.

SPEAKING TUBE MOUTH PIECE ALARM.—An electric bell that is rung at the distant end of a speaking tube by the movement of the metal plate in the mouth piece at the calling end.

SPECIAL LOOP.—A method of locating a faulty wire or cable where the length only is known and where there are two other wires which may be used to complete the loop. It is not necessary that the resistance of the faulty wire and the length and resistance of the other wires be known.

SPECIFIC CONDUCTANCE OR CONDUCTIVITY.—A standard of reference for comparing the conductances of different substances. It is the conductance between the opposite faces of a unit cube of a substance in mhos; being the reciprocal of specific resistance or resistivity. Taking silver as a standard, the specific conductivities are as follows:

Substance.	Specific Conductivity
Silver	100
Copper	96
Gold	74
Iron (soft)	16
Lead	8
German silver	7.5
Mercury (liquid)	1.6

SPECIFIC GRAVITY.—The weight of a given substance relatively to an equal bulk of some other substance which is taken as a standard of comparison. Water is the standard for liquids and solids, air or hydrogen for gases. If a certain mass be weighed first in air then in water, and the weight in air divided by the loss of weight in water, the result will give the specific gravity; thus, taking a ten pound piece of cast iron, its weight, suspended from the scale-pan in a bucket of water, will be 8.6 lbs., dividing 10 by the difference 10—8.6 or 1.4, the answer will be 7.14, which is the specific gravity of cast iron.

SPECIFIC HEAT.—The amount of heat required to raise the temperature of a given weight of a substance one degree as compared with the amount of heat required to raise the temperature of the same weight of water 1° at some specified temperature.

SPECIFIC INDUCTIVE CAPACITY.—The ratio of the change produced in a dielectric to the voltage that produces the change. Also called the dielectric constant.

SPECIFIC MAGNETIC CAPACITY OR CONDUCTIVITY.—The ratio of the magnetic flux density of a magnet to the magnetizing force acting upon it. It is the relative conducting power for lines of force and hence the reciprocal of reluctivity or specific magnetic reluctance. Also called permeability.

SPECIFIC RELUCTANCE.—Reluctivity.

SPECIFIC RESISTANCE.—The relative resistance of a substance to the passage of electricity, as referred to some standard substance.

SPECIFIC VOLUME.—In physics, the volume of a gas or vapor compared with that of the liquid from which it is generated.

SPECTROGRAPH.—An instrument for photographing a spectrum, consisting of a spectroscope in which a photographic plate is introduced instead of an eye piece, in the focal plane of the telescope objective.

SPECTRO-PHOTOMETER.—An instrument by means of which the spectra of two light sources are caused to be placed one above the other for the purpose of making a comparison of their color bands.

SPECTRO-PHOTOMETRY. — The science and practice of using the spectro-photometer in measuring and comparing the intensities of the colors of different spectra.

SPECTROSCOPE.—An instrument whereby a spectrum is produced from any source of light, in order that it may be examined. The rays of light are formed into a parallel beam, by means of a collimator, which is a tube with an adjustable slit presented towards the light, and a lens at or near the other end. As the light issues from the lens, it falls upon a prism, by means of which the parallel beam is split up into a spectrum. This latter is viewed through an adjustable telescope, the position of the various lines and bands being ascertained by means of crosswires, scales and verniers.

SPECTRUM.—1. Radiant energy rays arranged in the order of frequency or wave length.

2. An image or brilliantly colored band thrown on a screen by the refraction of a beam of light through a prism. The colors merge into one another, but form seven easily distinguishable groups: red, orange, yellow, green, blue, indigo, violet; each color being produced by a different wave length of the ray, and the grouping due to the varying deviation through the prism, which is greatest with the violet and least in the red. The rainbow furnishes a familiar instance of the solar spectrum, the rays of sunlight being decomposed and refracted by the falling rain drops.

3. The name spectrum is due to Sir Isaac Newton who placed a triangular glass in the sunlight, streaming through a small hole in a curtain and saw the display usually known as the rainbow.

SPEED AND TORQUE OF INDUCTION MOTORS.—At zero external load little torque is required to drive the motor, and the armature revolves at a speed but very little less than that of the rotating field (the speed of the rotating magnetic field is called the synchronous speed). When the motor is running with a load, the driving torque must be large, and therefore the current in the armature inductors must be large in order that the armature magnetism may exert the necessary driving force upon the armature inductors; furthermore the induced voltage in the armature inductors must be sufficient to produce the necessary armature currents, and to do this the armature must run appreciably below synchronism.

SPEED CONTROL OF SIGNALS.—In automatic block train signals, a form of signal control adapted to rapid transit rail roads, especially for closing in trains at busy stations where the duration of station stop is greater than at other stations of the line.

SPEED INDICATOR.—An instrument for recording r.p.m. of a shaft. It consists of a spindle geared to a graduated dial which turns inside a larger dial. The indicator automatically registers hundreds as well as units and tens, and thus relieves the mind from keeping tally. The large dial is graduated into one hundred lines, each one representing a revolution of the spindle. The small dial has fifty lines cut upon its face, each representing one hundred revolutions of the spindle (or one complete turn of the large dial). A spring finger trip attached to the case engages with one of the lines in the small dial and holds it from revolving until the large dial makes one complete turn, when the trip pin passing under the spring trip lifts it, and the dial is frictionally carried along by the large plate one line, thus showing that one hundred revolutions of the spindle have been made. The instrument has a hard rubber handle, making a safe insulator when used on electrical machinery.

SPEED LIMITING SWITCH.—On a rotary converter, a device for automatically opening the direct current circuit in case the speed become too high. This safety device consists of a switch which is operated by a centrifugal governor. The centrifugal weight is mounted on the shaft and revolves with it, while the switch is stationary and is mounted on the collector end pillow block. This weight is so designed that it operates at practically the same speed irrespective of the acceleration. The switch can be adjusted to operate at any predetermined speed. Under normal operating conditions, the circuit of the low voltage release coil on the line circuit breaker is closed, but should the speed of the converter increase to the predetermined setting, the switch will open, thus opening the line circuit breaker.

SPEED REGULATING DEVICES FOR SLIP RING MOTORS.—They consist of a resistance unit designed for continuous service together with a switching device for varying the amount of resistance in the armature circuit. They may be divided into two classes: a, those for use where the torque varies with the speed at which the machine operates; b, those for use where the torque is approximately the same at all speeds.

SPEED REGULATION OF D.C. MOTORS.—For many purposes, particularly for traction, and for driving tools, it is desirable to have speed regulation, so that motors running on constant voltage circuits may be made to run at different speeds. The following two methods are used on constant voltage circuits:

1. By inserting resistance in the armature circuit of a shunt wound motor.
2. By varying the field strength of series motors by switching sections of the field coils in or out of circuit.

Decreasing the field strength of a motor increases its speed, while increasing the field strength decreases the speed.

For shunt and compound motors, the first method (variable resistance in armature circuit) reduces the speed below the normal or rated speed of the machine, while the second method increases the speed above the normal. A wide range of speed regulation is secured by a combination of the two methods.

SPEED TOO LOW.—In shunt and compound dynamos there is a certain critical speed below which they will not excite. In all cases it is advisable, if the machine do not excite in the course of a few minutes, to slightly increase the speed. As soon as the voltage rises, the speed may be reduced to its regular rate.

SPEEDOMETER.—On an automobile, a device for showing the rate of speed at which the car is going.

SPELTER.—A commercial name for zinc cast in ingots.

SPELTER SOLDER.—An alloy of copper and zinc, mixed together in various proportions, of needle-like or granular form. This is used in brazing, and is the same as hard solder.

SPENT ACID.—An acid solution that has become exhausted so that it is no longer capable of performing chemical action.

SPENT LIQUOR.—The liquid of a plating bath out of which so much of the dissolved metal has been deposited as to render it no longer effective for electroplating.

SPERMACETI CANDLE.—A candle made from spermaceti, a white waxy substance obtained from the head of the sperm whale. The commercial candle contains an admixture of wax. It is the standard candle for establishing candle power, the British unit of illumination. One candle power is the light of a sperm candle consuming 120 grains per hour.

SPEWING OF CABLE CORE.—A break in a submarine cable such that the core protrudes through the sheathing.

SP. GR.—Abbreviation for specific gravity.

SPHERE.—1. A solid, every part of whose circumference is equidistant from a point within called the center.

2. The surface of a sphere.

SPHERE GAP.—Metal spheres placed at the end of gap rods to form a spark gap.

SPHERICAL ABERRATION.—A want of sharpness in images seen through lenses or reflected from spherical mirrors having an aperture of excessive length.

SPHERICAL ARMATURE.—An armature having its coils wound upon a spherical core, and designed to revolve in a circular chamber between the pole pieces. A form used on some types of d.c. watt hour meters.

SPHERICAL CANDLE POWER.—The candle power of a light source measured in every direction, as if illuminating the inner surface of a sphere surrounding the lamp.

SPHERICAL GEOMETRY.—That branch of geometry that treats of figures drawn on the surface of a sphere.

SPHERICAL REDUCTION FACTOR.—In illumination, the mean spherical candle power divided by the mean horizontal candle power.

SPHEROMETER.—An instrument for measuring the curvature of a spherical surface.

SPHYGMOGRAM.—A tracing made by the pulse with the use of a sphymograph showing the characteristics of the beating of the heart; a pulse tracing.

SPHYGMOGRAPH.—An instrument for recording the pulse.

SPHYGMOPHONE.—An electrical instrument including a microphone for examining the condition of the pulse.

SPIDER.—An arrangement consisting of three or four radially projecting arms by means of which the core of a dynamo or motor armature is sometimes mounted upon its shaft. Used on large machines.

SPIDER WEB COIL.—A flat coil formed by a spirally wound conductor. Also called pan cake coil.

SPINOGASTRIC GALVANIZATION. — In electro-therapeutics, galvanization in which the negative electrode is placed over the stomach while the positive is moved up and down the spine.

SPIRAL STORAGE CELL.—An early type of secondary cell consisting of two lead sheets rolled up together without contact, immersed in a dilute solution of sulphuric acid.

SPIRAL WINDING.—A winding composed of spiral coils and used extensively for armature windings of alternators.

SPIRIT COMPASS.—A form of mariner's compass in which the bowl is filled with alcohol upon which the compass card floats, thereby greatly lessening the friction and vibration.

SPIRIT LEVEL.—One in which the adjustment to the horizon depends on the position of a bubble, or small vacant space, in the upper side of a glass tube, which is slightly curved and nearly filled with alcohol or ether.

SPLASH PROOF APPARATUS.—Apparatus so constructed and protected that external splashing will not interfere with its successful operation.—NEMA.

SPLAYED JOINT.—A method of jointing a covered stranded cable, in which the covering is removed a short distance from each end, the separate wires opened out, the two sets brought end to end and laced together, and the whole secured with solder.

SPLICE.—In wiring, the interlaying of the strands of two stranded conductors so that the union will be good both mechanically and electrically. The careless and erroneous use of the terms splice and joint should be avoided.

SPLICE BAR.—A name sometimes given to a fish plate for joining the ends of two rails, as in electric railways.

SPLICE BOX.—In a system of underground wiring, a box containing the cable splices so situated as to be readily accessible for repairs or further connections.

SPLICING.—Joining two lengths of cable by cutting away the lead sheath at each end, laying bare the separate wires, twisting together and soldering the corresponding pairs, renewing the insulation throughout and covering the whole with a lead sleeve.

SPLICING EAR.—A trolley ear designed to join two lengths of a trolley wire.

SPLICING SLEEVE.—A lead sleeve drawn over a cable splice and wiped to the sheath at each end, completing the splice.

SPLIT CONDUCTOR.—A conductor which is divided into two or more parts, separated from one another by insulation which is thin compared with the insulation around the conductor. The term split conductor usually designates a conductor in two parts or splits, which may be either concentric or external to one another.

SPLIT DYNAMOMETER.—A dynamometer used in testing transformers, and provided with two coils, one carrying the primary and the other the secondary current, so that its readings are proportional to the mean value of the product of the currents.

SPLIT HEAD TEE.—A lead sleeve resembling the letter T, and split throughout its length so that it may be readily applied to a cable at a point where a branch is joined to it.

SPLIT PHASE.—There are several methods of splitting the phase to start single phase motors, as by providing in addition to the main single phase or running winding: a, a starting winding; b, shading coils. Practically all small single phase induction motors are started by means of a split phase starting winding.

SPLIT PHASE MOTOR.—A single phase induction motor.

SPLIT PHASE MOTOR CHARACTERISTICS.—The torque increases with the speed until the maximum torque point is reached, thus giving rapid acceleration, and insuring that the motor will bring up to speed anv load it will start.

Adding resistance to the armature not only increases its slip, but also decreases its maximum torque. The power factor is less than the power factor of a polyphase motor of the same speed and rating. The efficiency is lower than for a polyphase motor of the same ratio.

SPLIT PHASE MOTOR STARTING.—In operation when the circuit is closed, the armature starts to revolve upon the shaft; when it reaches a predetermined speed, a centrifugal clutch expands and engages the clutch disc, which is fastened to the shaft. The momentum overcomes the inertia of the driven apparatus. In this it is assisted by a certain amount of slippage in the clutch, which is the case when the armature speed is pulled down to such a point as to reduce the grip of the centrifugal clutch.

SPLIT PHASE MOTOR TROUBLES.—1. Speed Too Low.—This may be due to the following: a, wrong voltage and frequency; b, overload; reduce load on motor, replace with a larger motor if necessary; c, grounded starting and running windings. Test out with magneto lamp bell or volt meter; d, short circuited or open winding in field current. Test out as above; e, too small connection wires. Increase size of wires.

2. Faulty Starting.—Motor starts, runs slowly, will not pick up to normal full load speed, and blows fuses, due to: a, failure of cut out to work properly. Test cut out for grounds or short circuit. Oil pivots and springs, sand paper rough spots; b, grounded plate, test with lamp or magneto, one wire to each slip ring or contact plate; c, open circuit in starting or running winding. Test out with magneto or lamp; d, grounded or short circuited starting or running winding. Test out with magneto, bell and battery or volt meter.

3. Motor Fails to Start.—This fault is sometimes encountered. In such cases: a, test line voltage with lamp; b, test fuses with lamp; c, trace out all connections for grounds, open or short circuit; d, see if brushes be making proper contact with collector rings or contact plates; e, see that rotor is free to rotate in bearings.

4. Motor Fails to Start and Hums Loudly.—This may be due to the starting winding being burnt out, open, or grounded. If motor hum, this indicates that the main or running winding is not open; the motor may be started by rotating the armature by hand until it reaches its normal rated speed.

5. Sparking at the Brushes.—As the brushes of split phase motors are only used in starting, sparking may be due only to worn and loose brushes, or dirty slip rings. Clean slip rings with a benzine soaked rag. Apply a little vaseline with the finger to each slip ring to prevent cutting by the brushes.

6. Heating of the Windings.—This may be due to any of the following causes: a, moisture in windings. Dry out in an oven; b, short circuit or ground. Test out with magneto, lamp, bell or volt meter; c, overload. Reduce load or install a larger motor; d, too low line voltage. Check up with volt meter; e, too high line voltage. Any voltage in excess of 5% on 220 volts, 10% on 110 volts should be reduced as this will cause the windings to burn out; f, wrong frequency. A 40 cycle motor cannot be used on 60 cycle current as the rotor will not revolve in synchronism with the alternator; g, wrong voltage connections to motor; h, connection wires too small. This will cause a voltage drop.

7. Heating of the Rotor.—This is usually caused by overloading the motor or by broken soldered connections of end bars. Reduce load or solder broken connections.

SPLIT PHASE WINDING.—An auxiliary primary winding used in combination with the regular running winding in a single phase induction motor for the purpose of producing starting torque.—NEMA.

SPLIT PLUG.—A form of contact plug provided with two insulated contact sleeves.

SPLIT-POLE CONVERTER.—A rotary converter designed to permit varying at will the ratio of the d.c. voltage to the a.c. voltage by the variation of field excitation only. The change of flux is accomplished by splitting each pole into sections along axial planes. The sections are subjected to different magnetic pressures which may be varied. by hand or automatically, during operation.

SPLIT RING MAGNET.—A ring shaped magnet core with an opening or split throughout its length.

SPLIT SECONDARY.—A secondary of an induction coil made up of two sections.

SPLUTTERING ARC.—A voltaic arc producing a spluttering noise because of defective carbons.

SPONGE ELECTRODE.—In electro-therapeutics, a form of electrode for applying electricity to the body through a sponge.

SPONGE LEAD.—The active material employed for the negative plate of a storage battery. It gives the plate a grayish color which makes it easy to distinguish from the reddish brown positive plate. It is pure lead which has been reduced to a spongy state by the passage of the charging current.

SPONTANEOUS ELECTRICITY.—A term sometimes applied to the electricity derived from the melting of sulphur.

SPOT.—In a mirror galvanometer, a spot of light reflected by the mirror upon the scale.

SPOT LIGHT.—A device used in connection with a concentrated light source to project a narrow beam so as to form a spot of light. Spot lights differ from search lights in that they are usually of lower power and are employed at short distances, seldom exceeding 200 ft. Theatrical and show window spot lights usually consist of a concentrated filament incandescent lamp and a condensing lens mounted in a light tight housing. Color screen mountings are sometimes included. Automobile spot lights usually employ short focus parabolic reflectors and are so mounted as to afford flexible control.

SPOT WELDING.—In electric welding, the process of joining or fusing together electrically two or more metal sheets or parts without any preparation of stock. The principle of spot welding is simple. Two electrodes, or welding points are brought to bear on the plates where the weld is to be made and a heavy current at a low electrical pressure is passed through the electrodes. The metal plates, as they are much poorer conductors of electricity, offer so great a resistance to the flow of current that they heat to a molten state, and then, by applying pressure on the electrodes, the metals are forced together and the weld is made.

SPOTTED FILAMENT.—An incandescent lamp filament which, owing to defective construction, shows spots of unequal light.

SPRAY ARRESTER.—A glass plate placed on the top of a storage cell, and running back into the solution to prevent the spray of acid vapor, caused by the bursting of bubbles on the surface of the solution, pervading the air of the room, when the solution, having reached a fully charged condition, begins to "boil."

SPREAD.—The distance from tip to tip of the wings of an airplane.

SPREAD OF DISTRIBUTED COILS.—In a.c. windings, there will be little or no advantage in reducing the interior breadth below 25% of the breadth of the pole pitch, nor is there advantage in making the exterior breadth greater than the pole pitch. Undue spreading of distributed coils lowers the value of the Kapp coefficient by reducing the breadth coefficient and makes necessary a larger number of inductors to obtain the same voltage.

SPREAD OF WINDINGS.—The pitch or spacing of armature coils. It may be defined as the number of elements of the winding which must be passed through in forming a loop.

SPREAD OR SPAN FACTOR.—In alternator design a factor which corrects for variation in voltage from that of the fundamental equation. In order to minimize the voltage impedance and so improve the regulation, the coils in the various phases of an alternator armature are divided up over a number of slots, instead of being concentrated all in one slot. As a result of this, the voltage in the various coils is not all in the same phase, and the resultant voltage is not the arithmetical sum of the voltage in the several coils. For practical estimation this reduction factor may be taken as .96 in the case of a distributed three phase winding; .90 for a distributed two phase winding; and .84 for a single phase winding distributed over two-thirds of the pole pitch. The values of the spread factor as given in the table below are based upon the same number of inductors being placed in each of the slots and all of the slots being used.

Slots per phase per pole	Spread Factor		
	Single phase	Two phase	Three phase
1	1.000	1.000	1.000
2	.707	.924	.966
3	.663	.911	.960
4	.653	.906	.958
6	.644	.903	.956

SPREADER.—An insulating device for holding several conductors apart spaced a certain distance.

SPRENGEL PUMP.—A device for attaining a very high vacuum, such as is necessary in the manufacture of incandescent electric lamps. Mercury is fed into a funnel at one extremity of a long U tube, this tube having a return bend with a longer drop leg on its other end; a nozzle situated within an annular enlargement, at the top of the drop leg, breaks the flow of the mercury into a series of slugs with air between them. Each slug, falling down the drop leg, acts as a sort of piston, sucking the air behind it, and, as a connection on the return bend communicates with the vessel to be exhausted the latter is speedily emptied of air. The U tubes being over barometric height, air cannot pass up them even should the pump stop. Escaping mercury from the drop leg or "fall tube" collects in a vessel which surrounds its base.

SPRING AMMETER.—An ammeter in which the current to be measured moves the needle against the action of a spring.

SPRING ARM BRUSH HOLDER.—A commutator brush holder in which the brush is firmly attached to the extremity of a spring arm, the other end of which is secured to the brush spindle, and when once adjusted is not capable of movement about the brush spindle.

SPRING CLIPS.—Metal jaws provided with a spring so as to make firm contact with the blades of a knife switch when closed.

SPRING DYNAMOMETER.—A form of dynamometer employing an ordinary spring balance to measure the strength of a force.

SPRING JACK.—A device, employed especially in telephone switchboards, by means of which, when a plug is introduced into a socket, suitable contact springs engage the plug contacts and complete the connection with the circuit.

SPRING JACK CUT OUT.—A cut out construoted like a spring jack, so that a circuit may be closed by the insertion of an insulating plug or wedge between the spring contacts of the jack.

SPRING JACK SWITCHBOARD.—A telephone switchboard provided with spring jacks for every subscriber's line, with which connections are made by the insertion of calling plugs.

SPRING MOTOR SUSPENSION.—A method of suspending a street railway motor by springs carried on the truck.

SPRING RELAY CONTACT.—A relay contact which is broken by the release of a spring as soon as the current is cut off.

SPRING VOLT METER.—A volt meter which measures electric pressure by the turning of an index against the action of a spring.

SPUN SILK.—A coarse, short filament silk tightly twisted. More durable than floss silk.

SPURIOUS RADIATION.—Radio transmitter emission at frequencies outside its frequency band.

SPURIOUS RESISTANCE.—The opposition to the flow of alternating current due to inductance. It depends upon the frequency, the shape of the conductor, and nature of the surrounding medium.

SPURIOUS RESISTANCE OF ARMATURE.—An apparent increase of resistance in an armature winding, which is proportional to the speed of the armature and is due to the lagging of the current, due to self-induction. That is, in an armature winding, the action of the induced current upon itself during variations of its strength, opposes a rapid rise or fall of an electric current in just the same way that the inertia of matter prevents any instantaneous change in its motion.

SQUARE LAW CONDENSER.—A radio variable tuning condenser with the plates so shaped that the capacity is proportional to the square of the wave length to which the condenser's circuit is resonant.

SQUARE MEASURE.—A measure of the area of a surface. It involves two dimensions, length and breadth, that is:

$$\text{area} = \text{length} \times \text{breadth}.$$

The dimensions length and breadth may be taken in any denomination as inches, feet, yards, etc., but both must be taken in the same denomination. The word "square" is used to denote the product of the two dimensions, thus:

$$\text{ins. (length} \times \text{ins. (breadth)} = \text{sq. ins.}$$

SQUARE MIL.—The area of a square whose sides are one mil (.001 in. long) and is equal to $.001 \times .001 = .000001$ sq. in. Used for measuring conductors of square or rectangular cross section, such as bus bars, copper ribbon, etc.

SQUARE WIRE.—A wire having a square cross section, sometimes used in winding armatures.

SQUATTING.—Descriptive of a boat being "sucked down" at the stern when driven at full speed. It can sometimes be overcome by installing a propeller with narrow blades and low pitch ratio. Squatting, however, is usually due to the stern of the boat being too narrow to offer a sufficient amount of buoyancy when the boat is in motion. Squatting to a marked degree from this cause is noticed in the New England V stern dory. The use of "squat boards" has been moderately successful in some cases.

SQUEEZE.—In electro-plating, an impression or mould made in wax or paper pulp by pressing it hard against the type when set up ready for printing.

SQUIRREL CAGE AND SYNCHRONOUS MOTORS COMPARED.—The advantages of the squirrel cage motor over the synchronous motor are lower cost, greater simplicity and the fact that it can be applied where the pull in torque is too great for the synchronous motor. The starting torque on 100% voltage will be approximately 100 to 150% of full load torque, which is within the range of most synchronous motors.

SQUIRREL CAGE MOTOR.—An asynchronous motor, in which the currents supplied are led through the field coils only, and the armature, not being connected to the external circuit, is rotated by currents induced by the varying field set up through the field coils.

SQUIRREL CAGE WINDING.—A series of rods or bars having their ends attached to short circuiting rings and forming the armature winding of a squirrel cage motor. In a squirrel cage winding there are a large number of bars uniformly spaced. The name for this form of winding is suggested by the resemblance of the finished armature to the wheel of a squirrel cage.

S.r.g.—Abbreviation for standard railroad gauge, viz.: 4 feet, 8½ inches.

S.S.C.—Abbreviation for single silk covered.

S.S.E.—Abbreviations for single silk over enamel.

STABLE GALVANIZATION.—In electrotherapeutics, the process of applying the electric current to the body of a patient by means of two fixed electrodes; as distinguished from labile galvanization in which one of the electrodes is moved about.

STABILITY.—The property of an airplane to maintain its direction and return easily to its equilibrium against disturbing conditions.

STABILIZATION OF SHIPS.—The fitting of a ship with equipment for reducing or eliminating the motion of the waves. Some of the methods are the Frahm Anti-rolling tank system; the gyroscope; the Deparis and the Motora systems.

STABILIZER.—On an airplane, a surface, such as a fin or tail plane designed to give inherent stability.

STABILIZERS FOR ARC WELDING.—A device for preventing too great flow of current as in striking the arc, or on very short arc. The usual source of current for arc welding is the constant voltage machine whereas the resistance of the arc varies from a short circuit when the arc is struck to an open circuit when the arc goes out. The current of course must be limited at this short circuit point to something that can be handled by the apparatus also during the fluctuations of the resistance of the arc. The flow of current should be held then within some reasonable variations. Therefore, it is necessary to provide some device to "stabilize" this flow of current. There are several types of stabilizer:

1. Where the arc is fed by alternating current, it is a simple matter to put a choke coil in series with the transformer.

2. A special transformer having considerable inductance drop.

3. A rheostat for d.c. arcs taking about 25 to 50% of the line voltage with normal working current, absorbing practically all of it on a short circuit.

4. A separately excited dynamo supplying an exciter to feed the fields and then apply a heavy inverted compound to the fields of this dynamo. Feed the arc through this compound. When the arc has struck the inverted compound, it will reduce the field magnetism to such a point that the current flowing will be within reason. As the arc is struck the current will be reduced. The separately excited field will begin to do its work. The voltage builds up to an appropriate voltage for the condition of the arc.

STAGE OF AMPLIFICATION.—In radio, an amplifying unit with its circuits.

STAGGER.—The horizontal distance that the entering edge of the upper wing of an airplane is ahead of the entering edge of the lower wing. With this arrangement there is less interference with the vacuum on top the lower wing, thus the lower wing is rendered more efficient

STAGGER WOUND COIL.—A basket wound coil.

STAGGERED ARMATURE.—A term sometimes applied to an armature whose windings are laid on diagonally.

STAGGERING.—An arrangement of commutator brushes such that one brush rests upon the commutator surface slightly in advance of the other, so as to bridge over a break in the circuit of the armature wires.

STALK OF INSULATOR.—The pin upon which a line wire insulator is screwed.

STALLING.—In airplane operation, loss of control in assuming angle of incident greater than the control angle.

STAND-BY BATTERY.—A reserve storage battery in power stations for emergency use, as for instance, when it becomes necessary to shut down a faulty machine.

STAND OFF INSULATOR.—One attached to a standard so as to hold the conductor it insulates, at a required distance from a building.

STANDARD CANDLE.—A sperm candle ⅞ in. in diameter and made to burn 120 grains per hour, adopted as a standard source of light. from which the British unit of illumination, the candle power, is derived.

STANDARD CELL.—A primary cell made

according to specifications adopted as a standard of voltage.

STANDARD COIL.—A standard resistance coil.

STANDARD COMPASS.—A mariner's compass adopted as a standard for the comparison of other compasses.

STANDARD CROSS ARMS.—Cross arms for telegraph poles made in all particulars according to specifications.

STANDARD MEGOHM.—The megohm employed as a standard in measuring electrical resistance.

STANDARD OHM.—A standard of resistance equal to that offered by a column of pure mercury 106.3 centimeters in length, of uniform cross section, and weighing 14.4521 grams at a temperature of 0° C.

STANDARD QUADRANT.—The length of a quadrant of the earth's meridian taken through Paris, being 10^9 centimeters long.

STANDARD RESISTANCE COIL.—A coil having a known resistance employed for comparison in testing other resistances.

STANDARDIZED CELL.—A primary cell generating a known voltage of constant value which has been determined by comparison with a standard cell.

STAR AND DELTA CONNECTIONS COMPARED.—In wiring, the power output of each is the same, but the star connection gives a higher line voltage, hence smaller conductors may be used. When it is remembered that the cost of copper conductors varies inversely as the square of the voltage, the advantage of the Y connected system can be seen at once. Assuming that three transformers are used for a three phase system of given voltage each transformer, star connected, would be wound for $1 \div \sqrt{3} = 58\%$ of the given voltage, and for full current. For delta connection, the winding of each transformer is for 58% of the current. Accordingly the turns required for star connection are only 58% of those required for delta connection. An objection to the star connection for three phase work is that it requires the use of three transformers, and if anything happen to one, the entire set is disabled. When three transformers are delta connected, one may be removed and the two remaining units will carry 58% of the original three phase load.

STAR CONNECTION FEATURES. — In grouping alternators, star grouping gives a higher line voltage than the delta connection for the same pressure generated per phase, hence it is suited for machines of high voltage and moderate current. The delta connection gives a lower line voltage than the star connection for the pressure generated per phase, and cuts down the current in the inductors; since the inductors, on this account, may be reduced in size, the delta connection is adapted to machines of large current output.

STAR POINT.—The point where the phases of a three phase star connected winding join.

STARK EFFECT.—An electrical analogue of the Zeeman effect.

STARTER.—A controller designed for accelerating a motor to normal speed in one direction of rotation.—NEMA.

STARTER COIL.—In magneto ignition, an auxiliary spark producer for furnishing ignition spark in starting.

STARTING AND LIGHTING SYSTEMS.—For automobiles there are three systems:

1. The one unit system in which there is a motor and dynamo combined in one machine, the dynamo furnishing current for the starter, and for charging the storage battery.

2. The two unit system in which the motor and dynamo are separate units. There is another system, ill advisedly called two unit, consisting of a motor dynamo, and a magneto. The reason for this confusion is because some dynamos are arranged to furnish current for ignition when not charging the battery, thus ignition has to be considered in the classification to distinguish the last mentioned system from the arrangement of three independent units.

3. The three unit system which has a motor, dynamo, and magneto each separate. The term three unit system applies only to "starting, lighting and ignition systems," as distinguished from "starting and lighting systems."

STARTING BATTERY. — An automobile storage battery large enough to furnish the heavy current consumed by a starting motor in cranking the engine.

STARTING BOX.—A rheostat for starting a motor.

STARTING COMPENSATOR. — A device consisting of two or three auto-transformers, with switches, for supplying an induction motor with low voltage currents at starting, and then, as the motor gains in speed, increasing the voltage by steps to that of the line; an auto starter.

STARTING A COMPOUND DYNAMO.—All switches controlling the external circuits should be opened, as the machine excites best when this is the case. If the machine be provided with a rheostat or hand regulator and resistance coils, these latter should all be cut out of circuit, or short circuited, until tne machine excites, when they can be gradually cut in as the voltage rises. When the machine is giving the correct voltage, as indicated by the volt meter or pilot lamp, the machine may be switched into connection with the external or working circuits.

STARTING CURRENT.—The current passed through the armature and field magnets of a motor at the moment of starting in order to produce the required starting torque. The current at the instant of starting a squirrel cage motor is 500 to 600% of the full load current if full voltage be applied. Hence compensators or rheostats are almost invariably used to reduce the starting voltage for all squirrel cage motors above 5 h.p. Thus the current at starting depends on the compensator taps used or on the amount of resistance inserted in series with the motor. Usually the compensator is tapped at the 70% points so that the current at the instant of starting is limited to 300% of full load value, which is about equal to the maximum current in an internal resistance motor. However, there is a marked difference between the two motors in this respect. The governor inside the starterless motor automatically limits the current so that it never exceeds 300% of full load value.

When a squirrel cage motor is used the plant engineer can set the compensator taps so that the current at start is no more than 300% of full load, but at the moment when the compensator handle is pulled over from starting to running position, there is a sudden drop and jump of current, and considerable voltage fluctuations may result if the handle be pulled over too soon.

STARTING A D.C. MOTOR.—Resistance must be put in series with the armature in starting, because since there is no reverse voltage to counteract the applied voltage when the motor is at rest, the switching of the latter direct to the motor would result in an abnormal rush of current. This, in addition to being uneconomical and productive of a drop of voltage in the mains, would injure all except the smallest motors. A motor is started properly by use of a rheostat objectionably called a starting box.

STARTING DEVICES FOR SLIP RING MOTORS.—On small sizes, automatic starters are used. They consist of primary and secondary contactors or magnetic switches mounted on a slate panel with starting resistors, all being enclosed in a steel cabinet. With this type starter, operation is controlled by "start" and "stop" push buttons. In the drum type starters a star wheel is mounted on the shaft so that each step can be felt by the operator.

STARTING INDUCTION MOTORS.—To avoid the great current rush that would result if the motor, at rest, be thrown on the line, several methods of starting are used, as with: a, resistances in the field; b, auto-transformer or compensator; c, resistance in armature.

STARTING PROTECTIVE RELAY.—One which gives indioation to shut down a machine and prevent its re-starting if the control do not properly complete a predetermined sequence.—**NEMA.**

STARTING RHEOSTAT.—A series of resistance coils suitably arranged so that they may be cut out of the circuit of a motor when starting; objectionably called starting box or starter.

STARTING A SERIES DYNAMO.—The external circuit should be closed, otherwise a closed circuit will not be formed through the field magnet winding and the machine will not build up.

STARTING A SHUNT DYNAMO. — All switches controlling the external circuits should be opened, as the machine excites best when this is the case.

STARTING A SHUNT MOTOR.—The proper type rheostat must be used. In starting the switch is first closed, thus sending current through the field coils, before any passes through the armature The rheostat lever is then moved to the first contact to allow a moderate amount of current to pass through the armature. The resistance of the rheostat is gradually cut out by further movement of the lever thus bringing the motor up to speed.

STARTING TORQUE.—1. The torque exerted by the starting current of a motor to overcome the static friction of the motor at rest.

2. A turning moment possessed by polyphase induction motors at starting due to the reaction on the primary of the secondary current.

STARTING WINDING.—On a split phase motor a winding placed in slots at 90 electrical degrees from the main winding. The main winding and the starting winding are so proportioned that their respective currents are out of phase, the object being to produce a so-called rotating field. The starting winding usually consists of a relatively small number of turns of fine wire. This gives a high resistance and low reactance and the current is nearly in phase with the applied voltage.

STASSANO PROCESS.—A method of electric smelting which consists of heating, in an arc furnace, briquettes composed of iron ore, carbon, and lime made into a paste with tar. The smelting process occurs in a blast furnace, the iron being reduced, and the siliceous matter of the ore slagged off.

STATIC BALANCE.—In duplex telegraphy, a static capacity imparted to the artificial line to balance that of the main line.

STATIC BREEZE.—A current of air produced by the convective discharge of electricity from the tip of a pointed conductor.

STATIC COMPENSATOR.—In duplex telegraphy, a condenser employed to give to the artificial line a static capacity to balance that of the main line.

STATIC CONDENSER. — A device that stores up electrostatic energy by subjecting the insulation or the dielectric, between two conducting elements, to a voltage stress. When the voltage applied to a condenser is increasing, energy is being stored, and when the voltage is decreasing, energy is being returned to the circuit. When an inductance is connected to the line, electro-magnetic energy is stored, but this storage of energy takes place at a different time from that of electrostatic energy.

STATIC CONDENSER CONSTRUCTION.—They are made in units containing systems of metal plates separated by dielectric material, so that energy is stored by the application of voltage to the plates. In order to conveniently subject the dielectric material to uniform voltages, it is divided into many sheets spaced with metal foil, alternate layers of metal foil being connected together to form terminals. Various numbers of sheets are used between the foil, depending on the voltage. The kva. capacity of a given condenser is a function of the area of dielectric material and the voltage per unit thickness applied to this material.

STATIC COUPLING.—In radio, coupling by condensers.

STATIC DISCHARGE.—A disruptive discharge. A discharge of static electricity across a dielectric which takes place when the dielectric gives way under the mechanical stress of the electric lines of force. A static discharge takes the form of a spark bursting across an air gap.

STATIC ELECTRICITY.—A term sometimes applied to the electricity induced and retained in the plates of a condenser or that which is said to reside as a charge upon the surface of a body, as distinguished from dynamic or current electricity.

STATIC ELIMINATORS.—In radio, any device for cutting out undesired sound other than that coming from the transmitting station to which the receiver is tuned.

STATIC HEAD.—In hydraulics, the height, from a given point, of a column, or body of water at rest, considered as causing or measuring pressure.

STATIC INDUCED CURRENT.—In electrotherapeutics, a current due to the charging and discharging of a pair of Leyden jars or other capacitors, which current is passed through a patient.

STATIC INDUCTION.—A term sometimes applied to the electric influence exerted by an electrified body upon a body not electrified. A charged body placed near an insulated conducting body will induce electrification in the conductor across the intervening space. It is on this principle that influence machines for generating static electricity operate. Beginning with a small initial charge acting by influence, other charges are induced which are collected in the parts of the machine.

STATIC SHOCK.—In electro-therapeutics, a method of applying static discharges from Leyden jars to a patient seated upon an insulated stool.

STATIC VOLTMETER.—One where action depends upon the fact that two conductors attract one another when any difference of electric pressure exists between them. If one be delicately suspended so as to be free to move, it will approach the other. The Kelvin electrostatic volt meter consists of a pair of highly insulated plates, between which a delicately mounted paddle shaped needle is free to move. When the needle is connected to one side of a circuit and the stationary plates to the other side, the needle is attracted and moves between them as indicated by the pointer. Adjusting screws at the lower end of the needle allow it to be balanced so that its center of gravity is somewhat below the center of suspension. Gravity then is the restraining force. The range of the instrument may be changed by hanging different weights upon the needle. By increasing the number of blades, the instrument can be made to measure as low as 30 volts. The form having two stationary blades and one movable blade is suitable for measuring from 200 to 20,000 volts. The quadrant electro-meter or laboratory form will measure a fraction of a volt.

STATIC WAVE CURRENT.—In electro-therapeutics, the current resulting from the sudden periodic discharging of a patient who has been raised to a high voltage by means of an electrostatic generator.

STATICS.—That branch of dynamics which treats of the equilibrium of forces as opposed to kinetics. The forces acting upon a body are in equilibrium when they balance one another so that no motion is produced.

STATION, ELECTRIC.—The central plant for generating power for an electric system; a power house.

STATION INDICATOR.—A volt meter or other indicating instrument located at a central station.

STATION LINE CIRCUIT.—In a telephone system, the connections of the apparatus in the bell box, receiver and transmitter. This completes the path of the electric current from one side of the line through the primary of the induction coil and transmitter to the other side of the line and causes a relay in the subscriber's line circuit in the central office to operate and a lamp to light on the switchboard in front of an operator to notify her that a connection is desired. On a call coming into this station line circuit, a connection is made in the central office which places alternator current (16 cycles) on the line and rings the bell.

STATION VOLT METER ERRORS.—Since they are usually connected permanently in circuit; a certain amount of heat is developed in the wiring of the instrument. The effect of this heat increases the volt meter resistance and consequently reduces the current below that which otherwise would pass through the meter; since the deflections of the pointer are governed by the strength of the current, station volt meters invariably indicate a voltage slightly lower than that which actually exists across their leads.

STATOR.—1. In a dynamo or motor, the part which is fixed, as distinguished from the part which rotates.

2. In an induction motor, the fixed part, which is usually the field, as distinguished from the rotor or armature.

STATOR PLATES.—In a radio variable condenser, the fixed or stationary plates.

STATOSCOPE.—An instrument for detecting minute changes of altitude of an air craft. The indications of the instrument usually depend on changes of the static pressure of the air.

STAY BOLT.—A threaded rod which is screwed through two parallel plates as in a boiler to reinforce them against the pressure of the steam. They are secured in position by nuts or by riveting. All sizes of stay bolts have 12 threads per inch. In the approved form of riveted stay, a 3/16 in. hole is drilled in each end, extending ½ in. or more beyond the inside of the plate, which will indicate a break in the stay by a leak through the drilled hole.

STAY CORD.—A continuation of the outer braid of a cord used as a fastening to relieve the conductors of mechanical strain.

STAY EYE CLIP.—An iron band furnished with a ring secured to a rigid support for the purpose of attaching a stay rod.

STEADY CURRENT.—An electric current of constant amperage.

STEAM.—The invisible vapor given off by water at its boiling point, having a pressure corresponding to its temperature. The visible white cloud popularly known as steam coming out of an exhaust pipe or safety valve outlet is not steam, but a collection of fine watery particles, formed by the condensation of steam. Steam is conveniently classified as: a, moist; b, wet; c, dry; d, saturated; e, super-heated, etc. However, strictly speaking, these terms are objectionable. For instance, steam to be called such, must be saturated, hence the word saturated is superfluous; wet steam is the combination of steam and intermingled water from the boiler in the form of spray or condensate, etc.

STEAM EXPANSION.—In a steam engine the degree in which steam is expanded is expressed in terms of the original volume, thus, four expansions mean that steam has been expanded to a volume four times as large as its original volume. The number of expansions is determined by the cut off.

Rule 1. Number of expansions equal one divided by the cut off.

Thus, if steam be cut off at one-quarter stroke, number of expansions

$$=1\div\frac{1}{4}=1\times\frac{4}{1}=4.$$

Rule 2. Number of expansions equal absolute pressure at cut off divided by terminal pressure.

Thus, if steam be expanded from 100 lbs. absolute cut off pressure, to 20 lbs. absolute terminal pressure, number of expansion $=100\div20=5$.

STEAM LOOP.—In a steam plant, an arrangement of piping wherein condensate is returned to the boiler. It consists of four essential parts: a, riser; b, goose neck; c, condenser; d, drop leg. Each part has its special and well defined duty to perform, and their proportions and immediate relations determine the capacity and strength of the system. The riser does not contain a solid body of water, but a mixture of water and steam.

The steam part of this mixture is readily condensed by means of the condenser at the top, usually and erroneously called the horizontal pipe. This condensation reduces the pressure in the system which causes an upward flow of the mixture in the riser; that is, the riser is constantly supplying steam, conveying large quantities of water in the form of a fine spray to take the place of the steam condensed in the condenser.

As soon as the water mixed with the steam passes the goose neck, it cannot return to the riser; hence, the contents of the pipes constantly work from the separator toward the boiler, the condenser being slightly inclined toward the drop leg so as to readily draw the condensate into the drop leg.

The condensate will accumulate in the drop leg to a height such that its weight will balance the weight of the mixture in the riser.

In order to proportion a steam loop properly by calculation, the specific gravity of the mixture in the riser should be ascertained, the difference of pressure between the boiler and the separator, and the pressure under which the system is to work, the latter quantity being used to determine the weight of water at the existing pressure and temperature.

STEAM TABLES.—A tabulation of the properties of steam for various pressures. The present accepted standard is the tables by Marks and Davis. These tables and instructions on how to use them are given in Audel's Engineers and Mechanics Guide, Vol. 1.

STEAM TURBINE.—A machine in which rotary motion is obtained by the action of steam impinging upon blades or vanes set upon the circumference of a drum or ring, which works within a suitable casing. The operation of a turbine is due to centrifugal force produced by changing the direction of a jet of steam escaping from a nozzle at high velocity. This is done by so placing the nozzle that the jet will impigne on numerous curved vanes attached to a wheel free to revolve, thus causing rotation.

The kinetic energy of the steam is considerable, for although its weight at ordinary pressures is very small in proportion to its volume, the velocity of steam escaping from a nozzle is very great. There are numerous types of turbines designed to meet the varied requirements.

STEARNS' DUPLEX TELEGRAPHY.—A system of duplex telegraphy operated by alternately placing the line to ground and to the battery, so that there results an "increase and decrease" of current on the line.

STEATITE.—An insulating material consisting of a grade of soapstone which withstands high temperatures.

STEEL.—A compound of iron containing .25 to 3% of carbon, usually with small quantities of silicon and manganese. The carbon causes it to harden when cooled suddenly from a red heat and to soften again when cooled slowly. Steel classed as mild or ingot steel is made by a fusion process, which frees it from intermingled slag.

The more highly carbonized varieties, such as crucible and shear steel are used for tools, weapons and springs, their properties of hardening and tempering being invaluable.

STEEL PLATING.—The electro-plating of soft metal with a coating of iron to provide a good wearing surface. The process is employed to coat printing plates so that an indefinite number of impressions may be taken from them without showing wear; also called steeling.

STEEL POLES.—On account of the increasing cost of wood and the relatively short life of wooden poles, steel poles are extensively used. The various types may be classed as: a, tubular; b, structural; c, expanded.

STEEL WIRE.—In electric transmission, steel wire is used for very long spans where high tensile strength is required. The resistivity of steel wire is 9 to 12 times that of copper. It must be galvanized to prevent rust.

STEELING.—The electro-deposition of iron or steel plating. It is used to deposit a thin surface of iron upon a copper electrotype or other printing plates of soft metal in order to harden them, so that repeated impressions may be printed without wearing away the surface.

STEEPS.—In electro-plating, solutions into which objects are dipped for a final cleansing before they are suspended in the plating bath. Also called dips.

STEERING TELEGRAPH.—A telegraph system installed in a ship for sending steering instructions from the bridge to the wheel.

STEINMETZ, CHARLES PROTEUS.—A German-American electrical engineer, scientist and mathematician, distinguished for his researches in electricity, especially in connection with alternating currents, electrochemistry, magnetism and hysteresis, dielectrics, and the theory of electrical phenomena. Coming to America as a young man, he began work as a draftsman. By contributing to electrical journals he soon attracted notice which ultimately led to his engagement by the General Electric Co. Here opportunity for experiment led to many inventions which already number over 100, and the development of extensive laboratories where researches of great importance are carried on. His brilliant mathematical mind was productive of most advanced contributions to electrical knowledge, and his books and papers are of the highest authority and everywhere recognized.

STEINMETZ'S LAW.—A law of hysteresis loss determined by C. P. Steinmetz. It states that the loss by hysteresis is proportional to the one and six-tenths power of the induction flux density.

STEM.—1. The central pin or spigot of a mushroom valve which works within a hole in the perforated seat, constituting the guide for the valve.

2. A rod working through the stuffing box of a slide valve casing, one end being connected to the valve by means of a nut or yoke, the other end being jointed to the valve gearing; usually known as a valve spindle.

STENODE RADIOSTAT.—A radio superheterodyne receiver having a piezo electric resonator (quartz crystal) in the intermediate frequency amplifier to provide selectivity.

STENO-TELEGRAPHY.—A "short hand" system of rapid telegraphy for press dispatches, employing a code of single and double letters and contractions in place of words and phrases; the signals being received by an ink recorder and then written out by the operator.

STEP BACK RELAY.—One which operates to limit the current peaks of a motor when the armature or line current increases. A step back relay may, in addition, operate to remove the cause of the limitation to the current peaks of a motor when the armature or line current decreases.—NEMA.

STEP BEARING.—A form of thrust bearing for supporting a very large vertical armature or revolving field of great weight. It consists of two cylindrical cast iron plates bearing upon each other and having a central recess between them into which lubricating oil is forced under considerable pressure by a steam or electrically driven pump, the oil passing up from beneath. A weighted accumulator is sometimes installed in connection with the oil pipe as a convenient device for governing the step bearing pumps and also as a safety device in case the pumps fail.

STEP BY STEP DIAL SYSTEM.—An automatic telephone system comprising: a, wipers of the selecting mechanisms moved both vertically and in horizontal circular arcs; b, selecting mechanisms individually driven by a combination of electromagnet and ratchet mechanisms; c, dial pulses arranged to either actuate the successive selecting mechanisms directly or to be received and stored by controlling mechanisms, which in turn actuate the selecting mechanisms by pulses similar to dial pulses.

STEP DOWN TRANSFORMER.—A type used to transform high voltage current into low voltage current for lighting and power circuits. When current is supplied to consumers for lighting purposes and for the operation of motors, etc., considerations of safety as well as those of suitability require the delivery of the current at comparatively low pressures ranging from 100 to 250 volts for lamps and from 100 to 600 volts for motors. Transformers of this type have a large number of turns in the primary winding and a small number in the secondary, in ratio depending on the amount of pressure reduction required.

STEP UP TRANSFORMER.—A type used to transform a low voltage current into a high voltage current. Such transformers are employed at the generating end of a transmission line to raise the voltage of the alternators to such value as will enable the electric power to be economically transmitted to a distant point.

STEPPING POLES.—Poles which require frequent climbing should be provided with steps to prevent damage to the pole from the climbing spurs of the workman. The steps should be spaced 18 ins. apart and located alternately on opposite sides of the pole. The lowest step is placed not less than 6½ ft. from the ground.

STEREOSCOPE.—An optical instrument by means of which two identical photographs of an object are seen simultaneously through lenses so that the object appears in relief as in nature.

STEREOTYPE.—A duplicate of a form of type or cuts is made by moulding the form in plaster, clay or papier-mache, and applying melted stereotype metal to make the plate.

STERILIZATION, ELECTRIC. — Destroying germs in a liquid by passing electric current through it.

STERN SHEAVE.—In cable laying operations, a sheave or drum over which the cable is paid out from the stern of the cable ship.

STETHOSCOPE.—A tube fitted at one end with a microphone or telephone receiver by which waterworks inspectors are able to listen at night to the flow of water through the mains, thus being able to detect waste or leakage.

STICK LOCKING.—In railway interlocking equipment, a form of approach locking which becomes effective upon the reversal of the home signal lever and does not further depend on the approach of a train.

STICKING OF ARMATURE.—A clinging of the armature of an electro-magnet to its poles after the magnetizing current has ceased in its windings.

ST. M.—Abbreviation for starting motor.

STOCK TICKER.—A "step by step" printing telegraph in which a transmitter sends pulsating signals which are responded to by a type wheel maintained in synchronism, so that letters and figures corresponding to those transmitted are automatically printed upon a paper ribbon.

STOPPER MOUNTED FILAMENT.—An incandescent lamp filament which instead of being sealed into the bulb, is mounted upon a form of stopper which is plugged tightly into the chamber.

STOPPING CONDENSER.—One that prevents the flow of d.c., but permits the flow of a.c.

STOPPING A D.C. MOTOR.—Open the main switch. When the speed of the motor has decreased sufficiently so as not to endanger the motor should the main switch be thrown, the current in the series magnet becomes weakened, and the spring throws back the starting box arm.

It should be noted that in stopping a motor having a starting box provided with a no voltage release, simply open the main switch and do not touch the lever because otherwise the self-induced voltage of the field circuit may puncture the field winding or the insulation of the adjoining wires in the starting box.

STOPPING DYNAMOS. — When shutting down a machine, the load should first be gradually reduced if possible, by easing down the engine; then when the machine is supplying little or no current, the main switch should be opened. This reduces the arcing at the switch contacts and prevents the engine racing.

When the volt meter almost indicates zero, the brushes should be raised from contact with the commutator. This prevents the brushes being damaged in the event of the engine making a backward motion, which it often does, particularly in the case of a gas engine. **On no account should the brushes be raised from the commutator while the machine is generating any considerable voltage;** for not only is the insulation of the machine liable to be damaged, but in the case of large shunt dynamos the person lifting the brushes is liable to receive a violent shock.

STOPPING OFF.—In electro-plating, the application of a coating of insulating varnish to certain parts of a metallic object in order to prevent the deposit of plate upon those parts.

STOPPING OFF VARNISH.—In electroplating, an insulating varnish employed to cover any part of an object which is not to be plated.

STOPPING OUT.—In electrotyping, the application of a coating of hot wax or a hot iron to the parts of a mould which are not to be reproduced in the electro.

STORAGE BATTERY.—A source of electricity made up of a group of storage cells; a secondary, as distinguished from a primary battery. Each cell of a storage battery contains a positive electrode or plate provided with lead peroxide (PbO_2) as its active material, and a negative plate of sponge lead (Pb) immersed together in an electrolyte of dilute sulphuric acid. These elements are held in a containing cell or jar composed of glass, hard rubber, lead lined wood or any other acid proof, water tight material, insulated from the other cells and resting on insulated supports. The storage cell is charged by a current of electricity which performs chemical action upon the elements. When discharging, the chemical action is reversed and an electric current is derived from the cell ranging from 2.1 volts at the start, to 1.75 volts when the cell requires recharging.

There are three general types classified according to the type of plates: a, plante cells; b, Faure cells; c, Manchester cells. According to construction secondary cells may be classified as follows: a, lead sulphuric acid cells; b, lead copper cells; c, lead zinc cells; d, alkaline zincate cells.

STORAGE BATTERY CAPACITY.—The product of the current drawn from the battery, multiplied by the number of hours the current flows. The unit in which it is measured is the ampere hour.

STORAGE BATTERY CARE.—Note the following instructions:

1. A battery must always be charged with "direct" current and in the right direction.

2. Be careful to charge at the proper rates and to give the right amount of charge; do not undercharge or overcharge to an excessive degree.

3. Do not bring a naked flame near the battery while charging or immediately afterwards.

4. Do not overdischarge.

5. Do not allow the battery to stand completely discharged.

6. Voltage readings should be taken only when the battery is charging or discharging; if taken when the battery is standing idle, they are of little or no value.

7. Do not allow the battery temperature to exceed 110° Fahr.

8. Keep the electrolyte at the proper height above the top of the plates and at the proper specific gravity. Use only pure water to replace loss by evaporation.

9. In preparing the electrolyte never pour water into the acid.

10. Keep the cells free from dirt and all foreign substances, both solid and liquid.

11. Keep the battery and all connections clean; keep all bolted connections tight.

12. If there be lack of capacity in a battery, due to low cells, do not delay in locating and bringing them back to condition.

13. Do not allow sediment to get up to the plates.

14. Keep the tops of closed batteries clean.

STORAGE BATTERY DIAGNOSIS.—Look for conditions which indicate answers to the following questions:

1. Is the electrolyte at the proper height in all of the cells?

2. Are all of the plates and separators in proper position?

3. Are the negative plates light gray, dark gray or dark gray with white powder on the surface?

4. Are the negative plates cracked, buckled, or is the active material falling out in lumps?

5. Are the negative plates blistered?

6. Is the active material of the negative plates swollen out beyond the surface of the grids?

7. Is there a mossy deposit on the tops of the negative plates?

8. How much sediment is there in the bottoms of the jars?

9. Is the sediment dark brown, light brown, gray or white? (If the sediment be deposited in layers of different color, note the amount and color of each, beginning at the bottom. Note also whether the layers be composed of fine or lumpy material.

10. Are the positive plates dark brown or light brown?

11. Are the positive plates cracked, buckled, or is the active material falling out in lumps?

STORAGE BATTERY METER.—A form of meter for measuring the amount of electrical energy accumulated in a storage battery.

STORAGE BATTERY SHORT CIRCUITS.—A short circuit may arise through any of the following causes:

1. Through direct contact between adjacent plates.

2. Through some conducting material such as a piece of lead, solder, spongy lead or oxide of lead sticking between the plates.

3. Through direct or indirect contact with the lining of the tank, if lead lined tank be used.

4. Through foreign particles such as wood, straw, fibre, plaster, etc., getting into the cells.

5. Through unintentional touching of lugs on adjacent plates.

6. Through the accumulation of sediment in the bottom of the jar or tank.

7. Occasionally fine particles which are not noticeable at first, may bridge across, grow larger and become short circuits.

STORAGE BATTERY TESTING.—The following methods are based on practice used by many successful battery men:

1. When the electrolyte covers the plates, make a hydrometer test for gravity. If all the cells read below 1.175 put the battery on charge for several hours. This battery is too weak to give accurate results on a high rate discharge test.

2. If the electrolyte be low, fill with distilled water to the proper level and put on charge for several hours to mix the electrolyte and bring the gravity to 1.200.

3. If all three cells read over 1.200, make a high rate discharge test at once.

4. If two cells show a gravity of 1.200 or over and the third cell is off 50 points or more on the hydrometer, look for trouble. Make the high rate discharge test at once.

5. When the gravity of any two cells in the battery on charge passes 1.200, remove and make a high rate discharge test.

STORAGE BATTERY TRACTION.—Electric traction by means of storage batteries carried on the cars. Many attempts have been made to introduce this method of propulsion, but none have proved successful. The great weight of the cells, the acid fumes that arise from them and their rapid deterioration under vibration have been the chief drawbacks to their use. Batteries are, however, sometimes usefully employed to drive industrial locomotives in manufacturing plants.

STORAGE CELL.—A secondary cell consisting of plates or of grids in an electrolyte of such a character that the electrical energy supplied to it is converted into chemical energy (a process called charging). The chemical energy can be reconverted into electrical energy (a process called discharging). The electrolyte generally used consists of a weak solution of sulphuric acid which permits ready conduction of the current from the charging source; the greater the proportion of acid within certain limits, the smaller the resistance offered. Properly called secondary cell.

STORING POLES.—In transmission line construction where poles are to remain in the yard for a considerable period of time, they should be sorted according to different classes and lengths and placed on skids. Make the skids of old poles where practicable and space them about fifteen feet apart in a location where water does not accumulate.

STORM, ELECTRIC.—An exceptional disturbance in the earth's magnetism which sometimes occurs from unknown causes. It is evidenced by unusual irregularities in the magnetic compass and by extraordinary displays of the aurora; a magnetic storm.

STOVE PLATE, ELECTRIC.—A metal plate furnished with electrical resistance on its under side, so that it may be sufficiently heated for cooking purposes.

STRAGGLING FLUX.—The magnetic flux which escapes from the pole face of a dynamo electro-magnet by any other path than across the air gap to the armature; the leakage flux as distinguished from the useful flux.

STRAIGHT AIR BRAKE.—A type of air brake in which the brake cylinder is connected directly to the motorman's valve which governs the admission of air to the brake cylinder and the exhaust of this air from the cylinder to atmosphere. The brakes are applied by admitting air to the brake cylinder and are released when the air in the cylinder is exhausted to atmosphere.

STRAIGHT ANGLE.—One in which the sides of the angle extend in opposite directions and form a straight line. A straight angle is equal to two right angles.

STRAIGHT AWAY BUNCHED CABLE.—A bunched cable in which the conductors are arranged in parallel lines instead of being twisted together.

STRAIGHT LINE CONDENSER.—A type of radio tuning condenser in which the plates are so shaped that the number of degrees of rotation of the shaft is proportional to the change produced in: a, the condenser's capacity; b, wave length or; c, frequency. These are called: a, straight line capacity condenser; b, straight line wave length condenser; and c, straight line frequency condenser.

STRAIGHT LINE FREQUENCY CONDENSER.—A radio variable tuning condenser in which the number of degrees advanced by the rotor is proportional to the change in frequency.

STRAIGHT LINE INSULATOR.—A form of trolley hanger provided with extension lugs for the attachment of the wires used in connection with span wires where the line is straight.

STRAIGHT OUT COIL.—A type of former wound coil used on armatures for barrel winding.

STRAIGHT REPULSION MOTOR.—A type of a.c. commutator motor consisting of a single phase a.c. field and an armature similar to that used on a.c. series motors. There is no electrical connection between the field and armature, the brushes of the latter being short circuited.

STRAIN.—The deformation of a body resulting from a stress.

STRAIN INSULATOR.—One used for the double purpose of taking the mechanical strain at a bend or at the end of a conductor and also insulating the same electrically.

STRAIN SHEETS.—An engineering term applied to the various sheets of drawings and calculations, used to determine with precision the strength of the members, both iron and wood, of a structure; as, of a bridge or roof.

STRAND.—1. One of the wires, or groups of wires of any stranded conductor.

2. Group of single wires in one or more layers, twisted together helically and symmetrically with a uniform pitch around a single central wire or neutral axis. This construction is sometimes called concentric strand.

STRANDED CORE.—A cable core made up of a number of conductors as distinguished from a solid wire core.

STRANDED WIRE.—A group of small wires, used as a single wire. A wire is a slender rod or filament of drawn metal. If such a filament be sub-divided into several smaller filaments or strands, and be used as a single wire, it is called a stranded wire. There is no sharp dividing line of size between a stranded wire and a cable. If used as a wire, for example, in winding inductance coils or magnets, it is called a stranded wire and not a cable. If it be substantially insulated, it is called a cord.

STRANDING.—If a solid copper wire be made larger in diameter than .46 in. it becomes hard to splice and difficult to handle, owing to its size and stiffness. Conductors larger than this are nearly always built up of small wires twisted into a strand or cable. The flexibility of a cable will increase as the size of the constituent wires decreases or as the number of wires increases, and it will depend somewhat upon the method of laying up the cable.

STRAP.—A polishing belt used by electro-platers, burnishers and brass finishers. Sometimes made endless, of two thicknesses of duck with india rubber between, but generally of heavy cotton duck, supplied in widths from one to six inches, the ends being sewed together. Emery powder, quartz, flint or other abrading and polishing agents are used on the straps.

STRAP BRAKE.—A simple variation of the Prony brake for testing the horse power of engines. A strap or piece of belt furnished with shoes is so disposed around the fly wheel as to form a $\cap$; the curve enclosing at least half the circumference of the wheel, while a steelyard is interposed between either end and the floor or foundation. An arrangement is made for adjusting the tension on the tight side of the strap, so as to insure a fair pull, and the product of the difference between the indications, on the two spring balances, multiplied by the linear velocity of the rim, in feet per minute, gives the power supplied by the engine.

STRAP COPPERS.—Copper strips used as the conductors of a bar armature.

STRAP KEY.—A key making electrical contact by means of an elastic strip which is secured to the base at one end and provided with a button at the other.

STRAP SWITCH.—A term sometimes used for the simplest form of knife switch, consisting of a blade of copper hinged at one end and making contact at the other end between flexible copper jaws.

STRATHAM'S FUSE.—A variety of fuse for igniting an explosive by means of an electric spark.

STRATIFIED DISCHARGE.—The luminous discharge, consisting of stratifications or striae of light, which takes place in a low vacuum tube at a certain degree of exhaustion.

STRAY CHAIN.—In submarine cable operations, a section of chain by means of which the end of a cable may be fastened to a buoy or anchor.

STRAY CURRENTS.—1. Currents induced in the mass of a metal either by being cut by a moving magnetic field or by moving in the field. These currents circle about within the metal, absorbing energy and converting it into heat. They are usually called eddy currents, and sometimes Foucault currents after a French experimenter who investigated them. Eddy currents are the cause of much loss of energy in dynamos, motors and transformers. To obviate them, iron cores of armatures and induction coils are laminated or built up of thin metal stampings, the plane of division being arranged to lie parallel with the lines of magnetic force and at right angles to the direction the induced currents would tend to flow.

2. Currents which leak away from a street railway system through the ground, following underground pipes and other buried conductors, disentegrating and otherwise damaging them by the electro-chemical action known as electrolysis.

3. Upon the formation of stray or eddy currents depends the operation of squirrel cage motors. See how a squirrel cage motor works; page 1811, Audel's New Electric Library, Vol. IV.

STRAY FIELD.—A part of an electro-magnetic field which fails to find its way through the armature, being dissipated by leakage; a waste field.

STRAY FLUX.—Lines of force which follow a stray path or leak from an electro-magnetic machine. and are wasted. In a generator or motor certain lines of force pass from one pole piece to another through the air or through the frame instead of through the armature; leakage flux.

STRAY SIGNAL.—In radio, any interfering sound other than the desired signals to whose wave length the radio set is tuned.

STRAYS.—In radio reception, electro-magnetic disturbances not coming from the transmitter.

STREAM LINE.—The shape of a body or part of an airplane which presents the least resistance to the wind.

STREAMERS.—Streaks of pale light seen in connection with the aurora streaming in the direction of the magnetic north.

STREAMING DISCHARGE.—A form of disruptive discharge of very high frequency; phantom streams.

STREAMINGS.—1. The flux in an electro-magnetic or electrostatic field.

2. The radiation emitted by radio-active substances.

STREET CAR MOTOR.—A motor for propelling an electric trolley car, and geared to a large gear on one of the car axles. In order to insure the parallelism of these gears and pinions, one end of the motor is fastened directly to the car axle, the other end is supported by springs, which permits of a movement of the motor and does away with the jar and strain which would otherwise occur on the starting and stopping of the car.

STREET MAINS.—The principal conductors in a system of electrical distribution running through conduit systems under the streets, receiving current from feeders and distributing current to service wires along the line.

STRENGTH OF CURRENT.—The quantity of electricity which flows past any point of the circuit in one second. For instance, if during 10 seconds 25 coulombs of electricity flow through a circuit, then the average strength of the current during that time is 2½ coulombs per second, or 2½ amperes.

STRENGTH OF FIELD.—The intensity of a magnetic field. It is the force with which it acts upon a unit pole at any point. The unit of intensity is that which acts on a unit pole with a force of one dyne. The strength of a magnetic field corresponds to the acceleration of the force of gravity in the case of a falling body.

STRENGTH OF MAGNET.—The magnetic force exerted by either of the poles of a magnet. The strength of a magnet is not the same thing as its "lifting power." The strength of a magnet is the strength of its poles. The strength of a magnet pole must be measured by the magnetic force which it exerts.

STRENGTH OF MATERIALS.—A general expression for the measure of resistance possessed by solid masses or pieces of various kinds, to any causes tending to produce in them a permanent and disabling change of form or positive fracture.

STRIAE, ELECTRIC.—Luminous bands alternating with dark spaces seen between the electrodes in a low vacuum tube at a certain degree of exhaustion.

STRIKING THE ARC.—1. Producing an arc in an electric arc lamp by bringing the two carbon tips together and then separating them, so that the current causes a spark which, by volatilizing some of the carbon, maintains the passage of the electric current.

2. In electric welding, the principal precaution to be observed when striking the arc is to prevent freezing or sticking of the electrode to the work. This is caused in the following manner: The electrode touches the work only on a small surface, a point, or sharp corner. The heavy current melts this and it sticks to the plate. More of the electrode melts and, as it is being pushed against the plate, the end of the electrode will weld fast. The current then rapidly heats the rest of the electrode, unless it is broken away at once. This trouble is avoided by quickness in making the electrode touch the work and in bringing it back just away from the plate. The electrode should be drawn back to the arc length somewhat more slowly than the movement in the first part of the action

STRIKING BATH.—In silver plating, a preliminary bath, containing a weak solution of silver cyanide and a large proportion of potassium cyanide, employed to give an instantaneous coating of silver over an article for the purpose of insuring a perfect deposit in the regular silver bath.

STRIKING DISTANCE.—The distance between two electrodes of a spark gap across which a spark will jump. Inductions coils are designated by their sparking distance, thus, a "10-inch coil" is an induction coil which can produce a spark ten inches long between the points or knobs attached to the ends of its secondary circuit.

STRIKING MECHANISM. — An electromagnetic coil placed in the main circuit of an arc lamp for automatically striking the arc when the current passes.

STRING GALVANOMETER. — An electrocardiograph.

STRINGING.—In pole line construction, after erecting the poles and equipping them with cross arms, insulators, etc., the process of running the wires from pole to pole.

STRINGING TRANSMISSION LINE WIRES.—The order in which the operations of stringing the wires as usually performed on the average job is as follows:

1. Set up the reels at a starting point which call A.

2. Pull the wires out through the first section, the length of which is determined by the conditions;

3. Dead end the wires at the starting point A, and where necessary place a temporary guy on pole at end of the first section B;

4. Pull the wires to the proper tension and sag, in the first section, locating the apparatus for pulling at the end of the section B, and snub the wires at B.

5. Tie in the wires after they have been pulled up to the proper tension and snubbed.

6. Continue the operation in the succeeding sections in the same manner, except that the wires should be spliced to the wires of the preceding section instead of dead ending them as at the starting point.

7. Remove temporary head guys as the job progresses.

STRIP COMMUTATOR. — A commutator composed of flat metal strips.

STRIP FUSE.—The simplest form of safety fuse for breaking an electric circuit when the current becomes excessive. It consists of a thin strip of fusible metal provided with copper terminals by which it is screwed down to the terminals of the circuit.

STRIPPING.—Removing the layer of metal that has been deposited upon a plated article. It is effected, either by treating the article with a strong acid, or by suspending it as the anode in a stripping bath, and subjecting it to the action of electrolysis.

STRIPPING BATH.—A bath containing a metallic salt for the purpose of removing the plating from an article coated with the same metal as that in the solution, by the action of electrolysis.

STROBOSCOPE.—An instrument for the study of periodic motion, especially of a rotating body by periodically interrupted illumination, either by electric sparks or by a beam of light seen through a perforated disc.

STRUCK.—In electro-plating with silver, the state of an object that has been subjected to a striking bath preparatory to the regular plating bath.

STRUCTURAL FILAMENT.—An incandescent lamp filament in which the fibrous structure of a carbonized organic substance is retained.

STRUCTURAL MAGNETIC FLUX.—A magnetic flux occurring in a magnetizable substance by the action of its molecules, which are regarded as individual original magnets influenced by an external magnetizing force.

STRUCTURAL POLES. — For transmission lines, latticed steel poles; a type of construction largely used. The design and adaptation are greatly diversified.

STRUT. — A compression member of a structure.

STRUTS FOR POLES.—Supports which resist lateral stress by compression.

STUBS' WIRE GAUGE. — There are two Stubs' wire gauges: a, Stubs' iron wire gauge, and, b, Stubs' steel wire gauge. In using the gauges known as Stubs gauges there should be constantly borne in mind the difference between the two kinds. The Stubs' Iron Wire Gauge is the one commonly known as the English Standard Wire, or Birmingham Gauge, and designates the Stubs' soft wire sizes. The Stubs' Steel Wire Gauge is the one that is used in measuring drawn steel wire or drill rods of Stubs' make and is also used by many makers of American drill rods.

STUD.—1. A short rod, fixed in and projecting from something; sometimes forming a journal.

2. In machine shops, a boss or protuberance designed to hold an attached object in place.

STUD BOLT.—A bolt with threads on both ends to be screwed into a fixed part at one end and receive a nut upon the other.

STUFFING BOX.—A device affording passage and lengthwise or rotary motion of a piece, as of a piston rod or shaft, while maintaining a fluid tight joint about the moving part. In construction, there is an annular space around the moving part, closed by an adjustable flanged bushing or gland, so that when the annular space is filled with fibrous packing the proper pressure may be applied to same to secure a tight joint. In some cases the end surfaces of the annular chamber containing the packing are flat but usually are slightly conical to force the packing against the rod. In design, the length and diameter of the stuffing box depends on the material used and the working pressure. In the case of horizontal cylinders when the stuffing box becomes also a bearing, it may be made longer. For the valve stem, the box is proportionately deeper than for the piston rod. In general, the stuffing box may be from 2 to 3 times the diameter of the rod, and its diameter from 1⅝ to 1¾ times diameter of rod.

STUMM'S ADDED ADJUSTABLE LINE RESISTANCE.—A method of balancing multiplex telegraph office equipment against wet weather line leakage. Invented by Frank A. Stumm. This method leaves the artificial rheostat stand unchanged at normal ohmage, i.e., equal to the actual line resistance in dry weather and when the wet storm begins to cause leakage, line resistance is looped in between the relay and line sufficient to balance the artificial ohmage and by being added to sufficiently as required maintains a steady working balance reversing the procedure as the storm recedes.

STURGEON'S COMMUTATOR.—An early form of commutator for a dynamo armature, consisting of a split copper tube.

SUB-EXCHANGE.—A local telephone exchange, as, for example, an exchange for serving the telephones in a single building, as distinguished from a central exchange.

SUB-FEEDER.—Same class as a feeder, but is distinguished either by being one of two or more connecting links between the end of a single feeder and several distributing mains, or by constituting an extension of a feeder.

SUB-HARMONIC.—A wave motion having a frequency lower than the frequency of the fundamental wave; in value equal to the fundamental frequency divided by a whole number.

SUB-MAINS.—Electric conductors branching from mains, and themselves serving other branches.

SUBMARINE BOARD.—A telegraph set for submarine telegraphy, mounted upon a board.

SUBMARINE BOAT. — A boat for naval warfare, propelled and manoeuvered under water by electricity.

SUBMARINE CABLE. — A telegraph cable consisting of stranded copper wires surrounded by insulating material, and protected by a sheath of steel wires, for use in submarine telegraphy.

SUBMARINE FINDER.—An apparatus, on the principle of the induction balance, designed to indicate the location of metallic objects under water.

SUBMARINE FUSE.—A fuse for the purpose of exploding a torpedo or submarine mine.

SUBMARINE MINE.—In naval warfare, an explosive mine placed under water and fired by an electric current from the shore when an enemy's vessel passes over it.

SUBMARINE SEARCHLIGHT.—A powerful incandescent lamp designed for use in diving operations.

SUBMERSIBLE APPARATUS. — Apparatus so constructed that it will operate successfully when submerged in water under specified conditions of pressure and time. —**NEMA.**

SUBSCRIBER'S INDICATOR.—A telephone switchboard drop indicating the call of a subscriber.

SUBSTATION.—In an electric railway system extending over a considerable area, it is customary to distribute the power in the form of high tension a.c. and transform it by means of step-down transformers and rotary converters to d.c. for feeding the trolley wire. The apparatus for transforming is located in substations conveniently situated for meeting the demand for current at different sections of the line. Portable substations consisting of specially designed cars with complete substation equipment are frequently employed to provide for temporary excessive use of portions of the line, as at resorts or at the time of sporting events, etc.

SUB-STATION SYSTEM.—In electrical distribution by means of transformers, an arrangement in which transformers fed by high pressure currents, are located at advantageous points, having their secondaries joined to a complete network of low-pressure distributing mains.

SUBSTITUTION METHOD.—The simplest method of measuring resistance. The resistance to be measured is inserted in series with a galvanometer and some constant source of current, and the galvanometer deflection noted. A known adjustable resistance is then substituted for the unknown and adjusted till the same deflection is again obtained. The value of the adjustable resistance thus obtained is equal to that of the resistance being tested.

SUBTENDED ARC.—Portion of the circumference between the intersections of a chord.

SUBTERRANEAN MINE. — An explosive mine placed underground and ignited by an electric current from a distance.

SUBTRACTION. — The process of taking one number called the subtrahend from another number called the minuend. The result thus obtained, or "difference" between the two numbers, is called the remainder.

SUBTRACTIVE AND ADDITIVE POLARITY.—Take a single phase transformer having two high voltage and two low voltage external terminals. Connect one high voltage terminal to the adjacent low voltage terminal and apply voltage across the two high voltage terminals. Then if the voltage across the unconnected high voltage and low voltage terminals be less than the voltage applied across the high voltage terminals, the polarity is subtractive; while if it is greater than the voltage applied across the high voltage terminals, the polarity is additive.—**NEMA.**

SUB-TRANSFORMER STATION.—In a system of electrical distribution by means of transformers, the points where transformers are located for supplying low pressure currents to a network of distributing mains.

SUBWAY.—An underground electric railway used in large cities where the traffic is too heavy to be carried by street cars.

SUBWAY LIGHTING. — Typical methods are: a, direct lighting feeders from power houses or sub-stations of the traction company or of another traction company; b, direct lighting feeders from power houses or sub-stations of electric light companies; c, connections from both with interchange switches; d, connections from third rails with interchange switches; e, connections of separate groups of lights from separate sections of third rails or separate sources.

A typical installation employs high tension, 11,000 volt cables run from the traction company's power houses or substations to the subway stations. A transformer room is located at the end of each station platform. The current at 11,000 volts is transformed there to 600 volts and sent along the lines for lighting the stations and tunnels.

SUBWAY TRANSFORMER.—One which is so constructed that it will operate successfully when submerged in water under specified conditions of pressure and time.

SUCCESSIVE CONTACT KEY.—A key designed to close two or more electric circuits in succession.

SULPHATE OF COPPER.—Copper sulphate, a compound of copper, sulphur and oxygen. In a crystallized form it is known as blue vitriol or bluestone. It is used in copper plating, electrotyping, as the depolarizer in the Daniell primary cell. In dyeing and calico printing, etc.

SULPHATE OF IRON.—Ferrous sulphate. Also known as copperas or green vitriol. It forms bluish green transparent crystals which readily dissolve in water, and effloresce and oxidize in the air. In electro-plating ferrous sulphate is used in the preparation of iron baths, and for the reduction of gold from its solutions.

SULPHATION OF PLATES. — During discharge a storage cell deteriorates on account of the formation of lead sulphate over the surface of the plates. The lead sulphate is the product of the chemical combination of the active material with the electrolyte. It is an insulator, white in color and of greater volume, in proportion, than the active material. When the discharge of the cell is over prolonged, the sulphation is evidenced by the electrodes becoming lighter in color, because of the deposit of the sulphate which lessens the active surface, and, if further continued, by the loosening or breaking up of the active material or the "buckling" of the plates. Sulphation is sometimes caused by a too weak or too strong acid solution, but more generally by continued over discharging, or too rapid discharging of the batteries, or by allowing them to remain uncharged for long periods of time.

SULPHURIC ACID.—A compound of hydrogen, sulphur and oxygen. The most important and widely used chemical in commerce, and its manufacture is one of the greatest of chemical industries. It is a colorless oily liquid, fuming slightly in air. It is very poisonous and corrosive. It forms the basis of manufacture of nearly all the other acids and salts, chemical manures and fertilizers, and is used largely in metallurgy, in the manufacture of certain papers, cellulose, explosives, coal tar colors and dyes, in tanning, refining and the preparation of various sulphates. In electric practice, sulphuric acid solutions are used as electrolytes in many primary cells and universally in storage batteries, and in electro-plating, fuming sulphuric acid is used as a mixture with nitric acid for stripping silvered objects. Also called oil of vitriol.

SUMMER LIGHTNING.—Also called heat lightning. A form of lightning flash, seen at the horizon as a sudden lighting up of the clouds without any sound of thunder. It is merely the reflection from a thunder storm taking place at too great a distance for the thunder to be heard.

SUN FLOWER COMMUTATOR.—A form of disc armature with radiating parts resembling a sun flower.

SUN SPOT DISTURBANCE.—A disturbance of the earth's magnetism, such as a "magnetic storm," attributed to the occurrence of spots on the sun in an unusual degree.

SUN STROKE.—Any affection produced by the action of the sun on some part of the body, especially a sudden prostration of the physical powers with symptoms resembling those of apoplexy, occasioned by exposure to excessive heat. Treatment: "Put patient in cool place, apply ice water and pounded ice in cloths to the head, back of neck and spine. If there be more of exhaustion than of sunstroke, give stimulants gradually and be sparing of the ice and cold water."

SUN STROKE, ELECTRIC.—A name given to the effect, resembling sun stroke, sometimes experienced by persons too long exposed to the light of an intense electric arc; treatment for this is same as for sunstroke, as given above

SUN TELEGRAPH.—The heliograph, an instrument for long distance signaling by flashes of sunlight reflected from a mirror. The signals are read from the distant station by means of a telescope, according to a prearranged code.

SUPER FEED BACK.—In radio feed back regeneration, there is with the ordinary set a limit to the possible regeneration. This difficulty is overcome in the super-regenerative sets. These make use of the principle that by introducing into the circuit an alternator, whose frequency is above audibility, the feed back will periodically be raised and lowered about the oscillation point. By this means a tremendous feed back is possible, although the set is somewhat "critical" and difficult to adjust. The alternating current is usually produced by an electron tube oscillator, which may be a separate tube, or the detector tube itself.

SUPERFICIAL EDDY CURRENTS.—Eddy currents occurring upon the surface of a conducting body.

SUPERFICIAL MAGNETISM.—Magnetism in a bar of iron or steel confined to the surface of the metal only.

SUPER-HEATED STEAM.—Steam having a temperature higher than that corresponding to its pressure. If a closed vessel containing water and steam be heated the pressure of the steam will gradually rise until all the water has been evaporated. At this point the further addition of heat will not produce any appreciable increase in pressure, but will cause a rise in temperature in which condition the steam is said to be superheated. The reason for super-heated steam is to permit single stage expansion working in an engine through a greater temperature range before the temperature of saturation is reached, that is, with falling temperature, the temperature at which condensation begins.

SUPERHEATER.—In steam engineering, an arrangement of tubes and headers placed in a boiler to impart heat to the steam in addition to that which it already holds as saturated steam, and thereby giving it power to do more work. This additional heat is imparted after the steam leaves the dry pipe and before it enters the steam chests.

SUPERHEATING.—In steam engineering, the practice of heating steam to a temperature above that due to its pressure. According to Barrus, who has made many engine and boiler tests, the saving in feed water for engines operating with superheated steam is about one per cent for every eleven degrees of superheat. Superheating has been very successfully introduced in steam automobiles. According to tests of Prof. Carpenter, the White engine working with highly superheated steam, operates on less than eleven pounds of water per hour per brake horsepower, a performance only approached by large compound condensing Corliss engines and quadruple expansion pumping engines.

SUPER-HETERODYNE PRINCIPLE. — A radio principle of reception in which current is generated by a local oscillator at a frequency which, after combining with the original signal current, will be converted into an intermediate frequency beat current.

The intermediate beat current, which is low in frequency, can be amplified with minimum loss due to inter-electrode capacity, and then passed through the detector tube to be converted again, this time into an audio frequency current which is capable of reproducing the original signal wave in the phone or loud speaker.

SUPER-HETERODYNE WITH SECOND HARMONIC OSCILLATOR.—In this radio hook-up, the second harmonic oscillator is operated on the principle that an oscillating vacuum tube circuit generates a current of fundamental frequency and also produces other oscillations which are multiples of the fundamental frequency.

These upper frequencies in multiples of the fundamental are called harmonics; several of which are strong enough to be utilized in the same way as the fundamental.

SUPER IMPOSED RINGING CURRENT.—In telephony, a combination current for ringing, consisting of a direct and an alternating current.

SUPER-IMPOSED WAVE CURRENT.—In electro-therapeutics, a current consisting of a compound wave formed by superimposing a rapid sinusoidal on the galvanic current and retaining the valuable therapeutic properties of both. Adjustment 10 to 90 pulsations per minute. This current affords deep abdominal and pelvic contractions and hence is indicated in visceral or pelvic ptosis. Excellent results may be obtained by applying the current at the seventh and eighth dorsal vertebrae. Many clinicians precede this current with diathermy to aid in breaking up and absorbing deep adhesions. This modality is also valuable in treating flat foot, with one pad under each arch and each pad connected to one binding post of the polysine.

SUPERPOSED CIRCUIT. — An additional circuit obtained from a circuit normally required for another service, and in such a manner that the two services can be given simultaneously without mutual interference.

SUPER-REGENERATION.—A method of amplifying in which self-oscillations are prevented by periodically damping the circuit.

SUPERSONIC RECEPTION.—In radio, just above audibility reception; super heterodyne reception.

SUPER-SYNCHRONOUS MOTOR.—A synchronous motor in which the armature, or usual stator, is arranged so that it can rotate around the shaft, but is normally held stationary by a brake around its outer periphery.

When starting up the motor, the brake is first released and power is applied to the motor from the auto-transformer taps. Now, since the rotor is connected to the load, while the armature is entirely free to rotate except for the slight bearing friction, the armature begins to revolve around the field instead of the field revolving inside the armature, as in the standard motor. The armature is brought up to full speed and field applied, so that the motor is running in synchronism and capable of exerting its full pull out torque. To transfer rotation from the armature to the rotor the brake is now applied gradually, the relative motion remaining at synchronism and the armature comes to rest while the rotor and load come up to synchronous speed.

SUPERVISING OPERATORS.—In a telephone exchange, operators of exceptional ability who have the supervision of the switchboard operators.

SUPERVISORY SIGNAL.—In telephony, a device for attracting attention of an attendant to a duty in connection with switching apparatus or its accessories.

SUPPLEMENT OF ANGLE.—The difference between a given angle and 180°.

SUPPLY MAINS.—In a system of electrical distribution, the mains which convey the current from the central station.

SUPPRESSOR.—In radio, a resistance placed in the grid circuit of a radio frequency amplifying tube to prevent feed back oscillation.

SURD.—An indicated root that cannot be extracted. A quantity that cannot be expressed in figures.

SURFACE CONDENSER.—An apparatus for condensing steam, especially the exhaust of a steam engine, by bringing it into contact with metallic surfaces cooled on the other side by water. The modern surface condenser is formed of small brass tubes, usually ⅝ in. to ¾ in. diameter and 5 to 10 ft. long. The common arrangement is to place the tubes horizontally in a cylindrical or rectangular box and to admit the water in at the bottom and the steam at the top. The best practice is to bring the water through the tubes and the steam outside. The heat is thus drawn from every direction and absorbed by the rapidly moving cooling water. This water is generally called the circulating water, and its circulation through the condenser is maintained by a pump called the circulating pump. The condensate and the accumulating air are drawn away by a similar pump called the air pump (not vacuum pump). In marine practice the surface condenser permits the use of impure or salt cooling water without bringing same into contact with the condensate, hence the condensate is available for use as boiler feed. For this reason the only type of condenser that can be used for marine service on salt water where the condensate is to be used as feed water, is the surface condenser.

SURFACE CONDENSER COOLING SURFACE.—According to Seaton, in practice with the compound engines, brass condenser tubes 18 B.w.g. thick, a condensation of 13 lbs. of steam per sq. ft. per hour, with the cooling water at an initial temperature of 60° is considered fair work when the temperature of the feed water is to be maintained at 120°. In general practice the following holds good when the temperature of the sea water is about 60°.

Terminal pressure lbs. absolute	Sq. ft. cooling surface per i.h.p.
30	3
20	2.5
15	2.25
12½	2
10	1.8
8	1.6
6	1.5

For ships stationed in the tropics, the allowance should be increased 20%; for ships stationed in cold climates 10% less suffices (Seaton).

SURFACE CONTACT RESISTANCE.—The resistance offered at the contact surface between the metal plates and the solution in a primary or secondary cell.

SURFACE, CONTACT SYSTEM.—A system of electric traction employing a row of iron or steel studs projecting slightly above the roadway, and placed midway between the rails of the track so that a contact skate carried by the cars shall rub upon them and thus convey current to the motors.

SURFACE DENSITY.—The quantity of electricity per unit area at a given point on the surface of a charged body.

SURFACE LEAKAGE.—Escape of electric current over the surface of insulating material which provides a conducting path, due to moisture or other foreign matter.

SURGE.—A rapid fluctuation of voltage due to abnormal conditions such as lightning, switching, etc.

SURGICAL LAMP.—A miniature incandescent lamp of special design employed in surgery for exploring the cavities and examining the organs of the human body.

SURGING.—Current variations due to hunting of two alternators working in parallel. This condition causes the machines to alternately lag and lead with respect to each other. When two machines are operated in parallel with "peaked" current wave it is difficult to keep them in step. Any difference in the phase relation which is set up by the alternation will cause a local or synchronizing current to flow between the two machines and at times it becomes so great that they must be disconnected. This trouble is avoided by the use of dampers and amortisseur windings. The latter are often erroneously called squirrel cage windings.

SURGING CIRCUIT.—An electric circuit which is undergoing oscillations due to rapid charging and discharging.

SURGING DISCHARGE.—An oscillatory discharge. When a charged condenser is discharged through a conductor a series of extremely rapid oscillations or surgings take place, the condenser becoming positively and negatively charged in turn. An alternating current thus flows in the conductor and rapidly dies away as the energy of the condenser is dissipated.

SURINAM EEL.—The common name for the gymnotus electricus, a South American eel possessing animal electricity in the highest degree known. The electric organ extends the whole length of its body and is capable of giving a powerful shock.

SURVEYORS' OR OLD LAND MEASURE.—

7.92	ins.	=1 link (l.)
25	links	=1 rod (rd.)
4	rods or 66 ft.	=1 chain (ch.)
80	chains	=1 mile (mi.)

Unit equivalents

			l.	ins.
		rd.	1=	7.92
	ch.	1=	25=	198
mi.	1=	4=	100=	792
1=	80=	320=	8,000=	63,360

Scale—ascending, 7.92, 25, 4, 80; descending, 80, 4, 25, 7.92.

NOTE.—The denomination rods is seldom used in chain measure, distances being taken in chains and links.

SUSCEPTANCE.—One of the two components attributed to the property admittance (the reciprocal of impedance) in an alternating current circuit, in which the power component is called the conductance and the wattless component the susceptance.

SUSCEPTIBILITY MAGNETIC.—The ratio between the intensity of the magnetization of a substance and the magnetizing force applied to it to produce magnetization; the coefficient of magnetization.

Expressed as a formula:

$$k=\frac{I}{H}$$

in which k=susceptibility, I=intensity of magnetization, and H=magnetizing force.

SUSPENSION EAR.—A trolley ear; a device for suspending an overhead trolley wire. It is made in a great variety of forms, but consists essentially of a casting which is supported by the span wire or bracket, and, insulated from this casting, an ear that grips or is soldered to the trolley wire. A plain ear is used in ordinary work; a strain ear has lugs for tension wires; a feeder ear is provided with a special lug for a tap from the feeder; and a splicing ear acts as a splice where the trolley wire comes to an end at a hanger.

SUSPENSION INSULATOR.—One which is suspended by a hook or wire.

SUSPENSION OF MOTOR.—The method of supporting a motor upon the truck of an electric car. There are three well known methods: a, the nose suspension, in which the back of the motor is supported by the axle, and the front is carried by a crossbar resting on springs supported by the side frames of the truck; b, the cradle suspension, in which the motor rests in a cradle which is supported in front by a cross beam joined to the side frames of the truck, and at the back by springs which bear on the arm that carries the axle bearing; and c, side bar suspension in which two parallel spring-supported side bars carry the weight of the motor either from above or below.

SUSPENSION RAILWAY.—A form of monorail road, in which the cars travel underneath the track upon which their wheels run. Such forms are convenient for transporting material within an area where it is desirable to leave the floor quite clear, the car being usually driven by an electric motor, which is controlled by an attendant sitting in the cage suspended from the trolley.

SUSPENSION WIRE.—A wire or cable usually known as a messenger wire from which an overhead conductor is suspended. A messenger wire.

SUSTAINED OSCILLATION.—In a radio oscillatory circuit, the condition of equalized energy input and output.

SUSTAINED WAVES.—In radio, a name sometimes used for continuous waves.

SWAGING, ELECTRIC.—The use of a swage in imparting shape to metal which has been first softened by heat.

SWEATING.—A method of soldering in which the surfaces to be joined are cleaned, heated, fluxed and covered with a film of solder. The soldered surfaces are then placed together and heated either with a bit or blow torch until the solder melts and unites the two surfaces. During the heating operation the surfaces should be held firmly together with clamps or other means.

SWEEP.—In submarine cable operations, a drag made along the sea bottom with a grapnel.

SWEEPING OUT CHARGE.—The clearing of the line in double current telegraphy by reversing the direction of the current to remove the charge after one signal before sending another.

SWELLING CURRENT.—In electro-therapeutics, a faradic current that is repeatedly increased in strength to its maximum, and then reduced to zero while applied to a patient.

S.w.g.—Abbreviation for standard wire gauge.

S.w.g.—Abbreviation for Stubs' wire gauge.

SWIMMING RULE.—A rule suggested by Ampere for determining the direction of lines of force with relation to that of the current which produces them. It may be stated as follows: Suppose a man swimming in the wire with the current and that he turns so as to face a magnetic needle placed near the wire, then the north-seeking pole of the needle will be deflected toward his left hand.

SWINGING.—In radio, frequency variation due to some momentary change in the condition of the transmitter circuit.

SWINGING CROSS.—In overhead lines, an intermittent contact which sometimes results from the swinging of a line wire against another.

SWINGING EARTH.—A faulty connection with the earth sometimes occasioned in an overhead circuit by the swinging of a line wire against a conductor leading to the ground; an intermittent earth.

SWITCH.—A piece of apparatus for making, breaking or changing the connections in an electric circuit. The particular form and construction of any switch is governed by the electrical conditions under which it must operate, and this gives rise to a great multiplicity of types.

SWITCH BLADE.—The conducting blade of a knife switch by means of which a circuit is closed.

SWITCH CONTACTS.—Since it is impossible to instantly stop the current by opening the switch, the current continues to flow and momentarily jumps the air gap, resulting in a more or less intense arc which tends to burn the metal of the switch. To partially remedy this the contact pieces are so shaped that they open along their whole length at the same time, so as to prevent the concentration of the arc at the last point of contact.

SWITCH FINGERS.—In a trolley car controller, the spring contacts which are fixed parallel with the cylinder, so that, as the cylinder is revolved, they make contact with the segments on the cylinder.

SWITCH HOOK.—In a telephone set, a device for alternately connecting the talking apparatus and the signaling apparatus with the line. The action is automatically made by using it to hold the weight of the receiver. When the receiver is lifted off, the hook rises and the circuit through the talking apparatus is closed to line and that through the bell and generator opened. When the receiver is hung up, the hook falls and opens the talking circuit, making connection again between the line and the ringer.

SWITCH JACK.—A term sometimes used for spring jack, a switch socket employed in a telephone switchboard for the purpose of admitting a conducting plug attached to a flexible cord by means of which connections are made with terminals contained in the jack.

SWITCH PIN.—In a plug switch, the plug or pin which is introduced into the switch hole.

SWITCH PROPORTIONS.—The minimum area of the contact surfaces should not be less than .01 sq. in. per ampere, and in those used on arc lighting or other high voltage circuits where the current is usually small, the area of the contact surfaces is usually from .02 to .05 inch per ampere.

SWITCH SPRING.—A spring in the mechanism of a switch.

SWITCHBOARD.—A structure consisting of one or more panels on which are mounted control switches and indicating devices. Switchboards are classed as:

1. Live front boards (vertical).
2. Live front boards (bench).
3. Dead front boards: a, safety enclosed, vertical; b, safety enclosed, sectional; c, safety enclosed, truck.
4. Direct control.
5. Remote control: a, manual; b, electric.

Special designs are also built when necessary to meet unusual requirements.

SWITCHBOARD ARRESTER.—A lightning arrester provided for the protection of a switchboard.

SWITCHBOARD INSTRUMENTS.—The various instruments and meters employed in electric switchboard work. They include various types of ammeters, volt meters and watt meters, together with frequency and power factor meters and indicators, the wattless component indicator, synchroscope, ground detector, synchronizer, etc.

SWITCHBOARD PANEL.—The slab of marble or slate upon which is mounted the switches, and the indicating and controlling devices. There are usually several panels comprising switchboards of moderate or large size, these panels being classified according to the division of the system that they control, as for instance: a, generator panel; b, feeder panel; c, regulator panel, etc.

SWITCHBOARD PROTECTOR.—Any lightning arrester or safety fuse introduced into a circuit at a switchboard for the purpose of protecting the circuit from a powerful discharge or excessive current.

SWITCHBOARD WATT METER.—A watt meter mounted upon a switchboard for the purpose of determining the electrical output through a circuit connected with it.

SWITCHING DYNAMO INTO AND OUT OF PARALLEL.—In order to put an additional dynamo into parallel with those already working, it is necessary to run the new dynamo up to full speed, and, where it excites, regulate the pressure by means of a hand regulator until the volt meter connected to the terminals of the machines registers one or two volts more than the volt meter connected to the lamp circuit, and then close the switch. The load upon the machine can then be adjusted to correspond with that upon the other machines by means of the hand regulator. In this class of machine there is little or no danger of overloading an armature when connecting it to the bus bars and therefore the pressure need not be adjusted with very great accuracy; in fact, it is common practice in central stations to judge of the voltage of the new dynamo merely by the appearance of its pilot lamp.

When shutting down a machine, the load or current must first be reduced, by gradually closing the stop valve of the engine, or inserting resistance into the shunt circuit by means of the hand regulator; then when the ammeter indicates nine or ten amperes the main switch is opened, and the engine stopped. By following this plan, the heavy sparking at the switch contacts is avoided, and the tendency of the engine to race reduced. Great care, however, has to be taken that the current is not reduced too far, or otherwise there is a risk of the machine being stopped, receiving a back current from the other dynamos, resulting in heavy sparking at the commutator, and in the machine being driven as a motor. To obviate this danger, and to render these precautions needless, shunt dynamos when running in parallel are frequently provided with automatic cutouts, set so as to automatically switch out the machine when the current falls below a certain minimum value.

SYENITE.—A rock having a structure much resembling granite, but containing no free quartz. The stone is hard and durable, of a fine grain and light gray color. The name is derived from Syene in upper Egypt, where rock was quarried to build the vast monuments of the ancient Egyptians.

SYMMETRICAL MAGNETIC FIELD.—A magnetic field through which magnetic flux is uniformly distributed.

SYMPATHETIC VIBRATION.—A vibration set up in a body due to the vibration of another body when both have the same natural frequency. Thus the note A sounded on a piano will set in vibration a tuning fork tuned to A.

SYNCHRONISM.—1. The simultaneous occurrence of any two events. Thus two alternating currents or pressures are said to be "in synchronism" when they have the same frequency and are in phase.

2. A relation existing between two or more alternators such that the pressure waves generated by them are of equal period and corresponding phase, so that it is possible to successfully combine their output.

SYNCHRONISM INDICATOR.—An instrument which indicates the difference in phase angle at every instant, and the difference in frequency, between an incoming machine and the system to which it is to be connected, so that the coupling switch can be closed at the proper instant. There are several types of synchronizer, such as: a, lamp or volt meter; b, resonance or vibrating reed; c, rotating field.

SYNCHRONISM INDICATOR; LAMP OR VOLT METER TYPE.—It consists of a lamp or preferably a volt meter connected across one pole of a two pole switch connecting the incoming machine to the busbars, the other pole of the switch being already closed. If the machines be out of step, the lamps will fluctuate in brightness, or the volt meter pointer will oscillate, the pulsation becoming less and less as the incoming machine approaches synchronous speed. Synchronism is shown by the lamp remaining out, or the volt meter at zero.

SYNCHRONISM INDICATOR: RESONANCE OR VIBRATING REED TYPE.—A type which operates on the same principle as the resonance type of frequency indicator.

SYNCHRONISM INDICATOR; ROTATING FIELD TYPE.—A form of indicator whose operation depends on the production of a rotating field by the currents of the metered circuits in angularly placed coils, one for each phase in the case of a polyphase indicator. In this field is provided a movable iron vane or armature, magnetized by a stationary coil whose current is in phase with the voltage of one phase of the circuit. The method is that of the split phase bipolar synchronous motor with separate alternating current excitation.

SYNCHRONIZE.—To bring two or more alternators into such relation to each other that their pressure waves shall be of equal period and corresponding phase.

SYNCHRONIZED SOUND.—The method of recording on a motion picture film (or otherwise) sound so that the latter occurs at the right time with respect to the action of the picture. There are two fundamentally different methods of recording sound on film as by: a, variable area; b, variable density. Sound recorded on phonograph discs may be synchronized by suitable gearing between projector and phonograph.

SYNCHRONIZER.—A device for indicating when a.c. machines are running in phase with each other. The simplest form is the connection of incandescent lamps across a switch in the circuit, when the machines are in phase the lamps will not light up. Another form is the synchronizing transformer joined to a synchronizing lamp. When the machines are in step the lamp is lighted. In place of the lamp a dead beat volt meter is sometimes used. An instrument called the synchroscope is used in recent practice with large generators.

SYNCHRONIZING SOUND ON FILM.—Sound film is usually run on a separate machine from the camera for practical reasons, and the two films must be so synchronized that when they are printed together they will be in synchronism throughout the length of the film. This is accomplished by running the camera and the recorder at exactly the same speed. They are both driven by synchronous motors connected to the same power supply, and this keeps them always in synchronism. Some kind of marking is required so that the picture and sound track can be lined up for printing. This is sometimes taken care of by marking the film by means of a small marker lamp which shines on the film outside of the sprocket holes. Since the sound head of the projector is 19 frames from the picture in the frame, it is necessary to displace the sound track by 19 frames when they are printed together.

SYNCHRONIZING TRANSFORMER.—An arrangement for indicating when two alternating current machines are operating together in phase. It consists of a transformer having a double primary winding and a single secondary across which is joined the synchronizing lamp. When the machines are in step the lamp is lighted.

SYNCHRONOUS.—In unison; in step. Descriptive of two alternating variables having the same frequency and being in phase, for instance, an alternating current in which the voltage is in phase with the current.

SYNCHRONOUS BOOSTER CONVERTER.—A machine employed where it is necessary to adjust the voltage at the d.c. end over a considerable range, as for electrolytic work, or for central station service where it is desirable to vary the a.c. voltage supplied to the rotary by means of a special a.c. booster which adds to or subtracts from the a.c. voltage supplied, thus giving double the range of voltage generated by the booster. The voltage can be varied over the full range in very small steps by adjusting the field strength of the booster. The booster may be of the revolving armature or revolving field type, the former, however, being more simple. The booster armature is mounted on the shaft between the converter armature and collector rings, with its coils connected in series with the converter armature coils. Thus the voltage generated by the booster is added to or subtracted from the supply voltage.

SYNCHRONOUS CONDENSER. — A synchronous motor operated over excited to improve the power factor. Synchronous condensers should be considered for power factor improvement when the amount of leading reactive kva. required is 300 kva. or more and where this can be applied to advantage at one point.

SYNCHRONOUS CONDENSER ADVANTAGES.—a, low first cost; b, inherent characteristics which tend to stabilize the voltage; c, easy adjustment of the leading reactive kva. supplied; d, possibility of applying the synchronous condenser in conjunction with a voltage regulator to maintain constant voltage at a given point.

SYNCHRONOUS CONVERTER.—A machine which converts from an alternating current to a direct current. Usually called rotary converter.

SYNCHRONOUS IGNITION.—A system of high tension (jump spark) gas engine ignition. The system is called "synchronous" because: when a multi-cylinder engine has a coil unit for each cylinder, it requires the adjustment of several vibrators. Now, the time required by the vibrator to act is variable with the adjustment and with slight differences in construction, hence, with several vibrators, perhaps no two will act in the same time. Consequently, though in the ordinary multiple coil system the closing of the primary circuits may occur at exactly corresponding moments for all of the cylinders, the production of the spark of ignition will be more or less "out" owing to the variation in the "lag" of different vibrators. With a distributor and single coil, the lag is the same for all the cylinders, hence the application of the word synchronous.

SYNCHRONOUS MOTOR.—One which rotates in unison or in step with the phase of the alternating current which operates it. A condition only approximated in practice as there is always more or less phase difference. Any single or polyphase alternator will operate as a synchronous motor when supplied with current at the same pressure, and frequency and wave shape as it produces as an alternator, the essential condition, in the case of a single phase machine, being that it be speeded up to synchronism before being put in the circuit. In construction, synchronous motors are almost identical with the corresponding alternator, and consist essentially of two elements: a, an armature; b, a field, either of which may revolve. The field is separately excited with direct current.

SYNCHRONOUS MOTOR ADVANTAGES.—It is desirable for large powers where starting under load is not necessary. Its power factor may be controlled by varying the field strength. The power factor can be made unity and, further, the current can be made to lead the pressure.

A synchronous motor is frequently connected in a circuit solely to improve the power factor. In such cases it is often called a "synchronous condenser" for the reason that its action is similar to that of a condenser Especially adapted to high voltage service.

SYNCHRONOUS MOTOR CONSTRUCTION.—A synchronous motor consists of two elements: a, an armature; b, field, either of which may revolve. The field is separately excited with direct current. The armature is usually stationary, being attached to the frame, while the field magnets are attached to a frame which revolves with the shaft, the exciting current being delivered through slip rings.

SYNCHRONOUS MOTOR PRINCIPLES.—Operation depends upon the following:

1. A single phase synchronous motor is not self-starting.
2. The condition necessary for synchronous motor operation is that the motor be speeded up until it rotates in synchronism, that is, in step with the alternator.
3. The current which flows through the armature of a synchronous motor is that due to the effective pressure.
4. A synchronous motor adjusts itself to changes of load by changing the phase difference between current and pressure.
5. The effectiveness of armature reaction in weakening the field is proportional to the sine of the angle by which the current lags behind the impressed pressure.
6. A single phase synchronous motor has "dead centers" just the same as a one cylinder steam engine.
7. An essential condition for synchronous motor operation is that the mechanical lag be less than 90°.
8. If the torque and current through the motor armature be kept constant, strengthening the field will increase the mechanical lag, and the lead of the current with respect to the reverse pressure.

SYNCHRONOUS MOTOR TROUBLES.—1. Faulty starting. May be due to: a, voltage too low, at least half voltage is required to start; b, open circuit in one phase. Motor heats up; c, too much static friction due to too great belt tension and too tight bearings; d, too much field excitation; e, armature windings incorrectly connected; f, reversed phase in compensator.

2. Motor fails to start.—Usually due to a, too low voltage; b, faulty connection in the auxiliary apparatus; c, too great

starting load; d, open circuit in one phase, or short circuit; e, either condition results in a buzzing noise; f, too great field excitation.

3. Field faults. May be due to: a, field circuit broken; b, excessive induced voltage at start; c, punctured insulation due to excessive voltage.

4. Armature faults: These are usually: a, short circuit in armature coil, with resulting burn out of the coil; b, wrongly connected coil resulting in reversed polarity and requiring extra field current to make up for the bucking pole.

5. Hunting. This occurs especially in the case of a, long lines; b, unsteady speed of alternator as when driven by a gas engine. The application of "bridges" to the pole pieces tends to stop hunting; c, field too strong.

6. Weak torque.—This may be due to: a, exciter voltage too low; b, reversed field spool; c, short circuit in field; d, open circuit in field.

7. Heating.—This may be due to: a, overloading; b, excessive armature current.

SYNCHRONOUS MULTIPLEX TELEGRAPHY.—A system of telegraphy in which the instruments at each end of the line are caused to act in synchronism, so that it is possible to transmit four or more messages at practically the same time over the same wire.

SYNCHRONOUS PHASE ADVANCER.—A name sometimes given to a synchroneus condenser.

SYNCHRONOUS POLYPHASE MOTOR.—A polyphase motor running with period and phase equal to that of the generator driving it.

SYNCHRONOUS SPEED.—1. Speed of a rotating magnetic field.

2. The following table gives the synchronous speed for various frequencies and different numbers of poles:

SYNCHRONOUS SPEED FORMULA.—The r.p.m. of a rotating magnetic field is determined by the following formula:

$$S_f = \frac{2f}{P} \times 60$$

where

S_f = synchronous speed or R.P.M. of the rotating magnetic field;

P = Number of poles;

f = frequency.

SYNCHRONOUS TELEGRAPH SYSTEM.—One in which the proper transmission and reception of signals is dependent upon the synchronous operation of similar commutators or other devices located at the sending and receiving stations of a circuit.

SYNCHRONOUS VIBRATIONS.—Vibrations which correspond exactly in period and phase.

SYNCHROSCOPE. — An instrument employed to indicate when two or more alternators or motors are running in synchronism. It is in reality a special form of power factor indicator with a pointer free to rotate, and with no scale on the dial since only the point of synchronism is required. When the pointer becomes stationary and assumes the zero position, the main switch connecting the machines may be closed. Also called a synchronizer.

SYNTHESIS.—The process of uniting elements to form a compound, as opposed to analysis.

T

T.—Symbol for period.

T OR t.—1. Temperature.
2. Time.

T AERIAL.—In radio, an aerial with center connected lead in.

TABLE PUSH.—A push button fitted to a table for ringing a call bell, or other similar purpose; a desk push.

TABLET CHECK.—In a telegraph office, a system of recording and checking off messages sent and received, upon a suitably tabulated form.

TAIL.—The rear surfaces of an airplane.

TAIL SKID.—Flexible support under the tail of an airplane.

TAILS.—Induction coil core wires.

TAILINGS.—In high speed automatic telegraphy, a running together of the signals, producing prolongations of the characters recorded upon the paper ribbon.

TAKE SIDING SIGNALS.—A class of railway signals whose function is to notify the engineer or motorman without the use of train orders, to take siding at non - interlocked switches, especially where located at some distance from operating towers.

TALAUTOSCOPE.—An instrument consisting of a partially exhausted tube, used in connection with an oscillator to determine whether electric waves are being properly projected or not.

TALC.—A soft silicate of magnesia, also called "soapstone." It is easily split into thin plates, but differs from mica in not possessing elasticity. It is used as heat resisting insulation in spark plugs and in other details of electrical apparatus.

TALLOW.—A substance composed of the harder and less fusible fats, obtained by rendering beef or mutton fat, as also almost any of the animal fats, and of certain vegetable fats.

TANDEM CONDENSER. — Several radio tuning condensers geared to a single tuning knob. A gang condenser.

TANGENT AND SINE GALVANOMETER.—A compound form of galvanometer having a small needle for measurements by the tangent method, and a large needle for sine measurement.

TANGENT GALVANOMETER.—An indicating instrument in which the deflecting coil consists of a coil of wire within which is placed a needle very short in proportion to the diameter of the coil, and supported at the center of the coil. The diameter of the coil is about 17 times the length of the needle. If the instrument be so placed that when there is no current in the coil, the suspended magnet lies in the plane of the coil, that is if the plane of the coil be set in the magnetic meridian, then the current passing through the coil is proportional to the tangent of the angle by which the magnet is deflected from the plane of the coil, or zero position; hence the name: tangent galvanometer.

TANGENT SCALE.—The circular scale of a tangent galvanometer graduated into values of the tangents instead of into equal degrees of arc, in order to obviate the necessity of referring to a table of figures in making computations.

TANGENTIAL BRUSH. — A commutator brush that bears upon the surface of the commutator in the relation of a tangent to a circle. They are generally made of copper.

TANK HEATER, ELECTRIC.—An arrangement for heating liquids, consisting of an electric resistance coil introduced into the tank which holds the liquid.

TANNING, ELECTRIC.—Tanning hides in the preparation of leather by a process of electrolysis in which electric currents are caused to pass through the tanning liquor in the vats.

TANTALUM.—A rare metal, resembling platinum in color, with a specific gravity of 16.5, and a melting point about 4100° F. It is malleable, ductile and very tenacious. When repeatedly heated and flattened to a plate, under a steam hammer, it becomes so hard that a diamond will not bore it. It offers very little resistance to the electric current, and so, in view of its high melting point, it is used as a filament in incandescent lamps.

TANTALUM LAMP.—A form of incandescent lamp having a filament composed of the metal tantalum. The bulb contains a central glass rod bearing two supporting rims from which radiate arms of nickel wire having hooks at the end over which the tantalum filament is suspended. As compared with the carbon filament lamp, the tantalum lamp will take much greater current at starting, will reach incandesence more quickly and will be much less sensitive to voltage variation, at the same time consuming less watts with greater candlepower.

TANTALUM RECTIFIER.—An electrolytic rectifier in which the electrolyte is a solution of sulphuric acid, the rectifying electrode being made of tantalum and the other electrode of lead or lead peroxide.

TAP.—1. In wiring, the connection of the end of one wire to some point along the run of another wire. There are many kinds of tap as: a, plain; b, aerial; c, knotted; d, cross (double and duplex); e, wrapped.

2. A tool for cutting female or internal screw threads. It is made from a steel rod in which are cut the screw threads and has four flutings for clearance of chips in cutting. The tool is hardened to the correct temper. There are many types of tap. Machinists hand taps come in sets of three for each size, known as: a, taper; b, plug; c, bottoming.

TAP SPLICING.—The process of uniting the end of one multi-wire conductor at some point along the run of another, multi-wire conductor.

TAP SWITCH.—A multi-point switch designed for use with a multi-tap induction coil.

TAP WIRE.—1. In a trolley system, a conductor for connecting the feeders with the trolley wires.

2. In quadruplex telegraphy, a wire used to tap the battery and divide it into the "long" end and the "short" end.

TAPED WIRE.—A wire, or conductor, wrapped with insulating tape.

TAPER PLATE CONDENSER.—A radio variable tuning condenser with plates of tapered thickness, the entering edges being thin and trailing edges thick. The object of this construction is to obtain straight line effect within limited space.

TAPERS.—Conductors which gradually diminish in diameter for splicing cables of different types.

TAPERED MAINS.—In the "tree" system of incandescent electric lighting, mains which gradually diminish in size toward the extremities of the system.

TAPING.—Applying a wrapping of insulating tape to a conductor or cable.

TAPPED WINDING.—A winding tapped at various points and leads brought out to a tap switch so that more or less of the winding may be cut out.

TAPPER BELL.—A variety of electric bell which rings a single stroke with each depression of the signaling key.

TAPPER TAP.—A form of tap used in tapping nuts on tapping machines. Tapper taps, as a rule, are relieved only on the top of the thread of the chamfered portion. They are not relieved in the angle of the thread. The straight part, which performs no cutting, forming only the sizing part of the tap, should not be relieved, or, if relieved, the relief should be very slight in order to permit the tap to retain its size longer.

TAPPING A CIRCUIT.—Inserting a branch into a telegraph or telephone line for the purpose of appropriating information by listening in to messages passing over the line.

TAR.—1. A very dark, oily liquid obtained in the process of distillation of various substances; that resulting from the distillation of resinous woods, which is used as a paint, a preservative of cordage, etc.; the product derived from gas manufacture, coke ovens or other distillation of coal.

2. The residuum of petroleum left after the kerosenes or illuminating oils have been distilled off; the extent or nature of the residue depends upon the locality or the refined product demanded.

TARGET.—In a vacuum tube, the electrode on which cathode rays are focused and from which roentgen rays are emitted. It is usually of a heavy metal such as tungsten.

TAXIMETER.—A device used on taxicabs for the purpose of calculating fare and to give the management full information on the taxicab operation. It is usually driven by means of a spiral band attached to the front wheel. This spiral drives a ten toothed star gear which is connected by means of a flexible shaft to the recording mechanism of the taximeter. In some instances the taximeter is driven direct from the transmission. A clock mechanism within the meter is set in motion when the flag is "pulled" and the clock continues to tick until the termination of the trip. This clock mechanism, however, only engages with the fare counting mechanism when the cab is waiting or driving at a speed of six miles per hour. This accounts for the increase in the fare when a taxicab is caught in traffic, at railroad crossings, etc.

TEASER COIL.—In a monocyclic alternator, a coil wound in two phase relationship with and connected to the center of the main single phase coil. The monocyclic alternator is provided with three collector rings; two for the single phase coil, and one for the free end of the teaser coil. By this arrangement ordinary single phase incandescent lighting can be accomplished by means of a single pair of wires taken from the single phase coil.

TEASER TRANSFORMER.—In three phase connection with two T connected single phase transformers, the one which is connected between the mid-point of the main transformer and the third wire of the three phase system.

TECHNOCRACY.—A study of the economic conditions resulting from the displacement of men by labor saving machines and devices.

TEE BOX.—In underground cable construction, a junction box resembling the letter T, for connecting a branch at right angles with a main.

TEE CONNECTOR.—A connector shaped like the letter T for connecting a wire at right angles with another; a T connector.

TEETH OF ARMATURE.—In a slotted armature, projections upon the surface between which the coils are laid.

TELAUTOGRAPH.—A writing or copying telegraph for reproducing writing or drawings at a distance, by means of a receiving pen, which, directed by a complex mechanism, controlled by electric currents, follows the motions of a transmitting pen operated at the station of the sender. This is an invention of Elisha Gray, of Highland Park, Ill.

TELE-ANEMOGRAPH.—An apparatus for recording wind velocity, situated at a considerable distance from the anemometer.

TELE-BAROGRAPH.—An instrument for recording the changes of a barometer, situated at a considerable distance from the recording apparatus.

TELE-BAROMETER.—A barometer whose indications are electrically registered by means of a tele-barograph at some distance from it.

TELEGRAM.—A message sent or received by telegraph.

TELEGRAPH.—1. A system of communication to distant points by a series of electrically transmitted signals.

2. To send a message by telegraph.

3. In navigation, an apparatus for transmitting orders from a ship's bridge to the engine room, poop, forecastle head or elsewhere. A series of endless chains passing over pulleys in the machines at either place, cause the pointer on one dial to assume a position corresponding to that on the dial whence the signal has been transmitted: a gong calls attention to the movement of the telegraph pointer. For small craft, torpedo boats, etc., the endless chains are replaced by tubular rods rotated by sector gearing.

TELEGRAPH.—Electrical apparatus for transmitting messages between distant points. The simplest form of telegraph consists of: a, key or transmitting instrument; b, line wire; c, sounder or receiver; d, battery or other source of electricity.

TELEGRAPH FIXTURES. — In overhead telegraph line construction, the lesser appliances employed in supporting telegraph wires.

TELEGRAPH INSULATOR.—A contrivance, usually of glass or porcelain, for supporting telegraph wires and preventing escape of current.

TELEGRAPH JOINT.—The American or standard Western Union wire joint. It is made by tightly twisting the ends of sections of wire around each other a few turns.

TELEGRAPH KEY.—A form of switch which opens and closes the circuit in sending currents over the line for the transmission of signals. It consists essentially of a pivoted lever provided with a contact and adjusting screw, and carried on a base having an insulated contact and a spring to keep the lever normally in the open position. A switch is provided to close the circuit when the key is not in use.

TELEGRAPH LINE ADJUSTER.—An apparatus for overcoming the effects of escapes or grounds due to lack of proper adjustments on the part of telegraph operators at way stations on the line.

TELEGRAPH LINE FAULTS.—May occur in telegraph lines from several causes: either from the breakage of the wires or conductors, or from the breakage of the insulators, thereby short circuiting the current through the earth before it reaches the distant station, or, as in overhead wires, by two conducting wires touching each other. Various methods for testing the existence and position of faults are known to telegraph engineers; they depend upon accurate measurements of resistance or of capacity. Thus, if a telegraph cable parts in mid-ocean it is possible to calculate the distance from the shore end to the broken end by comparing the resistance that the cable is known to offer per mile with the resistance offered by the length up to the fault, and dividing the latter by the former.

TELEGRAPH LINE WITH RELAYS.—When the length of line becomes too great to operate sounders without unduly large battery capacity relays are used. The system consists of one main circuit and an auxiliary circuit at each station. The main circuit includes the relays, keys, and main cells all connected in series with ground return. The auxiliary circuit at each station is made up of a sounder and local cell joined in series and connected with the auxiliary circuit of the relay.

TELEGRAPH LOOP.—1. A continuous wire extending from a main office to a branch office and return.

2. In duplex or quadruplex telegraphy, the two short wires used to connect a station with a branch office.

TELEGRAPH MODULATED WAVE. — A continuous wave having its amplitude or frequency changed by keying.

TELEGRAPH NEEDLE.—A small pointer employed with the needle system of telegraphy to indicate upon a dial, by left and right deflections, the signals of the code. Obsolete.

TELEGRAPH PAPER WINDER.—An automatic device for winding up the paper tape of a printing telegraph ticker, or other similar registering apparatus, as fast as it is paid out by the receiving instrument.

TELEGRAPH POCKET RELAY.—A compact form of relay of small size for use in line testing.

TELEGRAPH REGISTER.—Any instrument for recording telegraph messages as received, by writing, printing, or embossing the signals upon a paper tape.

TELEGRAPH RELAY.—A device which opens or closes an auxiliary circuit under predetermined electrical conditions in the main circuit, and which acts as a sort of electrical multiplier, that is to say, it enables a comparatively weak current to bring into operation a much stronger current. In so doing it reduces considerably the battery capacity required for a line of given length.

TELEGRAPH REPEATER.—A sounder provided with a circuit maker for synchronously controlling a second circuit. That is to say, it is simply a piece of apparatus in which the sounder (or in some cases the relay), receiving the signals through one circuit, opens and closes the circuit of another line, in the manner that a relay opens and closes the auxiliary circuit of a sounder. The contact post is insulated and is provided with an insulated stop. This device forms a contact maker for the repeating section of the circuit.

TELEGRAPH SHORT LINE CIRCUIT.—The simplest telegraph system, consists of a key, sounder and battery at each station. Owing to the energy required to work the sounder this arrangement is suitable only for very short lines.

TELEGRAPH SOUNDER.—The receiving instrument employed for enabling operators to read telegraph messages on receipt, by sound alone. It consists of a heavy pivoted lever arranged to vibrate between two stops and held normally against one of these stops by the action of a spring; there is an electro-magnet which when energized, acts on an armature attached to the lever causing the latter to move from the upper stop to the lower stop.

TELEGRAPH SWITCHBOARD.—A switchboard in a telegraph office for making quick changes in the connections of wires, discs and batteries; it consists essentially of a series of vertical parallel brass straps on the front of the board, and a corresponding series of horizontal straps on the back, connection being made between the two by pin plugs fitting notched metal connecting discs.

TELEGRAPH SYSTEMS; CLASSIFICATION.—The multiplicity of systems may be classified with respect to:

1. The kind of circuit, as: a, ground return; b, metallic.
2. The method of operating the circuit, as: a, closed; b, open.
3. The transmitting capacity. a, Single Morse line; b, diplex; c, duplex; d, quadruplex; e, multiplex; f, phantoplex.
4. The method of receiving, as: a, non-recording; b, recording.

TELEGRAPH TIME SERVICE.—An automatic system of electric signals issued from a standard master clock to various points where it is required to preserve the precise time.

TELEGRAPH TRANSMITTER.—A transmitting key consists essentially of a pivoted lever provided with a contact and adjusting screw, and carried on a base having an insulated contact and a spring to keep the lever normally in the open position. A switch is provided to close the circuit when the key is not in use.

TELEGRAPH VALVE.—A valve operated from some distance, by means of a cord passing round the hand wheel as a pulley. Same as a telegraph cock.

TELEGRAPHER'S CRAMP.—A painful condition of a telegraph operator's hand, sometimes brought on by incessant constrained use of the same muscles in manipulating the key.

TELEGRAPH BOX SOUNDER.—A form of telegraph relay for use in special cases, having a wooden box set over the coils in order to reinforce the sound of the signals so that they may be clearly audible.

TELEGRAPH CLOCK.—The standard clock which controls the movement in dependent clocks in a system of electric timekeeping; the primary, or controlling clock; a master clock.

TELEGRAPH CODE.—Cipher systems, used in telegraphy for the sake of economy and secrecy. No cipher word may exceed ten letters, nor may it be a nonsensical or made up word, but one taken from civilized languages. Codes may be arbitrary or selective. In the former case, one word means a definite phrase or term, according to the vocabulary of the parties interested. With the latter, each word is regarded as a numeral of six to ten figures; each two figures represent a definite idea according to their position, the combinations being apparently numberless, yet easily translatable with the proper key. As an example, a message containing 144 code words, when translated, occupied 75 foolscap pages of typewritten matter.

TELEGRAPHIC PHOTOGRAPHY.—A system of reproducing a photographic representation at a distant point by telegraphy.

TELEGRAPHONE.—A sound recording system which employs a moving wire of steel which is passed by and in contact with the poles of electro-magnets. The coils of the magnets are in circuit with a telephone transmitter or microphone. With suitable hook up the variable magnetization of the iron produces audio frequency vibrations in the microphone and resulting sound.

TELEGRAPH SPLICE.—A sleeve soldered over the joint between two cable lengths.

TELEGRAPHY.—The science and practice of the telegraph.

TELE-HYDROBAROMETER.—An electrical instrument for recording at a distance the height of water in a reservoir.

TELE-INDICATOR.—Any electrical device for indicating or recording at a distance the readings of a measuring instrument; a telemeter.

TELE-MANOMETER.—A recording instrument for measuring the pressure of gases, having its electric recording apparatus located at a distance from the instrument.

TELEMETER.—A device which gives visible or audible indications of the operation and functioning of apparatus located at a distance.

TELE-METROGRAPH.—An instrument to draw and measure distant objects, having its recording apparatus located at some distance from the measuring instrument.

TELEPHONE. — An instrument for the transmission of articulate speech by electric current.

TELEPHONE "A" SWITCHBOARD.—In the central office, that part of the operating switchboard where the subscriber lines and outgoing trunks are terminated to enable the telephone operator to receive signals and calls from subscribers and to make the first connections on all calls originated by any subscriber in that particular Central Office area.

TELEPHONE ANSWERING AND TRUNK JACKS.—Equipment in the jack panel of the A board consisting of the subscriber's answering jacks at the bottom, the multiple answering jacks above them, and the outgoing trunk multiple jacks on top. Each answering jack has below it a small lamp. The answering jack and its lamp are connected to the subscriber line and cut off relays previously mentioned. The lamp lights when the receiver is removed from the hook at the telephone station associated with it.

TELEPHONE B SWITCHBOARD.—In the central station operating room, a board to which the subscriber's line is connected by means of cable from the I.D.F. (intermediate distributing frame) in the terminal room.

TELEPHONE BATTERIES. — The primary and secondary batteries employed in telephone work.

TELEPHONE BOOTH.—A form of sound proof closet containing a telephone set to permit private and quiet telephoning in public places.

TELEPHONE CABLE.—A cable composed of telephone lines which follow the same route, bunched together with proper insulation in order to simplify both overhead and underground line construction.

TELEPHONE CALL BELL.—A call bell connected with a current source, forming the telephone calling apparatus by means of which a subscriber is summoned to the telephone by the exchange operator to answer a call.

TELEPHONE COMPLETE CIRCUIT. — There are four main parts to this circuit, a, calling subscriber circuit; b, local A board cord circuit; c, trunk circuit which connects the local A board with the distant B board; d, called line at the distant end.

TELEPHONE CONDENSER.—In a subscriber's set a condenser consisting of two sheets of tin foil separated by a double thickness of paraffined tissue paper. The tin foil sheets are approximately 3½ inches wide and very long, so as to give the effect of a large surface. The combination is rolled up so as to occupy a small space, and is then boiled in paraffin and encased in a metal container for protection A lug is attached to each sheet of tin foil so that wires may be soldered to it.

TELEPHONE CORD CIRCUITS.—In each A position there are 17 cord circuits. Each cord circuit is composed of one pair of cords, one pair of lamps, one key to ring and talk and one register key.

TELEPHONE CORDS.—Flexible cords terminating in metal plugs employed at a telephone switchboard for interconnecting subscribers.

TELEPHONE DIAL EXCHANGE.—With the automatic system there is considerably more equipment in the central office than in the ordinary exchange. A great portion of the equipment is automatically operated and controlled, more maintenance men and less girl operators. In a dial telephone system all calls within a specified "local" area are handled exclusively by automatic switching apparatus, there being no operators required as in the manual system. Calls to more distant points, however, are routed through a special "A" operator. Besides the special "A" operators, in a dial central office, there are a number of girl operators working at "cordless" B-positions.

TELEPHONE DISTRIBUTING FRAME.—A frame made of structural steel with terminal strips on one side mounted horizontally and terminal strips or heat coil protector blocks on the other side mounted vertically. The lead covered cable from the subscriber's cable terminal is brought to the horizontal side of the Central Office distributing frame and is connected to the terminal strips. From this main distributing frame, or M.D.F., the line wires are led to a second frame, generally called intermediate distributing frame, or I.D.F., where cross-connections are made to terminal strips containing cable wires to line and cut off relays, and to the multiple jacks on the "B" switchboard.

TELEPHONE DROP.—One of the annunciator drops of a telephone switchboard, which falls and attracts the operator's attention when a subscriber desires a connection.

TELEPHONE EXCHANGE OR CENTRAL OFFICE.—A building (or rooms) which contains terminal facilities and equipment to supply the telephone needs of a given district and contains also a switchboard operated by girl attendants who make connections between the telephone subscribers in the same district or with subscribers in another telephone district, or exchange by using trunks. In the automatic, or dial system, the operators are replaced by automatic switching apparatus.

TELEPHONE GALVANOMETER.—A sensitive galvanometer used in connection with a bridge for testing telephone circuits.

TELEPHONE HOOK SWITCH.—An automatic arrangement of the telephone switch such that the switch lever is held down in contact with the terminal of the calling circuit by the weight of the receiver when not in use, and rises by a spring into contact with the talking circuit terminal when the receiver is lifted off

TELEPHONE IMPULSE REPEATER. — In telephony, a device for repeating impulses from one line circuit into another and for performing other duties.

TELEPHONE INCOMING TRUNKS.—Cord circuits at the B board. The operator completes the connection by inserting a cord plug into the jack of the desired line. When the cord is in the jack a relay associated with the cord circuit connects generator current and rings the bell of line called.

TELEPHONE INDICATOR.—Any indicator at a telephone switchboard, such as a drop, or lamp signal, for calling the attention of the operator to a subscriber's call.

TELEPHONE INSULATOR.—A type, usually of glass or porcelain, for supporting telephone wires and preventing escape of current.

TELEPHONE METER.—A device employed in a limited telephone service for recording the number of calls sent by a subscriber.

TELEPHONE OPERATION. — Atmospheric sound waves strike the diaphragm of the telephone and cause it to vibrate. The vibrating diaphragm produces a change in the magnetic field of the telephone. The changes in the magnetic field induce currents in the wire coil of the telephone. The induced currents are transmitted from the transmitter telephone through the line to the receiver telephone. In the telephone receiver, the induction currents produce changes of intensity in the magnetic field. In consequence of these changes in the magnetic field, the diaphragm of the receiver is thrown into vibration. The vibrations of the diaphragm of the telephone receiver give rise to air waves, which are propagated to the tympanum of the ear. Every time the human voice is used, vibrations of the air are produced, and the louder and higher the sound the greater the number of vibrations; with each change of tone the diaphragm vibrates in sympathy.

TELEPHONE OPERATOR'S SET.—A head receiver with chest transmitter attached to a double plug. When in use the plug is inserted into a double jack at the switchboard position.

TELEPHONE RECEIVER.—A device which is applied to the ear in receiving a message; it consists essentially of a hard rubber shell containing a permanent bar magnet with a thin iron diaphragm in close proximity to one of its poles. The varying amounts of electricity in passing through the receiver magnet change the strength of the magnet and as as result the diaphragm is pulled and released partly or totally at a very rapid rate, precisely the rate at which the transmitter vibrates.

TELEPHONE RELAY.—A telephone repeater in which a microphone is acted upon by the receiver of the first line circuit so as to introduce a local circuit, which in turn acts inductively on the second line wire, and repeats the message; a translator.

TELEPHONE RESISTANCES.—In telephone circuits resistances are of the flat type. They are used to take up the excess voltage in connection with the operation of relays or the lighting of lamps on switchboards. Resistances are also mounted on mounting plates with the associated relays on the relay racks.

TELEPHONE RINGER.—In a subscriber's set, a combination of a permanent magnet and electro-magnet, which is an inverted U magnet with many turns of fine insulated wire on each of the soft iron cores, with equal turns on each. The permanent magnet is attached at one end to the center of the electro-magnet. This establishes two south poles, S,S, of equal strength, and by induction two north poles N,N, also of equal strength at the ends of a piece of soft iron pivoted near the poles of the electro-magnet. This piece of soft iron acts as the armature and carries the hammer which strikes the bells. A biasing spring is attached to the armature at one end, which forces the armature to assume the normal position.

TELEPHONE SET.—The telephone equipment apart from the wiring and mounting, including the receiver, transmitter, induction coil, hook or other switch, call receiving and call sending apparatus.

TELEPHONE SIDE TONE. — The sound heard in a receiver by the use of the transmitter of the same set.

TELEPHONE STATION.—An assembly of telephone apparatus consisting of a transmitter and a receiver usually on a desk stand with a hook to hold the receiver, and also to serve as an automatic switch when the receiver is removed from the hook, connected to a bell box which contains, a, condenser; b, bell; c, induction coil.

TELEPHONE SUBSCRIBER'S SET.—A bell box containing three pieces of equipment, a, ringer; b, induction coil; c, condenser.

TELEPHONE SWITCHBOARD.—In a telephone exchange, an apparatus by means of which any subscriber may be placed in communication with any other subscriber in the system; each line entering the exchange terminates in a spring jack, into which a plug attached to a flexible cord may be inserted by the operator for any desired connection.

TELEPHONE TIME-CHECK.—An automatic device connected with a clock, employed in a telephone exchange to indicate to the operator the expiration of the time allowed a subscriber for the use of a trunk line.

TELEPHONE TINNITUS.—A nervous trouble sometimes affecting the ears of a telephone operator because of too constant work at the telephone.

TELEPHONE TRANSMITTER.—The speaking end of a telephone instrument. The transmitter consists of two carbon discs separated by about 3/32 of an inch and the space between filled with sharp carbon particles called granules. This unit is connected to a steady source of electricity so that the current must flow from one carbon disc through the carbon granules and out through the second carbon disc. In operation, the voice sets the air into vibrations which beat upon the transmitter diaphragm and set it into rapid back and forth movements, causing changes in the resistance of the carbon unit and resulting in the rapid variations of electric current which flows to the distant end where there is a receiver.

TELEPHONY.—The science and practice of the telephone.

TELEPHOTE. — An instrument employing the photo-electric properties of selenium for the electric transmission of pictures.

TELE-PHOTOGRAPHY.—The photography of distant objects by means of a camera mounted in the eye piece of a telescope.

TELESCOPE.—An instrument which magnifies the appearance of distant objects, causing them apparently to come nearer. It consists essentially of a tube containing the objective, a large converging lens or concave mirror (speculum) and a small lens or combination of lenses. The first forms an optical image of the object observed, and the latter magnifies the image.

TELESEME.—An annunciator in a hotel office which indicates upon a dial the service required by a guest sending a call from his room.

TELE-THERMOGRAPH. — An instrument for electrically recording the changes of a thermometer situated at some distance from the recording apparatus.

TELE-THERMOMETER. — A thermometer which electrically registers its indications by means of a tele-thermograph at some distance from it.

TELETYPE PRINTING TELEGRAPH SYSTEM.—The teletype machine is a simple intercommunicating machine for interchanging messages between two or more points. It has a keyboard like a type-writer. The depression of the keys causes various electrical signals to be sent out over a wire causing corresponding characters to be printed on a narrow strip of paper, both at the home and distant stations. The tape machine prints on a narrow strip of paper. The page machine prints on a wide sheet of paper usually 8½ inches wide. The automatic sending machine provides for sending from a perforated strip which acts as a storage medium for the message.

TELEVISION.—Vision obtained of a distant object through a telegraphoscope or instrument involving the use of selenium cells for telegraphically transmitting a picture. The problem of television broadly is that of: a, converting light signals into electrical signals; b, transmitting the electrical signals to a distant station; c, converting the transmitted electrical signals back into light signals.

TELEVISION IN COLORS.—In the beam scanning method of three color television the essential feature consists in the use of three sets of photo-electric cells, one set with its accompanying filters recording the red constituent, the second the green and the third the blue constituent of the image. The light source and the scanning disc are in no way altered from the form as used in monochrome television. The three sets of cells are each connected to a separate communication channel, and the television signals going over these three channels correspond to the three colors. At the receiving end one method is to superpose the light from three different colored television glow lamps by means of semitransparent mirrors. This is comparable to the additive superposition in three-color photography exemplified in the chromoscope.

TELEVISION LAMP.—The source of light for a television receiver. Neon and infra red lamps are used.

TELEVISOR.—In television, a transmitter scanning device.

TELL-TALE.—A small wire carried on the outside of a cartridge fuse which melts when the enclosed fuse blows, and thus indicates that the fuse is burned out.

TELL-TALE BOARD.—In automatic telephony, a group of incandescent lamps mounted upon a panel with a magnetic bell, so that when a fault or ground occurs on any line the operator's attention is called by the ringing of the bell and the glowing of the lamp.

TELL-TALE SIGNAL.—In. telephony, a device for locating the failure of some apparatus; for example, the blowing of a fuse, the continued drawing of heavy current by apparatus intended to receive only momentary current, etc.

TELLURIC MINES.—Explosive mines used in war for operations on land, as distinguished from mines used in naval warfare.

TELLURIUM.—A white lustrous metal or metalloid, closely resembling sulphur and selenium in its chemical reactions; it has a specific gravity of 6.2 and melts at 845° Fahr.; it occurs native, but it more frequently found in combination.

TELPHER LINE.—The conductors forming the supporting circuit in a system of telpherage.

TELPHER LOCOMOTIVE. — The electric motor which produces the locomotion in a telpherage system.

TELPHERAGE. — The automatic aerial transportation of material in a car suspended upon grooved wheels from a tightly drawn conducting cable, and propelled by electric motors actuated by a current from the supporting line.

TEMPER.—To harden. The process consists in heating the object (as steel in tool making) to the proper temperature (usually a red heat) and cooling it.

TEMPERATURE. — 1. That which determines the heat or coldness of anything. A relative term denoting the heat of anything as compared with that of a standard, the temperature being measured by the number of graduations upon a thermometer scale.

2. The sensible heat in anything. the measurement of which is made by the thermometer. As distinguished from the latent heat.

3. A bright bar of iron, slowly heated in contact with air, assumes the following tints at the given temperatures:

	Fahrenheit
Yellow at	437°
Orange	473°
Red	509°
Violet	531°
Indigo	550°
Blue	559°
Green	630°
Oxide Gray	752°

TEMPERATURE ALARM. — An electrical apparatus for giving an alarm when a certain temperature is passed.

TEMPERATURE OF A FURNACE FIRE.—A method of finding the furnace heat by submitting a small portion of a particular metal to the heat and noting melting temperature as in the following table:

Melting Points, Degrees Fahr.	
Tin	450
Lead	618
Zinc	786
Antimony	779
Silver	1733
Cast Iron	2300
Steel	2500
Wrought Iron	2800
Hammered Iron	2900

TEMPERATURE REGULATING RELAY.—A thermal relay which operates to hold temperature between given limits.—NEMA.

TEMPERATURE REGULATING SWITCH.—In a system of car heating by electric coils, a switch by means of which any heater may be cut out of the circuit as required.

TEMPERATURE SCALES.—The graduated scale by which the degree of heat is indicated on a thermometer. There are three kinds of thermometer scales in general use: a, Fahrenheit; b, Centigrade; c, Reaumur.

The Fahrenheit scale is generally used in English speaking countries, the freezing point is 32° and boiling point 212°.

The Centigrade scale is used in France. The freezing point is 0° and boiling point 100°.

The Reaumur scale is used in Russia, Sweden, Turkey and Egypt. The freezing point is zero and boiling point 80°.

Fahrenheit is converted into Reaumur by deducting 32° and taking four-ninths of the remainder, and Reaumur into Fahrenheit by multiplying by nine-fourths and adding 32° to the product.

There are two standard points: a, the temperature of melting ice; b, temperature of boiling water; at atmospheric pressure (14.696 lbs. per sq. in.). The divisions are proportioned with respect to these two standard temperatures.

TEMPERATURE, VOLUME AND PRESSURE RELATIONS.—In conformity with the laws of permanent gases, the mutual relations of the temperature, volume and pressure of a gas in the cylinder of an engine vary according to the conditions which obtain at heating.

1. If the temperature of the gas be kept constant, an increase of volume results in a decrease of pressure (Boyle's Law).

2. If the pressure of the gas is kept constant, an increase of temperature results in an increase of volume. (Gay-Lussac's Law).

3. If the volume of the gas be kept constant, an increase of temperature results in an increase of pressure. (Gay-Lussac's, Regnault's and Joule's Laws).

TEMPERING, ELECTRIC.—Bringing metal to a proper degree of hardness and elasticity by first raising it to a high temperature by electrical heat and then rapidly cooling.

TEMPERING TOOL STEEL.—The treatment to which tool steel is subjected, to ensure the proper hardness and toughness for a desired purpose. After hardening, the tool is reheated, and as its temperature rises, colors appear upon its polished surface; these colors, due to films of oxides, pass from very pale yellow through brown to blue and purple, the steel being quenched in brine or cold water as the desired color appears. Microscopic investigation explains the phenomena attending the process. Steel consists of various manifestations of the same substances, rather than separate compounds.

TENSILE STRENGTH.—The capacity of a material to resist forces that tend to produce elongation. The tensile strength of a given material is the ultimate stress it can withstand before breaking.

TENSION, ELECTRIC.—Voltage or electric pressure.

TENSION RATCHET.—A form of dynamometer used in overhead line construction to obtain the proper degree of tension in a wire; a line dynamometer.

TERELLA.—A small magnetized sphere of steel in which the distribution of magnetism resembles that of the earth; earthkin. A globular magnet.

TERMINAL.—A point at which a connection is made between an electrical apparatus and the external circuit.

TERMINAL BOARD.—An insulating base or slab usually mounted in the rear of a switchboard panel equipped with terminals for connecting the small wiring to the outgoing instrument and control cables in a convenient and orderly manner.—NEMA.

TERMINAL BRANCH CUT OUT.—A cut out for disconnecting a branch from the terminal of a main conductor.

TERMINAL INSULATOR.—A line insulator upon a terminal pole.

TERMINAL LIMIT SWITCHES.—Elevator safety control switches which operate each time the car approaches the terminal landings, and function to bring the car to rest at these landings in case the operator be careless.

TERMINAL POLE.—In pole line construction, the last pole on the line, properly guyed against the heavy strain, and carrying the cable head, terminal box or other terminal appliances.

TERMINAL REFLECTION.—A term sometimes applied to the radiation of electric waves from the terminal of a conductor left on open circuit.

TERNE OR "ROOFING" PLATES.—In distinction from plates coated only with tin, terne plates are made of soft steel or wrought iron and covered with a mixture of lead and tin. There are two methods employed in coating: a, the old or original method in which the block plates are dipped by hand into a mixture of tin and lead and allowed to take all the coating possible; b, the later method, known as the patent roller process by which the plates are put into a bath of tin and lead and then passed between rolls.

TERRESTRIAL MAGNETIC INDUCTION.—Magnetic induction derived from terrestrial magnetism.

TERRESTRIAL MAGNETISM. — The magnetism inherent in the earth; the determination of which depends upon the knowledge of the magnetic elements, viz., the intensity, the declination and the inclination.

TESLA, NIKOLA.—Born 1857. An American electrical engineer of Austrian birth; inventor of the system of polyphase electric currents (1887), and distinguished for his experiments with electric oscillations.

TESLA COIL.—A form of induction coil designed by Tesla for obtaining high voltages and frequencies: it consists of a primary of a few turns of coarse wire and a secondary of fine wire, both immersed in oil insulation; a Tesla transformer.

TESLA CURRENT. — In electro-therapeutics, a high frequency current having a voltage which is high, but intermediate between an Oudin current and a d'Arsonval current.

TESLA DISCHARGE. — A high frequency disruptive discharge.

TESLA FREQUENCIES.—The high frequencies which characterize Tesla discharges.

TESLA'S GROUND TRANSMISSION THEORY.—An explanation advanced by Tesla that radio transmission takes place mainly through the ground.

TEST BOARD.—In telegraph and telephone central offices, a board for permitting the ready introduction of testing instruments into any line entering the exchange.

TEST CELL.—A primary cell for the operation of the "busy" test in connection with a multiple telephone switchboard.

TEST CIRCUIT.—The circuit of the "busy" test in connection with a multiple telephone switchboard.

TEST CLIP.—A simple form of clamping device employed in telephone circuits for joining wires in such a way that they may be disconnected at that point for testing. Test clips are also used to connect branch wires and house wires to the main line wire.

TEST JACKS. — Simple forms of spring jacks in connection with a telephone distributing board, for the introduction of testing instruments into the line side of the circuit.

TEST PAPER.—A paper prepared by dipping into a solution or decoction of a substance and drying; to be used to detect the presence of a substance whose presence causes a reaction and a change in the color of the paper. **Blue litmus** paper changes to red by presence of an acid.

TEST PLUGS.—Plugs for insertion into test jacks, by means of which a testing apparatus may be introduced into a telephone circuit.

TEST RING.—1. Ringing up a subscriber from a central telephone exchange in order to determine whether the line is in proper working order.

2. The contact ring of a spring jack in a multiple telephone switchboard; **test thimble.**

TEST STAND.—A testing outfit for testing dynamos, starters, distributers, coils, magnets, etc., in the shop.

TEST THIMBLE.—In a multiple telephone switchboard, a thimble contact in front of a spring jack, which is connected to ground by the insertion of a plug, so that when an operator at another section of the board touches the test thimble of that line with the tip of the plug a "busy" signal is given if the line be in use.

TEST WIRE.—1. In a multiple telephone switchboard, a wire connecting all the jacks of the same number at all the sections, so that when a line is in use at one section the "busy" signal may be given at the corresponding jacks of the other sections.

2. Any wire used for testing.

TESTING POLE.—An electrode employed in electro-therapeutics merely for the purpose of closing the circuit through the part of the body to be treated, as distinguished from the electrode which actually applies the treatment; an **indifferent electrode.**

TESTING POST.—In underground cable construction, a hollow post sometimes set above ground, into which wires from the cables are led in order to facilitate testing.

TESTING PRIMARY CELL WITHOUT AMMETER.—Connect a wire to one terminal and momentarily touch the wire to the other terminal. A weak arc indicates a run down cell, whereas a strong arc, good condition. This test is best made in the dark and should not be relied upon in buying new cells.

TESTING SET.—A combination of the instruments used in ordinary testing put up in a neat and substantial case. There are innumerable forms of testing set, the usual combination being a bridge, galvanometer, battery and necessary keys and connections.

TESTING SWITCH.—In quadruplex telegraphy, a switch employed in balancing the resistance of the artificial line and the main line wire.

TETRAD ATOM.—An atom having the valency, or combining power, of four units, that is, of four atoms of hydrogen.

TETRIVALENT.—In chemistry, a term applied to an atom having a valence, or combining capacity of four units, that is, having a capacity to unite with four atoms of hydrogen.

TETRODE.—A radio four element vacuum tube.

THALLIUM.—A rare, bluish-white metal, widely distributed, but found in small quantities; as, in certain kinds of iron and copper pyrites, in some minerals and in many mineral springs. It has a specific gravity of 11.9 and melts at 561° F. It resembles lead and is so soft that it can be scratched with the finger nail. Thallium has been used in glass manufacture, producing a glass of extraordinary brilliancy and high refractive power.

THEATRE SWITCHBOARD.—A type designed to meet the lighting requirements of the various classes of show houses such as: a, legitimate; b, vaudeville; c, motion pictures, etc. The several types are: a, direct control switchboards; b, pre-selective switchboards (two screw and multi-screw).

THEOREM.—1. A proposition not self-evident, that is, clearly demonstrably true or acknowledged as such.

2. A proposition setting forth something to be proved, as opposed to problem.

THEORETICAL EFFICIENCY.—Ideal efficiency, as of an engine working under ideal conditions in which there are no losses. For instance, calculating efficiency of a steam engine on basis of the theoretical diagram instead of actual indicator cards.

THEORETICAL MAGNET.—A magnet existing only in theory for the sake of discussion and assumed to have infinite length and thinness, and to be uniformly magnetized throughout.

THERAPEUTIC ELECTRIZATION. — The treatment of disease by electricity; electro-therapeutics.

THEREMIN.—A sound instrument operated by manipulating the hands in proximity to it causing various sound waves.

THERM.—A unit of heat; applied especially to gas. One therm=100,000 B.t.u. It is the recognized unit for the scale of gas in Great Britain.

THERMÆTHESIOMETER. — In electro-therapeutics, an instrument for determining the degree of sensitiveness of different parts of the body to temperature variations.

THERMAL.—Relating to heat.

THERMAL ABSORPTION.—The absorption of heat rays in passing through a solid or liquid.

THERMAL AMMETER.—A hot wire ammeter.

THERMAL ARRESTER.—A protective device for telephone apparatus by means of which "sneak" currents are arrested by cutting an instrument out of circuit when a stray current exceeds a predetermined limit; a heat coil.

THERMAL OR THERMIC BALANCE.—An instrument of great sensitiveness, consisting essentially of a so-called Wheatstone bridge having two strips of blackened platinum foil inserted in the arms, for measuring minute quantities of heat energy by the changes of electrical resistance produced in a metallic conductor by variations of temperature; a bolometer.

THERMAL CAPACITY.—The quotient of the heat received by the rise of temperature produced in a body.

THERMAL CIRCUIT CLOSER.—A device for closing a circuit by the action of heat.

THERMAL COIL.—In a rheostat, a coil having a high temperature coefficient introduced for the purpose of indicating the amount of heat generated by the resistance.

THERMAL DISSOCIATION.—In chemistry, the decomposition or breaking down of a compound when its temperature is increasing.

THERMAL EFFECT OF CURRENT.—The conductor along which a current flows becomes heated. The rise of temperature may be small or great according to circumstances, but some heat is always produced.

THERMAL EFFICIENCY.—1. The thermal efficiency of an engine is the ratio of the heat transformed into work to the total heat supplied. In the case of a perfect engine, working under ideal conditions, the thermal efficiency is given by the formula:

$$\frac{T_1-T_2}{T_1}$$

in which T_1=absolute temperature of steam at initial pressure, and T_2=absolute temperature of steam at exhaust pressure. The absolute temperature may be found by adding 460 to the temperature in degrees Fahrenheit.

2. The efficiency of an engine is sometimes expressed in terms of the number of thermal units used by the engine per minute for each indicated horse power, instead of by the number of pounds of steam used per hour. A perfect steam engine converting all the heat energy of the steam into work would require 33,000 ft. lbs.÷777.52=42.44 thermal units per minute per indicated horse power. This figure 42.44 therefore, divided by the number of thermal units per minute per i.h.p. consumed by an engine, gives its efficiency as compared with an ideally perfect engine.

THERMAL EQUIVALENT OF WORK.—The amount of heat which can be produced by a given amount of mechanical work, thus, 1 unit of heat=777.52 units of work, that is 1 B.t.u.=777.52 ft. lbs. from which

1 ft. lb.=1÷777.52=.00129 B.t.u.

THERMAL RECEIVER.—A type of telephone receiver in which telephone currents cause temperature variations in a wire which causes the wire to expand and contract, the movements thus produced being transmitted to a diaphragm. In another type the variable temperature of the wire is communicated to the surrounding air, where resulting expansion and contraction produces sound.

THERMAL RELAY PRINCIPLE.—Relays acting on this principle depend not on the value or duration of the current, but on the rise of temperature due to an abnormal condition.

The thermal principle does not give complete protection, but must be combined with short circuit protection.

THERMAL RESISTANCE.—1. The opposition made by a body to the flow of heat through it.

2. The thermal resistance of iron to flow of electric current increases greatly after a certain critical temperature is reached. This property is utilized in some battery charging systems in ballast coils.

THERMAL UNIT.—A measure of mechanical work, found by experiment to be equal to 1/180 part of the heat required to raise the temperature of one pound of water from 32° to 212° Fahr. It should be noted that this is the definition adopted for the British thermal unit (B.t.u.) corresponding to the unit used in the Marks and Davis steam tables, which is now the recognized standard.

THERMIONIC.—A term which relates to electron emission due to heat. Hence any tube which depends upon heat for its operation is a thermionic tube.

THERMIONIC EMISSION.—Electron emission due to heat, as in a vacuum tube, emission of a stream of negative electrons from a heated filament (cathode).

THERMIONIC OSCILLATOR. — A radio vacuum tube oscillator.

THERMIONIC TUBE.—A vacuum tube in which the emission takes place under the influence of heat as in a tube with a heated filament.

THERMIT.—A granular mixture of aluminum and iron oxide, in exact chemical proportions, so that a perfect union may ensue on combustion and nothing but alumina and pure iron remain behind as products.

THERMIT WELDING.—A chemical process whereby internal local heat may be obtained to fuse together iron and steel parts of considerable size. The temperature of ignition is a little less than that of molten steel and below this it will not ignite. In practice, a special ignition powder is provided, which may be started by a lucifer match, thus causing a local heat of sufficient intensity to ignite the thermit, whose ingredients now combine and cause the enormous temperature of 5400° F. by their combustion. The iron being freed, the aluminum goes to form with the oxygen a slag of alumina, which appears as thin, dark red flakes of what may be called emery, ruby or sapphire;

both slag and iron remaining fluid at the high temperature. It is this immense evolution of heat that serves for the welding of two pieces of iron or steel, being thus analogous to electric welding, or to any other process where a sudden supply of intense heat is desired.

THERMO-CELL.—A term sometimes applied to a thermo-electric couple. It is a junction of two dissimilar metals, which when heated, produces a flow of electric current. A couple of this kind composed of platinum and an alloy of platinum and rhodium is the element used in thermo-electric pyrometers for measuring high temperatures.

THERMO-CHEMICAL CELL.—A primary cell which generates an electric current by means of chemical action induced by heat.

THERMO-CHEMISTRY.—That branch of chemistry which treats of the manifestations of heat which are associated with chemical action.

THERMOCHROSY.—The property of radiant heat which permits of its being analyzed into component rays of different refrangibilities, like light rays; heat color.

THERMO-COUPLE INSTRUMENT.—A moving coil indicating instrument actuated by a thermo-couple which is heated by the current to be measured.

THERMODYNAMICS.—The branch of the theory of heat that treats of the relations between heat and mechanical work, especially as acting in a heat engine; as, the steam engine.

THERMO-ELECTRIC ALARM.—An electrical apparatus for sounding an alarm when the temperature passes a certain danger point. In a typical alarm of this type the sensitive fire detecting element is a very small copper tube which is strung along or around the ceilings or roofs of the premises to be protected. The tubing contains nothing but air at ordinary atmospheric pressure. In case of fire, the contained air becomes heated and expands. At each end of the tube there is a diaphragm or small metal box with very thin sides capable of being bulged outward by air pressure. The bulging of the diaphragm closes electrical contacts which operate a transmitter, automatically sending the alarm to the fire department. An annunciator indicates the floor or section of the building where the fire originated and a local arm is sounded on gongs.

THERMO-ELECTRIC DIAGRAM.—A diagram illustrating the thermo-electric relations of various metals, in which the abscissas represent the absolute temperatures, and the ordinates the increase of voltage per degree rise of temperature with reference to lead as a standard metal.

THERMO-ELECTRIC EFFECT.—The effect of producing an electric current by unequally heating the junctions of dissimilar metals in a thermo-electric couple.

THERMO - ELECTRIC ELEMENT. — Any metal joined with another to form a thermo-electric couple.

THERMO-ELECTRIC INVERSION.—A phenomenon which occurs when the temperature of a thermo-electric junction is gradually raised to a high degree; the current originally flowing in one direction ceases altogether when the neutral point of temperature is reached, and beyond that is reversed in direction.

THERMO-ELECTRIC LAWS. — The two chief laws of thermo-electricity may be stated as follows:

1. The voltage developed by a heated junction depends on the metals used and is independent of the size.

2. If a complete circuit be made of two metals, joined at the extremities, and one junction be heated while the other is kept cold, the voltage generated is proportional to the difference between the temperatures of the hot and cold junctions within certain limits.

THERMO-ELECTRIC MULTIPLIER. — A sensitive instrument consisting of the combination of a galvanometer with a thermopile for measuring minute differences of temperature.

THERMO-ELECTRICITY.—That branch of the science of electricity which treats of electric currents generated by heat applied to the junction of dissimilar metals.

THERMO-GALVANOMETER.—A pair of instruments devised by Duddell for measuring the current delivered by a high frequency alternator. They are capable of registering through a very great range from a micro-ampere to many amperes. The operating principle is that the heat generated by the current in a wire acts upon a thermo-electric junction which forms a part of a galvanometer circuit.

THERMOGRAPH.—An instrument for recording temperature.

THERMOLYSIS.—The decomposition of a compound into its parts by heat; dissociation by heat.

THERMO-MAGNETISM. — The effect of heat upon a magnetized substance in developing new magnetic properties or in altering magnetic conditions; pyromagnetism.

THERMOMETRIC HEAT.—The sensitive heat possessed by a body, as distinguished from radiant heat..

THERMOMETRIC RESISTANCE COIL.—A coil of known resistance at a given temperature, used to indicate changes, or degrees of temperature, by the alterations in its power of resistance.

THERMO-PAIR.—A thermo-electric couple.

THERMO-PENERATION.—The application of low tension currents of high amperage to produce warmth in the body tissues.

THERMOPILE.—A thermo-electric battery whose operation depends on the fact that if the junctions in a circuit composed of two or more metals be kept at different temperatures, a current is created in the circuit. A thermopile consists of strips of dissimilar metals (usually bismuth and antimony) joined to one another alternately in zigzag fashion, so that the first, third, fifth, etc., junctions are at one side of the pile while the even numbered junctions are at the other. If the even junctions be exposed to one temperature and the odd junctions to another there will result a voltage difference across the ends of the pile so that a current will flow if the circuit be completed. Many attempts have been made to produce electricity directly from heat by this means, but none have been commercially successful. The reason for this is that the pile deteriorates with use, a circumstance which indicates that the generation of current is probably connected with some process of diffusion of the one metal through the other.

THERMOSCOPE.—1. An instrument for indicating differences of temperature at two neighboring places without measuring the amount.

2. In flash steam boilers, a device for regulating the temperature of the steam. It consists of a rod placed inside a tube through which the steam flows. The expansion and contraction of the rod controls an oil or gas burner. The movement of the rod may be communicated to the burner valve by mechanical or electrical means.

THERMOSTATIC ALARM.—An alarm given by the automatic closing of an electric circuit by means of a thermostat.

THERMO-TELEPHONE.—1. A telephone receiver in which the diaphragm is actuated by the effects of changes of temperature upon a fine wire attached to it through which the currents pass.

2. A telephone transmitter in which the heating effect of the current changes the resistance of a wire which, acting through an induction coil, sends currents out to the line.

THERMO-VOLTAGE.—A pressure created by the unequal heating of the junctions of a thermopile.

THIMBLE BRUSH.—A form of brush suitable for cleaning the interior of thimbles and similar surfaces preparatory to electro-plating.

THIRD BRUSH REGULATION.—An auxiliary brush used for the purpose of exciting the field windings. It is so placed on the commutator in relation to the main brushes that it serves to regulate or govern the current output of the dynamo. On battery charging dynamos, a method of regulating the charging current by adjusting the position of the third brush. The charging rate is increased by moving the brush in the direction of rotation and reduced by moving it in the opposite direction.

THIRD RAIL.—A bar conductor of electricity, properly insulated, running parallel with the railway track, and at the same level as the rails, transmitting power from a central point to the motors of the train.

THIRD RAIL SYSTEM.—A system of electric traction employing a third rail to convey the current to the motors; this rail is carried on insulators between the rails or along the side of the tracks, the contact being made by cast iron rubbing shoes carried on insulated spring supports.

THOMSON.—A name proposed for the mho, the unit of electrical conductance.

THOMSON EFFECT.—The tendency to increase or decrease the difference of temperatures when an electric current flows through an unequally heated metal; in copper the current transfers heat from the hotter to the cooler parts, tending to equalize the temperatures; in iron the current transfers heat from the cooler to the hotter parts, tending to increase the difference in temperature; in lead the effect does not exist.

THORIATED FILAMENT.—A vacuum tube filament having a surface layer of a thorium compound for the purpose of securing greater electron emission for a given temperature.

THORIUM.—A rare white metal. Its compounds, as in the ordinary Welsbach mantle, are radio-active, emitting alpha, beta and gamma rays, but the energy radiated as alpha-rays is about 22 times as much as that radiated by the beta-rays, and it has been calculated that one gram of thorium emits about 70,000 alpha particles per second, which is equivalent to .3 gram calories per year.

THREE ELEMENT RADIO TUBE.—A vacuum tube having a filament, plate and grid, and which may be employed as a rectifier, detector, amplifier, oscillator, etc. The grid is for the purpose of controlling the flow of electrons.

THREE ELEMENT TUBE OPERATION.—This radio tube is kept positive with respect to the filament and, therefore, attracts the free electrons to it. Since an uncontrolled flow of electricity is seldom useful, the grid is inserted in the tube for the purpose of controlling this flow.

If the grid be held at the same pressure as the plate, it will aid the plate in drawing electrons from the filament. If the grid be held at the same pressure as the filament, it will neither aid nor hinder the plate in drawing electrons from the filament.

If, however, the grid be kept negative, with respect to the filament, it will tend to drive back the electrons leaving the filament, and since the grid is between the plate and the filament, it will reduce the number of electrons which eventually reach the plate.

If the grid be only slightly negative, many electrons will reach the plate through the open spaces between the grid wires, but the grid may be held sufficiently negative so that it will repel the electrons so forcibly that none is allowed to pass it, and the number reaching the plate falls to zero.

THREE PHASE ALTERNATING CURRENT.—This consists of three alternating currents of equal frequency and amplitude, but differing in phase from each other by one-third of a period. It requires three equal windings on the alternator armature and they must be spaced out over its surface so as to be successively 1/3 and 2/3 of the period (that is, of the double pole pitch) apart from one another. Either three or six wires are used, usually three.

THREE PHASE ALTERNATOR.—One which delivers three alternating currents differing in phase by 120° or 1/3 of a cycle. Used on power and lighting circuits. For lighting purposes the phases are isolated in separate circuits, that is, each is used as a single phase current. For driving motors the circuits are combined. Polyphase current is used for power on account of the difficulty encountered in starting motors with single phase current.

THREE PHASE ARMATURE WINDINGS.—A three phase winding can be made from any single phase winding, by placing three identical single phase windings spaced out successively along the surface of the armature at intervals equal to one-third and two-thirds, respectively, of the double pole pitch, the unit in terms of which the spacing is expressed, being that pitch which corresponds to one whole cycle.

Each of the three individual windings must be concentrated into narrow belts so as to leave sufficient space for the other windings between them. This limits the breadth or space occupied by the winding of any one phase to one-third of the pole pitch. The coil ends are shaped for two or three ranges. For two range, hemitropic or half coils are used.

THREE PHASE CIRCUIT LOCATION.—In transmission line construction, a rule often followed in stringing power lines, to identify the phases is as follows:

When the lineman standing under a circuit has his back to the source of power (sub-station or generating station) phase A should be the left hand conductor, phase B the middle conductor, and phase C the right hand conductor. The circuit thus runs ABC from left to right.

THREE PHASE COMPOSITE WOUND ALTERNATOR.—The armature inductors are of the closed coil or delta connected type, but are tapped at three points per pair of poles to the three collector rings. All three connections between the armature coils and the collector rings run through primary circuits of the series transformer within the armature, these three primaries each giving their own effect upon the secondary. Since the resultant of three equal alternating electric pressures 120° apart is zero, some special arrangement must be adopted to make these pressures act with, instead of against each other. The arrangement is a reversal of the connection of one of the primaries of the series transformer.

THREE PHASE CURRENT.—Three alternating currents of equal frequency and amplitude, but differing in phase from each other by one-third of a period. When any one of the currents is at its maximum, the other two are of half their maximum value, and are flowing in the opposite direction.

THREE PHASE DELTA CONNECTED SYSTEM.—In wiring, this arrangement employs three wires. Assuming 100 amperes and 1,000 volts in each phase winding, the pressure between any two conductors is the same as the pressure in the winding, and the current in any conductor is equal to the current in the winding multiplied by $\sqrt{3}$, that is, $100 \times 1.732 = 173.2$ amperes, that is, disregarding the fraction, 173 amperes.

THREE PHASE DELTA GROUPING.—A method of grouping a three phase winding in which the three circuits are connected together in the form of a triangle, the three corners are connected to the three terminals, or in the case of revolving armatures to three slip rings.

THREE PHASE FOUR WIRE SYSTEM.—A three phase three wire system having a fourth wire connected to the neutral point of the source which may be grounded.

THREE PHASE MOTOR.—A three phase synchronous, or three phase induction motor.

THREE PHASE ROTARY FIELD.—A rotary magnetic field created by three phase currents.

THREE PHASE SEVEN WIRE SYSTEM.—An alternating current system made up of groups of three single phase transformers connected in Y so as to obtain a three phase four wire grounded neutral system for lighting and a three phase three wire grounded neutral system of a higher voltage for power, the neutral wire being common to both systems.

THREE PHASE STAR CONNECTED SYSTEMS.—In wiring, there are systems with star connections employing three wires or four wires. Assuming 100 amperes and 1,000 volts in each phase winding, the pressure between any two conductors is equal to the pressure in one winding multiplied by $\sqrt{3}$, that is, $1{,}000 \times 1.732 = 1{,}732$ volts. The current in each conductor is equal to the current in the winding, or 100 ampere-

THREE PHASE STAR GROUPING.—A method of grouping a three phase winding in which one end of each of the three circuits is brought to a common junction, usually insulated, and the three other ends are connected to three terminals, or in the case of revolving armatures to three slip rings. It is commonly called a Y connection or grouping, owing to the resemblance of its diagrammatic representation to the letter Y.

THREE PHASE SYSTEM.—An alternating current system transmitting three alternating currents of the same frequency, but differing in phase by one-third of a period; a triphase system.

THREE PHASE SYSTEM WIRING.—There are various ways of arranging the circuit for three phase current giving numerous three phase systems, which may be classed:

1. With respect to the number of wires used as: a, three wire; b, four wire.

2. With respect to the connections as: a, star; b, delta; c, star delta; d, delta star.

THREE PHASE TO ONE PHASE CONNECTION.—This transformation may be accomplished by the use of two transformers, one end of one primary winding being connected to the middle of the other primary winding, and the second end of the first primary winding at a point giving 86.6% of that winding. The two secondary windings are joined in series.

THREE PHASE TO TWO PHASE.—The three phase system is universally used for long distance transmission, because it requires less copper than either the single or two phase systems. For distribution, however, the two phase system presents certain advantages, thus, it becomes desirable at the distribution centers to change from three phase to two phase. This may be done in several ways. In the transformation by the Scott connection, two transformers are used, one having a 10:1 ratio and the other, a $\frac{1}{2}\sqrt{3}$: 1, that is, an .866:1 ratio. It may also be accomplished by using standard transformers having the ratios 10:1, and 9:1. The transformer having the 10:1 ratio is called the main transformer, and the other with the 8.66:1 ratio, the teaser transformer. Again, the transformation may be made by three star connected transformers by so proportioning the windings that two of the secondary windings are tapped at points corresponding to 57.7 per cent of full voltage. This method, however, is very seldom used.

THREE PHASE TRANSFORMER.—A combination in one unit of three single phase transformers with separate electric circuits, but having certain magnetic circuits in common. There are three magnetic circuits through the core, and the fluxes in the various circuits are displaced in phase.

THREE PHASER.—A three phase alternator.

THREE POINT SWITCH.—A switch provided with three stationary buttons, not including the pivot button, providing three paths. On a three point (single pole) switch there are four external wires.

THREE UNIT SYSTEM.—An electric system for automobiles in which the starting motor, charging dynamo and ignition magneto are separate machines.

THREE WAY SWITCH.—One having in addition to the hinged contact, three stationary contacts to which external wires are connected, that is, a switch which connects one conductor to any one of three other conductors.

THREE WINDING TRANSFORMER.—A type adapted to high voltage networks that must be tied together in order that power may be interchanged between them. In some cases three sections, operating at different voltages, are tied together by means of one bank of transformers. This requires three winding transformers so designed that power may flow in any combination of ways between the three sections and not suffer prohibitive voltage regulation.

THREE WIRE AUXILIARY DYNAMO SYSTEM.—A three wire system in which the neutral wire is connected to an auxiliary dynamo which supplies a pressure one half as great as that of the main dynamo. The auxiliary dynamo is usually belt driven by the main dynamo, and acts as a dynamo when the load is greater on the negative side of the circuit, and as a motor when the excess of load is on the positive side.

THREE WIRE DOUBLE DYNAMO SYSTEM.—Three wire distribution system fed by a double dynamo or one in which a double dynamo having two armature windings upon the same core, connected to two separate commutators, is used in the same manner as two separate dynamos connected in series.

THREE WIRE METER.—A meter designed to measure electrical supply in a three wire system of distribution.

THREE WIRE SYSTEM.—A system of electrical distribution, employing two dynamos or other current sources joined in series and connected at their free terminals to the positive and negative mains, respectively, between which a neutral or balance wire, usually smaller than the mains, is introduced and joined to the junction of the dynamos.

THREE WIRE SYSTEM COPPER ECONOMY.—Theoretically, the size of the neutral wire has to be only sufficient to carry the largest current that will pass through it. A large margin of safety, however, is allowed in practice so that its cross section ranges from about one-third that of the outside line, in large central station systems, to the same as that of each outside line in small isolated systems. If the neutral wire be made one-half the size of the outside conductor as is usually the case in feeders, the amount of copper required is 5/16 of that necessary for the two wire system. For mains it is customary to make all three conductors the same size, increasing the amount of copper to ⅜ of that required for the two wire system.

THREE WIRE SYSTEM, EXTENSION.—In order to attain still greater economy in copper, the principles of the three wire system may be extended to include four, five, six and seven wire systems. The comparative weights of copper required by such systems are as follows:

Two wire system	1.000
Three wire system, all wires of equal size	.370
Three wire system neutral wire one-half size	.313
Four wire system, all wires of equal size	.222
Five wire system, all wires of equal size	.156
Seven wire system, all wires of equal size	.096

THREE WIRE TWO PHASE CIRCUIT.—A transmission circuit for two phase currents employing, instead of four wires, three wires, one of which acts as the common return for the other two.

THROTTLE CONTROL.—In radio, apparatus placed in the plate circuit of a vacuum tube to control regeneration.

THROTTLING GOVERNOR.—On a steam engine, an automatic throttle valve which governs by altering the pressure at which steam is admitted to the cylinder, that is, the throttle valve is opened or closed inversely with changes in load, thus causing more or less drop in pressure so that the resulting mean effective pressure in the cylinder will vary with the load and maintain a steady speed. As compared with a variable cut-off governor, the throttling governor is less efficient.

THROW.—1. A term which relates to the extent of the blade movement, with respect to the contact range of a switch.

2. In valve motion, twice the eccentricity of the eccentric or the amount of to and fro movement produced. The throw is equal to the diameter of the circle described by the center of the eccentric as it revolves around the shaft. Not just the eccentricity as incorrectly defined, even by some writers.

THROW BACK INDICATOR.—An annunciator provided with electrically self-restoring drops.

THROW OF NEEDLE.—An impulse given to the needle of a ballastic galvanometer by the passage of electric discharge through the coils before the inertia of the needle is overcome.

THROW OVER REVERSING SWITCH.—A double throw switch for reversing a current.

THROW OVER SWITCH.—A knife switch which may be thrown over into either of two opposite sets of contacts; a double throw switch.

THUMB COCK ELECTRIC BURNER.—A gas burner which is ignited by a wipe spark produced by the turn of the thumb cock.

THUMB NUT.—A nut fitted with projecting wings so that it may be loosened or tightened by hand. A wing nut.

THUMP FILTER.—In radio a name sometimes applied to a key filter.

THUNDER.—The report which follows a discharge of lightning, caused probably by the heat of the air in the region of the flash, producing sudden expansion and compression, followed by a swift burst of air into the rarefied space.

THUNDER STORM.—A rain storm during which the electricity carried by the clouds passes to the earth in disruptive discharges in the form of lightning, accompanied by thunder.

TICKER.—1. A printing telegraph employed for reporting stock quotations, race-track information, etc. The message is printed out in full in the ordinary alphabet upon a strip of paper. Toothed wheels with letters and numerals upon their peripheries operate under control of an electro-magnet and signaling key. When the key is depressed at the sending station, the wheels of the receiving machine cease to rotate, and an electro-magnet presses the paper tape against the tooth that stops opposite. It is usually called stock ticker.

2. In radio telegraphy, an interrupter or chopper generally of the commutator form, for interrupting radio frequency currents.

TICKLER COIL.—In radio, a coil inserted in the plate circuit of a detector or amplifying tube to permit feed back and regeneration.

TIE BARS.—In railway track construction flat iron bars extending at right angles between the rails at intervals of six feet to prevent spreading of the track.

TIE FEEDER.—A sub-feeder for connecting a trolley wire with the feeder proper.

TIE LINE.—An electric conductor employed for the sole purpose of conveying current between two points in a system in order to equalize pressures.

TIE WIRE.—In pole line construction, a piece of wire, usually about sixteen inches in length, for tying the line wire to an insulator.

TIE WIRE SIZES.—The following table gives the proper size of tie wire to be used with conductors of various sizes:

Size of Wires

Size of line conductor (B. & S. gauge)	Size of tie wire (B. & S. gauge)
No. 4 and smaller	No. 6
No. 1 to No. 4	No. 4
No. 0 and larger	No. 2

TIGHT COUPLING.—Close coupling.

TIKKER.—Properly spelled ticker. A radio chopper.

TIMBER PRESERVATION.—Seasoned timber is placed in a long, closed, wrought iron cylinder from which the air is exhausted; creosote at 120° F. is then pumped in until a pressure of 170 lbs. per sq. inch is attained. Soft wood will absorb a maximum of 12 lbs. creosote per cubic foot, very hard wood not more than three lbs. Timber must always be well seasoned before painting, as the coat of paint tends to imprison moisture, rendering the wood liable to rot.

TIMBRE.—The quality of sound dependent upon the form of the sound wave. It does not depend upon the frequency or rate of vibration, as does the pitch, nor upon the amplitude of the wave, like the loudness, but upon the number of overtones superimposed on the fundamental tone and their relative intensities.

TIME BALL.—A ball suspended from a staff in a conspicuous position, which drops at the exact hour of noon by the electrical action of a standard clock, thereby indicating the exact time to the community.

TIME CONSTANT.—In an electric circuit, the time (in seconds) which must elapse from the moment the circuit is completed before the current attains .632, or nearly two-thirds of its full strength; it is equal to the self-inductance (in henries) divided by the resistance (in ohms) of the circuit.

TIME CUT OUT.—A cut out which automatically removes an apparatus from a circuit at the expiration of a given time, especially for cutting out a storage battery when fully charged.

TIME DELAY RELAY.—This type of relay is used for protecting motors from overheating and are usually adjusted for about 15% above the motor current rating. They are similar to the instantaneous types, except that they have a dash pot for retarding the action of the plunger. Both current and time features are adjustable. The relays are calibrated in air at 65, 100 and 150% of the continuous ampere rating of the coils.

The usual current setting is for 110% of the full load motor current in air and the time setting is for 20 seconds delay with 200% of the full load motor current, with oil in the dash pot. All dash pots must be thoroughly cleaned before and after calibrating and setting. No oil or dirt of any kind must be left in the dash pot or on the plunger.

TIME DETECTOR.—An electrical apparatus for recording the time a person, as a night watchman, arrives at a point in his rounds and makes or breaks the circuit which operates the register.

TIME ELEMENT.—An auxiliary device which retards the action of a relay. It may form part of the relay or may be quite distinct from it. It retards its action until the overload has lasted for a pre-determined time, several seconds or more.

TIME FALL OF SECONDARY CELL.—The fall of voltage in a secondary or storage cell as it becomes spent.

TIME GUN.—A signal gun which is electrically connected with a standard clock so that it is discharged at a given time as at sunrise or sunset.

TIME LAG OF MAGNETIZATION.—A peculiar quality of an iron core, such as an armature core undergoing rapid reversals of magnetism, by which there occurs an expenditure of energy which is converted into heat. This loss of energy is due to the work required to change the position of the molecules of the iron, and takes place both in the process of magnetizing and demagnetizing; the magnetism in each case lagging behind the force; hysteresis.

TIME LIMIT ATTACHMENTS.—Devices which are fitted to circuit breakers and which act as dampers and prevent the too sudden operation of the breakers on what may be only a temporary overload or reverse current.

By having different time limits on feeder and dynamo breakers, it can be insured that the former operate before the latter, and suitably in other cases where it is desired that one breaker shall operate before another.

A typical time limit attachment consists of a clockwork device, a weight acting on a small drum or pulley, a modified dash pot arrangement, or a device operating by the expansion of a conductor due to the heat generated by a current passing through it.

The device should be so arranged that the heavier the overload, the quicker the device acts, until with a short circuit the device is almost instantaneous in its action.

TIME LIMIT RELAY.—A relay for operating a circuit breaker after a predetermined time. It is provided with a time lag device which retards its action for a time, depending on the extent of the overload.

TIME MEASURE.—

60 seconds (sec. ″)	= 1 minute (min.′)
60 minutes	= 1 hour (hr.)
24 hours	= 1 day (da.)
365 days	= 1 common year (yr.)
366 days	= 1 leap year
12 calendar months	= 1 year
100 years	= 1 century (C.)

Unit equivalents

yr.	mo.	wk.	da.	hr.	min.	sec.
					1 =	60
				1 =	60 =	3,600
			1 =	24 =	1,440 =	86,400
		1 =	7 =	168 =	10,080 =	604,800
1 =	12 =	52 =	365 =	8,760 =	525,600 =	31,536,000
			366 =	8,784 =	527,040 =	31,622,400

Scale—ascending, 60, 60, 24, 7; descending, 7, 24, 60, 60.

TIME RELAY.—In a stock ticker system, a relay for the purpose of delaying for an instant the rotation of the type-wheel until the letter or figure is correctly printed upon the tape.

TIME SIGNAL.—1. A telegraphic signal given from an observatory to distant points, electrically connected therewith, to indicate standard time at noon or some other convenient hour, thus ensuring correct and uniform time at all points.

2. A signal given by time ball, cannon, etc., to indicate a certain known hour, generally noon, or 6 P. M., thus giving a standard time.

TIME SWITCH.—A self-acting switch controlled by a clock so that a circuit may be opened or closed automatically at a given time.

TIMER.—A revolving ignition switch which closes and opens the primary circuit. It is operated by the engine, being geared to revolve at one half the engine speed in the case of a four cycle engine, and at full engine speed for a two cycle engine. A timer consists of a stationary part and a revolving part or rotor. The former is usually made of a ring of hard rubber, into the inner face of which is let contact segments forming insulated contacts; one of these is provided for each cylinder of the engine. The rotor has an arm which makes contact with the insulated segments during one revolution. A vertical shaft geared to the engine imparts motion, by direct connection to the engine, and forms with the rotor arm, the ground connection of the primary circuit. The other wire of the primary circuit for each cylinder is connected to each stationary contact. Hence, during one revolution of the timer arm, the primary circuit is made and broken once for every cylinder in proper sequence. Careful distinction should be made between a timer and a distributer and the practice of calling a timer a distributer avoided.

TIMING.—In a gas engine, adjusting the point of ignition so that the charge is ignited or fired at a moment when the piston is in a position in the cylinder where the most power will be obtained from the engine. The exact point or place on the piston stroke for securing maximum power depends on the size of the engine, speed, load, etc. To make the spark occur at the right moment for different loads, some engines are provided with a device to shift the timing.

TIMING LEVER.—A lever fitted to automobiles by means of which the time of ignition is advanced or retarded, or as it is frequently termed, the spark lever, because it controls the timing of the electric spark.

TIMING A MAGNETO.—In timing a single cylinder high tension magneto, the engine must first be turned to the correct late firing position, usually the outer dead center, or a little past at the end of the compression stroke. The timing arm on the interrupter housing is put in its full retard position, as far as it will go in the direction in which the magneto revolves. The magneto armature is then turned until the interrupter contact points just start to open. In this position it is then connected to the engine drive shaft by putting together the magneto driving coupling or by meshing the driving gears as the case may be.

TIN.—A soft metal, the color being white with a tinge of yellow. It has a high lustre, hence is frequently used as reflectors of light. Tin when nearly pure has a specific gravity of 7.28 to 7.4, the pure tin is the lightest. It has a low tenacity but is very malleable and can be rolled or laminated into very thin sheets, known as tin foil. Melting point, 443° F. Ductile at 212° F.; easily drawn into wire; boils at white heat. Heat conductivity, 14.5; electricity conductivity, 12.4 (silver 100 in each case). Weight, 450 lbs. per cu. ft. Avoid the ignorant use of the word tin for sheet tin.

TIN BATH.—1. In plating by the dipping process, the bath of molten tin into which sheet iron is immersed.

2. In electro-plating with tin, the solution of tin salt in which the object to be coated is suspended as the cathode.

TIN CHLORIDE.—Stannous chloride, or tin salt. A white crystalline salt readily soluble in water. On fusing it forms a solid opaque mass of a pale yellow color. In electro-plating, it serves in the preparation of brass, bronze and tin baths.

TIN FOIL.—Tin or some alloy resembling tin rolled into very thin sheets. Tin foil is largely used in making condensers and for coating Leyden jars.

TIN PLATE.—Sheets of iron or steel coated with tin for protection against corrosion, as distinguished from sheet tin which consists of sheets entirely of tin. Tin plate is produced from steel sheets which range in thickness usually from 16 to 38 Stubs wire gauge. After the sheets are rolled, they are pickled to remove the scale, washed with water to remove the acid, and then annealed, pickled, washed, and passed through molten tin by means of from four to six pairs of rolls immersed in the molten tin. Formerly when iron was used instead of steel, the highest quality tin plate was called charcoal plate and the second quality, coke plate, these names signifying the mode of manufacture of the iron used. Although steel is now used, these names have been retained, but refer to the quality of the tin coating and finish. At present, charcoal plates have the heavier coating and higher finish while coke plates have a light coating. The amount of coating of pure tin when made according to the specifications of one manufacturer is .023 lb. per sq. ft. The various grades of charcoal plates are designated by the letters A to AAAAA, the latter having the heaviest coating and highest polish, thus: AAAAA tin plate is especially adapted for nickel plating. Tin plates are ordinarily made in sizes of 10 x 14 ins. and multiples of that size. The sizes generally used are 14 x 20 and 20 x 28 ins. Tin plates are packed in unit boxes called "base boxes," each holding 112 14 x 20 in. plates or 31,360 sq. ins. of any size. Plates lighter than 65 lbs. per base box (No. 36 gauge) are known as taggers tin. The stock size of coke tin plates is 20 x 28 ins. and the basis on which all coke plates are sold and figured is the base box of 112, 14 x 20 plates.

TIN PLATING.—The coating of iron or steel with tin to protect it from oxidation and to provide a bright surface. The iron is first cleaned by pickling and then dipped into a bath of melted tin.

TINNED CABLE.—A cable having a coating of tin outside of the lead sheath to protect the lead from chemical action in underground work.

TINNING A SOLDERING BIT.—Heat the bit in a fire or gas flame until hot enough to melt a stick of solder rapidly when it is lightly pressed against it. When the bit is at the right temperature, the heat can be judged by holding the bit close to the face. When hot enough, clean up the surface of the copper with an old file, or scrape it on a brick. If the temperature be too high, the copper surface will be found to tarnish immediately, in which case the soldering bit must be allowed to cool slightly and the cleaning repeated. When the surface only tarnishes slowly, it is at the right temperature for tinning. Take a piece of tin plate (ignorantly called sheet tin or just "tin") and place on it some solder and flux, and rub the bit on same. The surface of the bit should present a bright silvery appearance when properly tinned.

TINSEL.—A very fine flat copper ribbon wrapped around a cotton thread.

TITANIUM LAMP.—A form of incandescent lamp having a filament composed of the carbide of the metal titanium prepared in an electric furnace. The filament is strong and elastic and much shorter than that of carbon. Tests show initial watts per candle of 2.53 and final 3.35 at the end of 1000 hours.

TOBIN BRONZE.—A non-corrosive bronze of great tensile strength, capable of being forged at a dark red heat; much used in marine work. It consists of copper 59 parts, tin 2.16, zinc 38.40, iron .11 and lead .31.

TOE OF GRAPNEL.—One of the flukes or claws of a grapnel.

TOGGLE JOINT.—An elbow joint; a mechanism common in many forms of presses and in stone crushers; by its action it gives an enormous mechanical advantage. It consists of two rods or plates hinged together and employed to transmit a varying force by side pressure on the hinge, which is called the knuckle or knee from its resemblance to the knee of a man.

TOGGLE SWITCH.—A type of switch having a small projecting lever which is moved back and forth through a small arc in opening and closing the circuit.

TOLL STATION.—A telephone public pay station.

TONE.—Sound in relation to volume, quality, duration and pitch; specifically, in acoustics, a sound that may be employed in music, having a definite pitch and due to vibration of a sounding body; opposed to sound as mere noise. By common usage in music, tone generally means the timbre or quality of sound.

TONE CIRCUIT.—In radio, a modulation circuit.

TONE MODULATED WAVES.—In radio, audio frequency modulated waves.

TONE WHEEL.—In radio, a form of interrupter similar in principle to a ticker, and converting the incoming oscillations to audio frequency currents.

TONGUE OF RELAY.—In telegraphy, the lever upon which the armature of the relay electro-magnet is mounted, and which carries the contact point.

TONUS.—A condition of the muscles when undergoing no mechanical exertion and at rest.

TOOLING.—Passing a hot tool over the surface of the rubber covering for a wire joint for the purpose of properly shaping it.

TOOTHED CORE ARMATURE.—A laminated armature built up of toothed core discs.

TOOTHED CORE DISCS.—Metal discs for building up laminated armature cores, having notches cut in the circumference, resulting in a succession of projecting teeth.

TOP HAT CURVE.—A curve of pressure or current which has nearly constant value, suggesting in shape a high hat.

TOROID.—A surface generated by the revolution of a conic section about an axis lying in its plane; also called tore.

TOROIDAL COIL.—A coil so wound as to form a toroid.

TORPEDO CABLE.—A cable connected with a torpedo in order to explode it by electricity.

TORPEDO, ELECTRIC.—A torpedo propelled, exploded, or in any way operated by electricity.

TORPEDO NETS.—Heavy wire nets suspended about a war ship at anchor in order to protect it from torpedo attack.

TORQUE.—The value of the moment of a system which tends to produce rotation.

TORQUE EFFICIENCY.—The ratio of the actual torque of a motor to the torque which it would exert if free from frictional resistance.

TORRICELLIAN VACUUM.—The vacuum produced by filling with mercury a tube closed at one end, and immersing the open end in a vessel of mercury, so that the mercury in the tube descends until it is counterbalanced by the atmospheric pressure upon the mercury in the vessel. It is the space existing in the tube of a barometer above the surface of the mercury.

TORSIOMETER.—An instrument to measure the stress to which a bar is subject when in torsion, or under twisting strain, and the angular deflection. In testing, the specimen is gripped in the head so that it cannot turn and the deflector indicator attached; this end free to turn on the support. Torsion is applied by the weight, which twists the specimen in a clockwise direction, thus an element of its surface is distorted from a straight line, to a spiral form, the amount of distortion depending upon the intensity of the torsional force applied and the resisting power of the metal. By attaching at the deflection end, a suitable scale, the amount of twist can be read in degrees. The results sought in torsional tests are to determine the torsional elastic limit and ultimate torsional strength. Since the strain varies over the sectional area, it cannot be expressed as pounds per square inch, but must be stated as inch pounds. The value is obtained by multiplying the pull applied by the lever arm by the distance through which it acts. Thus if the weight be 100 pounds and the lever arm be 30 inches, then the torsional stress correspondingly is 100 x 30=3,000 inch-pounds. Again if the indicator register 20° on a 20-inch specimen the deflection in twist is stated as 20°÷20 inches=1° per inch.

TORSION.—1. In mechanics, that force with which a thread, wire, or rod of any material, returns, or tends to return, to a state of rest after being twisted.

2. The act of turning or twisting or the state of being twisted.

TORSION BALANCE.—An instrument for determining, by the torsion of a wire, the action of the forces of attraction and repulsion exhibited between two electrified spheres; Coulomb's balance.

TORSION GALVANOMETER.—A galvanometer in which the strength of an electric current is measured by the torsion produced upon the filament suspension of the needle.

TORSION SUSPENSION.—A delicate method of suspending a needle for sensitive movements, as in a galvanometer, by a filament of silk or fiber of quartz; fiber suspension.

TOSS.—In airplane operation, to plunge tail down.

TOTAL EARTH.—In telegraphy, a fault in the line involving a complete grounding or connection with the earth; a dead earth.

TOTAL EMISSION.—In a radio vacuum tube, the current resulting when all the electrons emitted are drawn away.

TOTAL HEAT.—In steam engineering, total heat is a term used in calculations: it represents all the heat, above 32° F., in a pound of steam. It is the sum of the sensible heat units in the water, above 32° F., and the latent heat of the steam, being made up of:

1. The sensible heat required to raise the temperature of the water to the boiling point	180	B.t.u.
2. The internal latent heat absorbed by the water at 212° before a change of state takes place	897.51	"
3. The external latent heat required for the work to be done on the atmosphere....	72.89	"
	1,150.4	"

It should be noted that the sensible heat is said to be in the water and the total heat in the steam.

TOTALLY ENCLOSED MOTOR.—A motor which is so completely enclosed by integral or auxiliary covers as to practically prevent the circulation of air through the interior. Such a motor is not necessarily air tight.

TOURMALINE.—A mineral occurring in crystalline form, exhibiting pyro-electric properties in a high degree.

TOURNIQUET, ELECTRIC.—A light, delicately poised wheel with radiations terminating in points bent at right angles in the same direction; when connected with a source of electricity, it spins rapidly on account of the discharge of convection streams from the points resisting the surrounding air; a reaction wheel.

TOWER SYSTEM OF ELECTRIC LIGHTING.—A method of lighting a considerable area by a group of arc lamps carried on the summit of a tower instead of by independent lamps distributed over the territory.

TOWER WAGON.—In an overhead trolley system, a repair wagon furnished with an elevated platform to give workmen ready access to the wires.

TOWING, ELECTRIC.—The application of electricity to the towing of canal boats.

T.p.—Abbreviation for terminal pressure.

T.P.M.—Abbreviation for turns per minute.

T.P.S.—Abbreviation for triple pole switch.

TRACK BOND, OR JOINT.—A copper strap with terminals for carrying the current around the track joints to increase the conductivity.

TRACK CIRCUIT.—An electric circuit with current fed from one point to another, using the rails instead of wires.

TRACK HANGER.—A hanging support for an overhead railway, upon which a traveling crane or similar appliance may run. It is generally used in connection with a monorail on which run carrier trolleys, by means of which weights are transported from one department of a plant to another.

TRACK INSTRUMENT.—An electric contact device connected with a railway track, so that a train closes the circuit in passing, and gives a signal of its approach at the next station.

TRACK SWITCH.—A switch at a point in a railroad track where a branch enters the main line, by means of which a car may be led from one track to the other.

TRACTION DYNAMOMETER.—A device used for determining the power required to pull a car or other vehicle, or a plow or harrow.

TRACTION, ELECTRIC.—The application of electricity to the propulsion of cars in street, and other railway systems.

TRACTION ELEVATOR MACHINE. — A hoist for an elevator, transmitting power to the car through a traction drive, that is by the friction existing between the driving pulley and the hoisting ropes. The traction machine carries the hoist ropes over the hoisting sheave and down to the counter-weight and relies on the grip of the ropes on the sheaves to give enough traction to lift the load.

TRACTIVE COEFFICIENT. — In electric traction, the ratio between the weight upon the driving wheels and the tractive effort.

TRACTIVE EFFORT.—In electric traction the pull transmitted by the gears from the armature shaft to the base of the car wheel. It is the torque in pounds developed at the rim of the wheels divided by total train weight in tons. It depends upon the rate of acceleration, grade, car friction, and air resistance.

TRACTIVE MAGNET.—An electro-magnet designed to perform certain work by the movement of a plunger. The coil effects a pull upon the plunger which is drawn into the core chamber of the coil.

TRACTOR.—1. A front drive airplane; one that is pulled instead of pushed through the air.

2. A power vehicle propelled by a gas engine, used especially in farming for drawing plows, wagons, etc.

TRAFFIC SIGNALS.—The movement of traffic is controlled by colored electric lights on signal units located at street intersections, the signals used are:

Green	go
Yellow	caution
Red	stop

The yellow signal is really a "transition" signal which is displayed a few seconds between the green and red lights in order to allow the moving traffic time to cross the street intersection before the other line of traffic starts. Sometimes instead of a yellow signal there is no light during the transition period.

T RAIL.—A form of rail employed in track work on railroads where street traffic does not have to be considered. It gets its name for the general resemblance of its cross section to an inverted letter T.

TRAILER.—In electric traction, any car not furnished with motive power coupled to an electric car to be drawn after it.

TRAILER GRAPNEL.—In submarine cable work, a second grapnel caused to trail behind the first in dragging for a cable.

TRAILING EDGE.—The rear edge of airplane wings.

TRAILING HORNS.—The projecting edges of the pole pieces of a dynamo which extend in a direction opposite to the rotation of the armature; the poles toward which the armature turns; following horns.

TRAILING WIRE, AERIAL.—A type of airplane aerial consisting of a bare wire with a weight on the end let down from the bottom of the air plane.

TRAIN DESCRIBER.—An electrical device in a block system of railway signaling for the purpose of indicating the position of an approaching train.

TRAIN FREQUENCY.—In radio, a name sometimes used for group frequency.

TRAIN LINE JUNCTION BOXES.—On electric cars, a wiring accessory used to simplify the installation of control wiring and the inspection of equipments as a whole.

TRAIN WIRE.—A special telegraph wire reserved exclusively for the purpose of despatching trains in a block railway system.

TRAINING.—In cable jointing the shaping of the two cables where they project into the manhole so that they will follow the contour of the walls and come together at the point where they are to be joined, with their ends overlapping.

TRAJECTORY.—The curve described by the path of a projectile through the air.

TRAM CAR.—English term for street car.

TRAM RAIL.—A name given to a form of girder rail for street railway service because of a flat tram or tread which forms an extension of the head.

TRAM SILK.—A long filament silk of the highest grade.

TRANSDUCER.—A device operated by power from one system and supplying power in the same or any other form to a second system. Either of these systems may, for example, be electrical, mechanical, or acoustical.

TRANSFER BUS BAR.—An auxiliary bus bar for transferring a feeder wire from one bus bar to another without shock.

TRANSFER DEVICE.—One which transfers control of breakers, etc., from automatic to test switches, or control of equipment from manual to automatic, automatic to continuous, or performs some transfer operation other than unit sequence.—NEMA.

TRANSFER EXPANSION.—A method of expansive working of steam in which steam is admitted full stroke in the first or small cylinder and then exhausted or transferred to a large cylinder in which the expansion takes place. An example of this cycle is the author's transfer expansion engine as described in Audel's Engineers and Mechanics Guide Vol. 3, page 1074.

TRANSFER OF HEAT.—When bodies of unequal temperatures are placed near each other, heat leaves the hot body and is absorbed by the cold body until the temperature of each is equal. The rate by which the heat is absorbed by the colder body is proportional to the difference of temperature between the two bodies. The greater the difference of temperature the greater the rate of flow of the heat. Transmission of heat takes place by: a, radiation; b, conduction, and c, convection. Thus, in a boiler, heat is given off from the furnace fire in rays which radiate in straight lines in all directions being transferred to the crown and sides of the furnace by radiation; it passes through the plates by conduction, and is transferred to the water by convection, that is, by currents.

TRANSFER OPERATOR.—A telephone operator at the switchboard of a transfer system.

TRANSFER RELAY.—A circuit opening relay, used where accurate time of operation is required and a separate source of control is not available. It operates in a manner somewhat similar to one having a direct trip attachment. The relay consists of two magnetic circuits, one above the other. The upper magnetic circuit contains the operating coil while the lower magnetic circuit contains the holding coil and release coil. A plunger in a normal position closes the lower magnetic circuit, but in operating, it raises and closes the upper magnetic circuit. The operating and holding coils are connected in series with each other and the current transformer and control relay circuit. Regardless of the current flowing the torque exerted by the holding coil prevents the plunger raising until the relay contacts short circuit the release coil, thus demagnetizing the lower magnetic circuit and permitting the operating coil to raise the plunger. The plunger in raising operates a switch which connects into the circuit, the breaker trip coil thus causing the breaker to open.

TRANSFER SYSTEM.—A telephone system dispensing with the multiple switchboard, and depending for its operation at the exchanges upon the transfer of a connection from one part of a switchboard to another by means of trunk lines.

TRANSFORMATION.—1. The changing of the value of electric current or pressure by means of the transformer.

2. The changing of electrical energy into mechanical energy, or into heat or light.

3. The changing of heat energy into mechanical energy.

TRANSFORMATION OF PHASES.—The numerous conditions met with necessitate various phase transformations, as: a, three phase to one phase; b, three phase to two phase; c, two phase to six phase; d, three phase to six phase. These transformations are accomplished by the numerous arrangements and combinations of the transformers.

TRANSFORMER.—An apparatus used for changing the voltage and current of an alternating circuit. A transformer consists essentially of: a, primary winding; b, secondary winding; c, iron core. In principle if a current be passed through a coil of wire encircling a bar of soft iron, the iron will become a magnet; when the current is discontinued the bar loses its magnetization

Conversely: if a bar of iron carrying a coil of wire be magnetized in a direction at right angles to the plane of the coil a momentary electric pressure will be induced in the wire; if the magnetization be reversed (by reversing the current), another momentary pressure will be induced in the opposite direction in the coil. The coil through which current from the source flows is called the primary winding. The coil in which voltage is induced is called the secondary winding. Similarly, the current from the source (alternator) is called the primary current, and the induced current, the secondary current.

TRANSFORMER ADMITTANCE.—If the impedance volts, as measured, be divided by the primary current, the impedance of the transformer is obtained. The reciprocal of this quantity is known by the term admittance. When two or more transformers are connected in parallel they divide the load in proportion to their admittance.

TRANSFORMER CLASSIFICATION. — Transformers may be classed:

1. With respect to the transformation, as: a, step up transformers; b, step down transformers.
2. With respect to the arrangement of the coils and magnetic circuit, as: a, core transformers; b, shell transformers; c, distributed core, sometimes called modified shell type.
3. With respect to the kind of circuit they are to be used on, as: a, single phase transformers; b, polyphase transformers.
4. With respect to the method employed in cooling, as: a, air cooled—natural draught, forced draught; b, self cooled—oil immersed; c, forced oil cooled—oil immersed; d, water cooled.
5. With respect to the nature of their output, as: a, constant pressure transformers; b, constant current transformers; c, current transformers; d, autotransformers.
6. With respect to the kind of service, as: a, distribution; b, power.
7. With respect to the circuit connection that the transformer is constructed for, as: a, series transformers; b, shunt transformers.
8. With respect to location: a, indoor; b, outdoor.

TRANSFORMER CONNECTION FOR MONOCYCLIC SYSTEM.—Motors on the monocyclic system are operated from two transformers. In this system the single phase current is used to supply the lighting load and two wires only are necessary, but if a self-starting induction motor be required, a third or teaser wire is brought to the motor and two transformers used.

TRANSFORMER COPPER LOSS TEST.—The secondary of the transformer is short circuited, and a voltage applied to the primary which is just sufficient to cause full load primary current. If full current pass through the primary of the transformer with the secondary short circuited, the secondary will also carry full load current. With a test hook up, including volt meter, ammeter, watt meter and rheostat connections, and with full load current the volt meter indicates the impedance volts of the transformer. This divided by the rated voltage gives what is called the per cent impedance of the transformer. In a commercial transformer of 5 kw. this should be approximately 3 per cent.

TRANSFORMER COUPLED AMPLIFIER.—One having a transformer coupled to the plate circuit of one tube and the grid circuit of the next tube.

TRANSFORMER COUPLING.—A method of connecting two a.c. circuits inductively. The primary winding of the transformer is connected in one circuit, and the secondary in the other. In radio, transformer or inductive coupling is by audio and radio frequency transformers.

TRANSFORMER CUT OUTS OR FUSE BOXES.—Fusible primary cutouts, sometimes called transformer fuse boxes, are placed in the primary circuit of transformers to protect the windings from overloads and short circuits. They are usually single pole devices and one is placed in each incoming line.

TRANSFORMER FLAMING ARC LAMP.—A compact transformer for 110 volts primary to 55 volts secondary. A hook in bottom of case provides means for suspension of lamp. The transformer may be operated on circuits from 100 to 120 volts primary, 50 to 60 volts secondary. The secondary capacity is 8 to 12 amperes.

TRANSFORMER GUARD.—A safety device for grounding the secondary circuit of a transformer, if through a fault in the insulation, a contact be made between the primary and the secondary which would increase the voltage in the secondary to a dangerous extent.

TRANSFORMER IRON LOSS.—The iron loss under approximately 3 per cent of the normal voltage will be negligible, and the losses measured will be the sum of the primary and secondary copper losses.

TRANSFORMER LIGHTNING ARRESTER.—A lightning arrester included in a transformer circuit.

TRANSFORMER LOSSES.—There are two losses in a transformer: 1. The iron or core loss: Due to a, hysteresis; b, eddy currents; c, magnetic leakage (negligibly small).

2. The copper losses: Due to a, heating the conductors (the I^2R loss); b, eddy currents in conductors; c, stray losses (eddy currents in tank, clamps, etc.).

TRANSFORMER OIL.—An insulating and cooling medium used in some types of transformer. Mineral oil is used and it should have low viscosity, that is, it should flow freely at operating temperatures. It should not decompose or throw down sludge under operating conditions. It must not contain moisture and should be free from acid, alkali or sulphur compounds. Since the dielectric strength or insulating value of oil depends upon the water content, it may be determined by finding the break down voltage of a standard sample. This test may be quickly and accurately made by the use of a standard oil testing outfit. A rough test consists of thrusting a red hot nail in the oil; if the oil "crackle," water is present Moisture may be removed by raising the temperature slightly above the boiling point, 212° F., but the time consumed (several days) is excessive.

TRANSFORMER OIL DRYER AND FILTER.—An efficient method frees the oil from moisture, slime and sediment by forcing it under pressure through several layers of dry blotting paper in a specially designed filter press. The paper is free from chemicals, foreign substances and coloring matter, and is furnished cut to exact size to fit the filter. The solid matter in the oil is caught by the paper, while the water is retained by capillary action. The capillary attraction between the paper and water is greater than that between the paper and the oil and effectiveness of the method is mainly due to this fact. One treatment is generally sufficient to produce a dielectric strength of 28,000 volts, corresponding to a water content of only one part in about 250,000. A purity greater than this is of no practical benefit as it cannot be maintained with the oil in regular use.

TRANSFORMER RATIO.—The ratio of the number of turns in the primary winding to the number of turns in the secondary winding.

TRANSFORMER SIZES FOR A.C. MOTORS.—For the larger motors, the capacity of the transformers in kw, should equal the output of the motor in h.p. Small motors should be supplied with a somewhat larger transformer capacity, especially if, as is desirable, they be expected to run most of the time near full load, or slight overload. For commercial motors from three phase systems, three single phase units or one three phase unit is recommended.

TRANSFORMER STAMPINGS. — Plates stamped from sheet steel and inserted in the completed coils of a transformer in the process of building up the laminated core. Core laminæ.

TRANSFORMER SYSTEMS.—Nearly all alternating current systems are transformer systems, since the chief feature of alternating current is the ease with which it may be transformed from one pressure to another. There are numerous transformer systems and they may be classed broadly as those employing: a, step down transformers; b, step up and step down transformers. With respect to the step down transformers, there are two arrangements: a, individual transformers: b, one transformer for several customers. Individual transformers, that is, a separate transformer for each customer is necessary in rural districts where the intervening distances are great.

TRANSFORMER TEMPERATURE TEST WITH NON-INDUCTIVE LOAD.—Connect the primary of the transformer to the line and carry normal secondary load by means of a bank of lamps or other suitable resistance, until full load secondary current is shown by the ammeter in the secondary circuit. The transformer should then be allowed to run at its rated load for the desired interval of time, temperature readings being made of the oil in its hottest part, and also of the surrounding air.

TRANSFORMER WITH GROUNDED SECONDARY.—An approved connection. It prevents a high voltage occurring upon the low tension wires in case of a breakdown or other electrical connections occurring between the primary and secondary windings. In case of a breakdown without the secondary grounded, any one touching a part of the low tension system, such as a lamp socket, might receive the full high pressure voltage. With the low tension grounded, the fuse in the high tension circuit will blow and the fault be discovered upon replacing it.

TRANSIENT CURRENTS.—Electric currents of brief duration.

TRANS ILLUMINATION.—An aid to diagnosis in electro-therapeutics, by throwing a powerful light through the parts of the body under examination.

TRANSIT.—In engineering, the surveyors' transit is a portable instrument of the theodolite kind, designed for measuring both horizontal and vertical angles. This instrument consists of a telescope mounted in standards which are attached to a horizontal plate called the limb. Inside of the limb, and concentric with it, is another plate called the vernier plate. The lower plate or limb turns on a vertical spindle or axis which fits into a socket in the tripod head. By means of a clamp and tangent screw, it may be clamped fast in any position, and made to move slowly through a small arc. The circumference of this plate is usually graduated in divisions of either one-half or one-third of a degree, and in the common form of transit these divisions are numbered from some one point on the limb in both directions around to the opposite point which will be 180 degrees. The graduation is generally concealed beneath the plate above it, except at the verniers. This upper plate is the vernier plate which turns on a spindle fitted into a socket in the lower plate. It is also provided with a clamp by means of which it can be held in any position, and with a tangent screw by which it can be turned through a small arc.

TRANSITION.—In railway motor control there are three methods of making the transition from series to parallel connection of the motors: a, open circuit; b, shunting; c, bridging.

TRANSITION LAYER.—A layer separating the positive and negative values of electric or magnetic properties in a body.

TRANSITION RELAY. — One functioning from starting to running which gives an impulse to main circuit devices for changing a machine from the starting to the running connections.—NEMA.

TRANSITION RESISTANCE.—In electrolysis, a resistance offered to the electric current by the appearance of ions at the electrodes.

TRANSLATING DEVICES.—Devices of various kinds designed for utilizing the electric current as it passes into or through them: electro-receptive devices.

TRANSLATING STATION.—In telegraphy, a station in which messages are repeated from one line to another.

TRANSLATOR, OR TRANSLATER. — A name sometimes given to a telegraph repeater or relay.

TRANSLATOR KEYS.—In telegraphy, the signaling keys of a repeater or translator.

TRANSLUCENT DISC PHOTOMETER.—A photometer employing a screen of somewhat opaque paper made translucent, except a central spot (or as to a central spot alone) by being saturated with spermaceti, paraffin, or other suitable material; the screen is mounted upon a graduated scale, at one end of which the standard light is fixed, and at the other the light to be compared. By moving the screen along the scale until the spot becomes invisible, the relative illuminating powers of the two lights may be determined as the square of their distances from the screen: also called the Bunsen, or grease spot photometer.

TRANSMISSION.—A term applied to various methods of transmitting and transforming power as by: a, line shaft; b, belts and pulleys; c, gears, etc. When the r.p.m. of the driving and driven elements are not changed, it is a simple case of transmitting power; when the velocity ratio is more or less than unity, the power is transformed, for instance, high torque and low r.p.m. of driver may be transformed to low torque and high r.p.m. as with belt drive having large and small pulleys. Again, mechanical or hydraulic power may be transformed to electric power as by a steam turbine or water turbine driving a dynamo or alternator.

TRANSMISSION DYNAMOMETER.—A device in which the power in a rotating shaft is measured during its transmission through a belt or other connection to another shaft, without being absorbed.

TRANSMISSION EFFICIENCY.—In any device such as a motor, line shaft, etc., output÷input.

TRANSMISSION, ELECTRIC.—The conveying of electric power from a generating station, by means of transmission circuits, to distant stations where the power is consumed.

TRANSMISSION INSULATOR. — A high voltage insulator for use in high tension transmission circuits.

TRANSMISSION LINE VOLTAGES.—The voltages ordinarily used for transmission lines are given in the following table:

Transmission Line Voltages

Length of Line	Voltages
1 to 3 miles	550 or 2,200 volts
3 " 5 "	2,200 " 6,600 "
5 " 10 "	6,600 " 13,200 "
10 " 15 "	13,200 " 22,000 "
15 " 20 "	22,000 " 33,000 "
20 " 30 "	33,000 " 44,000 "
30 " 50 "	44,000 " 66,000 "
50 " 75 "	66,000 " 88,000 "
75 " 100 "	88,000 " 110,000 "
100 " 150 "	110,000 " 132,000 "
150 " 250 "	132,000 " 154,000 "
250 " 350 "	154,000 " 220,000 "

The amount and cost of power to be transmitted is an important factor in determining the economic transmission voltage.

TRANSMISSION TOWER.—A rigid struc

ture for supporting a high tension conductor.

TRANSMITTER.—A telegraph sounder provided with a two way circuit breaker. That is, it is equivalent to a single pole two way switch, or a key with an insulated contact at each end. It differs from a repeater in that a repeater has a one way contact breaker and a transmitter has a two way contact breaker. A transmitter is used to obtain prolonged contacts. This is made possible because one of the three contacts of the contact breaker is mounted on a spring, which by its elasticity allows the contacts to remain together during a considerable portion of the stroke of the lever, whereas the key contacts touch each other only at the end of the stroke.

TRANSMITTING JIGGER.—In radio, an oscillation transformer with variable secondary winding. Various degrees of coupling between the two circuits are obtained by varying the secondary.

TRANSMITTING STATION. — A radio broadcasting station, the essential elements of which consist of:

1. Source of energy. Such as a storage battery, d.c. or a.c. supply, steam engine, or any other source from which energy might be obtained.
2. Oscillator, or high frequency alternator. The device for converting the available energy into the form of high frequency currents.
3. Controlling device. Such as a key, which makes and breaks a circuit, or modulator which varies the amplitudes of the high frequency current in accordance with sound waves which it is desired to send out.
4. Antenna. The device for radiating the energy due to the high frequency current into space in the form of electro-magnetic waves.

TRANSMITTING TUBE.—A radio vacuum tube of higher power than those used in receivers and designed especially for the transmission of signals.

TRANSPORTER.—A lifting and transporting machine designed to carry loads between two fixed points. It is used chiefly for handling comparatively light loads at quick speeds and employed largely for the conveyance of materials such as coal in bulk. For the latter service it is provided with an automatic grab instead of a hook.

TRANSPOSITION.—In pole line construction, an arrangement of telephone wires, consisting of intercrossing the different wires at definite intervals, for the purpose of eliminating electrostatic induction between circuits.

TRANSPOSITIONS.—In wiring, the effect of mutual induction between two circuits is proportional to the inter-linkage of the magnetic fluxes of the two lines. This in turn depends upon the proximity of the lines and upon the general relative arrangement of the conductors. The effect of mutual induction is to induce surges in the line where a difference of frequency exists between the two currents, and to induce high electrostatic charges in lines carrying little or no current, such as telephone lines. This effect may be nullified by separating the lines and by transposing the wires of one of the lines so that the effect produced in one section is opposed by that in another.

TRANSPOSITION INSULATOR.—A double grooved insulator employed in the transposition of telephone lines in an overhead circuit.

TRANSPOSITION WIRES. — Bridle wires sometimes employed in making transpositions, for bridging across from one wire to another at the transposition pole.

TRAVELING ARC.—An unsteady arc sometimes occurring between the carbons of an arc lamp employing certain types of rods, in which the arc seems to wander about the ends of the carbons, producing a varying light.

TREATED COKED FILAMENT.—A coked filament for an incandescent lamp further treated by the flashing process to prevent occlusion of gases.

TREE INSULATOR.—A form of insulator by means of which an overhead wire may be supported by a tree without suffering any strain from the swaying or other motion the tree may make.

TREE SYSTEM OF PARALLEL DISTRIBUTION.—A system of incandescent lamp distribution in which the mains and branches are so related, as to resemble the arrangement of the stem and branches of a tree, diminishing in size toward the extremities of the circuit.

TREE WIRE.—A specially insulated wire designed to resist injury from chafing against trees

TREGA.—A prefix to a unit of measurement to denote one trillion times that unit.

TREGADYNE.—A unit of force equal to a trillion dynes.

TREMBLER.—A vibratory device sometimes used in connection with the jump spark method of electric ignition for gasoline engines; a vibrating blade or spring having a weight attached to the end and actuated by the weight dropping into a recess in the rotor. This causes the blade to "tremble" and make a number of contacts which connects and interrupts the primary circuit, so that the coil produces a series of sparks between the points, rather than a single flash at the time of ignition; also called a mechanical vibrator.

TREVELYAN EXPERIMENT.—An experiment exhibiting the thermal properties of metals, in which a piece of brass, called a rocker, is heated to about 200° C., and caused to rest on projecting edges in its surface upon a cylinder of lead, the rocker then begins to oscillate to and fro upon its edges, giving forth a definite musical note.

TRIANGLE OF FORCES.—In physics, the triangular figure which graphically represents the magnitude and direction of three forces in equilibrium which are in one plane.

TRICKLE CHARGE.—The method of charging a storage battery continuously at a very low rate.

TRICKLE CHARGER. — Apparatus for charging radio storage batteries at a very low rate being usually arranged to automatically start charging each time the receiver is turned off. The charging rate is from about .1 to .5 ampere.

TRIFILAR SUSPENSION.—A suspension, as of a needle, by three equally long threads for measuring forces of rotation.

TRIGGER ACTION.—In radio, the action of an amplifier vacuum tube.

TRIGONOMETRICAL FUNCTIONS. — A function is a quantity in mathematics so connected with another quantity that if any alteration be made in the latter there will be a consequent alteration in the former. The dependent quantity is said to be a function of the other. Thus, the circumference of the circle is a function of the diameter. The trigonometrical functions are certain functions of angles, such as the sine, tangent and secant, employed in trigonometry in investigating the relations between the sides and angles of geometric figures. These functions may consist of: a, ratios; b, lines (natural functions). In the first instance they are defined by referring to a triangle made by drawing a perpendicular from any point on one side of a given angle to the other side. In the second instance the trigonometrical functions are defined by certain lines whose lengths depend upon the arc which measures the angle. These are virtually ratios, but by taking what corresponds to the hypotenuse of the triangle as a radius of unity length of a circle the denominators of the ratios become unity or 1, and disappear leaving only the numerators, that is, a line instead of a ratio or function; these lines are the so called natural functions.

TRIGONOMETRY.—That branch of mathematics which treats of the measurement of plane and spherical triangles, that is, the determination of three of the parts of such triangles when the numerical values of the other three parts are given. Trigonometry is divided into three branches: a, plane; b, spherical; c, analytical.

TRIMMER.—A workman employed to renew the carbons in arc lamps.

TRIMMING.—1. Stripping the insulation from a conductor and cleaning the surface of the wire at a point where a wire junction is to be made.

2. Renewing the carbons of an arc lamp.

TRIMMING CONDENSER.—In radio, a small variable condenser shunted across one unit of a gang condenser to facilitate adjusting the total capacity of the unit so as to permit simultaneous tuning with other units. An aligning condenser.

TRIMMING POLES.—In transmission line construction, trim off all knots and cut off all projecting parts of the butt which would interfere with the pole entering a full sized hole. Do not decrease any dimension which would reduce the life of the pole. Trimming includes stripping off all the bark; it is necessary in order to reveal defects in the pole, prevent decay and make the pole safer for the lineman.

TRIODE TUBE.—A three element vacuum tube.

TRIP FREE RELAY.—A type consisting of a circuit opening auxiliary relay equipped with two coils. One coil, the operating coil, opens the control circuit to the contactor which controls the circuit breaker closing coil, immediately upon the closing of the circuit breaker. The other coil, the holding coil, prevents the relay closing the closing contactor control circuits until the manually operated closing switch is opened. This prevents a circuit breaker being held in a closed position under short circuit conditions and enables the protective relays to trip the circuit breaker even though the manually operated closing switch is held in a closed position.

TRIPHASE.—In alternating current work, a term sometimes used for three phase.

TRIPLE EXPANSION ENGINE.—A steam engine in which the expansion of the steam is effected in three stages by successive cylinders, known as the high pressure, intermediate, and low pressure. The cranks are usually at equal angles of 120°. This type engine is largely used in marine practice. They are made in an unnecessarily great variety of cylinder arrangement. The natural sequence of cylinders is h.p. int. and l.p. This is the most used type, steam going directly from one cylinder to another. The cylinder ratio will depend on the initial pressure. In the opinion of the author four cylinder triple expansion marine engines are not justified under any conditions. In place of the expense and complication of the additional l.p. cylinder, it would be better to use a four stage or quadruple expansion engine so that the extra cost and complication would be offset by higher economy.

TRIPLE PETTICOAT INSULATOR.—A line wire glass insulator having three deep flanges or petticoats around the base.

TRIPLE POLE SINGLE THROW SWITCH.—A switch which opens or closes three leads by a single throw. It may be the leads of separate circuits, or the three leads of a three wire system.

TRIPLE-POLE SWITCH.—A switch which is provided with three contacts by which it may open and close three electric circuits.

TRIPLE VALVE.—A distribution valve forming a part of the automatic air brake system. It functions in numerous ways for the proper control of the air brake.

TRIPLEX CABLE.—Three insulated single conductor cables twisted together. They may or may not have a common insulating covering.

TRIPOD ROOF SUPPORT.—In overhead line construction, a tripod for supporting wires running over a roof.

TRIPPING COIL.—A coil in a circuit breaker which trips or unlocks the spring which controls the contacts, and opens the circuit when the current reaches a definite value.

TRIPPING TRANSFORMER.—One similar in design to the standard class of instrument transformer, but of lower accuracy.

TRIVALENT.—Having the combining power, of three units; as, a trivalent or triad atom.

TROLLEY.—A grooved brass wheel carried at the upper end of a trolley pole and pressed upward against the under side of the trolley wire, by which the current is collected and conveyed to the controlling switch of an electric car.

TROLLEY BASE.—A base resting upon the roof of a trolley car, upon which the trolley pole is mounted in a pivoted frame, provided with springs to press the wheel against the trolley wire.

TROLLEY BASE FRAME.—The pivoted frame by means of which a trolley pole is mounted upon its base.

TROLLEY BUS BAR.—In a railway power house, the bus bar leading to the trolley line.

TROLLEY CAR.—An electric railroad car in which the current for the motors is taken from an overhead wire by means of a trolley with grooved wheels, which is held up against the wire by a flexible pole. The wires from the contact wheels pass down the pole to the car controller and thence to the motor, the return circuit usually being through the rails.

TROLLEY CORD.—A cord attached to the upper part of a trolley pole, and hanging within easy reach of the rear platform of a trolley car, for the purpose of reversing the trolley, or for restoring it to the line when accidentally displaced.

TROLLEY CROSSING.—1. An insulated device suspended at the intersection of trolley wires, which permits the trolley on one line to pass another line without electrical contact.

2. An uninsulated guiding plate used at crossings, at which the angle is less than 75°, and protected by section insulators on either side of it.

TROLLEY EAR.—A piece of metal, grooved to fit the trolley wire, for the purpose of attaching the wire to the insulator which supports it; a suspension ear.

TROLLEY FORK.—The forked head of a trolley pole carrying a harp for the spindle of the trolley wheel.

TROLLEY FROG.—A device situated at a point where trolley lines branch from each other, so that the trolley wheels may be guided to the proper line; right hand, left hand and symmetrical frogs are designed to meet all requirements.

TROLLEY HANGER.—The trolley ear and insulator constituting the supporting device of a trolley wire.

TROLLEY HARP.—A forked device fitted to the head of a trolley pole for carrying the spindle of the trolley wheel.

TROLLEY ICE CLEARER.—A trolley wheel having its groove provided with projections for clearing a trolley wire of ice. A sleet wheel.

TROLLEY MAST.—In an overhead system of electric traction, the pole by means of which the trolley wheel is kept in contact with the wire. It is a rod of hard drawn steel 12 to 15 feet in length, and from 1½ inch to 1 inch in diameter, slightly tapering. A harp is riveted to the top of the pole, and within this the trolley wheel rotates.

TROLLEY PULL-OFF.—A hanger for suspending and holding in place a trolley wire in rounding a curve. It is a device for clamping a wire, and by means of one or two lugs fixing it by a span wire to a supporting pole.

TROLLEY SECTION.—A length of trolley wire with one or more feeders, forming a section of the line, and insulated from adjoining sections by section insulators, so that in case of accident at any point on the line, only the section affected need suspend operation.

TROLLEY SECTION INSULATOR.—A device placed in an overhead trolley wire at a point where two divisions of the line join that are fed by separate feeders from the power house. The sections of the wire are attached to two castings which are separated by hard wood insulating material, permitting the trolley wheel to run smoothly across.

TROLLEY SPLICE.—A method of uniting the ends of two trolley wires by means of a conducting sleeve over the junction point.

TROLLEY STAND.—The spring base pivoted to the top of a trolley car to which the trolley pole is clamped; the trolley base.

TROLLEY STRAIN INSULATOR.—An insulator designed to withstand strong tension inserted in a trolley strain wire.

TROLLEY STRAIN WIRES.—Wires employed in connection with strain insulators to hold the trolley wire at the proper tension, especially at curves in the line.

TROLLEY WHEEL.—In an electric street railway system with an overhead line, the rotary device by means of which contact is made with the trolley line and current derived for the motors. It is a brass grooved wheel from four to eight inches in diameter, which turns on an axle carried in a harp riveted to the upper end of the trolley pole.

TROUBLES IN IGNITION COILS.—Practically the only trouble in a coil is broken down insulation. A coil is either good or bad, and a test will show its operating condition. It is best to test a coil when it is hot as sometimes trouble shows up only when the coil is warm.

TROUBLES IN IGNITION DISTRIBUTORS.—Faults are rare. The mechanical troubles are: a, rotor brush worn; b, rotor brush arm cracked; c, distributor cap cracked; d, carbon path in distributor cap.

TROUBLES IN IGNITION PRIMARY CIRCUIT BREAKERS.—The faults ordinarily met with are: a, breaker points dirty, pitted or badly worn; b, breaker points out of adjustment or out of alignment; c, spring tension weak; d, worn bushing on breaker shaft; e, loose connections. It must be evident that since the primary circuit works on very low voltage (6 to 8 volts) not only must the connections be tight but the contact surfaces must be clean to reduce the resistance at the joints to a minimum.

TROUBLES IN STARTING A MOTOR.—The troubles usually encountered are: a, armature, grounded, shorted or open circuited; b, fields, grounded or open circuited, hardly ever shorted; c, brush holder, grounded, d, dirty or burned commutator; e, brushes too short or sticking in brush holder; f, brushes of improper grade; g, brush springs with improper tension; h, worn bearings or bent shaft causing armature to stick to pole pieces.

TROY MEASURE.—

24 grains (gr.)	= 1 pennyweight
20 pennyweights	= 1 ounce (oz.)
12 ounces	= 1 pound (lb.)

Unit equivalents

lb.	oz.	pwt.	gr.
		1 =	24
	1 =	20 =	480
1 =	12 =	240 =	5,760

Scale—Ascending, 24, 20, 12; descending, 12, 20, 24.

NOTE—Troy weight is sometimes called goldsmiths' weight.

TRUCK TYPE SWITCHBOARD.—A type of switchboard in which the bus bars are mounted in a steel housing and the panel, circuit breaker and instrument transformers are on a removable truck. The housing and truck carry disconnecting devices for both primary and secondary circuits. The truck is mechanically interlocked with the housing so that it cannot be inserted nor withdrawn unless the circuit breaker be opened. The breaker cannot be closed unless the truck is in the operating or in the disconnected position.

TRUE AIR-SPEED METER.—An instrument for measuring the speed of an air craft relative to the ground.

TRUE GALVANOMETER CONSTANT.—The strength of the electro-magnetic field at the middle point of a galvanometer coil when a unit current passes.

TRUE OHM.—The true value of the ohm$=10^9$ c.g.s. electro-magnetic units.

TRUE RESISTANCE.—The ohmic resistance in an electric circuit, as distinguished from the reverse pressure, or spurious resistance in the circuit.

TRUE WATTS.—In an alternating current circuit, the watts as measured by a watt meter.

TRUMPET, ELECTRIC.—An electric buzzer reinforced by a megaphone tube, or trumpet.

TRUNCATED.—Applied to a cone or pyramid whose vertex has been cut off by a plane, either oblique to or parallel with the base; and to a prism which has been cut off, usually oblique, to the base.

TRUNK LINES.—1. In a telephone system, the main lines between stations at distant points for the transmission of long distance messages.

2. The lines connecting telephone exchanges, as distinguished from the subscribers' lines.

3. In the transfer system, the lines connecting the a and b switchboards of the exchange.

TRUNK WIRE.—In an electric car wiring system, the wire which carries the total motor current of the car. It runs from the trolley wheel, third rail shoe or slot plow, according to the system employed, to the point of application to the motor circuit.

TRUNKING OUT TELEPHONE SWITCHBOARD.—A switchboard designed for use with trunk lines in long distance transmission.

TRUSSED POLE.—A telegraph pole stiffened against special strain by means of an iron truss, when circumstances do not permit the use of proper stays.

T SHAPED SPARK.—A spark having three branches sometimes seen in the discharge of a condenser through an induction coil.

TUBE CHECKER.—A testing instrument for determining some of the properties of a radio vacuum tube.

TUBE OF MAGNETIC FORCE.—Lines of magnetic force drawn through every point of a closed curve, forming a tubular surface.

TUBE OF MAGNETIC INDUCTION.—A tubular surface having its sides formed of lines of magnetic induction.

TUBE RECTIFIER.—A radio vacuum tube used as a rectifier. When alternating current is applied to a tube so that the plate is alternately positive and negative with respect to the filament during the positive half of the a.c. cycle, electrons will flow from the filament to the plate. However, when the current reverses during the negative half, no current will flow. A rectifier tube operating on this principle is called a half-wave rectifier.

TUBE REJUVENATOR.—In a radio testing set, apparatus for improving the emission in vacuum tubes.

TUBE SURFACE.—In steam engineering, the total area of the exterior surface of the tubes in a surface condenser. In general practice, the following holds good when the temperature of sea water is about 60°:

Terminal pressure lbs. absolute						
30	20	15	12½	10	8	6
Square foot per i.h.p.						
3	2.50	2.25	2.00	1.8	1.6	1.5

For ships whose station is in the tropics the allowance should be increased by 20% and for ships which occasionally visit the tropics 10% increase will give satisfactory results. If a ship be constantly employed in cold climates 10% less surfaces—Seaton, Marine Engineering.

TUBULAR BOILER.—A fire tube boiler: that is, one which has tubes through which the products of combustion pass and around which is the water to be heated. These boilers are generally called shell boilers, but the term fire tube is more specific. There are various types as: a, vertical or upright; b, return tubular; c, locomotive; d, Clyde; e, Scotch, etc. As compared with water tube boilers, tubular boilers: a, weigh more; b, occupy more space; c, contain larger volume of water; d, take longer to get up steam; e, water level and steam pressure fluctuate less, etc.

TUBULAR BRAID.—An insulating braid woven in tubular form for covering a wire joint.

TUBULAR CONDUCTORS.—Electric conductors in the form of hollow tubes.

TUBULAR CORE.—An iron core for an electro-magnet in the form of a hollow tube, sometimes employed instead of a solid core.

TUBULAR CURRENT.—An electric current considered as flowing only upon the surface of a conducting wire. Generally called skin effect. It is proportional to the size of the conductor and the frequency.

TUBULAR DROP.—A tubular form of telephone clearing out drop designed to overcome mutual induction with other drops in the switchboards.

TUBULAR ELECTRO-MAGNET OR MAGNET.—A type of electro-magnet designed to offer powerful attraction through a short distance; it consists of a short cylindrical electro-magnet with an outer tube united to the iron core at the bottom; an iron clad electro-magnet.

TUBULAR POLES. — Transmission line poles consisting of sections of steel pipe of varying diameter with the largest diameter at the butt. One end is expanded wider than the other and is used as the base of the pole.

TUSSAH SILK.—A natural tan silk somewhat coarser in texture than floss.

TUMBLING BOX.—A revolving box into which articles to be electro-plated are caused to rub against one another for a preparatory polishing.

TUNED ANTENNA.—In radio, the antenna circuit made resonant for a given frequency by varying the inductance and capacity in the circuit.

TUNED CIRCUIT.—In radio a circuit rendered resonant for a given frequency by varying the relative amounts of inductance and capacity in the circuit.

TUNED RADIO FREQUENCY.—The word tuned is defined as brought into resonance with the desired signal. A tuned radio frequency circuit is one in which the radio frequency amplifier circuits may be tuned to the desired wave lengths by varying the inductance or the capacity or both although the usual method of tuning is by means of a variable condenser in parallel with the secondary of the radio frequency transformer.

TUNED TELEPHONE.—One whose diaphragm is adjusted to vibrate at the frequency of current impulses to be indicated. In some cases the inductance and capacity are selected to have the same electrical frequency.

TUNED TRANSFORMER.—A radio frequency transformer having its primary or secondary or both tuned to resonance with the primary frequency.

TUNED TRANSFORMER COUPLING OF AMPLIFIER.—In radio, a type of radio frequency amplifier coupling which employs an air core transformer, the secondary being tuned to resonance at the desired frequency by means of a variable condenser shunted across the ends of the winding.

TUNER.—1. A term sometimes applied to a synchronizer or phase indicator, a device for indicating the synchronous relation between two alternators which are to be connected in parallel. The simplest arrangement consists of one or more incandescent lamps in series which show light or dark simultaneously at synchronism. For large alternators other devices are necessary. One type indicates by a pointer upon a dial whether the incoming machine be running too fast, too slow, or in exact step.

2. In radio, the portion of a circuit in which tuning is done.

TUNGAR RECTIFIER.—The word "Tungar" is a trade name for a rectifier made by the General Electric Co. consisting of one or two bulbs, a transformer and an enclosing case. The bulb is similar in appearance to an incandescent lamp. A low voltage filament, the cathode, and one or sometimes two carbon anodes are used for electrodes. The bulb is filled with argon gas. When the filament is energized the space between the electrodes acts as an electric valve of low resistance, allowing current to flow only from anode to cathode. Therefore, only uni-directional or direct current can flow from the battery charger. The transformer serves three purposes: First, it adjusts the voltage of the alternating supply to that required by the batteries; second, it furnishes a separate source of excitation for the filament; and third, it insulates the batteries from the supply current. Various battery voltages are used. 24 and 48 volt systems predominate, although 12 volts is often used on small and 110 volts on large systems.

TUNGSTEN.—A somewhat rare metal used as the filament in the tungsten incandescent lamp and in vacuum tubes. It is steel gray in color, very heavy (specific gravity 19.129), and hard enough to scratch glass. It passes directly into vapor at a very high temperature without entering the liquid state, and has a lower specific resistance than carbon.

TUNGSTEN FILAMENT.—The metal tungsten being too brittle to be drawn into wire, fine particles of the metal are made into a paste with binding material and squirted through a die. After drying, the particles are welded into a continuous wire.

TUNGSTEN LAMP.—A type of metallic filament incandescent lamp employing a filament composed of the metal tungsten. The tungsten, is mixed in a finely divided state with a solution containing a binding material, and then squirted into filaments. Tungsten lamps work on either direct or alternating current circuits, and are not affected by changes in voltage. The light given is white and brilliant, and their economy is high with remarkably long life, though the filaments are brittle and liable to break from any vibration.

TUNGSTOMETER.—A device for showing the comparative wattage consumption of the tungsten and ordinary filament lamps. It consists of three elements: a, a measuring system; b, a connection system consisting of an insulated tube on the upper end of which is a swivel type Edison screw plug, and on the lower end an Edison lamp socket; c, a special computing scale located just below the meter.

TUNING.—In a radio circuit the process of varying the inductance or capacity or both to bring the circuit to resonance for a given frequency. When the circuit is thus tuned it gives maximum response.

TUNING COIL.—In radio, an inductance coil in a circuit which by varying the inductance or capacity or both, the circuit may be tuned to resonance for a given frequency and thus obtain maximum response.

TUNING CONDENSER.—In radio, a variable capacity condenser having one set of fixed plates and a set of rotor plates. There are several types of these condensers including: a, straight line capacity condenser; b, straight line wave length condenser; c, straight line frequency condenser.

TUNING DIAL.—In radio, a dial having an arbitrarily numbered scale which indicates the setting of the tuning elements either in wave lengths or kilo-cycles.

TUNING FORK OSCILLATOR.—In radio, an audio frequency oscillator whose vibrations are determined by a metallic tuning fork. Attached to one tine of the fork is a microphone button through which the supply current passes.

TUNING INDUCTANCE.—In radio, a tuning coil.

TUNING SHORT WAVE RECEIVERS.—Start with any one, or pair, of the coils covering a certain wave band; and tune in the first station picked up. If it be a regular short wave station, mark down its known wave exactly opposite the figure on the chart which corresponds to the dial setting. If the station be one which is not known to have a short wave transmitter, then a harmonic has been heard. Look up the authorized wave length of the station and divide it by the number which will bring the result nearest to the wave length to which the coil should be tuned.

TUNING UP A METER.—A servicing which consists in straightening the pointer; varying the tension of the spiral springs; renewing the jewels in the bearings; altering the value of the high resistance and, in the case of a direct current instrument, strengthening the permanent magnet.

TURBINE.—A machine in which a rotary motion is obtained by transference of the momentum of a fluid; broadly speaking, the fluid is guided by fixed blades, attached with a casing, and impinging on other blades mounted on a drum or shaft, causing the latter to revolve.

TURBINE ALTERNATOR WINDING.—A multi-inductor stationary winding suitable for a high speed alternator. For the reason that steam turbines run at so much higher speed than steam engines, the construction of armatures and windings for alternators intended to be direct connected to turbines must be quite different from those driven by steam engines. Accordingly, in order that the frequency be not too high, turbine driven alternators must have very few poles—usually two or four, but rarely six.

TURBINE DRIVEN ALTERNATOR.—A type designed for high speed so that it can be connected direct to a steam turbine which is itself a high speed machine. To adapt the alternator to high speed operation the rotor is made very small in diameter and unusually long.

TURBINE HORSE POWER FORMULA.—The horse power of a water turbine is dependent on quantity of water, head and efficiency.

$$\text{h.p.} = \frac{62.4 \times H \times Q \times E}{550}$$

in which
62.4 = weight of 1 cu. ft. of water
H = head in feet
Q = flow in cu. ft. per sec.
E = percentage efficiency
(assuming that E = 80 per cent for full development)

$$\text{h.p.} = \frac{Q \times H \times E}{8.8} = \frac{Q \times H}{11}$$

TURBINE PUMP.—A multiple centrifugal pump, with several impellers in series, suitable for pumping against high heads. More generally known as multistage centrifugal pump.

TURBO-GENERATOR.—A dynamo or alternator driven by a steam turbine and coupled directly with it, usually mounted upon the same base plate; a turbo-generator set.

TURN.—In wire joints, the wrapping of one wire around another wire which remains straight.

TURNBUCKLE INSULATOR.—A form of insulator employed in a trolley line on span or pull off wires, for the purpose of adjusting or tightening up the wires.

TURN DOWN INCANDESCENT LAMP.—A lamp provided with a high resistance unit arranged in its socket so that the quantity of light can be changed at will by inserting more or less of the resistance.

TURN OUT.—In a single track trolley line, a loop or side track to enable cars to pass in opposite directions.

TURNS RATIO.—In a secondary induction coil the number of turns in the secondary ÷ the number of turns in the primary winding.

TURNTABLE.—The rotating support for a phonograph record.

TURTLE BACK ELECTROTYPE.—An electrotype with a slightly convex surface for use in a cylindrical printing press; a rotary electrotype.

TWIGS.—A name sometimes given to the extreme sub-branches in a tree system of distribution of incandescent lamps.

TWIN CABLE.—A cable composed of two insulated stranded conductors laid parallel, having a common covering.

TWIN CONDUCTOR.—A cable containing two insulated conductors running parallel.

TWIN WIRE.—Two small insulated conductors laid parallel, having a common covering.

TWIST.—In wire joints, the wrapping of each wire around the other.

TWIST SYSTEM.—A system of running cable wires in pairs, twisted together for the purpose of overcoming the inductive effect between them.

TWISTED CABLE.—A bunched cable in which the conductors are first twisted in pairs, then two pairs are twisted together, a second set of two pairs are then twisted with the first, and so on, for the purpose of eliminating inductive disturbances.

TWISTED PAIR.—Two small insulated conductors, twisted together, without a common covering. The two conductors of a twisted pair are usually substantially insulated.

TWISTED STRIP GALVANOMETER.—A type devised by Duddell. A fine strip of phosphor-bronze is twisted in both directions from its center, where it carries a small mirror. It is supported vertically in a frame arranged to compensate for atmospheric temperature variations. The deflection is simply produced by the heating effect of the current, which occasions a tendency to twist or untwist the strip, and so to rotate the mirror.

TWO CIRCUIT ARMATURE WINDING.—A method of winding the armature so that the current is divided between two paths only, whether in single pole or multi-polar dynamos.

TWO CIRCUIT DYNAMO.—A dynamo whose armature has a two circuit, or two path winding.

TWO CIRCUIT MULTIPLE WINDING.—An armature winding in which each of the independent sets of coils divides the current into two paths.

TWO-CIRCUIT RECEIVING SET.—A set in which the detector is connected to a secondary circuit coupled to the aerial circuit.

TWO COIL ARMATURE WINDING.—In an alternator, two coils in the armature winding supplied for each field magnet pole.

TWO CYCLE ENGINE.—A type of internal combustion engine in which the four operations of charging, compression, explosion and expulsion are carried out during two strokes of the one piston. The piston usually serves as exhaust valve; the exploded charge escaping through ports in the cylinder wall, which are uncovered by the piston as it nears the extremity of its outward or power stroke. The incoming charge is either admitted by a separate valve or pump, or else passes into the cylinder by ports opposite the exhaust port, the charge being deflected to the end of the cylinder by a ridge upon the piston, and scavenging out the products of combustion as it comes in. Compression ensues upon the closing of inlet and exhaust ports by the piston. The term two cycle means two stroke cycle.

TWO D.C. MOTOR SPEED REGULATION.—With a two motor equipment, regulation is obtained by the series parallel method. The motors are first operated in series until all the resistance is cut out by the controller. The next point on the controller puts the two motors in parallel with some resistance in the circuit, which resistance is gradually short circuited on the remaining controller points, until at full speed all the resistance is cut out, the two motors remaining in parallel.

TWO ELEMENT TUBE.—A radio vacuum tube having a filament and a plate. Formerly it was used as a detector, but now it is employed chiefly as a rectifier in power supply units.

TWO FLUID CELL.—A primary cell in which the positive (zinc) plate is immersed in the exciting liquid (usually dilute sulphuric acid) and is decomposed by the action upon it, while the negative plate is placed in the liquid depolarizer which is decomposed by the hydrogen arrested by it, thus preventing polarization. In some forms of cell, the two liquids are separated by a porous partition of unglazed earthenware, which, while it prevents the liquids mixing except very slowly, does not prevent the passage of hydrogen and electricity.

TWO PART COMMUTATOR.—A commutator composed of two metallic segments for use with a single coil armature winding and a bipolar field.

TWO PHASE ALTERNATING CURRENT.—Two single phase currents flowing in separate circuits but having a phase difference of 90°. There is often no electrical connection between them; they are of equal period and equal amplitude. Four or three conductors are used for transmitting two phase current. In order to save one wire, it is possible to use a common return conductor for both circuits. For long lines this is economical, but the inter-connection of the circuits increases the chance of trouble from grounds or short circuit. The current in the conductor will be the resultant of the two currents, differing by 90° in phase.

TWO PHASE ALTERNATOR.—A type of alternator which has two independent windings, and these so spaced out that when the volts generated in one of the two phases are at a maximum, those generated in the other are at zero. A two phase system requires four lines for its distribution: two lines for each phase It is possible, but not advisable, to reduce the number to 3, by employing one rather thicker line as a common return for each of the phases. If this be done, the voltage between the A line and the B line will be equal to $\sqrt{2}$ times the voltage in either phase, and the current in the line used as common return will be $\sqrt{2}$ times as great as the current in either line, assuming the two currents in the two phases to be equal.

TWO PHASE ARMATURE WINDING.—For two phase machines the winding can be made from any single phase winding by providing another set of slots displaced along the surface of the armature to the extent of one-half the pole pitch, placing therein a duplicate winding. The two armature circuits may be separate, each having two collector rings or the two circuits may be coupled at a common middle or they may be coupled in the armature so that only three collector rings are required.

TWO PHASE DELTA GROUPING.—A method of grouping a two phase winding in which the two phases are divided into two parts, and the four parts are connected up in cyclic order, the end of one to the beginning of the next, so as to form a square, the four corners of which are connected to the four terminals; this connection is obsolete.

TWO PHASE FIVE WIRE SYSTEM.—An alternating current system in which four of the five wires are connected as in a two phase four wire system, the fifth being connected to the neutral points of each phase.

TWO PHASE MOTOR.—An a.c. motor which, instead of having a single field winding, is furnished with two distinct windings, each supplied with a single phase alternating current of the same frequency but differing in phase one quarter of a period; a diphase motor.

TWO PHASE STAR CONNECTION.—A method of grouping a two phase winding in which the middle points of each of the two phases are united to a common junction, and the four ends are brought out to four terminals, or in case of revolving armatures, to four slip rings. It is practically equivalent to a four phase system.

TWO PHASE TRANSFORMER CONNECTIONS.—Each circuit may be treated as entirely independent of each other so far as the transformers are concerned. Two transformers are used, one being connected to one primary phase and supplying one secondary phase, the other being connected to the other primary phase and supplying the other secondary phase exactly as though each primary and secondary phase were an ordinary single phase system, independent of the other phase.

TWO POINT SWITCH.—A type of switch designed to control two circuits. Note that the number of points (referring to a single pole switch) is equal to the number of live contacts, not including the pivot contact. That is, one less than the number of external wires.

TWO PORT AND THREE PORT.—Two types of two cycle gas engine. The object of the third port is to adapt the engine to higher speeds. In the two port engine, admission and exhaust occur at the same time. In the three port engine, a carbureter can be used without a check valve as the port is opened and closed by the piston. This gives positive action rather than depending upon suction to open a check valve and avoids the lag of the valve in responding to the suction.

TWO TO ONE TRACTION DRIVE.—On traction elevators, a method of transmitting power from the power unit to the car by means of a frictional contact transmission with reduction gear pulleys; a type used for moderate speed elevators.

TWO UNIT SYSTEM.—An electric system for automobiles in which the starting motor and charging dynamo are separate machines.

TWO WAY DOOR TRIGGER.—A catch which acts so as to ring an electric alarm on the closing as well as the opening of a door.

TWO WAY SPLICE BOX.—In underground cable construction, a splice box furnished with two channels or ducts for a straight line.

TWO WAY SWITCH.—One having two stationary contacts to which external circuit wires are connected.

TWO WAY TROLLEY FROG.—A frog suspended in a trolley line for properly guiding the trolley wheel at a point where the road forks into two.

TWO WIRE SYSTEM.—A system of electrical distribution employed in incandescent lighting in which only two mains are required, as distinguished from the three wire system in which a third or balance wire is introduced.

TYING CONDUCTORS TO INSULATORS.—The tie wire should be of the same metal as the conductor. Copper line wire must be tied to the insulator with copper tie wire to avoid corrosion.

TYING IN.—Fastening an overhead line wire to the insulators by means of tie wires.

U

U.—Symbol for: 1. Various mechanical shapes as U bar; U bolt; U plate; U tube, etc.

2. In mathematics, a versor.

3. Symbol for uranium.

ULTRADYNE.—In radio, a modified superheterodyne circuit in which the modulation method is used to produce beats.

ULTRA-INCANDESCENT LAMP.—A variety of incandescent lamp in which the filament is treated with a radio-active substance in order to enhance the brilliancy of the light.

ULTRAUDION CIRCUIT.—A radio circuit used for long wave reception employing a form of regeneration.

ULTRA-ULTRA VIOLET RAYS.—Rays at the extreme limit of the ultra-violet rays.

ULTRA VIOLET RAYS.—Rays of light existing beyond the violet light of the visible spectrum, having a more rapid rate of vibration than 800 billion vibrations per second. They are invisible. Those contained in unfiltered sunlight extend down to about 300 millimicrons and the shorter wave lengths derived from mercury quartz lamps range down to about 190.

ULTRA VIOLET THERAPY.—Formerly it was thought various cures were due to the heat rays of the sun. Later it was established that the principal curative factor in the treatment of rickets and surgical tuberculosis was essentially the ultra violet energy contained in the sunlight. Many authorities claim that for the best results it is necessary to use both ultra violet and infra-red energy.

UMBRA.—During an eclipse, a conical shadow projected by a planet on the side opposite the sun.

UMBRELLA ANTENNA.—One having a number of conductors extending downward at an angle from a central elevated point and attached to insulated posts arranged radially around the central mast.

UMBRELLA TYPE ALTERNATOR.—An alternator in which the rotating part is suspended from a vertical shaft by a six-armed spider.

UNBALANCED POLYPHASE SYSTEM.—A polyphase system of electrical distribution in which current and phase are unsystematically distributed through its branches.

UNDAMPED OSCILLATIONS OR WAVES.—In radio sustained oscillation or waves such as are generated by a vacuum tube oscillator, or by an arc alternator; continuous waves.

UNDER-CARRIAGE.—The wheels and supports of an airplane for landing.

UNDER-CONTACT THIRD RAIL.—A method of mounting the conducting rail in the third rail system of electric traction, in which the rail is supported at intervals by iron brackets which hold suspended insulation blocks by a special clamp, so that the under surface of the rail is presented to make contact with the upper surface of the shoe. Between the supports, the upper side of the rail. The advantages of this method are: a, less danger from the live rail; b, less strain on the insulators; c, protection from the weather; d, self-cleaning.

UNDERGROUND CABLE SUPPORTS. — Hooks for supporting underground cables in passing around the sides of manholes.

UNDERGROUND CABLE TERMINAL.—A box provided with terminals for the wires in an underground cable at a point where the cable leaves the ground.

UNDERGROUND TROLLEY SYSTEM.—A trolley system in which the trolley wire is run in an underground slotted conduit midway between the rails of the track; the connection with the motor being effected by means of a shoe introduced through the slot; the conduit trolley system. This system is used in the streets of large cities where the use of overhead trolley wires is objectionable, but the cost of construction is very great. The underground trolley system differs from the overhead trolley in that it has a metallic circuit (two insulated conductors) while the overhead trolley has a ground return, that is to say, the track rails which are not insulated from the ground are used as the return.

UNDERLOAD CIRCUIT BREAKER. — A switch employed especially in charging storage batteries, for opening the circuit if the current becomes too feeble. If the charging current weaken too far, the battery will commence to discharge and tend to drive the charging dynamo as a motor. One type, used with motor starting boxes, has a switch arm held in place by an electro-magnet against the pull of a spring. When the current weakens, the spring pulls away the arm and opens the circuit.

UNDERLOAD RELAY.—A type similar in construction to low voltage relays but having current instead of pressure windings.

UNDER RUNNING OF CABLE.—A method of examining a cable laid across a river bottom, in which the cable is passed over a sheave in a boat from bow to stern, as the boat moves along the line of the cable.

UNDER RUNNING SHEAVE.—A sheave over which a sub-aqueous cable is passed in the operation of under-running a cable in examining for faults.

UNDER RUNNING TROLLEY.—A method of contact employed in the ordinary street railway systems, in which the trolley wheel runs along the under side of the trolley wire.

UNDERTYPE DYNAMO.—A form of simple two pole field magnet machine in which the armature is placed below the yoke the field magnets being inverted, instead of standing upright. The advantage of this arrangement is that the moving parts are brought low down, lessening the vibration.

UNDERTYPE FIELD MAGNET.—A field magnet employed in an under-type or inverted dynamo in which the armature is placed below the field magnet coils and yoke.

UNDERWRITER'S KNOT.—A special knot prescribed by the Underwriter's to be made where wires enter a rosette socket or an outlet box, so that the joint will be relieved of any strain due to the weight of the socket, shade and lamp. Square or granny knots are not approved; sockets may be obtained with strain relief devices attached.

UNDERWRITERS' PUMP.—A fire pump, of a pattern approved by insurance underwriters or by the insurance company's surveyor, such as is fitted in large buildings in connection with the fire fighting apparatus, to maintain the water supply for hose, hydrants, sprinkler tanks, etc.

UNDERWRITERS' REQUIREMENTS FOR FUSES.—They must carry a 10% overload indefinitely. The fuse which does not meet this requirement causes an unwarranted number of burn outs and interruptions. At 50% overload fuses must blow within the following time limit:

1 to	30 amperes	....	1 minute
31 "	60 "	....	2 minutes
61 "	100 "	....	4 "
101 "	200 "	....	6 "
201 "	400 "	....	12 "
401 "	600 "	....	15 "

The fuse which does not meet this requirement does not protect the apparatus sufficiently, and may cause the loss of valuable equipment.

UNDERWRITER'S REQUIREMENTS FOR WIRE SIZES.—In all cases the calculation of the size of wire should be compared with that allowed by the Underwriters for full load current of motor, plus 25 per cent of that current, and if the size calculated happen to be smaller than the allowable size, it should be increased to the latter, otherwise it will not pass inspection.

UNDERWRITERS' RULES.—The National Electrical Code; a set of rules and requirements drawn up by the National Board of Fire Underwriters for the installation of electric wiring and apparatus. Copies of these rules may be had free of cost from The National Board of Fire Underwriters, New York or Chicago, or from any local inspection bureau. All interior wiring must be done in accordance with this code in order that buildings may be insured.

UNDULATION.—A wave motion, as of an alternating or undulatory electric current.

UNDULATORY CURRENT.—An electric current uniform in direction, but varying in strength according to the law governing the velocity of air particles in a sound wave.

UNDULATORY DISCHARGE.—An oscillatory discharge, a series of rapid alternations of charges which are set up when the plates of a charged condenser are joined by a conductor, the plates of the condenser being positively and negatively charged in turn.

UNDULATORY THEORY.—In optics, a theory which assumes that all bodies, as well as the celestial spaces are filled with an extremely subtle elastic medium, called the luminiferous ether, the luminosity of a body being due to an infinitely rapid vibratory motion of its molecules, which, when communicated to the ether is propagated in all directions in the form of spherical waves, and this vibratory motion, being thus transmitted to the retina, produces the sensation called vision.

UNDULATORY WINDING.—A method of armature winding, usually known as wave winding. Each step of this winding is progressive, and two successive winding elements have the appearance of two successive waves.

UNI-COIL WINDING.—A concentrated or mono-tooth armature winding.

UNI-DIRECTIONAL CURRENT.—An electric current flowing in one direction only. It may be constant in magnitude or pulsating.—B.E.S.A.

UNIDYNE.—In radio, a solodyne circuit.

UNIFILAR SUSPENSION.—A suspension, as of a needle, by a single thread for measuring forces of rotation.

UNIFILAR WINDING.—One having only a single conductor.

UNIPHASE.—Single phase as distinguished from polyphase.

UNIPOLAR ELECTRIC BATH.—In electrotherapeutics, a bath in which only one electrode is applied to the body, the circuit being completed through the water.

UNIPOLAR MAGNET.—A name given to a magnet which, though possessing the necessary two poles, is so suspended that one of the poles lies in the axis of suspension, with the result that the magnet acts as if it possessed only one pole.

UNI-SELECTOR.—In radio receivers, single knob control in which the single knob is geared directly to all the tuning elements.

UNI-SLOT ARMATURE WINDING.—The simplest type of a.c. winding; a one slot or uni-coil winding.

UNIT ANGLE.—In circular measure, the angle measured by an arc equal to the radius. It is called the radian.

UNIT ANGULAR VELOCITY. — Angular velocity is measured in radians per second, or the number of radians or unit angles through which a particle moving in a circular path turns in a second of time.

UNIT JAR.—A Leyden jar so adjusted that a spark passes whenever the voltage difference reaches a definite value. It is used to measure the amount of electricity required to charge a condenser.

UNIT MAGNETIC POLE.—One which when placed in a vacuum at a distance of one centimeter from another unit magnetic pole will repel it with a force of one dyne. The relation between magnetic poles may be expressed by the equation:

$$f = \frac{m \times m}{d^2}$$

in which f is the force in dynes, m and m^1 the strengths of the two poles, and d^2 the distance between them in centimeters.

UNIT-MULTI-VOLTAGE CONTROL.—Variable voltage elevator control.

UNIT OF ACCELERATION.—The acceleration which imparts unit velocity in unit time, or one foot per second in one second.

UNIT OF CAPACITY.—The practical unit of capacity is the farad. A condenser is said to have a capacity of one farad if one coulomb (that is, one ampere flowing one second), when stored on the plates of the condenser will cause a pressure of one volt across its terminals. The farad being a very large unit, the capacities ordinarily encountered in practice are expressed in millionths of a farad, that is, in **microfarads**—a capacity equal to about three miles of an Atlantic cable. It should be noted that the microfarad is used only for convenience, and that in working out problems, capacity should always be expressed in farads before substituting in formulæ, because the farad is chosen with respect to the volt and ampere.

UNIT OF CURRENT.—The practical unit of current is the ampere, which is the current produced by a pressure of one volt in a circuit having a resistance of one ohm. It is that quantity of electricity which will deposit .005084 grain of copper per second.

UNIT OF ELECTRICAL SUPPLY.—The kilowatt-hour, called in Great Britain the Board of Trade Unit. It is equal to 1,000 watt-hours. The public supply of electricity for lighting and power purposes is usually measured in kilowatt hours.

UNIT OF EVAPORATION.—A unit employed in making boiler tests. It is the equivalent evaporation from and at the boiling point, at atmospheric pressure, or as usually expressed, "from and at 212° F." This forms a basis for comparison of boilers working at different pressures, from which their relative evaporative efficiencies per pound of coal may be ascertained. The unit of evaporation is equivalent to 970.4 B.t.u.; the latent heat of steam at atmospheric pressure (14.7 lbs. per sq. in.)

UNIT OF FORCE.—The dyne. It is that force, which, by acting upon a mass of one gram during one second, can impart to it an acceleration of one centimeter per second during every second that the force is maintained.

UNIT OF HEAT.—The British thermal unit (B.t.u.) which is 1-180 part of the heat required to raise the temperature of one pound of water from 32° to 212° F. It should be noted that this is the definition adopted for the British thermal unit corresponding to the unit used in the Marks and Davis steam tables, which is now the recognized standard. The French heat unit is called the **calorie.**

UNIT OF ILLUMINATION.—The foot candle, which is the illumination received when one lumen of light falls on one square foot of area. A fair idea of the illumination represented by one foot candle can be obtained by holding a piece of paper one foot away in a horizontal direction from an ordinary wax candle. 1 foot candle=10.76 lux (International) =11.95 meter-hefners.

UNIT OF INDUCTANCE OR SELF INDUCTION.—The practical unit of electro-magnetic inductance is the henry. It is equal to 10^9 c.g.s. units of inductance. The self-induction in a circuit is one henry when the induced pressure is one volt, while the inducing current varies at the rate of one ampere per second. When the henry is too large for convenience. the milli-henry or one-thousandth part of a henry is used.

UNIT OF LUMINOUS INTENSITY.—In illumination practice, the word **candle** refers to the International candle which is the unit of luminous intensity and which resulted in 1909 from agreements effected between the three National Standardizing Laboratories of France, Great Britain and the United States. Since that time this unit has been maintained by means of standard incandescent lamps in these laboratories. The International candle is the same as the pentane candle, bougie candle and American candle. 1 International candle =1.11 Hefner candle=.104 Carcel unit.

UNIT OF MAGNETIC FLUX.—The Maxwell, which is a single line of magnetic force. It has been named the maxwell after James Clerk Maxwell, the Scotch scientist.

UNIT OF MAGNETIC INTENSITY.—The unit value of flux density or intensity is one line or maxwell per square centimeter of the magnetic area. It is called a **gauss.**

UNIT OF MAGNETISM.—That quantity of magnetism which must be concentrated in an infinitely small pole, so that, when placed at a distance of one centimeter from an exactly similar pole, it repels it with a force of one dyne.

UNIT OF MAGNETOMOTIVE FORCE.—The gilbert, or that value of magnetic pressure which will establish one line or maxwell per centimeter cube of air.

UNIT OF MASS.—In the c.g.s. system absolute units of the gram. It is the one-thousandth part of the mass of a standard kept in Paris called the kilogram. For practical purposes the gram is equal to the mass of one cubic centimeter of water at 4° C., or 15.43235 grains. The English practical unit is the pound which is equal to 453.6 grams.

UNITS OF MEASURE.—For scientific purposes, three fundamental units have been fixed which are universally the same. They are the centimeter, the unit of length; the gram, the unit of mass; and the second, the unit of time. This system of units is known as the c.g.s. system, and from these fundamental units other units are derived.

UNIT OF PHOTOMETRIC INTENSITY.—The unit of intensity of a light source. A source of light is of unit illuminating intensity when it produces unit illumination of a square meter of concentric spherical surface at a radial distance of one meter.

UNIT OF POWER.—1. The horse power, or the rate of work done when a weight of 33,000 lbs. is raised one foot in one minute.

2. The watt or 1/746 of a horse power. It is the power due to a current of one ampere flowing under a pressure of one volt. In practice, however, a larger unit, the kilowatt, or 1,000 watts is used for convenience. 746 watts=1 horse power.

UNIT OF PRESSURE.—1. The volt, or pressure which will produce a current of one ampere against a resistance of one ohm.

2. The atmospheric pressure at the sea level, or 14.7 lbs. per sq. in. absolute.

UNIT OF QUANTITY.—1. The electromagnetic unit is the quantity of electricity which is conveyed by unit current in one second. The practical unit is the coulomb which is the quantity delivered by one ampere flowing for one second.

2. The electrostatic unit is the quantity which at a distance of one centimeter repels a similar and equal quantity with a force of one dyne.

UNIT OF RADIO ACTIVITY.—The uranium unit.

UNIT OF RELUCTANCE.—The reluctance offered by a cubic centimeter of vacuum is taken as a unit. The name for this unit, provisionally adopted by the American Institute of Electrical Engineers, is oersted, in honor of H. C. Oersted, the Danish scientist, who first discovered the relation of magnetism to the electric current.

UNIT OF RESISTANCE.—1. The ohm, which is the resistance offered to an unvarying electric current by a column of mercury at 32° F. 14.4521 grams in mass, of a constant cross sectional area, and of the length of 106.3 centimeters.

2. The resistance which permits a flow of one ampere when the impressed pressure is one volt.

UNIT OF SELF-INDUCTION.—The henry. The milli-henry or one-thousandth part of a henry is often used as a more convenient unit.

UNIT OF WEIGHT.—The pound, being the weight of a piece of platinum preserved in the office of the Exchequer in London. A number of authorized duplicates of it have been made and deposited at several institutions. The avoirdupois pound of 16 ounces is employed in the U.S. and in England in the weighing of all ordinary commercial commodities; the troy pound of 12 ounces, 5,760 grains, or more commonly its fractions, is the measure employed for weighing bullion, jewels, etc. The troy pound and ounce are used by the U.S. pharmacist in filling medical prescriptions while in Great Britain the weights used are the imperial or avoirdupois pound, ounce and grain.

UNIT OF WORK.—The c.g.s. unit of work is called the erg. It is that work which is done when a force of one dyne is overcome through a distance of one centimeter. It is therefore a unit of energy. The practical unit of electrical energy or work is the joule, which is the work done when one ampere flows for one second against a resistance of one ohm, and is equal to ten million ergs or 0.73734 foot-pounds.

UNIT POLE.—A magnetic pole which repels an equal and similar pole with a force of one dyne at a distance of one centimeter.

UNIT SEQUENCE SWITCH.—A device which changes the sequence of placing units in and out of service, in multiple unit equipments.—NEMA.

UNIT SYSTEM.—In an electric station, an arrangement by which the plant is divided into a series of units, each unit comprising a prime mover and generator and attendant auxiliary machinery. The switchboard is also divided, a panel being provided with all the necessary switches and instruments for each unit.

UNIT WIRE.—A unit for calculating electrical conductors. It is a wire one foot long and .001 of an inch in diameter. In the metric system, unit wire is one meter long and one millimeter in diameter.

UNITY POWER FACTOR.—1. This value of the power factor is reached when an a.c. circuit becomes resonant, that is, when the proportion of inductance and capacity are such as to neutralize each other bringing the current in phase with the impressed pressure and causing true watts to equal apparent watts, a condition seldom obtained in practice.

2. An alternating circuit has unity power factor when the product of the ammeter and volt meter readings is equal to the watt meter reading. The reason for this is because power factor=watt meter reading÷(volts×amperes). A circuit has unity power factor when there is synchronism of current and pressure.

UNIVALENT.—In chemistry, having the valency, or combining power of one unit, as a univalent atom.

UNIVERSAL BATTERY SYSTEM.—In telegraphy, a system in which a number of circuits are connected with one battery so that each circuit receives the same current.

UNIVERSAL DISCHARGE.—An apparatus for discharging a battery of Leyden jars through any object; it consists of two movable brass arms with universal joints and supported on glass posts; between the knobs terminating the arms the object to be exposed to the shock is supported upon a third insulated post.

UNIVERSAL GALVANOMETER SHUNT.—A shunt devised by Ayrton and Mather so as to be used with any galvanometer, the coils being arranged so that their relative multiplying powers are always the same whatever the actual resistance of the instrument may be. It is usually known as the Ayrton shunt.

UNIVERSAL JOINT.—A contrivance used for joining two shafts or parts of a machine endwise, so that the one may give rotary motion to the other when forming an angle with it, or may move freely in all directions with respect to the other: as, by means of a cross, connecting the two forked ends of the two shafts.

UNIVERSAL MOTOR.—A motor similar to a series d.c. motor and designed to run on either d.c. or a.c.

UNLOADING POLES FROM CARS.—There are several methods of unloading poles as: a, by cutting the stakes; b, by dragging off car end; c, by means of pole derrick; d, by lowering with rope.

UNMARKED END OR POLE.—The south pole of a magnet, so called to distinguish it from the north pole which is usually marked for identification.

UNPLUGGING. — Disconnecting resistance coils from a circuit by withdrawing the plugs of the resistance box.

UNSILVERING BATH.—A bath for removing the silver coating from an object that has been silver plated.

UNTUNED.—In radio, a circuit not in resonance for a given frequency.

UNTUNED TRANSFORMER COUPLING OF AMPLIFIER.—In radio, a type of radio frequency amplifier coupling which employs a transformer with only a small amount of iron as core. This method covers a very limited range of frequencies and accordingly is unsatisfactory.

U PACKING.—A hydraulic leather packing having a section resembling the letter U.

UP AND DOWN CONTROL.—On an air plane a transverse piece placed at right angles to the tail post forming a T and to which the up and down control flaps or elevators are hinged.

UP LINES.—In British telegraph practice, a term applied to the lines which lie in the direction toward the chief station of the circuit, as opposed to down lines.

UPPER HARMONICS OF CURRENT.—The higher frequencies which may exist in conjunction with a simple periodic current.

UPRIGHT BOILER.—A questionable title for a vertical boiler.

URANIUM.—A rare metallic element found combined in a few mineral substances, especially in pitchblende. It was in experimenting with uranium in 1896, that Becquerel made the first important discovery in the subject of radio-activity by producing the so-called Becquerel rays.

URANIUM RAYS.—A form of radiation from uranium discovered by Becquerel in 1896, and usually known as Becquerel rays. It was found that uranium and all salts containing it, emitted rays that passed through black paper and affected a photographic plate, and ionized the gas through which they passed. Their action is similar to Roentgen rays though more feeble. This property of ionizing air and other gases is known as radio-activity.

URANIUM UNIT.—A unit for the measurement of radioactivity. That of uranium being taken as 1.

USEFUL CURRENT.—In an alternating current circuit in which the current and pressure are not in phase, that component of the current in phase with the impressed voltage.

USEFUL LIFE.—The length of time an incandescent lamp will burn before its output of light decreases more than 20%. When a lamp has fallen below 80% of its rated candlepower, it should be replaced with a new one.

U. S. STANDARD SCREW THREAD.—The most used thread in the United States. The sides of the thread form an angle of 60° with each other. The thread is flattened at top and bottom; the width of the flat equals one eighth of the pitch. It should be noted especially that the ½ in. size has 13 threads per inch whereas the V thread has 12 threads for the same size. Note also the following variations:

Size	1⅝	2⅜	2⅞
V thread	5	4½	4
U. S. thread	5½	4	3½

V

V OR v.—Symbol for: 1. Volume.
2. Volt.
3. Velocity.

VACUO.—In physics, a term used in calculations on the behavior of falling bodies and liquids, by which their velocity is referred to that of a body falling in a vacuum, or in vacuo. The term in a vacuum is better.

VACUUM.—A space entirely devoid of air or anything which causes pressure; a space having zero absolute pressure. The loose usage of the word vacuum to indicate a partial vacuum (as a 24 or 28 inch vacuum) is tolerated for convenience. Since the lowest pressure that can be produced in nature is that which results from the removal of the atmospheric pressure from a vessel by the creation of a Torricellian vacuum therein, the absolute zero of pressure is 14.7 pounds below the zero of an ordinary pressure gauge.

VACUUM BRAKE.—1. In railroad operation, a method of braking which depends upon atmospheric pressure for its operation, made available by producing a vacuum by means of an ejector.

2. The vacuum brake is also applied to automobiles, being objectionably called a booster brake.

VACUUM GAUGE.—An instrument resembling a steam gauge in construction, for measuring the unbalanced pressure of the atmosphere upon condensers, etc. The dial is graduated into 30 divisions representing "inches of mercury." 30 inches of vacuum being equal to 14.7 lbs. pressure per sq. in. approximately, that is, this amount of pressure has been removed from the closed space to which the gauge is attached, leaving zero pressure inside. In practice with steam condensers usually from 24 to 28 in vacuum is obtained.

VACUUM INCANDESCENT LAMP.—One in which the filament is operated in a vacuum. This type of construction produces best results in low amperage lamps and is employed for 115 volt lamps of less than 50 watts. The term Mazda B has been used to distinguish vacuum lamps from gas filled, or Mazda C, lamps.

VACUUM LIGHTNING ARRESTER. — A lightning arrester consisting of a vacuum tube of glass through which a lightning discharge may be grounded.

VACUUM LINE.—A line ruled on an indicator diagram below the atmospheric line, at a distance corresponding to 14.7 lbs., on the scale of the spring, thus showing the absolute vacuum.

VACUUM PHOTO-CELL.—A photo-tube exhausted to a high degree as distinguished from a gas photo-cell.

VACUUM PUMP.—Wrong name for an air pump.

VACUUM TUBE.—A device consisting of a tube similar to an incandescent bulb exhausted to a high degree and provided with two or more elements. Used in radio as a rectifier, detector, amplifier, etc., also for many other uses. The term should not be applied to a gaseous tube.

VACUUM TUBE ARRESTER.—A lightning arrester constructed so as to give essentially a gap in a vacuum. The gap is formed between the inner wall of a drawn metal shell and a disc electrode mounted concentric with it.

VACUUM TUBE AS AN AMPLIFIER.—When a three electrode radio tube is used as an amplifier, the grid is kept at a negative voltage with respect to the filament. This negative grid voltage is called the grid bias of the tube. If an alternating voltage be added to the steady negative voltage of the grid, the relative negative voltage between the grid and the filament will vary in accordance with the alternating voltage. Variations of the grid voltage will cause variations in the plate current. If the resistance in the plate circuit be sufficiently high, the pulsations of the voltage produced in the circuit will be greater than the alternating voltage impressed on the grid. Therefore, three electrode vacuum tubes can be used to amplify (increase) variations of voltage.

VACUUM TUBE AS A DETECTOR.—The tube acts as a detector on account of its rectifying action; that is, the incoming high frequency alternating current is rectified or changed to a unidirectional current, one half of the alternating (the positive side) being permitted to pass through to the filament circuit. The three element tube can be made to act as a detector by three different methods: a, by keeping the average grid voltage negative with respect to the filament by means of the C battery. Connect positive terminal to negative leg of the filament and negative terminal to the grid circuit; b, by keeping grid positive by aid of battery; c, by using grid condenser and grid leak.

VACUUM TUBE AS AN OSCILLATOR.—When a radio vacuum tube is used as an oscillator the A, B and C batteries form the source of energy and the tube is connected to the oscillatory circuit, so that there is coupling between the grid circuit and the oscillatory circuit and also between the plate circuit and the oscillatory circuit.

VACUUM TUBE AS A RECTIFIER.—When alternating current is applied to a tube so that the plate is alternately positive and negative with respect to the filament during the positive half of the a.c. cycle, electrons will flow from the filament to the plate. However, when the current reverses during the negative half, no current will flow. A rectifier tube operating on this principle is called a half-wave rectifier. By adding another plate, a unidirectional flow may be obtained during both halves of the cycle, in which case the tube is called a full-wave rectifier.

VACUUM TUBE CLASSIFICATION.—There are a great many different types of vacuum tubes or valves, each of which has its own particular trade name, and they may be classified:

1. With respect to communication, as: a, transmitting; b, receiving.

2. With respect to the current, as: a, direct—dry cell, storage battery; b, alternating current.

3. With respect to its use in the circuit, as: a, rectifier; b, detector; c, amplifier; d, ballast.

4. With respect to the number of elements, as: a, two; b, three; c, four (screen grid); d, five.

VACUUM TUBE LAMP.—An electric lamp which depends for its operation upon the incandescence of the highly rarefied gas in a vacuum tube when an electric current is passed through it.

VACUUM TUBE OVERLOADING.—In radio a condition producing distortion and caused by low screen grid, control grid, or plate voltages, if the signal input be in excess of that being permitted by the voltages being applied.

VACUUM TUBE TRANSMITTER.—In radio one in which vacuum tubes are utilized to convert the applied electric power into radio frequency power.

VACUUM TUBE VOLT METER.—An a.c. radio instrument which takes a very small amount of power. It utilizes the characteristics of a vacuum tube for measuring a.c. voltages.

VALENCY.—The combining power of a chemical element indicated by the number of units represented by hydrogen with which it can combine, or which it can replace; quantivalence.

VALVE.—1. A device for opening or closing a pipe, to allow or prevent the flow of a liquid or gas. There is a great variety of valve types such as, globe, gate, needle, cross, etc.

2. A name used in England for what is known in the United States as a vacuum tube.

VALVE DIAGRAM.—In steam engineering, a diagram by means of which the properties of a valve (lap, travel, etc.) to meet given conditions of steam distribution is easily determined. The most practical diagram is the Bilgram diagram. With this diagram available for solving slide valve problems, there is no reason for using such a makeshift as the Zeuner diagram.

VALVE SEAT.—That part of a steam engine over which the valve slides (or rocks), in opening and closing the steam and exhaust ports, to control the steam distribution for proper operation of the engine.

VALVE TYPE ARRESTER.—A lightning arrester whose characteristic element has a very high resistance at normal voltage, which resistance decreases as the voltage increases and then returns to its normal value when the surge voltage returns to zero. These characteristics result in suppressing the follow current.

VAPOR.—1. Moisture in the air, any light cloudy substance in the air, as, smoke or fumes.

2. In physics, the semi-gaseous state of a substance which is liquid at ordinary temperatures; as, water in the state of saturated steam.

A vapor that is not near the saturation point, behaves like a gas under changes of temperature and pressure, but if it be sufficiently compressed or cooled, it reaches a point where it begins to condense. It then no longer obeys the same laws as a gas, but its pressure cannot be increased by diminishing the size of the vessel containing it, but remains constant, except when the temperature is changed. The only gas that can prevent a liquid evaporating seems to be its own vapor.

VAPOR GLOBE.—A glass globe for protecting an incandescent lamp in explosive atmospheres, as in mines, or in places where there is danger of fracturing the bulb by dripping water.

VAPORIZATION.—The process of causing a change of state from the liquid to the gaseous form by the application of heat, the action taking place throughout the mass of the liquid. Carefully distinguish from evaporation in which the change of state occurs only at the surface of the liquid.

VARIABLE AREA SOUND RECORDING.—In this method, a beam of light from an incandescent lamp is focused on a mirror. The vibration of the mirror sends the light across the exposed moving film through a suitable optical system containing lenses and a narrow slit. The mirror needs to move only a little to sweep the light beam comparatively large distances at the film.

VARIABLE CONDENSER.—A radio condenser consisting of two sets of sector shaped plates, mounted along a common axis. One set is fixed and the other rotatable, and the two sets are insulated from each other by Bakelite or other insulating material. Turning the movable plates varies the capacity. Used in radio sets for tuning.

VARIABLE DENSITY SOUND RECORDING.—In this method the light passing through an optical system, varies in intensity with the amplified sound currents and shines through a narrow slit on to the moving film, which is kept running at a constant speed of 90 ft. per minute. When the film is developed after being exposed to the variable intensity light, the sound track will be made up of lines of varying density extending across the sound track. The spacing of these lines at each point depends on the pitch of the sound which was recorded at that moment. The difference in density of the lines depends on the loudness of the sound, that is, the greater the contrast between light and dark lines, the louder the sound.

VARIABLE EXCITER SYSTEM.—A method of voltage regulation adapted to plants where it is necessary to run motors and other station auxiliaries from the exciter bus. With the standard type of voltage regulator, the regulation of the alternator voltage is accomplished by varying the exciter voltage and it is, therefore, impossible to run station auxiliaries from the exciter bus, but with this system the exciter bus voltage is not disturbed.

VARIABLE GAP MOTOR.—An adjustable speed d.c. motor in which the area of the air gaps is varied by shifting the position of the armature axially. This brings more or less of the armature in the field with resulting change in speed.

VARIABLE GRID LEAK.—A radio variable resistance unit capable of considerable resistance variation. It is placed in the grid circuit of a detector vacuum tube.

VARIABLE INDUCTANCE.—Any type of induction coil whose inductance can be altered during operation.

VARIABLE LEAD.—In valve gears, lead which changes with the degree of expansion.

VARIABLE MU TUBE.—A screen grid radio tube in which the amplification factor or mu varies with change of control grid bias. High amplification is obtained with only slightly negative grid bias, but the amplification is low with high negative grid bias. The variable mu tube has four electrodes: cathode, control grid, screen grid, and plate, the same elements that are used in any screen grid tube. The special characteristics of the variable mu tube are secured by alterations in the form of, and in the spacing between the cathode, control grid and screen grid. Any one or more of these elements may be altered in form to provide the varying amplification or varying transconductance.

VARIABLE RATIO TRANSFORMER.—One with a tapped winding permitting the ratio between primary and secondary tuning to be varied in steps.

VARIABLE RESISTANCE. — A resistor whose resistance may be varied while in operation, as a rheostat.

VARIABLE RESISTANCE REGULATION.—In storage battery charging a method of current control in which a variable resistance is placed in the charging circuit.

VARIABLE VOLTAGE CONTROL.—A method of elevator control also called unit multi-voltage control and was formerly called Ward-Leonard control. In the variable voltage system the elevator motor is always a d.c. machine. Each elevator has a motor generator set, thus having in effect its own private source of current, the voltage of which is varied at will to change the speed of the elevator.

VARIATION, MAGNETIC.—The declination, being the angle between the magnetic meridian and the geographic meridian of a place on the earth's surface. The compass needle comes to rest in the magnetic meridian which is an imaginary line passing through the earth's magnetic poles, but this line does not coincide with the meridian that is described through the geographic poles. The angle measured by this deviation is called the **declination** or **variation.**

VARIATION MAGNETOMETER.—An instrument for measuring the intensity of the earth's magnetic variation or declination.

VARIATION MAP.—A map or chart of the earth's surface, or any portion of it, with lines drawn connecting the places which have the same **declination** or **magnetic variation.** The lines so drawn are known as **isogonic** or **isogonal lines.**

VARIATION OF MAGNETIC NEEDLE.—The amount by which a magnetic needle pointing to the earth's magnetic poles deviates from the direction of the geographical north and south. The compass needle rests in the magnetic meridian, and the angle which the direction of the needle makes with the geographical meridian is called the **declination** or **variation of the magnetic needle.** This variation differs at different places, and at the same place at different times. Regular changes are known as **secular, annual** or **diurnal** as they occur through long intervals, yearly or daily. Irregular changes exhibit phenomena known as **magnetic storms.**

VARIO-COUPLER.—An inductive coupling with secondary coil arranged to rotate inside the primary coil. An early form of tuner.

VARIOMETER.—In radio, a modified vario-coupler in which the primary and secondary coils are electrically connected. A variometer may be used in a detector tube plate circuit to obtain regeneration. It may also be used as a tuned impedance coupling between radio frequency amplifying tubes or as a type of tuned transformer coupling with a variable secondary.

VARLEY LOOP TEST.—A method of locating a cross or ground in a telephone or telegraph line or other cable by using a bridge in a loop formed of a good wire and the faulty wire joined at their distant ends. One terminal of the battery is grounded and the other connected to a point on the bridge at the junction of the ratio arms. When the bridge is balanced, the unknown resistances may be readily determined by a simple equation.

VARNISH.—An insulating varnish is prepared for coating electric coils, which is claimed to be flexible, acid, salt and moisture-proof, not blistering under heat, and possessed of high insulating properties.

VARYING DUTY.—A requirement of operation or service in which the apparatus is called upon to run at loads, and for periods of time, which may be subject to wide variation, but which are in no case sufficient to cause the maximum temperature rating to be exceeded. In no case shall the no load losses be sufficient to cause the maximum temperature rating to be exceeded in any part under no load continuous operation.—NEMA.

VARYING SPEED MOTOR.—A motor in which the speed varies with the load, ordinarily decreasing as the load increases; for example, a series motor, compound motor, or series shunt motor. —NEMA.

VECTOR.—Any quantity which has direction as well as magnitude. Motion, displacement, velocity, acceleration, force, electric current, magnetic flux, lines of force, stresses and strains, flow of heat and fluids; all involve magnitude and direction, and are vector quantities. Straight lines of definite length may be used to represent vector quantities, the length of the line representing the magnitude, and the **inclination** of the line to some axis representing the **direction.** A representation of this kind is called a **vector diagram.** Vector diagrams are now almost universally used to express relationships in alternating current circuits. The most common methods of expressing the value of a vector are by means of rectangular co-ordinates and by means of spherical co-ordinates.

VECTOR DIAGRAM.—A diagram showing combinations and relations of vectors.

VELOGRAPH.—A type of speed indicator which makes a permanent record of the speeds and times which it indicates.

VENTILATED ARMATURE.—An armature having a spider constructed with as much open space as possible through which air currents may circulate. The core is divided into several sections with intervening air spaces, the discs being kept apart at these points by distance pieces. These openings between the discs are called ventilating ducts; they are usually spaced from 2 to 4 inches apart. Sometimes a fan is provided at one end to induce a current of air.

VENTILATING FAN.—A blowing machine, either of rotary or centrifugal type, used for ventilation.

VENTILATION DUCTS.—In large armatures, ducts or passages for ventilation, to carry off the heat, are provided in the core by occasionally separating the discs by the insertion of blocks of insulating material.

VERDET'S CONSTANT.—In magneto-optics, the angle through which the plane of polarization is rotated when a unit magnetic field acts upon a transparent plate of given material, one centimeter in thickness.

VERDIGRIS.—Copper acetate. Found in the market in the form of dark green crystals showing an acid reaction, or as a neutral bright green powder. It is employed in electro-plating for preparing copper and brass baths and for coloring, gilding, etc. Verdigris forms on the terminals of a storage battery.

VERNIER.—A small movable scale invented by Pierre Vernier in 1631, and used for measuring a fractional part of one of the equal divisions on the graduated fixed scale.

The vernier consists in its simplest form of a small sliding scale, the divisions of which differ from those of the fixed primary scale. On the scale of the tool is a line of graduations divided into inches and numbered 0, 1, 2, etc., each inch being divided into ten parts, and each tenth into four parts, making forty divisions to the inch. On the sliding jaw is a line of divisions of twenty-five parts, numbered 0, 5, 10, 15, 20, 25. The twenty-five divisions on the vernier correspond, in extreme length, to twenty-four divisions, or 24/40 of an inch, on the scale; each division on the vernier is, therefore, 1/25 of 1/40 or 1/1000 of an inch shorter than the corresponding division on the scale.

If the vernier be moved until the line marked 0 on the vernier coincides with that marked 0 on the scale, then the next two lines to the right will differ from each other by 1/1000 of an inch; and the difference will continue to increase 1/1000 of an inch for each division, until the line 25 on the vernier coincides with a line on the scale.

VERNIER CALIPER.—A caliper provided with a vernier for precise measurements. It consists of two L shaped pieces, one sliding on the other. The bar of the main piece is marked to a standard scale, say 40 to the inch, the sliding part is supplied with a vernier scale, 25 of whose gradations correspond to 24/40 on the main scale. The fine measurement is, therefore, $1/25 \times 1/40 = 1/1000$ inch or .001. The sliding part is usually made in two parts for quick setting, being roughly set to size, the outer slide clamped, and the inner jaw carefully set by a horizontal adjusting screw.

VERNIER COMPASS.—A surveyor's compass whose compass circle, with a vernier attachment, is movable about a common center by turning a tangent screw.

VERTICAL.—Upright or perpendicular to a horizontal line or plane. Vertical and perpendicular are not synonymous terms.

VERTICAL AIR CRAFT AERIAL.—One consisting of a six to ten foot metal rod, utilizing the bonded portions of the air craft as a counterpoise.

VERTICAL BOILER.—A type of shell boiler with vertical fire tubes directly over the furnace, requiring very little foundation space as compared to that required by horizontal boilers. As ordinarily designed, a heating surface grate ratio of only 20 is usually employed for stationary and even marine service. Such ratio is objectionable where there is any regard for economy. For a high efficiency marine type of light weight and having a h.s.-g. ratio of 49.4 see the author's design in Audel's Engineers and Mechanics Guide No. 6. Chapt. 71.

VERTICAL COMPONENT OF EARTH'S MAGNETISM. — The earth's magnetic force acting upon the compass needle in a vertical direction.

VERTICAL FIN.—The small vertical fixed plane in front of an airplane rudder.

VERTICAL GALVANOMETER.—A galvanometer having a needle that swings in a vertical plane upon a horizontal axis; an upright galvanometer.

VERTICAL INTENSITY OF EARTH'S MAGNETISM.—The intensity of the vertical component at any point on the earth's surface.

VERTICAL MAGNETIC NEEDLE.—A magnetic needle mounted upon a horizontal axis and deflected in a vertical plane.

VERTICAL STABILIZER.—The small vertical fixed plane in front of an airplane rudder.

VIBRATING BELL.—A continuous ringing electric bell which, when once started by the push, continues automatically until the battery is exhausted or some one stops it. It consists essentially of: a, electro-magnet; b, pivoted armature; c, hammer; d, contact breaker; e, bell; f, frame. In operation, when the push button is pressed, the current energizes the magnet which attracts the armature causing the hammer to strike the bell but before it reaches the end of the stroke, the contact breaker breaks the circuit and the hammer, influenced by the tension of the armature spring rapidly moves back to its initial position after it strikes the bell, thus completing the cycle.

VIBRATING REED COURSE INDICATOR.—An instrument used on an airplane in connection with the visual type radiobeam.

VIBRATION NEEDLE.—A device carrying weights for measuring the torsional rigidity of a suspension.

VIBRATOR.—A spring mounted tongue or blade which is actuated by the magnet of an induction coil, and by its vibration rapidly makes and breaks the primary circuit, resulting in inductive action in the secondary of the coil and when connected in a high tension ignition system it causes a series of sparks for ignition. To prevent sparking at the vibrating points and to more quickly stop the current at break a condenser is shunted across the vibrator.

VIBRATOR COIL.—A secondary coil used in high tension ignition having a vibrator connected in series in the primary circuit so as to give a series of sparks for each ignition instead of only one. The vibrator consists of a flat steel spring secured at one end with the other free to vibrate. At a point about midway between its ends, contact is made with the point of an adjusting screw, from which it springs away and returns in vibrating. The points of contact of blade and screw are tipped with platinum. One wire of the primary circuit is connected to the blade and the other to the screw, hence, the circuit is made when the blade is in contact with the screw and broken when it springs away.

VINE SYSTEM OF SPACE RELATIONS.—A system assuming that an advance, with left to right rotation in the manner of a vine tendril, is positive.

VIOLET RAYS.—Ultra violet radiation

VIOLLE.—A standard of light proposed by Violle; being that which is emitted by a square centimeter of molten platinum at the temperature of solidification; the violle.

VIOLLE, JULES.—Born 1824; a French physicist, distinguished for his researches concerning the temperature of the sun, and the mechanical equivalent of heat.

VIRGIN IRON.—A term applied to iron that has never been magnetized.

VIRTUAL ECCENTRIC.—In valve gear design, an equivalent eccentric.

VIRTUAL FOCI.—A double convex lens has a virtual focus when the luminous object is placed between the lens and the principal focus.

VIRTUAL RESISTANCE.—1. In an alternating current circuit, the impedance, which is the ratio of the impressed pressure to the current. It is that quantity which, when multiplied by the current gives the impressed pressure. It is equal to the square root of the sum of the squares of the resistance and reactance, and is measured in ohms.

2. In storage batteries, the total resistance due to all the internal effects within the cell, including internal ohmic resistance, polarization, increase of ohmic resistance due to movement of gases in the electrolyte, etc.

VIRTUAL VALUE.—In measuring values of electrical quantities which vary as a sine function, a value equivalent to a constant quantity which would produce the same working effect as the varying quantity. It is equal to the square root of the mean square of the instantaneous values of the varying quantity.

VIRTUAL VELOCITY.—In higher mechanics, a minute hypothetical displacement, assumed in analysis to facilitate the investigation of statical problems. Strictly speaking, it is not a velocity but a length.

VIRTUAL VOLTS AND AMPERES.—A value for alternating pressure or current, equivalent to that of a direct pressure or current which would produce the same effect; those effects of the pressure and current are taken which are not affected by rapid changes in direction and strength—in the case of pressure, the reading of an electrostatic volt meter, and in the case of current, the heating effect. If a Cardew volt meter be placed on an alternating current circuit in which the volts are oscillating between maxima of +100 and —100 volts, it will read 70.7 volts, though the arithmetical mean is really only 63.7; notwithstanding this, 70.7 steady volts would be required to produce an equal reading. If an alternating current is to produce in a given wire the same amount of effect as a direct current of 100 amperes, since the alternating current goes down to zero twice in each period, it is clear that it must at some point in the period rise to a maximum greater than 100 amperes. How much greater must the maximum be? The answer is that, if it undulate up and down with a pure wave form, its maximum must be $\sqrt{2}$ times as great as the virtual mean; or conversely the virtual amperes will be equal to the maximum divided by $\sqrt{2}$. In fact, to produce equal effect, the equivalent direct current will be a kind of mean between the maximum and the zero value of the alternating current; but it must not be the arithmetical mean, nor the geometrical mean, nor the harmonic mean, but the quadratic mean; that is, it will be the square root of the mean of the squares of all the instantaneous values between zero and maximum.

VIS.—1. Force; power.
2. Physical force.

VIS INERTIÆ.—Force of (i.e., due to) inertia. This term is obsolete, the simple word inertia is sufficient, being that property of matter by which it tends when at rest to remain so, and when in motion to continue in motion.

VIS VIVA.—In physics, the active or living force of a body or of the particles of which it is composed. It may be taken as the measure of the mass multiplied by the square of the velocity, although some writers take it as half this quantity.

VISCOUS HYSTERESIS.—When a weak magnetic force is applied to soft iron, the resulting change in the magnetism is not completed instantly. The magnetizing force requires a certain time to produce its full effect. There is a protracted creeping up of the magnetism which goes on long after the magnetic force has become constant. This phenomenon is called time-lag or viscous hysteresis, and is attributed to a property of the particles of the iron known as magnetic viscosity.

VISUAL ANGLE.—An angle formed by the intersection of two lines conceived to be drawn from the extremities of an object to the center of the eye.

VISUAL REED INDICATOR.—A resonance type frequency meter.

VISUAL SIGNALS.—1. In a telephone switchboard, the use of miniature incandescent lamps as signals for attracting the attention of the operator.
2. Telegraphic signals transmitted by means of light, as in heliography.
3. Telegraphic signals which may be read from a dial, as in needle telegraphy.

VISUAL TELEGRAPHY.—Any form of transmitting messages over long distances so that the signals may be read by sight, as when in needle telegraphy the swinging of the needle indicates the letters of the message, or in the heliograph flashes of sunlight are reflected from a mirror in terms of the telegraphic code.

VITAPHONE.—A method of recording synchronized sound by disc phonograph records.

VITREOUS.—Consisting of glass, of, pertaining to, or derived from glass; as, a vitreous substance, vitric.

VITREOUS ELECTRICITY.—A term applied to the electricity developed in a glass rod by rubbing it with silk. This electric charge will attract to itself bits of pith or paper which have been repelled from a rod of sealing wax or other resinous substance which had been rubbed with wool or fur. There is thus exhibited two kinds of electricity, vitreous or positive electricity produced on glass with silk, and resinous or negative electricity produced on sealing wax with wool. The terms positive and negative should be used.

VITRICS.—This term includes the fused compounds in which silex predominates, such as glass and some of the enamels; in contradistinction to the ceramics, in which alumina predominates; such as brick, tiles, pottery and certain of the enamels.

VITRIFIED CLAY.—A clay which has been subjected to intense heat so as to receive a glassy surface which renders it absolutely proof against chemical action. It has very high insulating properties which make it very valuable for conduits in underground wiring, being at the same time inexpensive and easily laid.

VITRIFIED CLAY CONDUIT.—It consists of troughs either simple or with partitions. They are usually made in tiles 3 or 4 inches square for each compartment, with walls about one inch thick. The length of the tiles ranges from two to four feet. Each of the two foot form duct troughs weighs about 85 pounds. When laid complete, the top trough is covered with a sheet of mild steel, about No. 22 gauge, made to fit over the sides so as to hold it in position, and then covered over with concrete.

VITRIOL.—1. A name given to sulphuric acid or some of its compounds, on account of their glassy appearance in certain states. Blue vitriol is hydrous copper sulphate; green vitriol, copperas; red vitriol is either a sulphate of cobalt or a ferric sulphate; white vitriol is hydrated zinc sulphate.

2. In chemistry, a sulphate of any one of certain metals; as, copper, iron, zinc, cobalt; so called on account of the glassy appearance or luster.

VITRITE.—A hard and infusible variety of glass useful for insulating purposes in electrical apparatus.

VIVAPHONE.—A method of synchronized sound for motion pictures introduced by Hepworth in London.

VOICING.—The art of obtaining a particular quality of tone in an organ pipe and of procuring uniform strength and quality throughout the entire stop. Voicing is one of the most delicate and artistic parts of the organ builder's art.

VOLATILIZATION, ELECTRIC.—The reduction of a substance to vapor through extreme electrical heat.

VOLATILIZATION OF CARBONS.—The reduction to vapor of carbon particles from the tips of the carbon electrodes of an arc lamp, forming a path between them for the passage of the voltaic arc.

VOLCANIC LIGHTNING.—Lightning flashes that accompany the eruptions of volcanoes.

VOLPLANE.—In airplane operation, a gliding descent.

VOLT.—The practical unit of electric pressure: 1. The pressure which will produce a current of one ampere against a resistance of one ohm.

2. The pressure induced when an inductor cuts 100,000,000 or 10^8 lines of force per second (c.g.s. electro-magnetic units).

3. The pressure which would charge a condenser of one farad capacity with one coulomb of electricity.

4. Approximately equal to that of a single Daniell cell. It derives its name from Volta, the Italian electrician.

VOLTA, ALESSANDRO.—Born 1745, died 1827. An Italian physicist, celebrated for his discoveries and inventions in electricity. As professor of physics in Italian universities he devoted himself to electrical experiments, and discoveries of great importance resulted. He proposed a new theory of electricity at variance with the "animal electricity" doctrine of Galvani, suggesting that electric power resided in metals, and operated when they were in contact. In 1775 he invented the electrophorus, a simple form of condenser. He constructed the first absolute electrometer, and in 1800 developed the famous electric "pile" which bears his name. The following year Napoleon invited him to Paris to show his experiments with the voltaic pile, and a medal was struck in his honor. He lived to see his work carried on to greater accomplishments by Davy, Oersted and Ampere. He is recognized as the discoverer of current electricity, and in his honor the unit of electric pressure has been named the volt.

VOLTA'S CONTACT LAW.—When two metals differing from each other are brought into contact, different results are obtained, both as to the kind of electrification as well as the difference of pressure. Volta found that iron, when in contact with zinc, becomes negatively electrified; the same takes place, but somewhat weaker, when iron is touched with lead or tin. When, however, iron is touched by copper or silver, it becomes positively electrified. Volta, Seebeck, Pfaff, and others have investigated the behavior of many metals and alloys when in contact with each other.

VOLTA'S CONTACT SERIES LAW.—The difference of pressure between any two metals, equal to the sum of the differences of pressures of all the intermediate members of the series.

VOLTA'S CONDENSING ELECTROSCOPE.—A device by which Volta exhibited the production of electricity by the contact of two dissimilar metals. It consisted of a simple gold leaf electroscope combined with a small condenser. A compound bar of two unlike metals when brought in contact with one of the plates of the condenser, during the course of the experiment, leaves an electric charge which is shown by the divergence of the gold leaves.

VOLTA EFFECT.—An effect discovered by Alessandro Volta as follows: If two dissimilar metals are placed in contact and then quickly separated an electric current will flow from one to the other. The effect is greatly increased by submerging both metals in a saline solution.

VOLTAGE.—1. The electric pressure available to cause flow of current when a circuit is closed.

2. A term that should be used in place of electromotive force.

VOLTAGE AMPLIFICATION.—In radio, output signal voltage÷input signal voltage.

VOLTAGE DIVIDER.—A device for obtaining a desired voltage. It consists of an adjustable slide resistance so arranged that by shifting the slide contact any fraction of the voltage impressed on its fixed end terminals may be obtained.

VOLTAGE DIVIDER DEFECTS.—Some radio power packs are designed so that the bleeder or waste current through the voltage divider exceeds the load current of the radio to be supplied with the power pack. The most common voltage divider defects are open circuits.

VOLTAGE DROP.—The drop of pressure in an electric circuit due to the resistance of the conductor. This loss exists in every circuit. It is directly proportional to the length of the conductor, and inversely proportional to its area of cross section.

VOLTAGE DROP AT BRUSHES.—For carbon commutator brushes it is about .8 to 1 volt at each contact, or 1.6 to 2 volts for the positive and negative, contacts of a machine.

VOLTAGE FORMULA FOR ALTERNATORS.—Since one volt is produced by cutting 100,000,000 or 10^8 lines of force per second

$$E_{max} = \frac{\pi f Z N}{10^8} \quad \text{(1)}$$

in which

E = volts;
f = frequency;
Z = number of inductors in series in any one magnetic circuit;
N = magnetic flux, or total number of magnetic lines in one pole or in one magnetic circuit.

The maximum value of the pressure, as expressed in equation (1), occurs when $\theta = 90°$.

The virtual value of the volts is equal to the maximum value divided by $\sqrt{2}$, or multiplied by $\frac{1}{2}\sqrt{2}$, hence,

$$E_{virt} = \frac{\frac{1}{2}\sqrt{2} \times \pi f Z N}{10^8} = \frac{2.22 f Z N}{10^8} \quad \text{(2)}$$

This is usually taken as the fundamental equation in designing alternators.

VOLTAGE IN THREE PHASE ALTERNATOR.—1. For three phase star connected alternator, voltage between any two collector rings is equal to the voltage generated per phase multiplied by $\sqrt{3}$ or 1.732.

2. For a three phase delta connected alternator, line voltage is equal to the voltage generated in each phase.

VOLTAGE REGULATION.—The maintenance of voltage throughout a system by means of voltage regulators. Voltages higher than normal result in increased transformer core losses and increased lamp renewals. Voltages lower than normal result in revenue losses and dissatisfied customers. Close voltage regulation not only permits the utility c to provide satisfactory service consumer, but it also makes economies in operation which w erwise be unattainable.

VOLTAGE REGULATION BY BRUSH SHIFTING.—In converter operation were it not for the difficulties encountered, this would be a most convenient method of voltage regulation, since by this procedure the direct current voltage may be varied from maximum to zero. It is, however, not practical because of the excessive sparking produced when the brushes are shifted out of the neutral plane.

VOLTAGE REGULATION BY MULTI-TAP TRANSFORMER METHOD.—A non-automatic method for rotary converters, and accordingly, is not desirable except in cases where the load is fairly constant over considerable periods of time. It employs a variable ratio step down transformer.

VOLTAGE REGULATION BY REACTANCE METHOD.—For rotary converters, the method consists in inserting inductance in the supply circuit and running the load current through a few turns around the field cores. This method is sometimes called compounding, and as it is automatic, it is generally used where there is a rapidly fluctuating load.

VOLTAGE REGULATION BY SYNCHRONOUS BOOSTER METHOD.—The combination of a converter with a revolving armature alternator having the same number of poles. The booster alternator armature is connected in series with the input circuits on the converter. Desirable for any application where a relatively wide variation in direct current voltage is necessary.

VOLTAGE REGULATION OF ALTERNATORS.—One method consists in opening and closing rapidly a shunt circuit across the exciter rheostat, thus varying the exciter voltage in order to maintain the desired alternating voltage. In order that the simplicity of this regulator may be understood, it should be borne in mind that the regulator consists mainly of two parts, a d.c. control system, and an a.c. control system.

VOLTAGE REGULATION OF CONVERTERS.—There are several methods available to compensate for voltage variation due to changes of load in order to maintain the direct current pressure constant. They are: a, shifting the brushes (objectionable); b, split pole method; c, regulating pole method; d, reactance method; e, multi-tap transformer method; f, synchronous regulator.

VOLTAGE REGULATION OF FEEDERS.—In order to provide for satisfactory regulation of the distributing system it is essential that each feeder be considered as a unit. With slight modification, the various methods of feeder regulation employed with direct current, may be applied to a.c. distribution circuits. Feeder regulation by means of rheostats is practically the same in the case of alternating current as in that of direct current. In the case of the former, however, the effect of self-induction may also be utilized to produce a drop in voltage. In practice, this is accomplished by the use of self-induction coils which are commonly known as reactance coils.

VOLTAGE REGULATION WITH REGULATING POLES.—For rotary converters, regulating poles insure sparkless commutation from no load to heavy over loads with a fixed brush position.

VOLTAGE REGULATION WITH SPLIT POLES.—For transformers. A method devised by Woodbridge in which each field pole is split into two or three parts. The effect of this is the same as shifting the brushes except that no sparking results. The other part is arranged so that its excitation may be varied, thus shifting the resultant plane of the field with respect to the direct current brushes. One of these parts is permanently excited and it produces near its edge the fringe of field necessary for sparkless commutation.

VOLTAGE REGULATOR CONTROL APPARATUS.—Two relays are employed with each regulator, a primary relay connected to the feeder circuit and operating under changes of voltage therein, and a secondary relay connected between the primary relay and the motor and operated by the contacts of the former, for starting, stopping and reversing the motor in accordance with changes in the feeder voltage, thereby causing the regulator to maintain that voltage at its predetermined normal value.

VOLTAGE RELAY.—One which functions at a predetermined value of voltage. A voltage relay may be either an over-voltage relay or an under-voltage relay. —NEMA.

VOLTAGE TAPS.—On a transformer, leads brought out at various points from one of the windings to obtain various winding ratios corresponding to the voltages desired. Standard distribution transformers, sizes 200 kva. and smaller, wound for voltages below the 6,600 volt class are not provided with taps.

Standard single phase distribution transformers 200 kva. and smaller of the 6,600 volt class or for higher voltages are provided with taps in the high voltage winding for approximately 5 and 10% voltage variation.

Standard three phase distribution transformers above 200 kva. wound for voltages below the 6,600 volt class, are provided with taps in the high voltage winding for approximately 5 and 10% voltage variation.

VOLTAIC.—A term formerly applied to electric phenomena produced by the current from primary batteries.

VOLTAIC ALTERNATIVES.—In electro-therapeutics, alternating currents derived from a voltaic battery.

VOLTAIC ARC.—The source of light in an arc lamp; it consists of a bow or arch of brilliant light produced between the points of carbon rods, which, after being brought into electrical contact and subjected to the passage of an electric current, are drawn a short distance apart; the heat thus produced is so intense that the carbon is disintegrated and vaporized and the space between the carbon tips becomes filled with carbon particles and vapor, which being good conductors, carry the current across in an arc of intense light.

VOLTAIC BATTERY.—Preferably called a primary battery.

VOLTAIC CELL.—Preferably called a primary cell. In its simplest form, a vessel containing a liquid called the electrolyte, into which two dissimilar metals, called electrodes, are immersed; upon one of which the liquid exerts chemical action, so that an electric current is set up through a circuit formed by a metallic contact between the electrodes by means of an external conductor; a primary cell.

VOLTAIC EFFECT.—The effect of current electricity discovered by Volta to result from the contact of dissimilar metals under certain circumstances. This discovery resulted from Galvani's famous frogs' legs experiment. Galvani attributed the muscular twitchings to electricity residing in animal tissue, but Volta more nearly approached the truth when he concluded that the effect was due to the contact of the two metals with which the muscles made connection. This led to the discovery that when a plate of zinc and one of copper are placed in dilute sulphuric acid and joined by a wire, a current of electricity traverses the wire. From this the voltaic or primary battery was the development.

VOLTAIC PILE.—An early form of battery devised by Volta, consisting of a series of pairs of zinc and copper discs in electrical contact placed on top of one another, each pair being separated from the next by moistened paper acting as a cell. A considerable difference of pressure develops between the zinc and copper terminals of the pile, the voltage increasing with the number of metallic pairs employed.

VOLTAMETER.—An electrolytic cell for measuring quantity of electricity by chemical action, based on the fact that the amount of chemical action produced by passing a current through an electrolyte is proportional to the quantity of electricity passed. There are two types of voltameter known as: a, weight; b, gas. In the weight type, the current strength is determined by the weight of metal deposited or weight of water decomposed. In the gas type, by the volume of gas liberated. The name voltameter was given by Faraday to an electrolytic cell employed as a means of measuring an electric current by the amount of chemical decomposition the current effects in passing through the cell.

VOLTAMETRIC LAW.—The law on which measurement by the voltameter is based, viz.: that the amount of chemical decomposition effected by an electric current passing through a solution is proportional to the quantity of the current.

VOLT-AMPERE.—The watt or unit of electric power, being one ampere multiplied by one volt. It is the rate at which work is expended when one ampere flows under a pressure of one volt. It is equal to one joule per second and is equivalent to 1/746 of one horse power.

VOLT-COULOMB.—The joule, or unit of electrical energy, being one coulomb multiplied by one volt. It is the amount of work done in transferring one coulomb of electricity (an ampere maintained for one second) under a pressure of one volt. It is equal to 10^7 ergs, or absolute units of work.

VOLTEX PROCESS.—A method of electric welding and brazing which uses an electric arc formed between two special carbon rods inclined to each other at an angle of about 90°. The whole apparatus can generally be held in one hand.

VOLT METER.—An instrument of high resistance for measuring differences of pressure in volts; it is essentially a current meter, but is so calibrated as not to give the strength of the current as an ammeter, but the voltage which produces the current. There are numerous types of volt meter and they may be classed with respect to principle of operation as

1. Direct current types:

a, Moving iron; b, Moving coil; c, Solenoid or plunger; d, Magnetic vane; e, Hot wire; f, Electrostatic; g, Astatic; h, Inclined coil; i, Fixed and movable coil.

2. Alternating current types:

a, Electro-magnetic (moving iron); b, Hot wire; c, Induction; d, Dynamometer.

VOLT METER FOR RADIO TUBE A.C. FILAMENT.—This instrument (Hickok) is used only when testing sets using a.c. tubes. The scale ranges are 3.3 and 10 volts and are selected by means of the three position switch located at the left of the meter. The meter is entirely disconnected from the circuits of the tester when the scale changing switch is set in the "O" or central position. When testing sets using d.c. tubes, this switch should always be in the "O" or central position, as this meter must be out of the circuit for all d.c. tests. To use this meter as a separate instrument, connect to posts marked "Positive A Battery" and "Negative A Battery," setting the scale changing switch in the proper position for the voltage to be measured.

VOLT METER FOR RADIO TUBE D.C. This instrument (Hickok) is a companion is the same type as the plate volt meter and has a scale range of 7.5 volts. The sensitivity of this meter is the same as the plate volt meter—1,333 ohms per volt, which gives a resistance for the 7.5 scale of 10,000 ohms. To use this meter as a separate instrument, connect to posts marked "Positive A Battery" and "Negative A Battery," setting the a.c. filament volt meter switch in the "O" or central position. The filament reversing switch should also be set on the left hand position.

VOLT METER FOR RADIO TUBE GRID.—This instrument (Hickok) is a companion instrument to the plate and filament volt meters, and has the same sensitivity. The scale is 50—0—10 volts and has a resistance of 80,000 ohms. The high sensitivity allows the grid bias to be read correctly through the secondary of all audio transformers. To use this meter as a separate instrument, set the grid switch, located at the right of the meter, on the position marked "Fil" and connect to posts marked "Negative A Battery" and "Negative C Battery."

VOLT METER FOR RADIO TUBE PLATE.—This instrument (Hickok) is a special high resistance type, having a sensitivity of 1,333 ohms per volt, which gives a resistance for the 300 volt scale of 400,000 ohms and for the 600 volt scale of 800,000 ohms. It is so connected that it can be used either separately or in conjunction with the other instruments in making tests of circuits in radio receiving sets. To use this instrument separately, connect to the posts marked "Positive B Battery" and "Negative A Battery." The switch for changing the scale range is located at the right of the meter. The grid switch, located at the right of the grid volt meter, should be set on position marked "Fil."

VOLT METER METHOD.—A resistance test based on direct deflection of the galvanometer needle. First determine the resistance that will deflect the needle through one division of the scale with a given battery current, then with this as a basis for comparison, the volt meter is connected across the unknown resistance whose value is easily calculated from the reading.

VOLT METER SWITCH.—A multi-connection switch used in a central station. Under ordinary conditions it remains connected to the circuit at the central point of distribution. When one dynamo is already in circuit, however, and it becomes necessary to connect up the other one, the voltage of the latter must be the same as that at the bus bars. Accordingly, connections are provided to the volt meter switch such that the attendant can compare the voltages at the dynamo terminals and bus bars before closing the dynamo switch. All the positive connections are on one side of the circle swept by the switch and all the negative connections on the other side.

VOLUME.—1. In radio, the degree of loudness of sound produced by a loud speaker.

2. A definite amount of space included by limiting surfaces being the product of length×breadth×thickness, thus the volume of a cube whose sides measure 2 ft. is $2\times2\times2=8$ cu. ft.

VOLUME VOLTAMETER.—A voltameter which determines the strength of an electric current by measuring the amount of gas evolved from the solution by the passage of the current; a gas or water voltameter. To calculate the current strength, divide the volume of gas liberated by the time in seconds, and by the volume of gas liberated (in cubic centimeters) by one ampere in one second and by .1733; that is, amperes=volume of gas liberated÷(time in seconds×.1733).

V SCREW THREAD.—The sides of the thread form an angle of 60° with each other. The top and bottom of the thread are, theoretically, sharp, but in practice it is necessary to make the thread with a slight flat. There is no standard adopted for this flat, but it is usually made about 1/25 of the pitch. Note especially that the ½ in. size has 12 threads per inch, whereas the U. S. standard thread has 13 threads for the same size. Note also the following variations:

Size	1⅝	2⅜	2⅞
V thread.........	5	4½	4
U. S. thread.....	5½	4	3½

VULCABESTON.—An insulating compound composed principally of asbestos and vulcanized rubber. It is tough, strong, non-absorbent and heat resisting, and is recognized as one of the standard materials for insulating electrical apparatus.

VULCANITE.—A hard compound produced by heating rubber to a high temperature (175°-200° C.) and mixing it with sulphur. As an insulating material its dielectric strength is very high, but it oxidizes in the air and is affected by oil. It is also called ebonite and hard rubber.

VULCANIZATION.—The process of imparting new properties to caoutchouc or rubber by causing it to combine with sulphur through the agency of a high temperature. This may be so done as to leave it soft and elastic, or to harden it into a substance like horn.

VULCANIZE.—To combine sulphur with natural rubber in order to prolong the life of its elasticity and to prevent its softening by heat.

VULCANIZED FIBRE.—A very strong and tough insulating material made from vegetable fibre which has been chemically treated, strongly compressed and vulcanized. Though it absorbs moisture, it is not injured by so doing, and it is insoluble in ordinary solvents. It comes in two grades, hard and flexible, and is easily machined. It is used for magnet bobbin insulators, and for other work in dry locations, also for lining and insulating machine parts.

VULCANIZED RUBBER. — A compound formed by heating rubber to a temperature of 120° to 150° C., and mixing it with sulphur. Rubber is thus changed into an elastic but not plastic substance, which is not affected by moderate temperatures and is less liable to deteriorate than untreated rubber. All rubber insulation for electrical purposes is made of vulcanized rubber.

VULCANIZER.—A furnace in which the flasks containing the component parts are exposed to a heat sufficient to combine the sulphur and caoutchouc, and produce the compound called vulcanite.

VULCANIZING POLES.—A method of

treating wooden telegraph and other poles to prevent decay, consisting of heating the pole in a closed vessel to a temperature of about 500° F., for the purpose of thoroughly expelling the sap from the wood.

W

W.—Symbol for: 1. Energy.
2. Work.
3. Electro-static flux density.
4. Magnetic flux density.

WALKING BEAM ENGINE.—A type of engine used on side wheel steamers. It consists essentially of a large vertical cylinder, the motion of the piston being transmitted to the crank by a walking beam and connecting rods. The engine occupies considerable space for its power because it is operated at low pressure and low number of revolutions. The pressures in use are from 25 to 75 lbs. at the boiler; and the usual speed is from 20 to 30 revolutions per minute. The valve gear is almost always of the double poppet valve type, actuated by cams on a rock shaft. To secure expansion in the single cylinder, some form of cut off arrangement is provided, of which construction the Sickels cut off gear is a well known one. Under the influence of a second eccentric, it allows the poppet valve to drop precisely by disconnecting it from the lifting rod. Reversal is effected by disconnecting the eccentric rods from the rock shaft lever and giving live steam by hand on the opposite side of the piston. This entire suspension of the automatic action of the valve, which would be impossible in quick running engines, proves exceedingly handy and serviceable in the beam engine. Some engines have the loose eccentric reversing gear. To reverse this type the valve gear has to be operated by hand for at least one half a revolution, for which a hand lever is used. Feed water consumption of these engines ranges between 20 and 25 lbs.

WALKING BEAM RELAY.—A pole changer having a beam pivoted at the center (hence the name "walking beam") and provided at each end with a contact maker, also an armature located on one side of the beam, directly over a magnet. Used in the polar duplex telegraph system.

WALL BRACKET.—1. A lamp bracket attached to a wall.
2. In overhead wiring, a bracket for the support of an insulator against a wall, especially when the wire is to be led into a building.

WALL PLUG.—A plug designed to be introduced into a wall socket for the purpose of making electrical connection with the supply wires.

WALL SET.—A telephone set designed to rest against the wall.

WALL SOCKET.—Any socket placed in a wall for the purpose of admitting a plug for making electrical connection with supply wires.

WALL TUBE.—A partition insulator.

WALSCHAERT VALVE GEAR.—A type of radial valve gear adapted especially for locomotives. The Walschaert gear like other radial gears gives a constant lead and cannot be adjusted without disturbing the other events. The layout of this gear is more or less a matter of trial, many minor locations may be varied in design, such as the position of the link pivot or the point where the eccentric rod is pivoted to the link, and in this way modifications in the action of the valve may be accomplished.

WAND, ELECTRIC.—A gas lighter containing an electrical device for producing a spark, which is operated by pressing a button in the handle.

WANDERING OF ELECTRIC SPARK.—A condenser discharge producing the effect of a spherical spark wandering over the surface of the tin foil, when a fault occurs in the dielectric.

WARD LEONARD CONTROL.—A name formerly given to variable voltage elevator control.

WARP.—In airplane operation, to distort a controlling surface.

WASH.—The disturbance of air produced by the flight of an airplane.

WASH IN.—An increasing angle of incidence of an airplane wing surface toward its tip.

WASH OUT.—A decreasing angle of incidence of an airplane wing surface toward its tip.

WASHBURN AND MOEN WIRE GAUGE.—A wire gauge prepared by the Washburn and Moen Mfg. Co. In accordance with the recommendations of the Bureau of Standards at Washington, a number of the principal wire manufacturers and consumers have agreed that it would be well to designate the American Steel & Wire Co.'s gauge, which is the same as the Washburn & Moen gauge, as the "Steel Wire Gauge." In cases where it becomes necessary to distinguish this from the British Imperial standard wire gauge, it may be called the U.S. Steel Wire Gauge. This gauge applies to all steel wire.

WASHER.—A ring of metal, leather or other material, used to relieve friction, to secure tightness of joints or for other purposes.

WASHER PLATE.—In pole line construction, a heavy metal plate buried in the ground to serve as an anchor to a guy wire.

WASTE FIELD.—The stray field or leakage flux. That portion of the magnetic field of force which fails to pass through the armature, and hence does not contribute to the generation of current.

WATCH CASE RECEIVER.—A compact form of telephone receiver resembling a watch case in shape. This type is used in telephone exchanges. The receiver is held constantly at the ear of a switchboard operator by means of a head band, both hands being thus kept free for manipulating the switchboard.

WATCHMAN'S TIME CLOCK OR REGISTER.—An electric time detector for recording the time a night watchman arrives at a point in his rounds, and makes or breaks the circuit which operates the register.

WATER AS A CONDUCTOR.—Water is a conductor, though of an order greatly inferior to the metals. The atmosphere contains, suspended in it, always more or less aqueous vapor, the presence of which impairs its insulating property. The best insulators become less efficient if their surface be moist, the electricity passing by the conducting power of the moisture. This circumstance also shows why it is necessary to dry previously the bodies on which it is desired to develop electricity by friction.

WATER BOX.—A name given to a water rheostat in the form of a wooden box containing metal plates immersed in slightly acidulated water.

WATER COOLED.—Gas engines are said to be water cooled when a water jacket surrounds the cylinders, to carry off the heat of combustion, which, if unchecked would volatilize the lubricant and heat the engine to a dangerously high temperature. The circulation is maintained either by a pump or by thermo-syphonic action.

WATER COOLED TRANSFORMER. — A type in which water is the cooling agent, and, in most cases, oil is the medium by which heat is transferred from the coils to the water. In construction, pipes or a jacketed casing is provided through which the cooling water is passed by forced circulation. In some special cases tubular conductors are provided for the circulation of the water. For a water temperature rise of 52° F., 2.78 lbs. of water per minute is required per kw. of load.

WATER COOLED TUBE.—A vacuum tube having a water cooled plate. The water cooled high power therapeutic X-ray tube is so constructed that water, properly cooled, can be circulated within the reverse side of the anode and by conduction, transfer the heat to a point outside the walls. It is essential that the cooling system be such that the water passing through the tube and thereby charged with high tension current be safely conducted and disposed of; this prevents the use of direct connection to the city water mains as the high voltage would make it dangerous wherever the water might be conducted. A method in use provides a reservoir of chemically pure water from which water can be drawn and passed through the tube, cool the anode and return. This reservoir has to be properly insulated and must be safe. Proper cooling of the reservoir keeps the water at the proper temperature.

WATER DROPPING STORAGE BATTERY.—An apparatus for exhibiting the electrification of the atmosphere, consisting of a metal can filled with water resting upon an insulated support, and allowed to discharge from an orifice so small that the water breaks away in detached drops which serve to convey electric charges.

WATER GRATE.—In steam boiler construction, a grate having instead of grate bars, tubes or pipes through which the water in the boiler circulates. Some locomotives have grates composed of alternate bars and water tubes. An example of water grate is the boiler built by the author to furnish steam for experimental purposes; illustrated in Audel's Engineers and Mechanics Guide No. 5, page 2077.

WATER JET ARRESTER.—A form of lightning arrester sometimes used in water power electric plants. It may consiseither of a jet of water playing upon a conductor connected to the lines, or a column of water contained in an insulated pipe, and connected at one end to the earth and at the other to the line.

WATER LINE.—In a steam boiler, the height of the water or true working level. It should be noted that the water gauge indicates a false level, that is, the level in the gauge is lower than that in the boiler because the column of water in the gauge and connections outside of the boiler being at a lower temperature than the water in the boiler is heavier; and the level is accordingly lower than that in the boiler.

WATER POWER ELECTRIC PLANT.—A hydro-electric plant.

WATERPROOF.—So constructed or protected that moisture will not interfere with its successful operation.

WATERPROOF WIRE.—An electric conductor protected by a waterproof covering.

WATER RHEOSTAT.—A device for absorbing the energy developed in testing dynamos and other electrical apparatus. It consists essentially of a wooden box or barrel containing acidulated water, in which are immersed two metal electrodes which can be adjusted with relation to each other.

WATER TENDING.—1. In steam boiler operation, the first thing to do in entering the boiler room is to see that there is the proper amount of water in the boiler.

2. The water level should be high enough to submerge all heating surfaces exposed to intense heat, the exact level depending on the type of boiler thus:

3. In vertical through tube boilers, as high as is practical to operate without unduly increasing the moisture over the steam.

4. In horizontal tubular marine boilers, sufficiently high to avoid exposing any of the heating surface due to rolling of the vessel.

5. In locomotive boilers sufficiently high to avoid exposing the crown sheet due to inclination of the locomotive in descending a hill.

6. The safe range of water level is detained by the designer in locating the water gauge, and in general, the water level is normally carried between the second and top cocks.

7. The water gauge glass indicates a false level. Why? (See water line.)

WATERTIGHT.—So constructed that moisture will not enter the enclosing case.

WATERTIGHT APPARATUS.—Apparatus so constructed that a stream of water from a hose (not less than 1 in. in diameter) under a head of about 35 ft. and from a distance of about 10 ft. can be played on the apparatus for several minutes without leakage.—NEMA.

WATER TUBE BOILER.—A type in which the water is inside the tubes instead of outside as in the case of shell boilers. The word tube is incorrectly used when applied to boilers having pipes instead of tubes. Such boilers are properly called pipe boilers. The advantages of tubes (or pipes) is that the water is divided into a large number of columns of small diameter, each entirely surrounded by heating surface, thus the generation of steam is very rapid. The circulation is positive, being governed by the arrangement of the tubes. A water tube (or pipe) boiler should have the following essential elements: a, mud drum or manifold; b, upflow coils; c, feed water heater; d, steam drum with feed distributor and dry pipe; e, down flow pipes; f, superheater.

WATER TUBE BOILER CHARACTERISTICS.—This type boiler has the following characteristics: a, small amount of water carried; b, suitable for high steam pressures; c, high capacity per lb. weight; d, extra sensitive to temperature changes in furnace; e, in case of a sudden demand for steam, the pressure will fall more in a water tube boiler than in a shell boiler, because the relatively large volume of water in the shell boiler forms a reservoir for the storage of heat. The fluctuations in water level are usually greater in water tube boilers, and because of the relatively small amount of water carried, they require closer attention than shell boilers.

WATER-TUBE DEAD-BEAT SUSPENSION.—A method of damping the oscillations of a galvanometer by attaching to the needle or mirror a vane of mica which turns against the resistance of water in a glass tube.

WATER VOLTAMETER.—A device for measuring an electric current by the amount of gas liberated by the electrolysis of water performed by the current; also known as gas voltameter.

WATER WHEEL ALTERNATOR.—A type designed to meet most successfully the requirements of the modern hydro-electric plant, which are that the alternator must combine those characteristics which result in high electrical efficiency with a mechanical strength of the moving elements which will insure uninterrupted service, and an ample factor of safety when operating at the relatively high speeds often used with this class of machine. They are built both horizontal and vertical.

WATT.—The practical unit of power, being the amount of energy expended per second by an unvarying current of one ampere under a pressure of one volt. With a.c. the product of the instantaneous value of the amperes and the instantaneous value of the volts give the instantaneous value of the power in watts, and the mean value over a whole period is the power in watts. One watt=10^7 ergs per second or one joule per second, or 1/746 of a horse power.

WATT, JAMES.—Born 1736, died 1819. A Scottish engineer and inventor, famous for his improvements in the design of the steam engine. While repairing a model of Newcomen's steam engine, he discovered the cause of its waste of power, and he devised the separate condenser and the air pump to remedy the defect (1765). He patented his improved steam engine (1769), and entered into partnership with Matthew Boulton for the manufacture of steam engines, in which he continued for twenty-five years (1775-1800). During that time he introduced many important improvements of his own invention, making use of the expansiveness of steam to obtain the double stroke (1782). He discovered the composition of water (1782) and projected the screw propeller (1784). At his death a national monument to him was erected in Westminster Abbey. The name watt was given to the unit of electric power in his honor.

WATT BALANCE.—An electric balance intended to measure electric power in terms of watts.

WATT FOOT.—The product of one watt multiplied by one foot. It is a convenient unit for quick calculation with the aid of tables.

WATT-HOUR.—A unit of electrical work, equal to a rate of one watt expended for one hour. The watt hour represents the amount of work done by an electric current of one ampere strength flowing for one hour under a pressure of one volt.

WATT-HOUR EFFICIENCY OF STORAGE BATTERY.—The ratio of the watt-hours obtained from a storage battery to the watt-hours required to charge it; the real or energy efficiency as distinguished from the quantity or ampere-hour efficiency.

WATT HOUR METER.—A meter that will register the watt hours expended during a period of time. Watt hour meters are often erroneously called recording or integrating watt meters. A typical d.c. watt hour meter consists of four elements: a, a motor causing rotation; b, a dynamo providing the necessary load or drag; c, a registering device, the function of which is to integrate the instantaneous values of the electrical energy to be measured, and d, means of regulation for light and full load.

WATT HOUR METER INACCURACY.—Meter errors always mean loss to the central station. If a meter run slow it causes a direct loss of income; if it run fast, it will make a dissatisfied customer and result in loss of his good will and confidence, and in both cases it will cost money to readjust the meter to accuracy and maintain it. It might be well to point out that the general tendency of meters is to run slow rather than fast, which is at variance with the opinion of the general public.

WATT HOUR METER OPERATION.—The motor rotates at very slow speed and since there is no iron in its fields and armature, it has very little reverse voltage. Its armature current, therefore, is independent of the speed of rotation, and is constant for any definite voltage applied at its terminals.

The torque of this motor being proportional to the product of its armature and field currents, must vary directly as the energy passing through its coils. In order then that the motor shall record correctly, it is necessary only to provide some means for making the speed proportional to the torque. This is accomplished by applying a load or drag, the strength of which varies directly as the speed. The currents generated in the disc armature consist of eddy currents, which circulate within the mass of the disc.

WATTAGE.—In incandescent electric lighting, the number of watts of electric current consumed by a lamp in order to provide a given candle power of light. The commercial term is watts per candle.

WATTLESS COMPONENT.—In an alternating current, a component of the current in quadrature with the volts so that it fails to contribute to the energy of the current; the idle component as distinguished from the active component.

WATTLESS CURRENT.—An alternating current that can do no useful work. The condition at zero power factor. The term wattless current, as understood, does not indicate an absence of electrical energy in the circuit; its elements are there, but not in an available form for external work. The false power due to the so called wattless current, pulsates in and out of the circuit without accomplishing any useful work.

WATT LOSS AT BRUSHES.—For carbon

commutator brushes, the watt loss is equal to 1.6 to 2 volts multiplied by the total current carried.

WATT METER.—An electrical instrument designed to measure directly the products of the amperes and volts in a circuit and give its readings in watts, a volt-ammeter. In the dynamometer type there are two coils or sets of coils, one of which is fixed and the other movable. The movable coil is connected in the current circuit, and the fixed coil in the pressure circuit, or the reverse. The induction type is used on alternating current circuits. In this type, electromagnets are arranged near a vane in which eddy currents are caused to flow, which react on the magnetic field and the record made is proportional to the force of the reaction.

WATT METER REGISTERING MECHANISM.—The registering mechanism comprises the dials, pointers and gear train necessary to secure the required reduction in speed. This gear train is driven directly by the rotating element. The object of the registering mechanism is to register either the revolutions of the rotating elements of the motor, or the equivalent of those revolutions in kilowatt hours.

WATT METER REGISTERING MECHANISM DEFINITIONS.—Note the following:

Dials.—The graduated circles over which the dial pointers move.

Dial Pointers.—Those parts of the register which move over the dials and point to the numbers on the divisions of the dials.

Dial Train.—All the gear wheels and pinions used to interconnect the dial pointers.

First Dial.—The graduated circle over which the most rapidly moving dial pointer moves, the test dial not being considered.

Gear Ratio.—(R_g) The number of revolutions of the rotating element for one revolution of the first dial pointer.

Register.—That part of the meter which registers the revolutions of the rotating element or the equivalent of those revolutions in kilowatt hours.

Register Constant.—K_r) The factor used in conjunction with the register reading in order to ascertain the total amount of electrical energy, in the desired unit, that has passed through the meter.

Register Ratio.—(R_r) The number of revolutions of the wheel meshing with the worm or pinion on the rotating element for one revolution of the first dial pointer.

Register Reading.—The numerical value indicated on the dials by the dial pointers. Neither the register constant, nor the test dial, if any exist, is considered.

Registration.—The numerical quantity expressed in the desired unit corresponding in value to the energy that has passed through the meter. It is equal to the product of the register reading and the register constant. The registration during a given period of time is equal to the product of the register constant and the difference between the register readings at the beginning and the end of the period.

Standard Register.—One in which each of the four dials is divided into ten equal parts, the division marks being numbered from zero to nine and the gearing between the dial pointers is such that the relative movements of adjacent dial pointers are in opposite directions and in a 10 to 1 ratio. The constant necessary for use in conjunction with the register reading may be 1, 10 or any power of 10. Nothing appears on the register face in addition to the dials except the word kilowatt hours and the register constant.

Test Dial.—An extra dial placed upon the register face, or other part of the register, of some meters and used only when testing the meter. The term test dial does not apply to any of the dials on a rotating standard.

WAVE.—The process whereby energy is transmitted through a medium by virtue of its inertia and elasticity, or properly analogous to these, the parts of the medium merely undergoing periodic change without resultant permanent change.

WAVE AERIAL.—An aperiodic horizontal conductor operating to receive wave energy by virtue of wave tilt along the ground, the length of which is of the same or greater order of magnitude as that of the wave received, and which is so used as to be strongly directional.

WAVE DISTORTION.—Change in the amplitude, shape or frequency of a radio wave in transmission.

WAVE FORM.—There is always more or less irregularity in the shape of the a.c. waves as met in practice, depending upon the construction of the alternator.

The ideal wave curve is the so-called true sine wave, and is obtained with a rate of cutting of lines of force, by the armature coils, equivalent to the swing of a pendulum, which increases in speed from the end to the middle of the swing, decreasing at the same rate after passing the center. This swing is expressed in physics as "simple harmonic motion."

The losses in all secondary apparatus are slightly lower with the so-called peaked form of wave. For the same virtual voltage, however, the top of the peak will be much higher, thereby submitting the insulation to that much greater strain.

By reason of the fact that the losses are less under such wave forms, many manufacturers in submitting performance data on transformers, recite that the figures are for sine wave conditions, stating further that if the transformers are to be operated in a circuit more peaked than the sine wave, the losses will be less than shown.

WAVE FORM, DETERMINATION OF.—The following conditions determine the a.c. wave form: a, the number of coils per phase per pole; b, shape of pole faces; c, eddy currents in the pole pieces, and d, the air gap.

WAVE FORM MEASUREMENT.—The desirability of a complete knowledge of the manner in which the alternating pressure and current varies during the cycle, has resulted in various methods and apparatus being devised for obtaining this knowledge. The apparatus in use for such purpose may be divided into two general classes: a, wave indicators b, oscillographs, and the methods employed with these two species of apparatus may be described respectively as: a, step by step; b, constantly recording.

WAVE FORM MEASUREMENT: BALLISTIC GALVANOMETER METHOD.—This method which is due to Kubber, employs a contact breaker instead of a contact maker. In making the test the contact breaker is placed in successive positions, the switch being turned one way in measuring the current wave, and the other way in measuring the pressure wave. The results thus obtained are plotted giving respectively current and pressure waves.

WAVE FORM MEASUREMENT: CONSTANTLY RECORDING METHODS.—The various methods based on the constantly recording principle are: by use of various types of oscillograph, such as: a, cathode ray; b, glow light; c, moving iron; d, moving coil; e, hot wire.

WAVE FORM MEASUREMENT: FOUR PART COMMUTATOR METHOD.—The contact device consists of two slip rings and a four part commutator. One slip ring is connected to one terminal of the source, the other to the volt meter, and the commutator to the condenser. By adjusting the resistance, when a known direct current pressure is impressed across the terminals, the volt meter can be rendered direct reading.

WAVE FORM MEASUREMENT: JOUBERT'S METHOD.—Apparatus required consist of a galvanometer, condenser, two two-way switches, resistance and adjustable contact maker. The contact maker is attached to the alternator shaft so that it will rotate synchronously with the latter. By means of the adjustable contact, the instant of "making" that is, of "closing" the testing circuit may be varied, and the angular position of the armature, at which the testing circuit is closed, determined from the scale, which is divided into degrees. A resistance is placed in series with one of the alternator leads, such that the drop across it, gives sufficient pressure for testing.

WAVE FORM MEASUREMENT: MODIFIED 4 PART COMMUTATOR METHOD.—By this method one contact maker can be used for any number of waves having the same frequency. Electro-dynamometers are used. The moving coils are connected in series to the contact maker, and the fixed coils are connected to the various sources to be investigated, then the deflection will be steady and by calibration with direct current can be made to read directly in volts.

WAVE FORM MEASUREMENT: STEP BY STEP METHODS.—The various methods based on the step by step principle are: a, Joubert's method; b, four part commutator method; c, modified four part commutator method; d, ballistic galvanometer method; e, zero method; f, by hospitalier ondograph.

WAVE FORM MEASUREMENT: ZERO METHOD.—A method of measuring wave form in which the arrangement of the testing devices is such that the value of the quantity being measured is shown when the galvanometer needle points to zero. Either a contact maker or contact breaker may be used in connection with a galvanometer and slide wire bridge. In measuring the instantaneous values, the bridge contact is adjusted till the galvanometer shows no deflection, then the length on the slide valve bridge to the contact is a measure of the voltage. Mershon modified the test by using a telephone instead of the galvanometer to determine the correct placement of the bridge contact. The instantaneous values are recorded by attaching to the contact a pencil controlled by an electromagnet arranged to strike a revolving paper card at the instant of no deflection, the paper being carried on a drum.

WAVE FORM OF ALTERNATING CURRENT.—The question of wave form is of special interest to the power station engineer. Upon it depends the answer to the questions: whether he may ground neutral wires without getting large circulating currents; whether he may safely run any combination of alternators in parallel; whether the constants of the distributing circuit are of an order liable to cause dangerous voltage surges due to resonance with the harmonics of the pressure wave; what stresses he is getting in the insulation due to voltage surges when switching on or off, etc. A distorted wave is due to the properties of the circuit, for instance, the effect of hysteresis in an iron core introduced into a coil is to distort the current wave by adding harmonics so that the ascending and descending portions may not be symmetrical. A peaked wave has a large maximum as compared with its virtual value. A peaked wave is produced by a machine with concentrated winding.

WAVE LENGTH.—In radio since the electric strain and flux lines move with the velocity of light, 186,300 miles per second, or 300,000,000 meters per second, the distance between two successive maxima of electric strain directed in the same direction, or, wave length=300,000,000÷number of waves per second. As usually expressed,

$$\text{wave length} = \frac{300{,}000{,}000}{\text{wave frequency in cycles per sec.}}$$

From the formula it is seen that the shorter the wave length the higher the frequency.

WAVE METER.—A frequency meter calibrated to measure radio wave length.

WAVE SHAPE.—The shape of the curve obtained when the instantaneous values of an alternating current are plotted against time in rectangular co-ordinates. Two alternating quantities are said to have the same wave shape when their ordinates of corresponding phase bear a constant ratio to each other.

WAVE TRAIN.—The series of continuous radio waves between interruptions.

WAVE TRAP.—In radio, a variable condenser placed in parallel with a coil, usually connected in the aerial circuit. This is a successful method of cutting out local interference.

WAVE WINDING.—A method of arranging the coils upon a drum armature, in which the conductors travel around the armature without turning back until all the coils are connected, thus describing a zigzag or wavy path; also called series winding.

WAVELESS OSCILLATORY CURRENT.—In electro-therapeutics, a current somewhat similar to the rapid sinusoidal, except that it does not follow the sine wave form and its frequency is higher while the duration of each impulse is the same as with the oscillatory wave. Plank recommends that this current be used at the end of each treatment for nerve stimulation, as it is waveless and gives a mild cell massage along the course of the nerve, thus increasing its blood supply and nutrition.

WAY.—The throw of a switch. Thus, a three throw switch is one in which connection can be made through the center contact with any one of three circuits.

WAY LEASE, OR LEAVE.—A right of way obtained from a property holder for erecting telegraph poles or other electric appliances across his land or over his buildings.

WAY STATION.—In telegraphy, any intermediate station as distinguished from a terminal station.

WAYS FOR MACHINE.—Provisions made on the base of a rotating machine (dynamo, motor, etc.) for moving the machine a short distance, when required to change the distance between pulley centers to tighten the belt.

WEATHER CONTACT OR CROSS.—A leak occurring in an overhead line at the insulators during wet weather, because of the weakening effect of moisture upon the insulation.

WEATHER PROOF APPARATUS.—Apparatus so constructed or protected that exposure to the weather will not interfere with its successful operation.

WEATHER PROOF WIRE.—A conductor protected from the weather by a water proof covering, consisting usually of braided cotton of two or three thicknesses saturated with a moisture resisting insulating compound.

WEBER.—A name proposed for the practical unit of magnetic flux, being 10^8 c.g.s. units; not generally accepted or used.

WEBER, WILHELM EDUARD.—Born 1804, died 1891. A German physicist, noted for his researches in magnetism and electricity, and especially for the introduction of the absolute system of electrical units, first adopted in 1881. A proposed unit of magnetic flux equal to 10^8 c.g.s. units was named after Weber.

WEBER'S THEORY OF MAGNETISM.—The theory that in an unmagnetized iron bar all the constitutent atoms are individual molecular atoms lying with their axes in irregular directions; but when a magnetizing force is applied, the molecules tend to become set with their axes pointing in the same direction. It is practically identical with Hughes' theory.

WEDGE BATTERY.—A battery for a telegraph circuit employing a wedge or plug for making the necessary connections.

WEDGE CUT OUT.—In a telegraph circuit, a cut out effected by the insertion or withdrawal of a specially designed wedge or plug.

WEEDING-OUT OF HARMONICS.—In a complex harmonic current, the gradual reduction of the upper harmonics by changing the frequency until a resonance is obtained with the fundamental frequency.

WEEP HOLE.—A small hole left for drainage through the masonry of a retaining wall, or of a bridge abutment, etc.

WEHNELT BREAK.—An electrolytic interrupter having an electrolyte of dilute sulphuric acid into which are placed a platinum and a lead electrode.

WEHNELT OSCILLATIONS.—A radio frequency alternator employing an electrolytic interrupter connected in a circuit having suitable inductance and capacity.

WEIGHT MEASURE.—The measure of the force with which bodies tend toward the earth's center; the downward pressure due to gravity minus the centrifugal force due to the earth's rotation. Weight differs from gravity in being the effect of gravity or the downward pressure of a body under the influence of gravity. Weight is the measure of the quantity of matter a body contains. Three scales of weight are used in the U.S.:

1. Troy (for weighing gold, silver, etc.).
2. Apothecaries (used by druggists in compounding medicines).
3. Avoirdupois (for all ordinary purposes).

WEIGHT PER MILE OHM.—A standard of conductivity used in comparing the relative electrical resistance of various grades of metals used in making wire. It is the weight of a conductor a mile long, and of such uniform cross section as to have a resistance of one ohm. The greater the conductivity, the less is the weight-per-mile-ohm. The weight-per-mile-ohm of pure copper is 859 lbs., that is, a wire one mile long of pure copper and having a resistance of one ohm weighs 859 lbs.

WEIGHT VOLTAMETER.—A voltameter, such as a gas or silver voltameter, in which the amount of chemical change wrought by the electric current is measured by weighing one or more of the products of the electrolysis.

WEIR.—A device for calculation of the quantity of water available for water power. It consists of a sharp crested dam placed so that all the water will flow over it without restriction. It is known that for any given depth of water over the crest of the weir a definite quantity will flow per minute. The factors for this flow have been determined and tabulated.

WELDER, ELECTRIC.—An apparatus for welding metals by electricity. A typical welder consists of a self-excited dynamo, a self adjusting stabilizing reactor which automatically steadies the arc under all welding conditions, making the arc easy to start and maintain.

WELDING, ELECTRIC.—That branch of welding in which an electric current is used to create the great heat required for jointing together into firm union two pieces of metal. The constant voltage machine can be used to supply welding current to any number of welding circuits, while the variable voltage type supplies current for only one welding arc.

WELDING NON-FERROUS METALS.—As commercially used, non-ferrous metals have been welded with varying degrees of success. Such metals are more or less difficult to weld with the electric arc, due principally to their low melting points.

WESTERN UNION WIRE JOINT.—A simple method of joining the ends of two wires so as to be mechanically strong and preserve electric conductivity. It consists in overlapping the ends of the bare wire for a few inches, and then twisting each end around the other wire for a few turns. The strength of this joint unsoldered is from 50 to 55 per cent of the strength of the wire; when soldered it becomes 80 or 90 per cent of the strength of the wire itself. It is also called the American twist joint.

WESTINGHOUSE, GEORGE.—Born 1846. An American inventor, engineer and manufacturer. His first notable invention was a railroad frog (1865), but the same year, a collision of freight trains near Troy, N. Y., drew his attention to the matter of power brakes. The result of his experiments was the invention of the air brake (1868) which at once proved its great efficiency. In 1869 the Westinghouse Air Brake Co. was formed, and many developments and improvements on the original invention followed. In 1883 Mr. Westinghoue patented a system of railway signaling which is now manufactured by the Union Switch and Signal Co. of Pittsburgh, Pa. The Westinghouse Electric Co. was organized in 1886 which grew into the Westinghouse Electric and Manufacturing Co. in 1891, and has made rapid advances in the manufacture of electrical apparatus and machinery, largely invented and developed in its own shops.

WESTON CELL.—A standard voltage cell. It is made in two forms; one known as the Weston normal cell, in which the solution of cadmium sulphate is saturated at all temperatures at which the cell may be used. The other, known as the Weston standard cell, in which the cadmium sulphate solution is unsaturated at all temperatures above 4° C. The Weston normal cell, or saturated form is slightly affected by changes in temperature, but, on account of the fact that it can be accurately reproduced, it was adopted by the London Conference in 1908, as a convenient voltage standard. The value of its voltage suggested by the committee of the London Conference on Electrical Units and Standards, and adopted by the Bureau of Standards at Washington, Jan. 1st, 1911, is 1.0183 International volts at 20° C. At any other temperature its voltage is:

$$E_t = E_{20} - .0000406\ (t - 20) - .00000095\ (t - 20)^2 + .0000000\ (t - 20^\circ)^3$$

The Weston standard cell, or unsaturated form is practically unaffected by changes in temperature and is the form most commonly used for laboratory work and general testing. The average pressure of this form is 1.0187 Int. volts.

WET STEAM.—A questionable term indicating a mixture of saturated steam and condensate, or water from the boiler in the form of mist or spray.

w.h.—Abbreviation for watt-hour.

WHEATSTONE BRIDGE.—The so called "Wheatstone" bridge was invented by Christie and improperly credited to Wheatstone, who simply applied Christie's invention to the measurement of resistances.

WHEATSTONE BRIDGE METHOD.—The Christie (erroneously called Wheatstone) bridge is almost universally used for accurate measurements of resistance, which are determined by the proportion existing between the resistances of the arms of the bridge. The resistance of one of them can be calculated when the resistances of the other three are known.

WHEATSTONE TRANSMITTER.—In telegraphy a high speed transmitter.

WHEEL BRUSH.—A rotary brush for cleaning surfaces preparatory to electro-plating.

WHEEL PIT.—In hydraulics, the excavation formed for the reception of a turbine or other water wheel.

WHIP.—A name sometimes given to a vibrating contact.

WHIPPING.—Tie string or tie wire wound around the end of a rope to prevent its unraveling.

WHIRLS, ELECTRIC. — 1. The circular lines of force which are conceived to surround a conductor carrying an electric current.

2. A name sometimes given to the so-called electric wind mill or flyer. A device consisting of a vane of pointed wires bent at the tips which rotates upon a pivot on the conductor of an electrostatic machine, illustrating the escape of electricity from points and the electric wind set up by the discharge.

WHISTLING EFFECT.—A musical sound sometimes heard in a telephone receiver when a carbon transmitter held close by it is suddenly jarred.

WHITE BRASS.—An alloy of copper and zinc, with sufficient of the latter, or of nickel, lead, etc., to give it a white color. Brass should have an ultimate strength of 30,000 lbs. per sq. in. The higher the nickel content, the more permanent will be the color. Also called **white nickel brass.**

WHITE DIPPED.—Thinly coated with unpolished white metal.

WHITE HEAT.—An intense heat which causes a substance to become incandescent and emit a white light. In forge work the white heat of iron is approximately 2,200° F. According to Howe, different substances heated to the same temperature give out the same color tints. Objects which emit the same tint and intensity of light cannot be distinguished from each other, no matter how different their texture, surface, or shape may be. When the temperature at all parts of a furnace at a low yellow heat is the same, different objects inside the furnace (firebrick, sand, platinum, iron) become absolutely invisible.

WHITE METAL.—A name given to an alloy of varying composition, into which tin enters largely, used for the bearing surface of journal brasses. Its elastic nature easily accommodates minute inequalities in the journal, and therefore insures almost even distribution of the frictional load.

WHITE VITRIOL.—A term sometimes applied to zinc sulphate. In electro-plating it is used in the preparation of brass and zinc baths and for matt pickling. It is also known as **white copperas.**

WHITWORTH STANDARD SCREW THREAD.—The British standard; which is used principally in Great Britain, but also to some extent for stay bolts in the U.S. The top and bottom of the threads are rounded. The radii for these rounded portions are determined by the depth of the thread which is two-thirds of the depth of a thread of the same angle, sharp at the top and bottom. The radii at the top and at the bottom are the same.

WHOLE COIL WINDING.—An armature winding in which there is one coil per phase per pole, the whole (every one) of the poles being subtended by coils.

WHUR.—A humming or whirring sound, like that of a body moving rapidly through the air; a whir.

WIG-WAG SIGNALING.—A system of visual signaling employed in the army and navy, in which messages are transmitted by the waving of small flags according to code.

WIMSHURST INFLUENCE MACHINE.—An electrostatic induction machine consisting of two insulating plates or drums. On each plate are fixed a large number of strips of conducting material, which are equal in size and are equally spaced, radially if on a plate, and circumferentially if on a drum. The plates, or drums, are made to rotate in opposite directions. The capacity of the inductors therefore varies from a maximum when each strip on one plate is facing a strip on the other, to a minimum when the conducting strips on each plate are facing blank or insulating portions of the other plate. There are three pairs of contact brushes, the members of two of the pairs being at opposite ends of diametrical conducting rods placed at right angles to one another; the third pair are insulated from one another and form the principal collectors, the one giving positive and the other negative electricity. The plates are revolving in opposite directions; thus if there be a charge on one of the conducting segments of one plate and an opposite charge on one of the conducting segments on the other plate near it, their pressure will be raised as the rotation of the plates separates them.

WIND AND WATER LINE.—The region of a telegraph pole just at the surface of the ground, where it is exposed to the action of both air and water, and hence is most susceptible to decay.

WIND, ELECTRIC.—At the tip of a charged pointed conductor, the density becomes so great that the air surrounding the point becomes electrified by contact and is at once repelled. Unelectrified air takes its place and is repelled in turn. This goes on until so much electricity is carried away from the conductor that not enough remains to electrify the air. During the discharge an electric wind or convection stream blows from the point. It is caused by the stream of ions communicating its momentum to the air.

WIND MILL.—A machine which receives its power from the wind, and designed for various applications, especially that of pumping water. The operation of a wind mill is due to the pressure of the wind acting on numerous vanes inclined to the direction of the wind and rotating in a plane perpendicular to the direction of the wind. To accomplish this, the main casting on which the wheel is pivoted is arranged to turn in a stationary collar or turn table. This turning is controlled by a tail attached to the main casting and upon which the wind acts. The Corcoran mill is a typical example of a first class wind mill.

WIND MILL, ELECTRIC.—1. An experimental device for illustrating the escape of electricity from points. It consists of a vane of five or six pointed wires bent at the tips in the same direction, radiating from a center which rests upon a pivot. When mounted upon the conductor of an electrostatic machine, the vane rotates in a direction opposite that of the points. The movement of the vane is due to the repulsion of the electrified air particles near the points and the electricity on the points themselves. The motion of the air is called electric wind. This device is also called electric flyer, and electric whirl.

2. A wind mill suitably geared to a dynamo forming a unit for charging a storage battery, the latter being used as current source for house lighting. Instead of a multiplicity of blades as in the ordinary mill, the electric mill has only two blades similar to the propeller of an airplane.

WINDAGE.—A name sometimes given to the air gap between the surface of a dynamo armature and the pole pieces of the field magnets.

WINDING DIAGRAM.—A method of representing by means of a diagram the relations of windings as they actually appear upon the armature. Different colors are often used for indicating the different circuits or phases in the winding.

WINDING PITCH.—In armature winding, the number of slots spanned by the sides of a coil is called the winding pitch. It is usually the number nearest to, or next smaller than, the quotient of the number of slots in the armature divided by the number of poles in the field frame.

WINDING SPACE.—The space on an armature, or on the core of an electro-magnet, spool or bobbin, provided for the winding of the coils.

WINDOW CONTACT.—An electric contact which rings an alarm upon the opening of a window, or upon any tampering with a window in an effort to effect an entrance by it.

WINDOW TUBE INSULATOR.—A tube composed of insulating material for introducing an electric conductor into a building through a window.

WING BARS.—The longitudinal spars of the interior wing framework of an airplane.

WING SKID.—Flexibility support under the lower wing of an airplane.

WING TIP.—The right or left hand extremity of the surface of an airplane.

WINGS.—The main supporting surfaces of an airplane.

WIPE OUT.—Stopping the operation of a radio vacuum tube because of excessive negative voltage on the grid.

WIPE SPARK.—An electric spark produced by the brief contact of one conductor brushing past another.

WIPED JOINT.—A plumber's joint employed in uniting sections of lead cable sheathing, consisting of solder applied by a moleskin or cloth pad over the surface of the junction.

WIPING CONTACT.—An electric contact made by the brushing of one conductor past another.

WIRE.—A slender rod or filament of drawn metal. The definition restricts the term to what would ordinarily be understood by the term "solid wire." In the definition, the word "slender" is used in the sense that the length is great in comparison with the diameter. If a wire be covered with insulation, it is properly called an insulated wire; while primarily the term "wire" refers to the metal, nevertheless when the context shows that the wire is insulated, the term "wire" will be understood to include the insulation.

WIRE ANNEALING.—Softening a wire by heat after it has been hardened by drawing or by exposure to cold after heating.

WIRE CALCULATIONS.—Starting with the expression:

$$\text{ohms} = \frac{\text{feet} \times 10.8}{\text{circular mils}} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

(calling the resistance per mil foot 10.8 instead of 10.79 to facilitate calculation). Substitute the value for ohms thus obtained in the following (ohm's law) equation:

$$\text{volts} = \text{amperes} \times \text{ohms}$$

and obtain

$$\text{volts} = \text{amperes} \times \frac{\text{feet} \times 10.8}{\text{circular mils}} \quad \ldots\ldots\ldots\ldots (2)$$

that is

$$E = I \times \frac{\text{feet} \times 10.8}{\text{circular mils}} \quad \ldots\ldots\ldots\ldots\ldots (3)$$

Now, since the length of the circuit is given as the "run" or distance one way, that is, one half the total length of wire in the circuit, formula (3) must be multiplied by 2 to get the total drop, that is:

$$E = I \times \frac{\text{feet} \times 10.8 \times 2}{\text{circular mils}} = \frac{I \times \text{feet} \times 21.6}{\text{circular mils}} \quad \ldots (4)$$

In the above formulæ E=volts; I=amperes.

Solving the last equation for the unknown quantity, the following equation is obtained for size of wire:

$$\text{circular mils} = \frac{\text{amperes} \times \text{ft.} \times 21.6}{\text{“drop”}} \quad \ldots (5)$$

WIRE CALCULATIONS FOR D.C. MOTORS.—The proper size of wire may be readily determined by means of the following formula:

$$\text{circular mils} = \frac{\text{H.P.} \times 746 \times L \times 21.6}{E \times D \times K}$$

in which

H.P.=horse power of motor;

746=watts per H.P.;

L=length of motor circuit from fuse block to motor;

21.6=ohms per foot run in circuit where wires are one mil in diameter;

E=voltage at the motor;

D=drop in percentage of the voltage at the motor;

K=efficiency of the motor expressed as a decimal.

The average values for K are about as follows: 1 H.P., .75; 3 H.P., .8*; 5 H.P., .80; 10 H.P. and over, 90 per cent.

WIRE CORE.—A core, as of an electromagnet, composed of a bundle of soft iron wires, instead of being a solid iron mass.

WIRE DRUM.—In overhead wire construction, a drum or sheave upon which the wire is wound ready for paying-out.

WIRE DYNAMOMETER.—A line dynamometer, an instrument employed in overhead line construction, in conjunction with a "come-along," to obtain a proper degree of tension in a wire.

WIRE FINDER.—A dynamometer for the purpose of identifying any one of the separate wires contained in a cable.

WIRE FOR MARINE SERVICE.—The kind used is copper, tinned, extra heavy rubber insulated and covered with impregnated, waterproofed, cotton braid. For use in conduit the wire is much like New Code R. C. wire used on land and is handled in the same manner. Where wire may suffer from abrasion it is covered with a steel braiding for protection; steel braid covered wire is known as "basket weave" cable.

WIRE GAUGE.—1. A gauge for measuring the diameter of round wire according to an arbitrary standard. The American or Brown & Sharpe (B. & S.) gauge is used almost exclusively in America in electrical work. Other well-known gauges are the **Roebling** gauge used extensively for iron and steel wire, and the **Birmingham** gauge used largely in Great Britain and also in America for wires other than those designed for electrical conductors. The diameters of wires on the B. & S. gauge are obtained from the geometric series in which No. 0000 equals 0.46 inch and No. 36 equals .005 inch.

2. A device for determining the gauge of a wire. It is often in the form of a disc or broad flat ring of sheet steel with notches in the circumference corresponding to the numbers and sizes fixed by that gauge. A more accurate gauge is in the form of a vernier caliper measuring the wire in mils or thousandths of an inch.

WIRE GAUGE CLASSIFICATION. — 1. Brown & Sharpe (B. & S.).—American wire gauge (A.w.g.).

2. New British Standard (N.B.S.) British Imperial, English Legal Standard and Standard Wire Gauge, and is variously abbreviated by S.W.G. and I.W.G.

3. Birmingham Gauge (B.w.g.) Stubs'. Old English Standard and Iron Wire Gauge.

4. Roebling.—Washburn & Moen, American Steel & Wire Co.'s Iron Wire Gauge.

5. London—Old English (Not Old English Standard).

6. Birmingham or Stubs' Iron Wire Gauge is not the same as Stubs' Steel Wire Gauge.

WIRE GAUGES; USES.—1. B. & S. All forms of round wires used for electrical conductors. Sheet copper, brass and nickel silver.

2. U.S.S.—Sheet iron and steel. Legalized by act of Congress, March 3, 1893.

3. B.W.G.—Galvanized iron wire. Norway iron wire.

4. American Screw Co.'s Wire Gauge. —Numbered sizes of machine and wood screws, particularly up to No. 14 (.2421 in.).

5. Stubs' Steel Wire Gauge.—Drill rod.

6. Roebling & Trenton.—Iron and steel wire. Telephone and telegraph wire.

7. N.B.S. hard drawn copper. Telephone and telegraph wire.

8. London Gauge.—Brass wire.

WIRE GAUZE.—Wire woven into gauze having a fine mesh. It is sometimes employed in making steam joints, the gauze being cut to the size and shape of the flanges, and smeared with red or white lead previous to the bolting together of the flanges.

WIRE GAUZE BRUSH.—An early type of brush for collecting the current from the armature of a dynamo. It consists of a bundle made up of thin sheets or strips of copper wire gauze. Gauze brushes have been replaced by carbon brushes, as metal contact with the commutator tended to injure the commutator surface.

WIRE GRATING POLARIZER.—A device for polarizing electro-magnetic waves, consisting of a grating of parallel wires.

WIRE JOINT.—Any means of uniting the ends of two wires, as the American twist joint, the Britannia joint, etc.

WIRE PLIERS.—Small jawed pincers in which a pair of smooth jaws, circular in section and tapered lengthwise, are substituted for the ordinary flat and roughened jaws, their purpose being the bending of wire into small curves and loops.

WIRE RAIL BOND.—In an electric traction system, short pieces of copper wire riveted into the adjoining ends of two rails for the purpose of effecting good electrical conductivity through the track.

WIRE ROPE SOCKET.—A socket by means of which a wire rope is attached to another part. One plan consists in stranding or opening out the rope within the coned socket and driving in a conical wedge from the opposite end; by this means the strain on the rope tends to tighten the wedge. A better plan is to curve back the various strands within the socket, so as to resemble a mushroom or umbrella. The space is then filled with melted lead or babbitt metal, which secures all. The socket is provided with eyes, male or female threads, according to the proposed connection.

WIRE SHADE GUARD.—A wire netting for the protection of an electric lamp shade.

WIRE, STRAP AND BAR WINDINGS.—In the construction of alternators, the windings may be of either wire, strap, or bar, according to which is best suited for the conditions to be met.

WIRE TERMINALS.—Metal eye sockets for brazing on or soldering ends of wires to switchboards.

WIRE WRENCH.—A spanner or key whose shank is made of twisted wire, for the sake of lightness, as in a bicyclist's equipment.

WIRED WIRELESS.—A method of transmitting radio signals by wire. Invented by Major Gen. Sir George Owen Squire. Also called line radio.

WIRELESS TELEPHONY.—Radio telephony.

"WIREMOLD" METAL MOULDING.—This type of moulding has no removable cap and is installed like wrought pipe except that a "slip joint" is used for coupling lengths and for coupling with fittings rather than the threaded coupling required for pipe.

WIRING.—In electrical work, putting in place and connecting the various conductors of lighting and power circuits, also for miscellaneous applications, so that the installation will be safe and meet the requirements of the National Electric Code. Wiring may be classed broadly as: a, inside; b, outside, and c, underground. There are many systems and devices used to facilitate installation (especially in buildings) and to render it safe.

WIRING FOR MOTORS.—Make the run from mains or distribution center as short as possible to save materials and to reduce loss of voltage. Locate starting boxes about 54 ins. from floor to bottom of starter. Conduit should be used to run down walls across floors to motors. If the length of conduit be less than 10 ft. it need not be grounded, but if there be several lengths of conduit and their total length be over 10 ft. it is suggested that they be all bonded together as if they were one continuous piece of conduit. The use of flexible metallic conduit is suggested when it is impossible to bend conduit in awkward positions. The use of special cable connectors at motor outlets is suggested so that in case the motor is to be removed it will be easy to disconnect it. The use of non-metallic sheathed cable from wall to the motor is not recommended, as it is more desirable to run conduit up to motor terminal block.

WIRING FORMULA FOR A.C. CIRCUITS.—The formula for d.c. circuits is modified for a.c. circuits as follows:

$$\text{circular mils} = \frac{\text{watts} \times \text{feet} \times M}{\%\ \text{loss} \times \text{volts}^2}$$

in which M is a coefficient which has various values according to the kind of circuit and value of the power factor.

For table giving values of M see Audel's New Electric Guide, Vol. 7, page 3,047.

WIRING FORMULA FOR A.C. MOTORS.—If the efficiency and power factor of an a.c. motor at a given horse power load be known, the current in amperes per phase which will be required to drive the motor at rated voltage is given by the formula:

$$\text{amperes} = \frac{\text{horse power} \times 746}{K \times \text{volts} \times \text{efficiency} \times \text{p.f.}}$$

in which

$K = 1$ for single phase;
$= 2$ for two phase, four wire system;
$= \sqrt{3}$ for three phase, three wire system.
p.f. = power factor.

Find size of wire from table of safe carrying capacity of wires.

WIRING UNDER FLOORS.—A typical under floor system consists of a network of rectangular steel ducts, single or multiple, embedded in the floor. Each length of duct is equipped with outlet extensions applied in the course of manufacture, at minimum cost, at specified regular uniform intervals.

WIRING UNDER PLASTER.—For under plaster extensions, the Code specifies that such extensions shall be run in rigid or flexible conduit, armored cable, metal mouldings, or electrical metallic tubing of approved standard types. For under plaster work the various forms of flexible conduit are made flat or oval shaped so that when installed, the conduit will not project outside the surface of the plaster.

WOLFRAM.—A name sometimes given to tungsten, a somewhat rare metal employed for the filament in the tungsten incandescent lamp.

WOLLASTON WIRE.—Platinum wire drawn very fine.

WOODEN CONDUITS.—A type of conduit in which the ducts are formed of wooden pipe, troughing or boxes, and constitute the simplest and cheapest form of conduit. A cylindrical projection is turned on one end of each section, which, when the conduit is laid fits into a corresponding recess in one end of the next section. The sections are usually laid in tiers, those of one tier breaking joint with those of the tiers above or below. The trough conduit consists of ducts about 3 inches square made of horizontal boards and vertical partitions, usually of yellow pine about one inch in thickness. This form of conduit can be laid in lengths of 10 and 12 ft., or it can be built along continuously. The life of wooden conduit may be increased by sterilizing.

WOODEN POLES.—For telegraph and other lines the properties required in wooden poles are strength, comparative lightness in weight, durability, straightness, a gradual and well defined taper and an abundant and accessible supply. According to wire capacity, poles are divided into several classes, as follows

A.—Poles to be used in lines carrying or ultimately to carry forty wires.

B.—Poles to be used in lines carrying or ultimately to carry from twenty-one to forty wires.

C.—Poles to be used in lines carrying or ultimately to carry from thirteen to twenty wires.

D.—Poles to be used in lines carrying or ultimately to carry from seven to twelve wires.

E.—Poles to be used in lines carrying or ultimately to carry from three to six wires.

F & G.—Poles to be used in lines of two wires, the wires being carried on brackets.

WORK.—The overcoming of resistance through a certain distance. The mechanical units of work are:

1. The foot pound or the work done when a weight of one pound is raised to the height of one foot.

2. The erg, or the work done when a force of one dyne acts through a distance of one centimeter. This is the unit of work in the c.g.s. system. Carefully distinguish between work and power.

WORKING CONSTANT.—The galvanometer constant; a calibrating or standardizing quantity applied to a galvanometer for establishing a fixed relation to the currents causing the deflections. It may be generally defined as the number of the divisions of the deflection caused by the current of a certain battery passing through the galvanometer and a resistance of one megohm.

WORM GEAR.—Spiral gearing in which a worm or screw is used to rotate a wheel with suitably shaped teeth; a worm wheel; a form of gear sometimes used with electric motors where a considerable amount of speed reduction is required

WORN OUT PLATES.—If the solution in the cells of a storage battery can quickly be brought up under charge to the proper density and only a small capacity can be obtained on discharge, the battery is worn out, due to age or poor material in the plates.

WORSTEDS.—In mechanics, filaments of worsted or wool, conducting oil by capillary attraction, from a reservoir into the lubrication ducts of a bearing; used chiefly on marine engines. When worsteds become clogged with foreign matter, they should be replaced by new ones, otherwise the full flow of oil will not be obtained. An engineer should at all times keep on hand spare worsteds.

WOUND ROTOR.—The armature winding of an external resistance or slip ring induction motor. The winding is polyphase similar to the field winding, and is connected at one end and brought out to a variable external resistance through slip rings.

WRAPPED WIRE.—A conductor wrapped in an insulating covering.

WRITING TELEGRAPHY.—A system of autograph facsimile telegraphy which records at the receiving station a facsimile of the handwriting of the sender. The principle of operation is that of compounding the movements of a point in two directions, the one at an angle to the other, the actual movement of the point being the resultant of the two movements.

WRONG CONNECTIONS. — This fault, sometimes due to factory mistakes, will prevent a dynamo building up. Test the armature coils and field coils for polarity mistakes.

WROUGHT IRON AND WROUGHT STEEL PIPE.—Formerly wrought iron was almost exclusively used in the manufacture of wrought pipe, but because of its expense and also on account of the improved methods in the manufacture of steel pipe, conditions have been reversed and now almost all wrought pipe is made of steel. The term "wrought iron pipe" is often erroneously used to refer to pipes made to Briggs standard sizes rather than of the material, hence, in ordering pipe, if iron pipe be wanted instead of steel, care should be taken to specify genuine wrought iron, or guaranteed wrought iron pipe.

It is customary for manufacturers to stamp each length of such pipe as genuine wrought iron to distinguish it from steel, and no wrought iron pipe should be accepted as such without the stamp.

WROUGHT PIPE.—A welded pipe, made of wrought iron or wrought steel and to Brigg's Standard sizes, threaded at each end and having a coupling at one end. In order to adapt wrought pipe to different pressures it is regularly made up in three grades of thicknesses (weights) known as: a, standard; b, extra strong (or heavy); c, double extra strong (or heavy). For the three grades, the outside diameters of the listed sizes remain the same, but the thickness is increased by decreasing the inside diameter. Wrought pipe comes in lengths up to 22 ft.

X

X.—Symbol for: 1. Reactance.
2. Unknown quantity.
3. Ordinate.

X_L.—Inductance reactance.

X_C.—Capacity reactance.

X RAY DERMATITIS.—Inflammation of the skin from long exposure to X rays.

X-RAY FIELD.—The field or region within which X-rays are active.

X-RAY FLUOROSCOPY.—Experiments with X-rays upon a fluorescent screen.

X-RAY LAMP.—A name sometimes given to the vacuum tube for generating X-rays.

X-RAY PHOTOGRAPH.—A photograph in shadows of the interior of bodies opaque to ordinary light, taken by means of the penetration of X-rays; a radiograph or Roentgenograph.

X-RAY PRODUCTION.—The apparatus necessary for the production of X-rays consists of: a, source of current; b, induction coil; c, X-ray tube; d, control devices. X rays are produced by the striking of cathode rays on the anode or target.

X-RAYS.—Roentgen rays; a peculiar radiation possessing remarkable properties discovered by Roentgen in 1895, while experimenting with a highly exhausted Crookes tube. These rays are projected from a target within the tube against which the rays from the cathode are directed, and are found to differ from any form of radiation hitherto known. They pass readily through many substances opaque to light; they act on an ordinary photographic plate; they are incapable of reflection, refraction or polarization; they produce brilliant fluorescence on certain substances; they render the air a conductor of electricity, and cause painful trouble on the human skin if too long exposed to them.

X-RAY SCREEN.—In radiography, a screen coated with fluorescent material for exhibiting the shadows of substances that are opaque to X-rays. It consists of a sheet of cardboard, or similar material which has been coated with certain chemical salts which have the power of absorbing light, and of shining afterwards in the dark. Such a screen mounted in a box forms a fluoroscope. X-rays passing from a tube through an object will display on the screen images of substances contained in the object that are not transparent to the rays. The intensity of the illumination produced by the fluorescence on the screen rapidly diminishes with the distance of the screen from the tube, therefore, in order to obtain a maximum illumination and consequently a sharply defined shadow, the screen should be held close as possible to the source of X-ray, and the object close to the screen.

X-RAY SHIELD.—Lead being extremely opaque it is used as a shield for X-rays and diagnostic rooms are lined with it. Leaded glass is used to cover the tubes and apertures provided for the admittance of the rays and for concentration on the object. The leaded glass is usually in the form of a bowl with two slots on which the tube rests. Another form is a lead glass shield which is clamped over the tube.

X-RAY TRANSFORMER.—A step up transformer designed to furnish a current of high voltage to the electrodes of an X-ray tube.

X-RAY TUBE.—A vacuum tube having two elements: a cathode and a target. In operation, when high voltage is passed between the elements, minute particles are emitted from the cathode at right angles to the cathode surface. If the cathode surface be shaped like a concave mirror, these particles will be focused at the center of the curvature. When these rays strike the target a ray is emitted from the spot struck, and if a sufficient number strike, a luminous beam appears; this has the penetrating power and these rays are the unknown or X-rays. In general, the cathode, or negative terminal may be heated by an external low voltage electrical source. The object of heating the cathode is to provide a means to liberate electrons or cathode rays without resulting in the intense heat to which an ordinary X-ray tube is subject, where the high voltage both liberates and drives the electrons to the target. There are numerous types of X-ray tubes designed to meet the various conditions and requirements. These types are called: a, universal; b, radiator; c, radiator dental; d, portable radiator; e, oil immersed; f, air cooled deep therapy; g, water cooled deep therapy.

XYLANTHRAX.—Wood coal, charcoal, in distinction from mineral coal.

XYLONITE.—The same as celluloid. A mixture of camphor with pyroxylin. The camphor is heated and the pyroxylin added, the whole worked into a mass under rollers, the color being added before working. After this the mass is warm pressed into the desired forms. It is used for fittings, ornaments, and other substitutes of ivory and bone. The material is highly inflammable, but not explosive.

Y

Y, y.—1. Symbol for admittance.

2. A pipe fitting, where two branches unite together to form one, resembling the letter Y in appearance. The enclosed angle is usually 45°.

3. Symbol for the metal Yttrium.

YAGI SPARK GAP.—A quenched spark gap invented by H. Yagi.

YALE LOCK ALARM SWITCH.—A device which will sound an electric alarm if a door be unfastened by any other means than by the proper key.

YARN.—Cotton fibrous material. When used to cover electrical conductors it is braided or twisted over the surface of the conductors usually to serve as a support for varnish or other insulation. When dry, yarn has excellent insulating properties.

YARROW BOILER.—A straight water tube boiler of the accelerated circulation class. It consists of a steam drum and two oval water drums; each water drum is connected to the steam drum on its own side by straight seamless drawn steel tubes, expanded into each drum. The steam drum is made up of a top drum sheet and a tube sheet, butt jointed with double butt straps. The joints are on a line parallel with the axis of the drum. The tube sheet is made much thicker in wake of the tubes. The feed water enters the steam drum, and flows down to the water drums through the tubes farthest away from the fire; the steam and water flow up to the steam drum through the hottest tubes. Some types of the Yarrow boiler have down comers outside the boiler casing. Without down comers the water circulation varies under the different conditions of steaming, and different degrees of steadiness of the ship. Tubes which, under certain conditions act as down comers, change to generating tubes with the changed conditions. Although the circulation path of the water is slightly in doubt, it is certain that the circulation is satisfactory, as there are many boilers of this type in successful operation. The latest system is to discharge the feed water into both lower drums through an internal feed pipe extending nearly the entire length of the drum.

Y-CONNECTED ARMATURE. — A three phase armature having one end of each of the coils connected to a common junction in a so-called Y or star connection.

Y CONNECTION.—This method of transformer connection, consists in connecting both the primaries and secondaries in star grouping.

Y-CONNECTOR.—A connecting device for a conductor and two branches.

Y DELTA CONNECTION.—This method of transformer connection consists in connecting the primaries in star grouping, and the secondaries in delta grouping.

YELLOW BRASS.—A brass suitable for commercial castings. It is used for the commoner class of turned and other work, also for name plates and similar castings where durability and strength are not essential. S.A.E. specifications: copper, 62.00 to 65.00; lead, 2.00 to 4.00; zinc, 31.00 to 36.00; tin, maximum, 1.00; iron, maximum, .50; impurities, .25; ultimate strength, 25,000 lbs. per sq. in.

Y-GUY.—In pole line construction, a form of stay provided for points along the line where bends occur, or where other severe strains are exerted on the poles; it consists of two guy wires attached one above and the other below the center of the stress, and joining in a common stay a short distance above the ground.

YIELD POINT.—In testing materials, the point at which the stresses and the strains become equal, so that deformation or permanent set occurs. The point at which the stresses equal the elasticity of a test piece.

YOKE.—In certain forms of electro-magnet, having two straight cores, a piece of soft iron screwed to the cores yoking them together.

YOKE ARBOR.—A form of double journal box for pulley spindles, in which a curved branch extending from one bearing to the other on each side of the pulley, serves to protect the belt from being chafed or otherwise injured.

YOKE ELECTRO-MAGNET.—A form of electro-magnet built up of two straight cores with a piece of soft iron yoking them together at one end.

YOUNG'S MODULUS.—The modulus of elasticity. It is the intensity of stress required to strain a bar by an amount equal to its own length, assuming the material to remain perfectly elastic.

Y-SHAPED SPARK.—A spark having three branches sometimes seen in the discharge of a condenser through an induction coil.

Z

Z, z.—Symbol for impedance.

ZAMBONI'S DRY PILE.—A voltaic pile composed of paper discs silvered or tinned on one side, and on the other side coated with powdered binoxide of manganese, placed on top of one another in a glass tube.

ZEEMAN EFFECT.—The broadening of the lines in the spectrum of a heated substance when placed in the flux of a powerful magnetic field. So named from Zeeman, the Dutch scientist who discovered it.

ZENITH.—That point in the visible celestial hemisphere which is directly above the spectator; the point of the heavens just overhead; opposed to nadir.

ZEPPELIN.—A large dirigible air ship designed for long sustained flights. Incorrectly spelled zepalin and zepelin.

ZERENER SYSTEM.—A method of electric welding in which an arc is used in combination with a magnet which deflects the arc, making a flame similar to that of a blow pipe, but having the temperature of the arc. The apparatus contains a self regulating device which is driven by a small electric motor. For welding iron, a current of 40 to 50 amperes at 40 volts will suffice for strips of metal three millimeters thick.

ZERO.—1. Cipher; nothing; naught; the point from which the graduation of a scale, as of a thermometer, commences.

2. On a steam gauge, the zero point (atmospheric pressure) corresponds to 14.7 lbs. per sq. in. absolute, or if referred to the "standard atmosphere," 14.696 lbs.

ZERO BEAT RECEPTION.—In radio, a method of reception in which the carrier wave is combined with a locally generated wave of the same frequency. Also called **homodyne reception.**

ZERO BIAS.—In a radio vacuum tube, a control grid voltage such that there is no pressure difference between the grid and the filament.

ZERO MAGNET.—A magnet employed in the adjustment of the zero indication of a galvanometer scale.

ZERO METHOD.—An accurate method of obtaining electrical measurements, as with a differential galvanometer or bridge, in which the unknown resistance is equal to the known when there is no deflection; the null method.

ZERO POWER FACTOR.—A value of the power factor which corresponds to a phase difference between current and pressure of 90°.

ZERO PRESSURE.—1. The pressure of the earth's surface taken as an arbitrary zero; so that bodies positively electrified are said to be of a higher pressure and those negatively electrified of a lower pressure than that of the earth.

2. On an indicator card, the point of no pressure, as in a perfect vacuum, that is zero pressure absolute.

ZIGZAG LIGHTNING.—A form of lightning flash which follows a zigzag path. It is also called forked lightning when it splits up into branches.

ZINC.—A white metal with a faint bluish tinge. Atomic weight 65.4; melts at 780° F. It is ductile and malleable. It is used in making galvanized iron, and in the preparation of many alloys such as brass, bronze and German silver. It forms the negative pole of nearly all primary cells. The electrical conductivity of zinc is 29 and heat conductivity 36. (silver=100).

ZINCS.—Zinc electrodes prepared for use in primary cells.

ZINC BATH.—In electro-plating with zinc, the solution of zinc sulphate or chloride, or an alkaline solution of zinc, which is subjected to the action of electrolysis.

ZINC CARBON CELL.—A primary cell having electrodes of zinc and carbon, as for example, the Leclanche cell.

ZINC CHLORIDE.—A white crystalline or fused mass which is very soluble and deliquescent. It serves in electro-plating for preparing brass and zinc baths, and in solution is used for nickeling by immersion, soldering, etc. It is also called hydrochlorate or muriate of zinc.

ZINC-COPPER CELL.—A primary cell having electrodes of zinc and copper, as for example, the Daniell cell.

ZINC-MERCURY CELL.—A primary cell having electrodes of zinc and mercury, as for example, Clark's standard cell.

ZINC PLATES.—In a steam boiler, slabs of zinc used to prevent corrosion. They are suspended in the water by means of wires which are soldered to the upper part of the shell so as to make an electrical connection. The zinc forms one element of a galvanic battery and the iron the other, with the result that the zinc is eaten away and the iron is protected. On account of this action it is generally believed that zinc will prevent corrosion and that it cannot be harmful to the boiler. In numerous cases, however, zinc has not only been of no use, but has even been harmful. In one case a tubular boiler contained scale consisting chiefly of organic matter and lime, and zinc was tried as a preventive. The beneficial action of the zinc seemed apparent for some time until the water supply was changed. The new water was supposed to be free from line, and after three months' use, the tubes and shell were found to be coated with an obstinate adhesive scale, composed of zinc oxide, organic matter and the sediment of the water. The deposit became so heavy in places as to cause overheating and bulging of the plates over the fire.

ZINC PLATING.—Depositing a coating of zinc by the process of electro-plating.

ZINC POLARITY.—In a zinc copper primary cell, the polarity of the zinc element, that is, the part submerged in the electrolyte is negative, but it should be noted that its terminal is positive.

ZINC SENDER.—In telegraphy, a device for sending a reverse current momentarily into the circuit after each signal for the purpose of overcoming retardation in the line.

ZINC SULPHATE.—White vitriol or white copperas. It forms small colorless prisms of a harsh metallic taste which oxidize on exposure to the air. In electro-plating, it is used for the preparation of brass and zinc baths, as well as for matt pickling.

ZINCING.—A term sometimes used for galvanizing. The process consists merely in dipping iron into melted zinc to obtain a coating of zinc as a protection against rust. The term is also used for the electro-deposition of zinc.

ZINCITE.—A brittle, translucent mineral of a deep red color, sometimes inclining to yellowish, and consisting chiefly of oxide of zinc, but containing also a small quantity of oxide of manganese, to which its color is supposed to be due; also called red zinc ore and red oxide of zinc.

ZINCODE.—A term formerly applied to the zinc electrode or cathode of a primary or electrolytic cell.

Z-INSULATOR.—A variety of earthenware line wire insulator.

ZIRCON.—An oxide of zirconium. It is found in certain metamorphic and eruptive rocks and in alluvial deposits.

ZIRCON-WOLFRAM LAMP.—A type of incandescent lamp having a filament made of a mixture of zirconium and tungsten (called "wolfram" in Germany). The lamp has a specific consumption of about 1.4 watts per candle power.

ZIRCONIUM. — A rare metal. Atomic weight 90.6. Oxidizes at a very high temperature. It is obtained from zircon by heating with carbon in an electric furnace. It has been experimented with to produce an efficient incandescent lamp filament. For the control of the vacuum in high vacuum tubes, a small quantity of thorium or zirconium is included in the tube.

ZIRCONIUM-CARBON LAMP.—An incandescent lamp developed in Europe, having a filament made by heating an ordinary carbon filament in a vapor of some volatile zirconium compound. This lamp shows a slight advantage over the carbon filament lamp.

ZIRCONIUM LAMP.—A type of incandescent lamp employing for its filament hydrides or nitrides of the metal zirconium in combination with some organic binding material. This lamp takes about two watts per candle power. It is of European origin, and has not been adopted in America.

ZODIAC.—An imaginary belt in the heavens, 16° or 18° broad, in the middle of which is the ecliptic, or sun's path. It comprises the twelve constellations which once constituted, and from which are named, the twelve signs of the zodiac.

ZOETROPE.—An optical toy in which figures in different stages of motion are caused to revolve on the inside of a cylinder open at the top and having slits in the side, so that when seen through the slits the figures have the appearance of life.

ZONAL HARMONIC.—A spherical surface harmonic having all its axes coincident.

ZONE.—One of the five great divisions of the earth, with respect to latitude and temperature. They are the torrid zone, extending from tropic to tropic 46° 56', or 23° 28', on each side of the equator; two temperate or variable zones, situated between the tropics and polar circles; and two frigid zones, situated between the polar circles and the poles.

2. In mathematics, the portion of the surface of a sphere included between two parallel planes.

ZONE LAMP.—A lamp provided with a lens arrangement so that all the light rays are projected in a single zone.

ZOOMAGNETISM. — A name sometimes given to so-called animal magnetism, or the power of hypnotism.

ZWITTER IONS.—Ions which are both positively and negatively charged at the same time.

New Word Section

A

ACHROMATIC.—In the science of optics, transmission of light is said to be achromatic when it takes place without decomposition into the primary colors, although the light has passed through a refracting medium.

ACTINIC RAYS.—The light rays which act on photographic emulsions.

ACTINIC SPECTRAL.—A term used in cathode ray tube operation. It is the relation between the energy per element of wave length which affects a certain photographic surface, and each wave length of the spectrum. This is generally shown in a curve plotted with relative actinic energy against wave length in angstroms, microns or millimocrons. *Relative actinic* energy is obtained by multiplying the relative radiant energy values (taken from the screen's spectral characteristic) for each wave length by the relative sensitivity of a given photographic surface at that wave length.

ACTIVE COMPONENT.—That component of the voltage (or current) in a circuit, equal to the average power divided by the current (or voltage); the component of the voltage (or current) in phase with the current (or voltage); the product of the voltage and the conductance or of the current and the resistance; based upon sinusoidal wave forms.

ALKALI METALS.—Metals such as caesium, lithium, potassium, rubidium sodium, which produce an alkali having varying photoelectric properties.

APERIODIC INSTRUMENT.—An instrument whose pointer comes to rest without any oscillation. A dead-beat instrument.

ATOMIC WEIGHT.—The weight of the atom of any element as compared with another as a standard; usually hydrogen is taken as 1.

AUTOMATIC DOOR.—One which closes or opens automatically, by means of a mechanical or electrical device.

AUTOMATIC VOLUME CONTROL.—In radio, a system by which the output from a radio receiver or amplifier is kept constant irrespective of variations in the input.

AUTO-TRANSFORMER.—A transformer in which part of the winding is common to both the primary and the secondary circuits.

B

BALANCED POLYPHASE LOAD.—A balanced polyphase load is a load to which symmetrical currents are supplied when it is connected to a system having symmetrical voltages.

NOTE.—The term balanced polyphase load is applied also to a load to which are supplied two currents having the same wave form and *rms* value and differing in phase by 90 electrical degrees when it is connected to a quarter-phase (or two-phase) system having voltages of the same wave form and *rms* value.

BAND SPREADER.—In radio a variable condenser having a very small capacity connected across a timing circuit to assist in fine tuning. Developed to facilitate tuning on ultra-short and short waves. In effect, is a vernier to the main tuning condenser.

BEAM CURRENT.—In cathode ray tube operation, it is the current in the electron beam at the screen, usually measured in microamperes.

BEAM VOLTAGE.—In cathode ray tube operation, it is the instantaneous voltage of the electron beam at any point; usually referred to as the voltage of the beam at the point of deflection, where the beam voltage is substantially the same as the second anode voltage.

BELT SCANNER.—In mechanical television, a scanning arrangement consisting of an endless belt of opaque material in which has been punched the usual formation of scanning holes. The device was developed to produce a less cumbersome television receiver than those employing scanning discs.

BIO-LUMINESCENCE.—Luminescence emitted by living organisms.

BRIDGE, CIRCUIT.—A network which is so arranged that, when an electromotive force is present in one branch, the response of a suitable detecting device in another branch may be made zero by a suitable adjustment of the electrical constants of still other branches; and which is characterized by the fact that, if the electromotive force and the detecting device be interchanged, after completing an adjustment, the response of the detecting device is still zero.

BRILLIANCE CONTROL.—A control which on a cathode ray tube of television receiver, allows the general brilliance of the image to be varied. It generally takes the form of the fixed bias to the grid of the tube.

B.X.—A trade name for a flexible armored cable used in electric wiring.

C

CANDLE-POWER DISTRIBUTION.—In operation of cathode ray tubes, it is the relation which when plotted is invariably represented by a polar curve illustrating the luminous intensity of a cathode-ray tube in a plane of the tube axis and with the screen at the origin. This characteristic shows how the candlepower of a luminescent screen varies when the screen is viewed at different angles.

CANDO-LUMINESCENCE. — Luminescence of incandescent solids.

CAPACITANCE, SYMBOL C.—Capacitance is that property of a system of conductors and dielectrics which permits the storage of electricity when potential differences exist between the conductors. Its value is expressed as the ratio of a quantity of electricity to a potential difference. A capacitance value is always positive.

CAPACITIVE LOAD.—A reactive load in which the current leads the voltage across the load.

CATHODE RAY.—In radio and television, the stream of electrons emitted by the cathode and proceeding the whole length of a cathode ray tube until it impinges on the fluorescent screen at the end of the tube, where its presence is made apparent by a spot of light on the screen.

CATHODE RAY TUBE.—In electronic television, an elongated flask with a long neck. In the neck is arranged an assembly of electrodes comprising a cathode which emits an electron stream when heated. The electrons are attracted by an anode placed further along the tube. The anode may take many forms, such as a disc with a small central hole, a ring or a cylinder, the object of the anode being not to draw electrons to itself, but to project them on the large flat end of the tube. On the inside of the flat end of the tube is a coating of fluorescent material called the screen. The electron stream causes a spot of light to appear on the screen. Various control electrodes are arranged in the neck of the tube, such as the grid or shield (to vary the intensity of the light spot), deflector plates (to deflect the cathode ray or electron stream as desired), special multiple anode arrangement for focusing, etc.

CATHODO-LUMINESCENCE. — Luminescence produced by the impact of electrons.

CELL, STANDARD.—A cell which serves as a standard of electromotive force.
NOTE: Standard cells of technical importance includes the "Weston Normal Cell", a saturated cadmium cell used as the international primary standard of *emf*, and the secondary or working standard unsaturated cadmium cell.

CHEMI-LUMINESCENCE. — Luminescence created by chemical reactions.

CHROMATIC.—The science of colors. The branch of optics dealing with the properties of colors of light and natural bodies such as pigments.

CIRCUIT, ELECTRIC.—An electric circuit is the path or a group of interconnected paths in which there may be electric currents.

CIRCUIT, MULTIPLE OR PARALLEL.—A multiple or parallel circuit consists of two or more circuits connected to the common junction points so that the same potential drop is established through each branch.

CIRCUIT, MULTIPLE-SERIES.—A circuit in which a number of separate sources, or receptive devices or both, are connected in a number of separate groups subsequently connected in multiple.

CIRCUIT, POLYPHASE.—A polyphase circuit is a group of associated current paths (usually interconnected) which is energized, or which is intended to be energized, by a set of alternating electro-motive forces, all of which have the same period but which differ in phase.

CIRCUIT, QUARTER-PHASE.—A quarter-phase or two-phase circuit is a combination of circuits energized by alternating electromotive forces which differ in phase by a quarter of a cycle; i. e. 90 degrees.

CIRCUIT, SERIES.—A circuit supplying energy to a number of devices connected in series, i. e. the same current passes through each device in completing its path to the source of supply.

CIRCUIT, SERIES-MULTIPLE.—A compound circuit in which a number of separate sources, or separate electro-receptive devices, or both, are connected in a number of separate groups in multiple, and these separate groups subsequently connected in series.

CIRCUIT, SINGLE-PHASE.—A single phase circuit is either an alternating current circuit which has only two points of entry or one which, having more than two points of entry, is intended to be so energized that the potential differences between all pairs of points of entry are either in phase or differ in phase by 180 degrees.

CIRCUIT, SIX-PHASE.—A six-phase circuit is a combination of circuits energized by alternating electromotive forces which differ in phase by one-sixth of a cycle, i.e. 60 degrees.
NOTE.—In practice the phases may vary several degrees from the specified angle.

CIRCUIT, THREE-PHASE.— A three-phase circuit is a combination of circuits energized by alternating electromotive forces which differ in phase by one-third of a cycle; i.e. 120 degrees.
NOTE.—In practice the phases may vary several degrees from the specified angle.

CIRCUIT, TWO-PHASE.—A quarter-phase or two-phase circuit is a combination of circuits energized by alternating electromotive forces which differ in phase by a quarter of a cycle i.e. 90 degrees.
NOTE.—In practice the phases may vary several degrees from the specified angle.

CIRCUIT, TWO-WIRE.—A metallic circuit formed by two adjacent conductors insulated from each other.

CLOCKWISE MOTION.—Rotation in the same direction as that of the hands of a clock, front view.

CONCAVE LENS.—A lens which causes the rays of a beam of light to become less convergent and more divergent. A physical characteristic of concave lenses is that they are thinner at the center than they are at the edges.

CONDUCTIVITY CELLS.—A term applied to light-sensitive cells of the selenium type, that vary in conductivity in sympathy with fluctuation in light intensity falling on the cells.

CONNECTED LOAD.—The connected load on a system, or part of a system, is the sum of the continuous ratings of the load-consuming apparatus connected to the system, or part of the system, under consideration.

CONSEQUENT POLE.—A magnetic pole developed at some point of a magnet other than its extremities. In the plural, this term is used to designate adjacent poles of like polarity.

CONVERGENT RAYS.—Rays of light heat, etc., which converge toward a point. A condensing lens or "burning glass" causes light rays to converge or concentrate onto a small area.

CONVEX LENS.—A lens that causes the rays of a beam of light to converge or to become less divergent. A physical characteristic of a convex lens is that it is thicker at the center than it is at the edges.

CORNEA.—The transparent membrane forming the front portion of the ball of the eye, and through which light passes to the pupil.

COUNTER - ELECTROMOTIVE FORCE.—The counter electromotive force of any system is the effective *emf* within the system which opposes the passage of current in a specified direction.

COUNTER-CLOCKWISE MOTION.—Rotation in a direction opposite to that of the hands of a clock, front view.

CREST FACTOR.—(Crest factor of a periodic quantity)—The crest factor of a periodic quantity is the ratio of the crest value to the effective value of the quantity.

CREST VOLT-METER.—A volt-meter depending for its indications upon the crest, or maximum value of the voltage applied to its terminals. Crest volt-meters should have clearly marked on the instrument proper whether readings are in equivalent root-mean-square values or in true crest volts. It is preferred that the marking should be root-mean-square values of the sinusoidal wave having the same crest value as that of the wave measured.

CRYSTALLO-LUMINESCENCE. — Luminescence excited by emission from radio-active materials.

D

DAMPING.—Damping is a term applied to instrument performance to denote the manner in which the pointer (or marking device) settles to its steady indication after a sudden change in the value of the measured quantity. Two general classes of damped motion are distinguished: namely (a) periodic, in which the pointer oscillates about the final position before coming to rest; (b) aperiodic, in which the pointer comes to rest without overshooting the rest position. The point of change between periodic and aperiodic damping is called critical damping.

DEFOCUS.—In cathode ray tube operation, a term used to describe a spot which is not optimum with respect to shape and size.

DEMAND FACTOR.—The ratio of the maximum demand of a system, or part of a system to the total connected load of the system or the part of the system under consideration.

DEMAND INTERVAL.—The length of the interval of time over which the demand is measured. For example, in a 30 minute demand, the demand interval is 30 minutes.

DEMAND, MAXIMUM.—The maximum demand of an unstallation or system is the greatest of all the demands which have occurred during a given period.
NOTE.—The maximum demand is determined by measurement according to specification, over a definitely prescribed time interval.

DEMAND METER.—A device which indicates or records the demand or maximum demand. A demand meter records or indicates the maximum average load over any specified time interval, or the average load over a number of equal time intervals.

DEMAND OF AN INSTALLATION OR SYSTEM.—The demand of an installation or system is the load at the receiving terminals averaged over a specified interval of time.
NOTE.—Demand is expressed in kilowatts, amperes or other suitable units.

DIURNAL.—Daily; diurnal task, a task recurring every day.

E

EFFECTIVE VALUE.—(Root-Mean-Square current—r.m.s. current)—The effective value of a periodic current is the square root of the average of the squares of the instantaneous values of the current taken throughout one period.

ELECTRIC POTENTIAL (Symbol E or e).—Note: When distinction between electromotive force and potential difference is desirable, E, e and V, v, may be used respectively. The electric potential of a point is the potential difference between the point and some equipotential surface, usually the surface of the earth, which is arbitrarily chosen as having zero potential.

ELECTRICITY METER.—An integrating device used for measuring electric energy or quantity of electricity.

ELECTRO-LUMINESCENCE.—The property of luminescence which certain substances and gases have after they have been subjected to an electric discharge or to a cathode ray.

ELECTRO-STATIC, DEFLECTION SENSITIVITY.—In cathode ray tube operations, it is the ratio of the distance which the electron beam moves across the screen to the change in potential difference between the deflection plates; this is usually expressed in millimeters per volt. The sensitivity varies inversely with the beam voltage at the point of deflection.

ELECTRON BEAM.—In television a term generally applied to the cathode ray tube, or stream of electrons which are shot off by the cathode and travel toward the anode system of the cathode ray tube.

ELECTRON FURNACE.—An electron furnace capable of heating metals to 4,500 degrees Fahrenheit or approximately half the temperature of the sun.

ELECTROSTATIC INSTRUMENT.—An instrument which depends for its operation on the forces of attraction and/or repulsion between bodies charged with electricity.

ELECTROTHERMIC INSTRUMENT.—An instrument which depends for its operation on the heating effect of a current. Two distinct types are (A) the expansion type, including the "hot wire" and "hot-strip" instruments. (B) The thermocouple type.

F

FACSIMILE.—The electrical transmission of graphic or textual material and its reception as a recorded copy.

FACSIMILE INDEX.—In normal scanning, this is the product of the total length of a scanning line in inches by the number of scanning lines per inch.

FACSIMILE NEGATIVE TRANSMISSION.—This occurs when a decrease in initial light intensity causes an increase in transmitted power.

FACSIMILE NORMAL SCANNING.—That in which the scanning point moves at a constant rate from left to right in parallel equidistant straight scanning lines, these lines being taken progressively from top to bottom of the subject area.

FACSIMILE POSITIVE TRANSMISSION.—Positive transmission occurs when an increase in initial light intensity causes an increase in the transmitted power.

FACSIMILE SCANNING.—The process of transmitting or analyzing successively, according to a predetermined method, the light values of elements constituting the subject area, or correspondingly synthesizing in receiving.

FACSIMILE SCANNING LINE.—A single continuous narrow strip which is determined by the process of scanning.

FACSIMILE SCANNING LINE RATE.—In normal scanning, this is the number of lines traversed per minute.

FIFTH COLUMN.—Spies, provocateurs, sabateurs, and traitors working behind the lines to aid the enemy and ready to give him succor and guidance when he comes. Phrase originated in Spanish Civil War. Generalissimo

Francisco Franco had four columns pressing at gates of Madrid when General Gonzalo Queipo de Llano broadcast that the Nationa-ists had a "fifth column" inside Madrid, ready to strike at a propitious moment.

FLOATING POWER.—A method of mounting the engine in the chassis frame of an automobile so that the vibration of the engine is absorbed by rubber cushions.

FLUORESCENT LIGHT.—A method of lighting which makes use of ultra-violet energy to activate a fluorescent material coated inside of the bulb's surface. The kind of coating material used depends upon the color effect desired and may consist of zinc silicate, cadmium silicate or calcium tungsten. These organic materials are known as phosphors, which powder transforms short-wave invisible radiation into visible light.

FLUORESCENCE LIGHT COMPONENTS.—Unless otherwise stated, it includes the ballast coil and power-factor corrective condeser.

FLUORESCENT LIGHT STARTING SWITCH.—A switch usually functioning on the thermal principle, which momentarily closes and then opens the electrode heating circuit.

FLUORESCENCE TUBING.—A term sometimes applied to fluorescent lamps, on account of the lamp's tubular form or shape.

FRANCIS TURBINE.—A reaction type water turbine used for heads of from 65 to 900 ft. This is one of the most commonly used turbines.

G

GALVANO-LUMINESCENCE. — Luminescence phenomena observed at electrodes during some electrolyses.

GRAPHIC INSTRUMENT.—(Recording instrument; recorder)—An instrument which makes a graphic record of the value of quantity as a function of time.

GROUND CONDUCTOR.—A ground connection is a connection used in establishing a ground and consists of a ground conductor, a ground electrode and the earth (soil) which surrounds the electrode.

GROUND RETURN CIRCUIT.—A circuit in which the earth is utilized to complete the circuit.

GUN CURRENT EFFICIENCY.—In cathode ray tube operation, it is the ratio of the beam current to the current which leaves the cathode. This ratio, multiplied by 100, gives th gun-current efficiency in per cent.

H

HARMONIC COMPONENT.—A harmonic component of a periodic quantity is any one of the simple sinusoidal quantities of the Fourier series into which the periodic quantity may be resolved.

HOROGICAL STANDARDS.—Standards for the measurement of time.

HYDRAULIC DRIVE.—A form of drive recently incorporated in automobiles (it is sometimes called liquid drive, fluid or hydromatic drive, etc.). It consists principally of two paddle wheels termed *driver* and *follower* enclosed in a low viscosity mineral oil, and by means of which power is transmitted from the engine to the rear wheels without any mechanical connection.

HYSTERESIS-LOOP.—A hysteresis-loop for a ferro-magnetic material is a curve (usually with rectangular co-ordinates) showing for successive ranges of increasing and decreasing (or vice versa) magnetizing forces, the corresponding magnetic inductions when the material is in a cyclicly magnetized condition.

HYSTERESIS-LOSS. — Magnetic hysteresis-loss in a material for a specified cycle of magnetic intensity is the energy converted into heat as a result of magnetic hysteresis when the magnetic induction is also cyclic.

I

INDUCED ELECTROMOTIVE FORCE.—Electromotive force, produced by electromagnetic or electrodynamic action.

INDUCTANCE, MUTUAL.—(Symbol M or *m*)—The common property of two associated electric circuits which determines, for a given rate of change of current in one of the circuits, the electromotive force induced in the other. The ratio of the electromotive force induced in a circuit to the rate of change of the inducing current in a magnetically associated circuit.

INDUCTIVE.—Having inductance, e.g. inductive circuit, inductive load. Circuits containing iron or steel that is magnetized by the passage of current are highly inductive.

INDUCTIVE REACTANCE.—Reactance due to inductance, as distinguished from reactance due to capacitance.

INTERVAL.—A term used with demand meters meaning a specified time interval.

J

JOULE.—The international joule is the energy required to transfer one international coulomb between two points having a potential difference of one international volt. One international joule equals 1.0005 absolute joules.

JUNKERS.—Trade name of line of German planes.

K

KAPLAN TURBINE.—A reaction type water turbine (sometimes termed propeller turbine) with adjustable runner blades, especially suitable for run-of-river installations with variable head and flow

KEEL, AIRSHIP.—The assembly of members at the bottom of the hull of a semi-rigid or rigid airship, which provides special strength to resist hogging and sagging and also serves to distribute the effect of concentrated loads along the hull.

KNEE ACTION WHEELS.—A name given to front of automobile wheels independently sprung and where the linkage corresponds to the action of the human knee joint.

L

LEADING CURRENT.—An alternating current wave or component in advance of the electromotive force producing it.

LIGHT-SENSITIVE CELL.—Any device which converts a variation of light intensity into a variation of electric current or which generates an electric current when illuminated.

LIGHT QUANTUM.—An amount of radiant energy equal to the quantum, having a momentum equal to the energy divided by the velocity of light. It occupies a small volume, and moves as a whole in one direction with the velocity of light

LINES OF FORCE.—Imaginary lines within a magnetic or electrostatic field which indicate by their direction the direction of magnetic or electrostatic force at each point. By convention it is considered that the number of such lines per unit area (taken at right angles to lines of force) is a measure of the strength of the field.

LOAD, ARTIFICIAL.—A load used for convenience or for energy saving in testing; used in place of a customer's load which may not be readily controllable, or which for other reasons should not be used.

LOADING TRANSFORMER. — (Phantom load)—A multi-tap, resistor controlled, step-down transformer used to supply low energy meter load currents regulated to specific values at known phase relations with the impressed voltage.

LUMINESCENT SCREEN SPOT.—In cathode ray tube operation, it is the spot formed on the screen at the impact point of the focused electron beam.

M

MAGNETIC MINE.—Type of marine mine exploded by magnetic action set up by steel hull of passing vessel. British have secret defense known as the "De-Gaussing" apparatus which apparently nullifies magnetic action of steel hulls.

MARKED RATIO OF INSTRUMENT TRANSFORMER.—The marked ratio of a current or a potential transformer is the ratio of the primary current or voltage, as the case may be, to the secondary current or voltage, as given on the rating plate.

MESSERSCHMITT.—Twin engined German fighter monoplane, especially adapted to bomber escort work. Most improved type is Messerschmitt 110 for which maximum speed of 385 miles an hour is claimed. Armament: Two 20 millimeter cannons in fuselage, two fixed machine guns in wings and one flexible machine gun at gunner's cockpit. Carries two men.

METACHROMATISM.—A change of color due to a change in physical conditions, especially in the temperature of a body.

N

NAVICERT.—Contraction of navigation certificate, paper issued by British Government to merchant vessel certifying that cargo is not consigned to an enemy power. Obviates delay of search at contraband control stations.

NEGATIVE POTENTIAL.—A potential of a point or conductor such as determines a tendency of electricity to flow toward it from the earth, or from any point of positive potential. Generally, the lower potential. The property of a point in space by virtue of which electric work is done by the movement of a small positive charge to that point from an infinite distance.

O

OCTANT.—A variation of the aircraft sextant which measures angles up to 90°. Its artificial horizon is usually the bubble type.

ORDNANCE.—Equipment or material used in actual fighting.

ORNITHOPTER.—A form of aircraft heavier than air, deriving its chief support and propelling force from flapping wings.

P

PARAVANE.—A torpedo-shaped under-water protective device with saw-like teeth in its forward end, for use by vessels in mined areas to sever the mooring of mines. Paravanes are towed one on each side of the bow, at some distance from the vessel.

PATTERN DISTORTION.—In cathode ray tube operation, when the electron beam is moved by changing fields, a pattern is formed on the screen; the wave form of the spot movement will be identical with the resultant wave forms of the electrical phenomena producing these fields unless there be pattern distortion présent. This distortion takes many forms, such as: amplitude, frequency, phase, brightness, persistence, spot size, etc.

PEAK, INSTANTANEOUS.—On a load-time curve, an instantaneous value greater than the values immediately preceding or following it.

PELTON WHEEL.—A form of impulse turbine consisting of a row of double cup-shaped buckets arranged around the rim of a wheel and actuated by one or more jets of water playing into the cups at high velocity. This type of turbine is used almost exclusively for heads over 900 ft.

PERIOD OF AN INSTRUMENT (sometimes called the "periodic time").—The time between two consecutive transits of the pointer or marking device in the same direction through the rest position.

PERMEANCE (Symbol P.).—The permeance of a portion of a magnetic circuit extending between two equipotential surfaces is the ratio of the flux through any cross-section to the magnetic potential difference between the surfaces when taken within the portion under consideration.

PERSISTENCE.—A term used in cathode ray tube operation. It is the relation showing the brilliance of light emitted by a cathode ray tube screen as a function of time after excitation. This characteristic is generally shown in a curve where relative brilliance as the ordinate is plotted on a logarithmic scale against time on a linear scale. *Relative brilliance* is used to denote luminous intensity per unit area evaluated in arbitrary units.

PHASE SHIFTER.—An adjustable device for creating differences in the phase angle between current and electromotive forces, or between electromotive forces.

PHOSPHORESCENCE.—A term used in cathode ray tube operation. It is the luminescence emitted after excitation. As applied to a cathode ray tube, this term refers to the radiation which persists after the electron-beam excitation has ceased.

PHOTO-LUMINESCENCE. — Luminescence created by exposure to radiation.

POLYPRISM.—A device for showing differences of refractive and dispersive power, consisting of a series of prisms, identical in size form, but of different materials (as crown glass, flint glass, etc.) mounted one above the other on a common axis.

POWER, ACTIVE.—Polyphase circuit.—The active power at the points of entry of a polyphase circuit is the time average of the values of the instantaneous power at the points of entry, the average being taken over a complete cycle of the alternating current. The active power, P, at any set of points of entry of a polyphase circuit, at which the instantaneous power is p, is given by the equation:

$$P = \frac{1}{T} \int_{0}^{T} p\,dt$$

Where T is the period of the alternating current.

POWER, ACTIVE. — Single-phase circuit. —Active power at the points of entry of a single-phase, two-wire circuit is the time average of the values of the instantaneous power when the average is taken over a cycle of the alternating current. The value of active power is given in watts when the effective current is in amperes and the effective potential difference is in volts.

POWER, APPARENT.—Polyphase circuit.—Algebraic.—The algebraic apparent power at the points of entry of a polyphase circuit is the algebraic sum of the products obtained by multiplying the effective current at each point of entry by the effective potential difference between that point of entry and an artificial neutral, the potential of which is established by joining it to each point of entry by a resistance that has a value (positive or negative) such that the ratio of the effective current in a resistance to the current in the point of entry to which it is connected, is the same for each of the resistances. The product corresponding to each point of entry has the algebraic sign of the resistance connected to that point of entry. The unit of algebraic apparent power is the volt-ampere.

POWER, APPARENT.—Polyphase circuit.—Arithmetic.—The arithmetic apparent power at the points of entry of a polyphase circuit, is equal to the arithmetic sum of the products obtained by multiplying the effective current at each point of entry by the effective potential difference between that point of entry and the neutral point of entry, or, if one does not exist, an artificial neutral, the potential of which is established by joining it to each of the line points of entry by a set of equal resistances. The unit of arithmetic apparent power is the volt-ampere.

POWER, APPARENT.—Single-phase circuit.—Apparent power at the two points of entry of a single-phase two-wire circuit is equal to the product of the effective current in one conductor multiplied by the effective potential difference between the two points of entry.

Q

QUEEN ANNE, 1702-1714.—A style of furniture which was much influenced by the Dutch, Flemish, French, and Chinese. Lacquer was freely used, and the style was similar to the William and Mary, although the carving was much simpler.

R

REACTIVE COMPONENT.—The square root of the difference between the square of the total current and the square of the active component of the current. Similarly for voltage power and energy.

REACTIVE POWER.—Reactive power at the two points of entry of a single-phase, two-wire circuit is, for the special case of a sinusoidal current and a sinusoidal potential difference of the same frequency, equal to the product obtained by multiplying the effective value of the current by the effective value of the potential difference; and is, for the more general case of a periodic current and a periodic potential difference of the same fundamental frequency, the algebraic sum of the reactive powers corresponding to the sinusoidal harmonic components. The value of reactive power is given in *vars* when the effective current is in amperes and the effective potential difference is in volts.

NOTE.—The name *var* for the unit of reactive power was adopted at the Stockholm meeting of the International Electrochemical Commission in 1930. (Also called reactive volt-ampere, rva.)

REACTOR.—A device the primary purpose of which is to introduce reactance into a circuit.

RESULTANT.—A single force compounded of two or more forces and able to produce their combined effects. Applied to electricity, the words current, voltage, magnetizing force, etc., can be substituted for the words force and forces in this definition.

S

SCREEN ACTINIC EFFICIENCY.—In cathode ray tube operation, it is the measure of the ability of a viewing screen to convert the electrical energy of the electron beam to radiation which affects a certain photographic surface. This term should be expressed in *microwatts per watt*, but is often expressed for ease of measurement in terms of actinic power per watt relative to a screen of well-known characteristics.

SCREEN FLUORESCENCE.—In cathode ray tube operation, it is the luminescence emitted by a phosphor during excitation. As applied to a cathode ray tube, this term refers to the radiation emitted by the viewing screen during the period of beam excitation.

SCREEN LUMINOUS EFFICIENCY.—In cathode ray tube operation, it is the measure of the ability of a viewing screen to produce visible radiation from the electrical energy of the electron beam. The efficiency should be measured in lumens per watt. For convenience of measurement, however, it is usually expressed in candlepower per watt, because candlepower is a measure of the luminous flux per unit solid angle in a given direction and can be converted to lumens where the candlepower-distribution characteristic of the screen is known. It is usual practice to measure candlepower in the direction normal to the screen.

SCREEN RADIANT EFFICIENCY.—In cathode ray tube operation, it is the measure of the ability of a viewing screen to produce luminescence rom the electrical energy of the electron beam. The efficiency should be expressed in *microwatts per watt*, but due to the difficulty of making absolute measurements, is more often expressed in radiant energy per watt relative to some screen of well-known characteristics.

SECONDARY BURDEN.—In an instrument transformer it is that property of the circuit connected to its secondary which determines the flow of true and reactive power from the transformer. It is expressed either as total ohms impedance, together with the effective resistance and reactance components of the impedance, or as the total volt-amperes and power factor of the secondary devices and leads. The values expressing the burden shall apply to the condition of rated secondary current or voltage of the instrument transformer and a stated frequency, both of which must also be included with the burden expression.

SELSYN MOTORS.—Two specially designed synchronous motors connected to a single A.C. source in such a manner that any position or any speed and direction of rotation of the rotor in one machine is accomplished by a similar position, or similar speed and direction of rotation of the rotor in the other machine.

SPECTRAL.—A term used in cathode ray tube operation. It is the relation between the radiant energy per element of wave-length and each wave-length of the spectrum. It is generally shown in a curve plotted with relative radiant energy against wave-length in angstroms, microns, or millicrons. *Relative radiant energy* is expressed in arbitrary units of radiant energy.

SPOT DIAMETER.—In cathode ray tube operation, it is a term used to express the true size of a round spot.

SPOT DISTORTION.—In cathode ray tube operation, it is the condition of a spot which is not optimum with regard to shape.

SPOT SIZE.—In cathode ray tube operation, it is the true dimension or dimensions of the spot. Spot size may be measured under various conditions, and is commonly designated by such names as *spot diameter* or *line width*. When the spot is stationary, its size can be measured in any direction, but is usually determined by its dimensions along the longest and shortest axes.

STEEL BELT.—Thin, flat, steel belts varying from 0.008 to 0.035 in. in thickness and from ⅞ to 8 in. in width have been successfully used. The pulleys should be faced with a thin layer of cork. Steel belts can be run at speeds as high as 10,000 feet per minute. It has been claimed that a 4 in. steel belt will transmit as much power as a 19 in. leather belt.

STRATOLINER.—Airplanes designed for flying at extremely high altitude.

SURGE TANK.—A form of tank used in hydroelectric plants, to relieve against excessive pressure of water in long penstocks. The surge tanks to be effective must be located as near the power house as possible.

T

TRIBO - LUMINESCENCE. — Luminescence created by the disruption of crystals.

THERMO-COUPLE.—A pair of dissimilar conductors so joined as to produce a thermoelectric effect.

TRACKLESS TROLLEY.—A trolley usually running on inflated tires similar to that of the automobile; the motivating force may be electricity, Diesel, etc.

TRUE LINE WIDTH.—In cathode ray tube operation, it is the width of the moving spot measured at right angles to its direction of motion.

U

U-BOAT.—German submarine. Comes from Unterseeboot. A warship adapted to submersion by admitting water to ballast tanks and using horizontal rudders. Carries deck gun but principal weapons are torpedoes, fired when submerged or afloat. Latest and most popular types displace about 1,200 to 1,300 tons and carry sixty men. French Surcouf, world's largest, displaces 4,300 tons, carries 150 men and is equipped with two eight-inch guns and small seaplane in watertight deck housing. Ten knots is about top submerged speed. Diesel engines provide surface propulsion and electrical power undersea propulsion.

V

VAR.—Reactive volt-amperes.

VARHOUR.—Reactive volt-ampere hour.

VECTOR SUM.—The geometrical sum of two or more vector quantities.

VELOCITY METER.—An instrument for measuring the velocity of air currents; used in the air conditioning industry.

VISCOSITY.—The density of fluid, gauged by the rate at which it flows through a gauge pipe of standard length and diameter.

VISUAL SPECTRAL.—A term used in cathode ray tube operation. It is the radiation between the luminous energy per element of wave length and each wave length of the spectrum. It is generally shown in a curve plotted with relative microns. *Relative luminous energy* is obtained by multiplying the relative radiant energy values (taken from the screen's spectral characteristic) for each wave length by the relative response of the eye at that wave length.

VOLT-BOX.—A series of resistors so arranged that a definite fraction of a given voltage may be measured and the given voltage computed therefrom.

W

WELLINGTON.—Vickers-made plane. Most popular is twin-engined long-range bomber monoplane. Carries normal crew of five. Has note gun at bomb aimer's position and rear gun positions, including windowed gun-compartment in tail. Maximum speed 265 m.p.h.

Z

ZERO HOUR.—Time set for attack. In American and British World War operations time was given out in advance as mere "O-Hour". Announcement of real time was withheld as long as possible to insure surprise.

ZERO POTENTIAL.—An arbitrary potential level from which electric levels are measured. The earth's potential.

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