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# Post Office Engineering Department

## TECHNICAL PAMPHLETS FOR WORKMEN

*Subject*

### TECHNICAL TERMS

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# LIST OF Technical Pamphlets for Workmen.

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8. Standard List of Terms and Definitions used in Telegraphy and Telephony. (*Not on sale.*)
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**TECHNICAL TERMS.**

BRIEF DEFINITIONS OF SOME OF THE THEORETICAL AND PRACTICAL WORDS AND TERMS USED IN CONNEXION WITH TELEGRAPHY AND TELEPHONY.

**ABSOLUTE TEMPERATURE.** The temperature reckoned from the absolute zero. In centigrade units, the absolute temperature is  $273 + t$ , where  $t$  is the number of degrees above the centigrade zero.

**Absolute Units of Electricity.** Units expressed in terms of length, mass and time, in the Metric System. The units from which the practical ones (Volt, Ohm, etc.) are derived.

**Absorption.** See **Electrification.**

**Accumulator.** A voltaic battery which can be repeatedly charged and discharged without renewing the plates or electrolyte. It is charged by passing a current through it in the opposite direction to that of the current when discharging.

**Admittance.** The reciprocal of Impedance.

**Aerial.** A wire or wires above a wireless station, for the purpose of radiating transmitted electrical waves and collecting received electrical waves.

**Air-Space, Lead-Covered Cable.** A lead-covered cable, in which the conductors are insulated partly by a paper wrapping round each wire and partly by dry air between the conductors.

**Alternating Current.** A current which constantly reverses in direction in a regular periodic manner, flowing alternately round the circuit in the positive and negative directions. One complete double reversal is called a cycle.

**Alternator.** A dynamo which delivers alternating current.

**Amalgamation (of zinc battery plates).** That process which consists in cleaning the zinc with sulphuric acid and afterwards coating it with mercury.

**American Wire Gauge.** The Brown and Sharpe wire gauge (which see).

**Ampère.** The practical unit of current; one-tenth of the absolute unit of current. The current produced when an E.M.F. of one volt is steadily applied to a conductor having a resistance of one ohm. See **Volt.**

**Ampère-Hour.** An Ampère acting for an hour. Ampère-hours = Ampères  $\times$  hours.

**Ampère-Meter or Ammeter.** An instrument for measuring the strength of a current in ampères.

**Amplifier.** See **Thermionic Valve.**

**Amplitude of Sine Wave.** The maximum value of volts or current in an alternating current cycle. See **Alternating Current.**

**Angle of Lag.** In an alternating current circuit, an angle which shows the amount by which the current lags behind the impressed volts.

**Angular Velocity.** The speed of a revolving body, usually expressed in terms of the number of radians per second, or in terms of the number of degrees per second. In an alternating current circuit  $2\pi$  times the frequency (which see) measures the radius per second.

**Annealing.** The heat treatment of metal to soften it and make it suitable for working.

**Annunciator.** An indicator with a drop shutter, by means of which a signal is given.

**Anode.** The plate at which the current enters an electrolyte. The positive electrode of a thermionic valve.

**Answering Jack.** The jack directly associated with the calling apparatus of a telephone circuit in a multiple telephone switchboard.

**Antenna.** See **Aerial.**

**Aperiodic.** Dead beat (which see).

**Armature.** The movable member of a relay (which see). It usually consists of a piece of iron which is attracted towards the core of an electro-magnet, when a suitable current is passed through the coils of the electro-magnet. The armature causes one or more local contacts to be opened or closed.

**Armoured Cable.** A cable having a strong protective metallic sheath.

**Arrester.** See **Protector.**

**Articulation.** The articulation of a telephone circuit is expressed by the percentage of syllables correctly received with respect to the number of isolated syllables transmitted. By syllable is meant the smallest possible vocal combination. See **Intelligibility.**

**Artificial Cable or Line.** In telegraphy and telephony this is usually a combination of resistances and condensers, or of resistances only, which is equivalent, in certain specified conditions, to a real line. A voltage applied at the sending end terminals of the artificial line, in these conditions, produces the same current at the receiving end terminals as the real line to which the artificial one is equivalent. (Sometimes inductance

must be added to the resistance and capacity to produce a required equivalent line.) An artificial line consisting of resistances only is called a non-reactive line.

**Astatic Pair.** A pair of magnetic needles bound together, the north pole of one being over the south pole of the other, so that the earth's magnetic field does not deflect the combination.

**Atomic Weight.** The comparative weight of an atom of any element as compared with hydrogen, the weight of which is taken as unity.

**Attenuation of Power Volts or Current.** The cutting down or diminution of power, volts, or current in the course of their transmission along a circuit owing to the resistance, leakage and capacity of the circuit.

**Attenuation Constant (of a transmission line).** A constant which gives the compound interest rate at which the power, current, or volts fall off or become attenuated when propagated along a uniform and infinite transmission line.

**Automatic Circuit Breaker or Cut-out.** A device for breaking a power or other circuit, when the current in it exceeds a safe limit or if a direct current changes in direction.

**Automatic Coin Box.** See **Coin Collecting Box.**

**Automatic Telegraphy.** A system of telegraphy in which a machine, instead of a manual operator, performs the operation of transmitting the line signals. See **Wheatstone Automatic.**

**Automatic Telephone Exchange.** A telephone exchange, in which the switching operations necessary to connect one subscriber with another, are performed by automatic switching machines, controlled by impulses sent from the calling subscriber's telephone set, usually by means of a rotating numbered dial, operated by the calling subscriber.

**BACK E.M.F.** An induced electromotive force in a circuit possessing inductance, or the E.M.F. generated by a motor when operating and which opposes the supply voltage and limits the current taken. It is dependent on the rate of change of current, and is opposite to the impressed E.M.F. when this is commencing or increasing in value.

**Balancing of Capacity in Multiple Twin Cables.** The process of equalising the electrostatic capacity associated with each wire in a given cable length, by selecting shorter lengths of conductor in that length, some of which have a capacity in excess of the mean, and others a deficit, and connecting these short lengths of conductor in such a way that the capacities of all the conductors in any phantom circuit (which see), when

measured from the end of the given cable length, are equal to each other. As a rule, each loading-coil section is balanced independently. The operations are for the greater part conducted on the road during laying. The main object of capacity balancing is the prevention of overheating in phantomed and loaded cables, and balancing is absolutely necessary at present for this purpose. The balancing of cables also reduces inductive disturbance in cables generally, when not used for phantom working.

**Ballistic Galvanometer.** A galvanometer having a comparatively heavy needle (or other moving system), which moves so slowly that transient currents—say those due to a condenser discharge—pass through the coils of the galvanometer before the needle has time to move appreciably. The amount of the deflection of the first swing is proportional to the quantity of electricity that passes through the coil.

**Battery, Central.** See **Common Battery Speaking and Signalling.**

**Battery Mud.** A sediment which collects at the bottom of cells when working.

**Battery, Primary.** A battery giving a direct current, due to chemical action, which also consumes one of the battery plates much more than the other, and exhausts the liquid, so that both the plate and liquid require to be replaced after exhaustion. It cannot be re-charged in the same way as the accumulator (which see).

**Battery, Secondary.** See **Accumulator.**

**Battery Symbols.** The symbols +, - and ||||| are alternatively used. The *plus* symbol and the thin vertical stroke are used to indicate the carbon terminal and the *minus* sign and the short, thick vertical stroke to indicate the zinc terminal.

**Baudot Multiplex Type-Printing Telegraph System.** A multiple telegraph system, invented by a French telegraph engineer named Emile Baudot. Each letter of the alphabet is transmitted by different combinations of five *plus* and *minus* electrical signals, which are sent from a keyboard having five keys operated by hand. The signals are converted by a special apparatus at the receiving end into typed letters printed on a tape. Several messages may be sent at the same time over the same line by the aid of distributors synchronised at each end of the line.

**B.A. Unit of Resistance.** A unit fixed by the British Association, now superseded.

**Bell, Trembler.** This consists essentially of a battery in circuit with an electromagnet which breaks the circuit through its own coils each time its pivoted armature is attracted. The armature in its movement strikes a bell gong, and is then restored to its original position by means of a spring, and the circuit is again thereby completed. The cycle of operations described is repeated indefinitely, so long as the external bell circuit is closed by a press-button or other similar device.

**Bias of a Relay.** A tendency of a relay tongue to remain on one stop when the relay is at rest.

**Bichromate Cell.** A zinc-carbon cell in which dilute sulphuric acid is used as an excitant, and bichromate of potassium mixed with sulphuric acid is used as a depolariser.

**Bonding of Cable Sheaths and Pipes.** The attachment of a lead strip to connect two contiguous lead cable sheaths or sections of iron pipes, to prevent electrolytic action at points of discontinuity.

**Booster.** A supplementary dynamo to raise the voltage at an intermediate point in a D.C. power circuit, where it is necessary to regulate the voltage. In the A.C. case, a transformer with tappings may be used to raise or lower the voltage.

**B.O.T. Unit of Power.** Board of Trade unit of power: 1,000 watts supplied for one hour—one kilowatt-hour.

**Breakdown Test.** A test of the dielectric strength of an insulating material, by means of a relatively high voltage.

**Breastplate Transmitter.** A telephone transmitter, which is fixed upon a light metallic plate, and worn upon the breast of a telephone operator.

**Bridge Duplex.** A duplex telegraph circuit in which, the principle of the Wheatstone Bridge is utilised for balancing an artificial line against the real line, the telegraph receiving apparatus replacing the Wheatstone Bridge galvanometer.

**Bridge (In).** See **Multiple Circuit.**

**Bridge Megger.** A portable instrument for testing conductivity and insulation. It embodies the essential principles of the Megger and the Wheatstone Bridge (which see).

**Bridging Coil.** See **Choke Coil.**

**Brown and Sharpe Wire Gauge.** The wire gauge principally used in America. The American wire gauge. Each gauge of wire is known by a definite number; the numbers are consecutive and are such that the resistance approximately doubles with an addition of 3 to the gauge number of any wire; thus the resistance of No. 13 B. and S. gauge copper



wire is twice that of No. 10, and No. 16 wire has twice the resistance of No. 13.

**Busyback Signal.** An interrupted buzzer signal, given by a telephone exchange to a calling subscriber ; the signal indicates that a called telephone subscriber is engaged.

**Buzzer.** An electrical signalling apparatus, which operates on the principle of the electric bell, but which has no gong, and gives a humming sound due to the rapid vibration of the armature.

**CADMIUM CELL.** A cadmium-mercury primary cell, which is used as a standard cell. The Weston Cadmium cell is usually referred to.

**Calculagraph.** A clockwork device, under a telephone operator's control, to permit of the accurate timing of the duration of trunk calls.

**Calibration.** The determination of the true value to be attached to the indications recorded on an instrument scale.

**Call Wire or Order Wire.** A telephone circuit used by telephone operators for service purposes, such as the transmission of called Subscribers' numbers between exchanges and assignment of junctions.

**Calorie.** The metric unit of heat. The quantity of heat required to raise 1 gramme of water from 0 degree to 1 degree centigrade. The dynamic equivalent is 42 million ergs. One calorie is also equivalent to 4.2 joules.

**Calorimeter.** An instrument for measuring quantities of heat.

**Capacity.** The quantity of electricity which a condenser can store when unit potential difference exists between the electrodes, also the capacity of a secondary cell in ampère hours. The practical unit of capacity is the Farad (which see). See also **Specific inductive capacity**.

**Carbon Granules.** Small grains or granules of carbon, which have the property that their resistance varies with pressure. They are utilised in telephony between the electrodes of a telephone transmitter. See **Transmitter (Telephone)**.

**Carrier Telephony.**

**Carrier Telegraphy.** The use of high frequencies for carrying telephonic or telegraphic signals to a distance. The carrier frequency may be any frequency not required for ordinary telephonic use on the same circuit. The various frequencies are separated, when required, by filters. The

carrier currents are modulated at the sending end by the telephonic or telegraphic signals which it is desired to transmit, and the original signals are reproduced at the receiving end by demodulation or rectification of the carrier currents.

**Carrying Capacity of a Wire.** (1) The greatest strength of current which can safely be carried by a wire. (2) The number of words per minute which a telegraph circuit can carry.

**Cathode.** The electrode at which the current leaves an electrolyte. The negative electrode of a thermionic valve.

**Centi.** A Metric System prefix, meaning one-hundredth part.

**C.G.S. System of Units.** The system adopted for the absolute system of electrical units. All the units are expressed in terms of the centimetre, gramme and second; hence the name C.G.S.

**Channel.** When a number of separate means of communication are provided over one electrical circuit between the ends of a line by multiplexing, superposing, or use of carrier currents, each is spoken of as being one "channel."

**Choke Coil.** A coil with an iron core, designed to have a high impedance to alternating current.

**Circuit, Electric.** The path of the current from the positive to the negative source of energy.

**Circuit, Magnetic.** The path of the magnetic lines of force of a magnet. See **Reluctance**.

**Circuit, Open.** See **Open Circuit**.

**Circular Mil.** The area of a circle having a diameter of one one-thousandth of an inch.

**Clark Standard Cell.** A zinc-mercury cell, which was used as a general standard cell before the introduction of the Cadmium cell.

**Clearing Signal.** An electrical signal on a telephone circuit, which is transformed into a visual or an audible signal, to inform an operator that a telephonic conversation is finished.

**Closed Circuit.** A circuit having a continuous conducting path from the + to the - source of energy. A circuit closed at the receiving end.

**Closed-Circuit Working.** A system of telegraph working in which the battery is normally applied to the line, and signals are registered by first breaking and then closing the circuit.

**Co-efficient.** A letter or number prefixed to a general mathematical symbol, to show how many times the quantity involved in the symbol is to be taken.

**Coefficient of Mutual Induction.** Not often used at present = Mutual Inductance.

**Coercive Force.** The magnetomotive force necessary to remove residual magnetism.

**Coin-Collecting Box.** A device for collecting a fee for a telephonic conversation from a distant caller, by means of a box with a slot, into which coins are dropped by the caller. The coins complete a metallic contact and as a result an electrical signal is sent to the controlling operator, who then establishes the desired telephonic connexion.

**Combined Resistance.** See **Multiple Resistance.**

**Common Battery Signalling System.** An exchange system in which a battery at the central exchange is utilized to furnish the current required for signalling on subscribers' lines, no signalling battery being located at the subscriber's station.

**Common Battery Speaking System.** A telephone exchange system in which a secondary battery at the central exchange is utilized to furnish to the telephone apparatus at subscribers' stations the necessary current for telephone speech, and to permit of signalling from that point.

**Common Return.** A single return conducting path common to two or more circuits.

**Compensation Circuit.** The artificial balancing line in a duplex telegraph circuit.

**Complex Attenuation Constant.** A constant which gives the combined attenuation constant and wave-length constant—usually of a telephone circuit.

**Composite Circuit.** A combined telegraph and telephone circuit.

**Concentration (Night).** The concentration or grouping of a number of circuits at one point to facilitate manipulation when the traffic is relatively small, and to bring the circuits under the observation of the available operators.

**Condenser.** An instrument usually consisting of two parallel or two sets of parallel plates separated by air or by a dielectric, which stores a quantity of electricity by virtue of its capacity (which see).

**Conductance.** See **Conductivity.**

**Conductivity.** The degree of conducting quality in any conductor. It varies inversely as the resistance, or  $\frac{1}{R} = G$ ,  $R$  being the resistance in ohms and  $G$ , the symbol for conductance, which is expressed in mhos. See **Mho**.

**Conduit (Multiple Duct.)** A group of earthenware ducts in one piece, forming a number of ducts for telegraph and telephone cables. See **Self-Alignment Duct**.

**Consequent Poles.** The name given to the extra poles (over and above two) which are sometimes present in a magnet.

**Converter, Rotary.** See **Rotary Converter**.

**Cord Circuit (Double Wire.)** A pair of flexible insulated conductors terminated, as a rule, by plugs at both ends, usually with clearing apparatus and operator's speaking apparatus bridged across the two conductors. The cord circuit is used for connecting two separate telephone circuits, by the insertion of the cord plugs into the circuit jacks. In the common battery system, the battery connexions are also included in the cord circuit. Cord circuits involving the same features as those here described are used in connexion with telegraph switching systems.

**Coulomb.** The quantity of electricity transferred in a circuit when one ampère flows for one second.

**Counter Communication Telephone Switch.** A switching arrangement controlled by a Post Office counter clerk or other official, giving control of telephonic communication by the public from that point.

**Creed Receiving Perforator.** Telegraphic apparatus invented by Mr. F. G. Creed. It utilizes received automatic Wheatstone signals, at any speed up to 200 words per minute, to prepare a punched Wheatstone slip, which can be used to re-transmit the signals by Wheatstone apparatus, to a distant town, or alternatively the signals may be converted into Roman characters for delivery to the public, when the perforated tape is passing through a "Creed Printer" at about 100 words per minute.

**Creosote.** An oily, heavy liquid obtained from tar, used for injection into timber to preserve it from decay. A powerful antiseptic.

**Creosoting.** The injection of creosote into wood to prevent decay.

**Cross-Talk.** Conversation originating in one circuit which is heard in another.

**Cross-Talk Meter.** A form of rheostat with fixed non-reactive series resistances, and variable non-reactive shunts, designed to measure cross-talk. The apparatus has four terminals, two for the connexion of an A.C. generator or a transmitting telephone, and two for the connexion of a telephone receiver. The dial of the instrument is calibrated, so as to read in terms of millionths of the current entering the meter, and the reading shows the millionths of that current passing through the receiver. The amount of the shunt is varied by a revolving arm sliding over contacts. The resistance of the apparatus to currents entering it is about 666 ohms, and is nearly constant in all positions of the shunt. To measure cross-talk (say between two pairs in a cable), speech is conducted on one pair, and a listening test made by means of a receiver on the other pair, and the volume of the cross-talk noted. The same apparatus is then connected to the cross-talk meter, and the shunt varied until the same volume of cross-talk as previously observed is noted. The dial then shows the cross-talk expressed in millionths of the incoming current.

**Curb Signalling.** A method of submarine signalling in which the main signal sent is followed by a weaker reversed signal, to curb the original signal and hasten its discharge. Where block condensers are used, the sending end is earthed for a certain percentage of the time occupied in sending the signal.

**Cycle of Alternating Current.** A complete alternation of positive and negative current or voltage.

**DAMPING.** (1) A device to prevent the needles of galvanometers swinging to and fro for a long time.

(2) The decrease in amplitude of an electrical oscillation with time.

**Deadbeat Instrument.** An instrument so well damped that it comes to rest without setting up a periodic swing.

**Deca.** A Metric System prefix, meaning ten times.

**Deci.** A Metric System prefix, meaning one-tenth part.

**Decibel (symbol *db*)** (formerly named Transmission Unit).

New unit of attenuation or gain. The attenuation or gain between any two points of a transmission system (acoustical, mechanical or electrical, or combinations of these) is defined in terms of the ratio of the two powers at the respective points. If  $P_1$  is the power at one point and  $P_2$  at the other, the attenuation or gain in decibels is given by the expression

$$\text{Decibels} = 10 \log_{10} \frac{P_1}{P_2}$$

In a uniform telephone line the attenuation or gain in decibels may be given in terms of current or voltage as follows:—

$$\text{Decibels} = 20 \log_{10} \frac{V_1}{V_2} = 20 \log \frac{I_1}{I_2}$$

1 Mile of Standard Cable = 0.923 decibels = 0.1062 népers at 800 cycles per sec.

**Demagnetization.** Depriving a magnet of its magnetic properties.

**Depolarize.** To prevent by chemical, electro-chemical or mechanical means the phenomena described under **Polarization of a Battery**.

**Desiccation.** The pumping of dry air or gas into an air-space paper-core cable, to expel moisture from it and thereby raise the insulation.

**Diaphragm (for a Telephone Transmitter or Receiver).** A disk of elastic material capable of receiving and transmitting the sound waves generated by the voice.

**Dielectric.** Any insulating material which permits of an inductive capacity action through its substance.

**Difference of Potential.** Difference of potential between two points is defined as the work done by the electric field on a body charged with unit quantity of electricity when it passes from the point of higher to the point of lower potential.

**Differential Duplex.** A system of telegraph signalling in which signals are exchanged from each end of the line at the same time without interference, on the differential principle. The necessary apparatus at each end of the line consists essentially of a differential relay and artificial line. The relay is wound on the same principle as the differential galvanometer (which see). If the line (including the distant apparatus) is joined to one of the equal windings of the relay, and the rheostat to the other equal winding, the relay is not energized when a current is sent in opposite directions round the two windings, if the resistance of the artificial line circuit is equal to that of the line circuit. In such a case, signals may be sent without affecting the relay at the sending end. A current received at the same end from the line, however, passes mainly through only one winding of the relay, and signals from the distant station are thereby recorded. In this way messages may be sent and received at the same time from both ends of the line. In practice, a galvanometer is necessary to assist in balancing the artificial line against the actual line. In practice also, the artificial line consists of combinations of resistances and condensers.

**Differential Galvanometer.** A galvanometer in which two coils are wound side by side. If two equal currents are sent in opposite directions at the same time round the coils, the galvanometer needle is not deflected.

**Diplex.** The system of telegraph signalling in which two messages in the same direction are sent at the same time over one wire.

**Direct Current.** A steady current which does not reverse in direction.

**Direct Sounder.** A sounder which works by direct line signals without the interposition of a relay.

**Disconnect.** To break the continuity of an electric circuit.

**Distributor (Multiplex).** An apparatus for giving a number of operators the use of a telegraph line for short and frequent intervals. The apparatus consists essentially of a rotating arm or arms connected to the line, and a number of insulated segments arranged in a circle or circles, the segments being connected to the apparatus controlled by the operators. As the arms revolve over the segments, they make contact with each segment once in every revolution and complete its circuit. The distributors at each end of the line work in synchronism. (See **Synchronism**.)

**Double-Current Working.** The system of telegraph signalling in which a positive and negative current of electricity are used for the formation of each signal.

**Drop of Voltage.** The drop of voltage in a resistance is numerically equal to the product of the resistance in ohms and the current in ampères between the points where the drop takes place.

**Dry Cell.** A Leclanché cell, in which the chemical liquid is reduced to a minimum and contained in a paste.

**Dry Core Cable.** See **Air-Space Cable**.

**Duplex Telegraph.** A system of signalling which permits of two messages—one in each direction—being sent over a wire at the same time.

**Dynamic Induction.** Electromagnetic induction.

**Dynamo.** A machine for converting mechanical power into electrical power by the motion of conductors in a magnetic field.

**Dynamotor Ringing.** A combination of dynamo and motor on one and the same driving shaft, arranged to receive power from an external source and convert it into a ringing current.

**Dyne.** The unit of force in the C.G.S. System. The force which, when acting for a second on one gramme, gives it a velocity of one centimetre per second.

**EARTH.** The conducting path offered by the earth to electric currents.

**Earth Return.** A circuit in which the return path of the current to the source of energy is the earth.

**Eddy Currents.** Induced currents having a closed path, which circulate in conductors and masses of metal, due to lines of force cutting the conducting mass.

**Effective Resistance.** The particular value of resistance observed in an A.C. circuit in connexion with a given alternating current of some definite strength and frequency. The effective resistance is greater than the direct current resistance and increases with frequency and sometimes with current. The additional resistance is due to skin effect, hysteresis and eddy current losses (which see).

**Electric Field.** A space containing lines of force.

**Electrification.** The phenomenon observed when a battery is connected to a disconnected submarine cable, insulated with gutta percha or balata, etc. When the testing battery is first applied to such a cable, there is a large rush of current into it due to its capacity, but a diminishing charge continues to flow into the cable for some time if the battery is continuously applied. This phenomenon is known as electrification. If the battery is removed and the cable earthed, a reverse phenomenon occurs and a current, due to the previous **absorption**, flows out.

**Electrochemical Equivalent of an Element.** The weight in grammes of the element which is liberated in an electrolyte, by the passage of 1 coulomb of electricity through it. It is equal to the chemical equivalent of the element multiplied by 0.00010352 (the electro-chemical equivalent of hydrogen).

**Electrodes.** Solid conductors which lead the current to and from an electrolyte, or alternatively to and from a thermionic valve.

**Electrolyte.** A liquid which conducts an electric current and is decomposed by chemical action in the process.

**Electrolytic Corrosion of Metals.** Corrosion of metals due to chemical action brought about by electrolysis at the



surface of a metal in the presence of an electrolyte, due to the passage of a current from one to the other.

**Electromagnet.** A coil or coils of insulated wire with soft-iron cores, which are converted into temporary magnets by the passage of an electric current through the coils, and cease to be magnets when the current is cut off.

**Electromagnetic Units.** The system of units derived by considering as a unit magnetic pole, one that will attract or repel a similar pole one centimetre away, with a force of one dyne.

**Electrophone.** A term applied to an arrangement of specially designed telephones, which are placed near speakers, singers, instrumentalists, etc., and transmit speech or music simultaneously to a number of persons over circuits supplied with suitable receiving apparatus.

**Electrostatic Units.** The system of units derived from taking as a unit the amount of static electricity which repels an equal amount, one centimetre away, with a force of one dyne.

**E.M.F., Impressed.** The applied E.M.F. at the sending end of a circuit.

**Energy.** That which is the cause of work ; work is done in virtue of the energy of a system, and the unit of work is the same as the unit of energy. See **Joule**.

**Erg.** The unit of work in the C.G.S. System. The work done by a dyne in acting through a distance of one centimetre.  $\text{Work} = \text{Force} \times \text{Length}$ .

**Extension (Telephone).** A telephone station which obtains its communication with the general system through a main set with which it is directly connected. See **Main Set**.

**FACTOR OF SAFETY (OF WIRES AND POLES).** A provision of extra strength in mechanical construction to resist exceptional stresses (due to storms, etc.), over and above those met with in ordinary normal conditions.

**Farad.** The practical unit of capacity. The capacity of a condenser which would be raised to a potential of one volt by a charge of one coulomb. It is  $10^{-9}$  absolute units. The farad is too large for general purposes, and the microfarad is largely used.

**Filter.** An arrangement of inductances and condensers by means of which currents of different frequencies may be separated.

A high pass filter is one which passes all frequencies above a certain critical value and stops all below.

A low pass filter is one which passes all frequencies below a certain critical value and stops all above.

A band pass filter is one which only passes frequencies lying in a certain band.

A band stop filter is one which stops all frequencies within a certain band and passes all others.

**Flux.** See **Reluctance.**

**Flux Density (Magnetic).** The number of lines of magnetic force per unit of area of cross section of a magnetised substance. The symbol is *B*.

**Foucault Currents.** See **Eddy Currents.**

**Frequency.** The number of complete cycles made by an alternating current per second.

**Fuse.** A fusible metal strip which fuses when an electric current which exceeds a known and safe limit, passes through it. It is used as a protective device—principally against fire.

**Fusing Current.** The strength of current which causes a fuse to melt.

**GALVANOMETER, BALLISTIC.** See **Ballistic Galvanometer.**

**Galvanometer, Direct Current.** An instrument for detecting the presence or measuring the value of direct currents. It consists of a coil or coils with a pivoted magnet at the centre, which deflects when a direct current passes through the coils. Alternatively, the arrangement may consist of a coil pivoted or suspended between the poles of a powerful permanent magnet; the coil deflects when a current is passed through it. An indicating needle or a pointer, moving over a scale, is attached to the pivoted magnet or coil to indicate the magnitude of the deflection.

**Galvanometer, Reflecting.** A galvanometer having a mirror attached to the moving needle or coil. Light from a lamp is thrown on to the mirror, the light is reflected, the motion magnified, and the spot of light thrown on to a graduated scale, from which it is read.

**Galvanometer, Tangent.** A galvanometer in which the tangent of the angle of deflection of the needle is proportional to the current passing through the galvanometer coils.

**Gauge of Wire.** A standard of measure. A number allotted to a wire in a given system (such as the standard wire gauge), to indicate its diameter, etc.

**Gauss.** The unit of magnetic field intensity. The symbol is *H*.

**Generator, Hand.** A machine which works on the principle of the dynamo (which see), but in which the mechanical work is done by hand. It is frequently used for generating ringing signals on telephone circuits, but may be used for other purposes.

**Generator, Machine (Ringing).** This differs from the hand generator (which see) in that the mechanical work is done by motive power, such as an electric motor.

**Ground.** An American term signifying **Earth**.

**Gulstad Relay.** A highly sensitive vibrating telegraph relay named after its inventor. A relay, the tongue of which is caused to vibrate at the same frequency as that of the "dots" sent by a transmitter on the line to which it is connected. The vibration is brought about by a local circuit, including extra windings on the relay, and the results of the tendency to vibrate at the required frequency is that the relay is in a highly sensitive condition for responding to the line signals.

**HARMONIC CURRENT.** A current fulfilling the Sine law. This term is usually used to indicate currents whose frequency is a multiple of that of the main current (fundamental frequency) in a circuit.

**Harmonic Party-Line System.** A party-line system in which the call-bells are designed to respond only to signals of some definite and prearranged frequency, different subscribers having bells responding to different frequencies. By this means each subscriber can be called without disturbing the others.

**Heat Coil.** A coil wrapped round a metal bobbin which becomes heated, due to the passage of a current of sufficient strength for a given time through the coil. A fusible metal is attached to the metal bobbin and to a pin joined to a spring. The fusible metal melts, and the circuit is disconnected by the action of the spring.

**Heating Current.** The current which heats the cathode in a thermionic valve or amplifier. This term is applicable to other circuits, *e.g.*, thermo-couple.

**Hecto,** A Metric System prefix, meaning a hundred,

**Henry.** The practical unit of inductance. The inductance produced in a circuit when the induced electromotive force is one volt and the inducing current changes at the rate of one ampère per second. See also **Inductance**.

**Hot Wire Instrument.** An electrical testing instrument which operates by the expansion of a heated wire, due to the heating properties of an electric current. Alternatively, the hot wire may be made to heat a thermo-couple (which see) a galvanometer being used to indicate the thermo-EMF produced.

**Howler.** A loud form of buzzer (which see). It is often used as a source of electric current for testing purposes.

**Hughes Type-Printing Telegraph.** This consists essentially of two wheels, with type around their circumference, which rotate synchronously at each end of a telegraph line. By means of a piano keyboard at the sending end of the line, single impulses, separated by a definite time interval, are sent and actuate mechanism at the receiving end. This mechanism presses a paper slip against the type wheel at the required instant, and records the communication in typed Roman letters on the slip.

**Hydrometer.** An instrument for measuring the specific gravity of liquids. It is used to determine the condition of secondary cells, as shown by the density of the electrolyte.

**Hysteresis.** The lagging of magnetization in iron behind the magnetizing force, resulting in a loss of energy, due to the work done in changing the position of the iron molecules.

**IMPEDANCE.** The ratio of volts to current in an alternating current circuit. The usual symbol for impedance is  $Z$ . More exactly it may be defined as the vector sum of the effective ohmic and reactive resistances in an A.C. circuit.

**Impedance, Characteristic.** The A.C. impedance at the sending end of an electrically long and uniform telephone circuit or infinite line.

**Impedance Coil.** See **Choke Coil**.

**Incandescent Lamp.** An electric lamp consisting of a metal or a carbon filament, in a sealed glass bulb which may either be exhausted of all gas or filled with an inert gas such as argon or nitrogen. Light is given by the heating of the filament to incandescence or white heat, due to the passage of a suitable current through the high-resistance filament.

**Incoming Junction Circuit.** A telephonic exchange circuit, arranged to receive calls incoming at one exchange from a second exchange in the same area.

**Induced Current.** A current induced in a conductor, due to the latter being cut by lines of force.

**Inductance, Unit of.** See **Henry**.

**Induction Coil.** A combination of two or more coils or windings, so placed with regard to each other, that a change of current through one of them (usually the primary) induces an EMF in the other one (the secondary), due to the medium of magnetic energy.

**Inductive Disturbance.** Disturbance in a circuit, due to that circuit being cut by lines of electromagnetic or electrostatic force, generated in a disturbing circuit and giving rise to an induced voltage in the disturbed circuit.

**Insulation (Line).** The apparent resistance measured at one end between the two conductors of a telephone or telegraph circuit or between either of the conductors and earth, the circuit being disconnected at the distant end and at every other station or point of connexion. If the insulation resistance is comparable with the conductor resistance, a correction must be applied to obtain the true insulation resistance.

**Intelligibility** of words of a telephone circuit is characterized by the percentage of words correctly received with respect to the number of isolated words transmitted.

**Intelligibility** of phrases of a telephone circuit is characterized by the percentage of phrases correctly received with respect to the number transmitted.

The **Intelligibility** is characterized by the percentage of words correctly received with respect to the total number transmitted in a continuous conversation.

**Intensity of Magnetic Force in Air.** The number of lines of force per square centimetre in air, produced by the action of a magnetic force (say, a force due to a current in a coil) acting on the air space at that point. The usual symbol is  $H$ .

**Intermediate Distributing Frame (Telephone Exchange).** An iron frame having wires from the exchange terminated on one side, and wires from the Main Distributing Frame on the other side, to permit of crossing the circuits according to the needs of the service.

**Interrupted Current.** A direct current of practically constant strength which is cut in and out (or interrupted) at regular intervals.

**Interrupter.** An apparatus for disconnecting a direct current circuit at regular and frequent intervals, to produce a pulsating current (which see).

**Ion.** In an electrolyte, a free molecule carrying an electric charge, which tends to appear at the electrodes. The anion appears at the anode and the cation appears at the cathode.

**JACK.** A spring contact or contacts, usually accessible to the operator from the front of a telephone exchange switchboard, and connected at the back of the board to a line which it is required to extend by means of the jack in association with a plug (which is connected to another circuit) by inserting the plug in the jack.

**Joint Resistance.** See **Multiple Circuit.**

**Joule.** The practical unit of work, 10,000,000 ergs.

**Jumper-Wire.** Wire used for cross-connexion purposes on distributing frames, etc.

**Junction Board.** A switchboard on which incoming junction circuits are terminated in a telephone exchange.

**Junction Circuit.** A telephone circuit connecting two exchanges in the same local area.

**Junction (Outgoing).** A telephone circuit giving service for outgoing calls from a given exchange to (or through) another in the same area.

**KEY (MORSE).** A hand-operated lever instrument for making or breaking the continuity of a telegraph circuit for any required time at hand-speed, to permit of Morse telegraph signals being transmitted. A single-current key is arranged to make and break only, but a double-current key automatically reverses the direction of the current at the end of every signal.

**Keyboard (Exchange.)** A hinged shelf in front of an exchange operator, on which the keys of the position are accommodated.

**Keyboard (Perforator).** A typewriter keyboard for perforating or punching Wheatstone or other slip at a rapid rate. See **Punching.**

**Kilo.** A metric system prefix meaning a thousand.

**Kilowatt.** 1,000 watts.

**Kilowatt-Hour.** One kilowatt acting for one hour, or the equivalent. Example:  $\frac{1}{100}$  kilowatt for 100 hours = 1 kilowatt-hour. It is the Board of Trade unit of electrical power.

**LEAKAGE (LINE).** The loss of current to earth or from the outgoing wire to the return wire, due to imperfect insulation in a circuit.

**Leakance (Line).** The reciprocal of the effective insulation resistance of a telephone or telegraph line at the frequency of the current.

**Line, Infinite.** A telephone line of such a length that the opening and closing of the circuit at the receiving end does not alter the impedance at the sending end.

**Lines of Force.** Lines which indicate the direction of magnetic or electrostatic force at any point.

**Loading by Coils.** The addition of inductance coils in a telephone circuit at regularly spaced intervals to reduce its attenuation.

**Loading Coil.** A coil, usually having a core made up of finely divided magnetic material compressed so as to form a solid core, designed to give inductance, with a relatively small effective resistance. They are used for the loading of telephone circuits. See **Loading by Coils**. When used for side circuit loading, the windings are divided into two equal parts, one half being inserted in the *A* line, and the other the *B* line, to avoid unbalancing the circuit. Similarly a phantom circuit coil has four windings for the same reason.

**Loading Coil Section.** The length of cable which separates two loading coils in a loaded cable. Normally all the loading coil sections are of equal length except at the cable ends. A common arrangement is to make the end sections as nearly as possible half the length of the full loading coil section. For phantom working all the sections are independently balanced as regards capacity. See **Balancing of Capacity**.

**Loading, Continuous.** The addition of continuously distributed inductance to a telephone circuit, by means of a continuous magnetic wire or tape wound on the conductors of the telephone circuit, to reduce its attenuation.

**Loading, General Definition.** Inductance distributed along the wires of a telephone circuit to improve its transmitting qualities.

**Lock-out System (Partly Line).** A party-line telephone system, in which the subscribers using the line automatically

operate apparatus which prevents other subscribers overhearing the conversation or interfering with a call.

**Loop (Circuit).** A two-wire circuit, one wire being the outgoing wire, and the other the return.

**MAGNET, BIPOLAR.** A two-pole magnet.

**Magnet, Permanent.** A piece of magnetized steel (usually either straight or bent in the form of a horse shoe), which maintains its magnetism indefinitely.

**Magneto Exchange System.** A telephone exchange system in which, the subscribers are provided with magneto generators for calling and clearing.

**Magnetomotive Force.** A term having an analogy with electromotive force. See **Reluctance**.

**Main Distributing Frame (Telephone Exchange).** An iron test frame, having rows of horizontal insulated terminals on one of its sides and vertical rows of insulated terminals on the other side. The external underground cables connected to the exchange are frequently, but not necessarily, led to the horizontal side, and the internal line wires are joined to the vertical side and led to the switchroom (usually *via* an intermediate frame). Protective devices are also inserted in the circuits on the vertical side. The external circuits maintain a fixed order on the horizontal side and are cross-connected as required to the internal circuits on the vertical side.

**Main Set (Telephone).** A telephone speaking set communicating directly with a telephone exchange with which it is connected, and having one or more extensions which communicate with the exchange *via* the main set.

**Manhole.** An underground chamber on a cable route, with an iron cover at the street surface, large enough to permit of handling the cables and loading coils, which may be accommodated in it. Manholes are fixed at points where access to cables is often required, and at loading points.

**Manual Operation.** Operation by hand.

**Manual Switchboard.** A switchboard on which the operating is performed by hand.

**Maxwell.** The unit of magnetic flux. The symbol is  $\phi$ .

**Mega.** One million times.

**Megger.** A portable apparatus enclosed in a box, for measuring insulation. The essential parts consist of a direct-current hand generator to furnish the required current, and a moving-coil system for measuring the insulation. The moving



parts consist principally of two coils pivoted on the same axis, which tend to move an indicating needle in opposite directions over an indicating scale. One of the coils has a turning force proportional to the applied voltage, and the other coil acts in proportion to the current flowing in the line. The resultant of the action of the two coils is proportional to the insulation, and the scale is calibrated to read in megohms.

**Megohm.** One million ohms.

**Metallic Circuit.** See **Loop (Circuit)**.

**Metric System.** A system of measurement in which the metre is the lineal unit, and all other values are multiples of this unit, increasing by ten times this value, or submultiples decreasing by steps of one-tenth of the value of the unit.

**Mho.** The unit of conductivity. The reciprocal of the ohm. One mho is the conductivity of a conductor whose resistance is one ohm.

**Micro.** One millionth.

**Microfarad.** One millionth part of a farad. See **Farad**.

**Microhm.** One millionth part of an ohm.

**Micro-Micro.** One millionth of one millionth.

**Micro-Microfarad.** One millionth part of a microfarad.

**Microphone.** A loose carbon contact, or series of contacts, in an electric circuit. When submitted to varying pressure, the granules change in resistance and vary the current. The principle of the carbon telephone transmitter.

**Microtelephone.** A compact form of portable hand telephone, in which the transmitter and receiver are mounted at opposite ends of the same handle.

**Microvolt.** One millionth part of a volt.

**Mill.** One thousandth part of an inch.

**Milliampère.** One thousandth part of an ampère.

**Millihenry.** One thousandth part of a henry.

**Millimetre.** One thousandth part of a metre.

**Modulation** is the operation performed on a high frequency current by which its amplitude is varied at a lower signal frequency.

**Demodulation** is the reverse process to modulation, by which the original signal and the carrier frequencies are separated. It is usually performed by some process of **rectification**.

**Molecule.** The smallest part of matter which can exist in a free state.

**Morse Apparatus.** Hand-worked telegraphic apparatus adapted for transmission of morse code signals.

**Motor.** A machine for converting electrical into mechanical power. See **Dynamo**.

**Multiple Circuit.** A circuit which is branched or divided into two or more paths at one point.

**Multiple Resistance.** The resistance of a multiple circuit (which see).

**Multiple Switchboard, Branching (Telephone).** A telephone exchange switchboard (which see) behind which the wires of every multiplied circuit are led past every operator's position at a suitable height, and a 3-point jack, branched or multiplied on the wires at every such position, so as to give every operator, through the medium of jacks, plugs and cords, the means of extending calls to every circuit connected to the switchboard.

**Multiple Switchboard, Series (Telephone).** A telephone exchange switchboard, in which the wires of every multiplied circuit are led to every operator's position, and connected in series through a jack at every such position, so as to give every operator the means of extending calls to every circuit connected to the switchboard, through the medium of jacks, plugs and cords. In this system the multiple circuit passes through all the multiple jacks in series, and the insertion of a peg in a jack cuts off all the multiple jacks beyond it on the local side of that jack.

**Multiple Twin Cable.** A cable in which the conductors are divided into groups of (usually) four wires or two pairs, two wires being twisted together to form a pair, and the two pairs then twisted together to form a phantom circuit, superposed on the two pairs.

**Multiplex Telegraph.** A telegraph system which transmits a number of messages in one, or both directions, at the same time, by means of distributors working in synchronism at both ends of the line. The distributors may be arranged to give a number of operators the use of the line for brief and frequently repeated periods. An alternative method of multiplex telegraph working is the *Voice-frequency System* (which see).

**Murray Automatic System of Telegraphy.** A system of telegraphy invented by Mr. Donald Murray. The signals to be transmitted are first prepared on a punched slip by means of a typewriter keyboard perforator, and then sent by passing the

slip through an automatic transmitter. The received signals perforate a slip exactly similar to the sent one. The received slip is then passed through a translator, which actuates a specially adapted typewriter, and prepares the message in printed page form ready for delivery. The 5-unit alphabet is used in this system.

**Murray Multiplex.** A multiplex system of automatic telegraphy, in which the fundamental principles of the Baudot are utilized to actuate a column or page printing typewriter.

**NÉPER.** The Continental unit of attenuation. This is similar to the decibel (which see). The number of népers is given by—

$$\text{Népers} = \frac{1}{2} \log_e \frac{P_1}{P_2}$$

and in a uniform line

$$\text{Népers} = \log_e \frac{V_1}{V_2} = \log_e \frac{I_1}{I_2}$$

**Non-Inductive Load.** A load in which the current is in phase with the voltage.

**Null Method.** A method of measurement in which the indications of the detecting instrument are reduced to zero when balance is obtained.

**OHM.** The practical unit of resistance. The ohm =  $10^9$  absolute units of resistance. The resistance of a circuit in which a current of one ampère will pass when one volt is steadily applied to it.

**Ohm-Mile.** The resistance of a wire one mile long, multiplied by its weight in lbs. per mile. This gives the weight in lbs. per mile of a wire one mile in length, having a resistance of one ohm.

**Ohm's Law.** A law first stated by Dr. G. S. Ohm, *viz.*:—  
“The current varies directly as the electromotive force, and inversely as the resistance of the circuit.” The expression of this law in symbols is :—

$$\frac{E}{R} = I.$$

where  $E$  is the number of volts,  $R$  the number of ohms of the circuit, and  $I$  the number of ampères.

**Open Circuit.** Any electrical circuit open at one or more points.

**Operator's Position.** That portion of a switchboard, including the exchange equipment on it, which is allotted to

one operator to enable her to operate and provide inter-communication either among circuits upon it or between them and any others in the exchange system.

**Order-Wire Circuit.** See **Call Wire or Order Wire.**

**Oscillation.** The surging backwards and forwards of an alternating current in a circuit containing inductance and capacity, due to the storing of energy first in the condenser and then in the inductance. The period of oscillation depends on the magnitude of the electrical constants of the circuit. The oscillation becomes damped owing to the frittering away of electrical energy in overcoming the resistance of the system. The number of oscillations per second may vary from a relatively small number to millions.

**Overhearing.** In Great Britain this term is generally understood to mean cross-talk, but the term is sometimes used to designate only the overhearing between a phantom and a side circuit.

**PARALLEL CAPACITY.** The joint capacity of condensers, when the positive plates are connected together, and the negative plates are similarly connected.

**Party Line.** A subscriber's telephone circuit, in which several subscribers use the same line.

**P.B.X.** Private Branch Exchange.

**Period.** The time in seconds required for a current to pass through a cycle. See **Cycle.**

**Periodic Current.** See **Alternating Current.**

**Permeability.** The conductivity of a substance for magnetic lines of force. The permeability of the air is taken as unity. The symbol for permeability is  $\mu$ . It is the ratio of flux density to intensity of magnetic field. See **Flux Density** and **Gauss.**

**Phantom Circuit.** A telephone circuit obtained by transmitting currents in parallel over the *A* and *B* wires of two independent but similar metallic circuits called side circuits. The *A* and *B* wires of each side circuit may be considered as equivalent to one limb of the phantom circuit. The two limbs of the phantom circuit are twisted round each other in the same way as the *A* and *B* wires of the side circuits are twisted together and for the same reason.

**Pilot Lamp.** In a telephone installation a prominent incandescent lamp, common to a group of incandescent lamps. The pilot lamp lights when any one of the group is operated and draws attention to the call.

**Plug and Cord or Peg and Cord.** A metal-slotted cylindrical sleeve, terminated by a rounded metallic tip, which is insulated from the sleeve, both tip and sleeve being connected by separate flexible conductors, which are extended externally as desired. The plug is used for insertion and connexion with a jack.

**Pneumatic Ticket-Distributing System.** A system of distributing ticketed demands and records of calls to recording operators in a telephone exchange by pneumatic tubes.

**Pneumatic Tube.** A tube through which air is pumped in order to despatch telegraph or other messages from one place to another in small fibre cylinders called carriers.

**Polarization of a Battery.** The chemical action in a battery which results in the creation of an opposing E.M.F. and a deposition of hydrogen or other element on the positive plate.

**Pole Changer.** A device for periodically reversing the polarity of a signalling battery to produce an alternating current.

**Pole Test-Box.** A covered test tablet erected on a pole, on which the wires fixed on the pole are terminated for testing purposes; usually fitted at the junction of overhead and underground lines when lightning protectors are required, and at testing boundaries for localization purposes.

**Polyphase.** A term applied to a power system of more than one phase.

**Potential Energy.** Power to do work.

**Potentiometer.** An instrument by means of which any desired proportion of a P.D. may be tapped off. It consists essentially of a resistance to which the P.D., is applied, and a sliding contact. Any fraction of the total P.D. may be obtained between one end of the resistance and the sliding contact.

**Power.** Rate of doing work. The watt, which is equal to one joule per second, is the unit of electrical power. See also **Kilowatt-Hour.**

**Power Board.** A highly-insulated test tablet on which all the power circuits in a given power system are concentrated and controlled by suitably designed switches.

**Power Factor.** The ratio of the power in watts to the volt-ampères.

**Power Plant.** The whole of the machines and measuring and controlling devices which make up a power installation.

**Power Station.** A central point where power is generated and from which it is distributed.

**Propagation Constant.** The complex attenuation constant (which see).

**Protected Cable.** A cable with a heavy lead sheath, armoured and laid in the ground without a pipe or duct.

**Protector, Lighting (Apparatus).** Two plates or other conductors, separated by a short gap of high resistance, one of the conductors being connected to the circuit, and near to the apparatus requiring protection, and the other joined to earth. A high tension voltage (such as lightning) jumps the gap instead of following the normal circuit path and conducts the dangerous charge to earth, thus saving the apparatus.

**Pulsating Current.** A current which always has the same direction, but which varies in strength, rising and falling by regular gradations.

**Punching.** The preparation of a perforated slip by means of a perforator or machine containing punches, which perforate holes in paper ribbon or slip when actuated directly or indirectly by hand. The perforations are converted into telegraphic signals by passing through a transmitter which automatically transmits the signals.

**Pupin System of Loading (Series Lumped Loading).** Loading by the insertion of inductance coils in series with a line at regular intervals.

**QUADRUPLEX.** A system of telegraph working, in which four messages—two in each direction—can be sent over a circuit at the same time. One message is sent by the reversal of the current and the other by an increase in the strength of the current. The circuit is balanced as in duplex working.

**RADIATION (ELECTRIC).** The projection of electric waves through the ether.

**Radio-Telegraphy.** Wireless telegraphy.

**Ratio Arms.** The arms of a Wheatstone Bridge, which have a fixed and known resistance and ratio in any given test.

**Reactance.** That portion of the impedance of a circuit which depends on the circuit inductance and capacity and on the frequency of an alternating source of electrical energy.

**Rectifier.** An apparatus which converts alternating currents into pulsating uni-directional currents.

**Reflection.** An effect occurring in telephone or telegraph transmission lines at points where the characteristics of the line change, such as at the ends of the circuit or where an underground joins an overhead line. The effect consists of a reflection of a portion of the electrical energy back along the line in the opposite direction to which it is being transmitted.

**Relay.** (1) To retransmit a current.

(2) An instrument consisting of an electro-magnet having an armature which closes or opens local contacts when a suitable current is passed through the coils of the electro-magnet.

**Reluctance.** Resistance to magnetic lines of force. In a magnetic circuit, the magnetomotive force divided by the reluctance is equal to the flux, or

$$\frac{\text{Magnetomotive Force}}{\text{Reluctance}} = \text{Flux}$$

**Repeater (Telegraphic).** See **Telegraphic Repeater.**

**Repeater (Telephonic).** See **Telephonic Repeater.**

**Residual Charge.** The additional charge which appears in a Leyden Jar a short time after it has been apparently discharged.

**Residual Magnetism.** Magnetism which remains in soft iron when the cause which produced it has been removed.

**Resistance (Non-reactive).** A resistance which maintains the same ohmic value for direct and alternating currents.

**Resistance, Ohmic.** The resistance in a given direct current circuit, such that

$$\frac{\text{Volts}}{\text{Amperes}} = \text{Ohms.}$$

See **Ohm.**

**Resistivity.** The resistance of a centimetre cube of a substance. The specific resistance (which see).

**Resonance (Electric).** An A.C. phenomenon which occurs in circuits possessing inductance, capacity and resistance

when the impressed frequency is such that  $2\pi f = \sqrt{\frac{1}{LC}}$

**Retentivity.** The power of retaining magnetization when the magnetizing force is removed. See **Coercive Force.**

**Revolved Wires.** Wires which are revolved around each other on pole arms or in a cable to neutralize the inductive disturbances originating in neighbouring wires.

**Rheostat.** A variable resistance, the amount of which may be varied by definite and uniform steps, by the insertion of plugs, or the rotation of a handle over sliding contacts, connected to the resistances.

**Root Mean Square (r.m.s.).** See under **Virtual Volts and Virtual Current.**

**Rotary Converter.** An electric machine which converts an alternating current to a continuous current or *vice versa*, by means of mechanical rotation.

**SATURATION.** A permanent magnet is said to be saturated when it has received the maximum magnetization which it can permanently keep. A piece of soft iron is said to be saturated when it is magnetized up to the highest practicable degree.

**Screened Conductors or groups of Conductors.** A conductor or group of conductors having a metallic tape wrapped continuously round it over the paper insulation of the wire, to prevent electrostatic induction between the screened wire and the other wires in the cable.

**Self-Aligning Ducts.** Earthenware underground ducts which are so made that they are in alignment when the spigot of the one is connected to the socket of the other.

**Self-Induction.** See **Inductance.**

**Semi-Automatic Telephone Exchange.** A telephone exchange system in which the automatic subscribers are not provided with a dial for calling other subscribers. Calls are passed by subscribers to operators (at the semi-automatic exchange), who control automatic apparatus and complete the calls.

**Side Circuit.** A double-wire telephone circuit which is also used as part of a phantom circuit (see **Phantom Circuit**). A telegraph circuit may be similarly worked.

**Simplex Circuit.** A circuit which permits of one signal at one time being sent in one direction.

**Sine Current.** An alternating current which rises and falls in intensity in the positive and negative directions, in accordance with the law of Sines, the strength  $I$  of the current at any instant  $t$  being proportional to the sine of the angle  $2\pi ft$  (measured in radians) of the alternating current cycle, *i.e.*, in such a case  $I = A \sin 2\pi ft$ , where  $A$  is the amplitude and  $f$  the frequency of the alternating current.



**Single-Current Working.** The method of signalling in a telegraph circuit in which one pole only of the battery is applied to the line and apparatus, the other pole being earthed.

**Single-Phase Circuit.** A power circuit energized by one alternating electromotive force.

**Sinusoidal Current or Voltage.** One whose wave shape is in accordance with the law of Sines. See **Sine Current**.

**Skin Effect.** An effect occurring when high frequency currents are transmitted along a conductor, especially if the conductor is solid. The effect consists of the greater proportion of the current being carried by the outside layers of the conductor. This causes an increase in the effective resistance (which see) of the conductor.

**Sounder Silencer.** A device for preventing the local sounder circuit of a relay—usually at a Telegraph Repeater Station—from being operated until a signal, which is appreciably longer than a morse signal, is sent. By this means the normal signals which are repeated at such a station pass without noise, but the Relay Station can be called by bringing the sounder in circuit by means of a suitable long signal.

**Specific inductive capacity** of a dielectric is the ratio of the capacity of a condenser when the space between its plates is entirely filled with the dielectric, to the capacity of the same condenser when the space between its plates is entirely filled with air.

**Specific Resistance.** The resistance between the opposite faces of a centimetre cube of a substance at a given temperature. It is usually expressed in millionths of an ohm.

**Split-Order-Wire Call-Seeker.** An automatic device in a telephone exchange, which connects the *B* operator to one order wire at a time, and thus prevents the loss in transmission efficiency which results from the connection of a number of circuits in parallel.

**Standard Apparatus (Transmission), Common Battery.** A common battery circuit, including subscriber's station set, subscriber's line or its artificial equivalent of 300 ohms resistance, and repeating coils, cord apparatus and common battery. The combination, when selected to have a definite and suitable transmission value, is treated as a transmission standard, and the efficiency of all other transmitting apparatus is expressed in terms of such a standard and in miles of standard cable or decibels.

**Standard Cable.** An air-space lead-covered cable, used for transmission tests, having conductors weighing 20 lbs. per mile per wire, and a capacity of 0.054  $\mu$ f. per mile wire to wire. Leakance of 1 micromho and Inductance of 0.001 henry per mile.

**Standard Cable Equivalent of a Line.** The length of standard cable which cuts down or attenuates speech transmitted through it to the same extent as speech over the line whose standard cable equivalent is required. (*Now obsolete.*)

**Starting Rheostat or Starter (Motor).** A series of resistances in a motor circuit, arranged in conjunction with a rheostat arm which moves over the rheostat contacts and gradually cuts the resistances out of circuit as the motor is run up to speed at starting.

**Stay.** A pole support usually made of stranded wires designed to keep a pole upright when the tension on it tends to deflect it from the vertical position away from the stay. At its upper end it is looped round the pole and at its lower end it is fixed to a rod attached to a block which is buried in the earth.

**Strut.** A wooden pole support, constructed to push against a pole, which has a tendency to deflect from the vertical towards the strut, to counteract its tendency to deflect from the vertical position.

**Sub-audio Telegraphy.** The use of low frequency currents to operate a telegraph on a circuit also carrying telephonic currents. The two channels are separated at the ends and at intermediate points as desired by "low pass" and "high pass" filters. See Van Rysselberghe System.

**Superposing.** The provision of a phantom circuit on two telephone circuits or one telephone circuit and earth, usually for use as a telegraph circuit.

**Switchboard (Telephone Exchange).** A group of sections (see **Switch Section**) on which are mounted jacks (also called switch springs) and lamps, or other indicators, together with cord circuits, keys, relays, etc., to permit of intercommunication among telephone subscribers. The subscribers' and other equipment is divided into convenient groups, each controlled by one operator. See **Multiple Switchboard**.

**Switch Section (Telephone Exchange).** A unit of an exchange switchboard including one or more operator's positions. In very small exchanges, one switch section, having one operator's position, may suffice for the needs of the service.

The jacks and line signalling indicators are generally accommodated on the vertical panel, and the operator's keys, etc., on the horizontal (or sloping) keyboard. The section wiring and relays, etc., are arranged behind the section.

**Synchronism.** The occurrence of two or more events or facts at the same time. This term is frequently used in connection with two distributors (which see) at the two ends of a telegraph circuit. If one of the stations is called "A" and the other "B" then if at any instant one arm is on any segment at station "A" (say, segment No. 9), and at the same time the arm at station "B" is on any given segment (say, segment No. 11), there will be synchronism if at each revolution, the arm at "A" is on segment No. 9 when at the same time that at "B" is on segment No. 11, and the same reasoning applies to any other similarly related pairs of segments at the two stations.

**TELEGRAPHIC REPEATER.** An arrangement consisting fundamentally of a relay, or relays, and a battery inserted at an intermediate point in a long telegraph line. A telegraph signal received at the intermediate point from either end actuates a relay and connects the battery to line in such a way that the received signal is augmented, and retransmitted to the terminal receiving station.

**Telephone Cabinet.** A large box or cabinet designed to accommodate a telephone subscriber and telephone speaking apparatus, the cabinet having its sides packed with sound-proof material, to permit of telephone conversations in the cabinet being inaudible outside.

**Telephonic Relay.** A device, such as a thermionic valve, for magnifying speech currents in a telephone circuit.

**Telephonic Repeater.** A complete apparatus installation (including relay, balancing and ringing devices) for magnifying telephonic speech, and transmitting it in both directions, in a telephone circuit.

**Teleprinter.** A printing telegraph system using a keyboard typewriter for transmitting. The received signals are printed in roman characters on a continuous slip.

A five-unit code is used with starting and stopping impulses.

The apparatus at each station is normally at rest, except for the running of a small motor, and is set in motion automatically when signalling commences and stopped when signalling is finished.

**Temperature Coefficient.** A constant which permits of calculating the change in resistance which occurs when the temperature of a conductor is raised or lowered, the resistance of the conductor at a given temperature being known.

**Terminal Loss.** A transmission loss over and above the line attenuation (which see), which occurs at the junction of a long line and its terminal speaking apparatus when the terminal apparatus has an impedance which differs from the characteristic impedance of the line.

**Test Box.** A panel with insulated terminals, on which lines, apparatus and batteries are terminated for testing and crossing purposes. Lightning protectors are fitted.

**Thermionic Valve.** An exhausted glass bulb with a metallic filament (cathode) and plate (anode). The passage of a current through the filament heats it, and causes the space between the anode and cathode to become a conducting medium in one direction. If a grid is then interposed between the anode and cathode the valve magnifies telephonic currents and acts as a relay.

**Thermo-couple.** An electric circuit made up of two dissimilar metallic conductors and having the property that when one of the junctions between the different metals is at a higher temperature than the other an E.M.F. is produced.

**Three-Phase Circuit.** A power circuit energized by three alternating electromotive forces of the same frequency, but which differ in phase by 120 degrees.

**Toll Line.** See **Trunk Circuit.** In America this is the same as "Trunk line" in this country. A toll circuit in this country is a short trunk circuit operated on a no-delay basis.

**Traffic Distributor.** An automatic device in a telephone exchange which enables a calling telephone subscriber to find a disengaged operator in the exchange to which the subscriber is connected. In the absence of such a device the subscriber's calling apparatus is associated with one fixed operator's position.

**Transformer.** A stationary piece of apparatus with two or more windings insulated from each other, but so placed with regard to each other, that the magnetic field caused by an alternating current in the one winding induces a voltage in the opposite direction in the other winding, through the medium of magnetic energy. The principle is the same as the induction coil, but the dimensions and output are different.

**Transmission Scheme.** A scheme for providing a given decibel equivalent grade of transmission between any two points in a telephone area, by means of the most suitable and economical arrangement of conductors and apparatus.

**Transmitter (Telephone), Carbon Granule.** A transmitter consisting of carbon granules held between conducting plates, one of which is a carbon diaphragm, or a mica diaphragm carrying a carbon button. The voice imparts a vibratory movement to the diaphragm, and the resulting variation of pressure on the granules alters their resistance and varies the current in the transmitter circuit, with the result that speech is transmitted.

**Transposition System of Crossing Telephone Wires.** An anti-inductive system of erecting telephone wires on poles. The two wires of a pair are run straight, and crossed at regular intervals to prevent inductive disturbance from outside sources. Cross-talk among circuits which are liable to interfere with one another in a given section is avoided by systematic crosses made in such a way that each circuit is balanced against the others.

**Trunk Circuit.** A telephone circuit connecting two telephone exchanges in different local areas; a long distance or inter-urban circuit.

**Twisted Wires.** See **Revolved Wires.**

**Two-Phase Circuit.** A power circuit energized by two alternating electromotive forces of the same frequency, but which differ in phase by 90 degrees.

**UNDULATOR.** A telegraph receiving instrument which utilizes a light syphon instead of the tongue of a specially designed polarized relay. The syphon spurts ink on a slip when the relay is actuated and registers visible signals.

**VACUUM TUBE.** A bulb from which air has been exhausted.

**Van Rysselberghe System.** A system of simultaneous telegraphy and telephony in the same circuit, based on the different behaviour of an impedance to slow telegraph signals and relatively high frequency telephone currents. Invented by Van Rysselberghe, a Belgian engineer.

**Virtual Volts and Virtual Currents.** The virtual values of alternating volts and current are those which are read on alternating current measuring instruments. The readings of these instruments when calibrated by continuous currents are the

square roots of the mean of the squares of the instantaneous values in a cycle of A.C. volts and current. If the alternating volts and current vary in accordance with the Sine Law, the virtual value of an A.C. cycle is obtained by taking the maximum value of the cycle multiplied by 0.707.

**Voice-frequency Telegraphy.** A system of multiplex telegraphy in which a number of independent channels are obtained by the use of alternating currents of different frequencies all lying between about 300 and 2,000 periods per second.

**Volt.** The unit of electromotive force. The E.M.F. which, when steadily applied to a conductor having a resistance of one ohm, produces a current of one ampère in it. The volt= $10^9$  absolute units.

**WATCH RECEIVER.** A telephone receiver which has approximately the external form of a watch.

**Watt.** The unit of power= $10^7$  absolute units of power= $1$  joule per second.

**Wattmeter.** An instrument for measuring electrical power in watts.

**Wave Length of a Circuit.** The circuit length in which a sine wave of alternating current passes through a complete angular cycle.

**Wheatstone Automatic.** A system of telegraphy in which the hand-worked Morse key is replaced by a transmitter which is designed to automatically transmit signals at a very rapid rate, when a punched slip (see **Punching**) bearing the signals it is desired to transmit, and which has previously been prepared by hand, is passed through it by clockwork. The received signals are generally too rapid to be read by sound, and may be recorded at the receiving end on a Morse tape and afterwards transcribed by hand, or by a Creed Receiving Perforator and Printer.

**Wheatstone Bridge.** A testing instrument for measuring resistance. It consists essentially of three known resistances which may be denoted by *A*, *B*, and *C*, one at least of which must be variable (say *C*), and one unknown resistance denoted by *D*, which latter resistance may then be measured by the aid of a battery and a sensitive galvanometer in association with the known resistances. The essentials of a common arrangement may be seen by connecting *A*, *B*, *C* and *D* in

series to form a continuous circuit. If one pole of the battery be then joined to the junction of *A* and *B*, and the other pole to the junction of *C* and *D*, and at the same time the galvanometer connects the junctions *A D* and *B C*, no current will flow through the galvanometer when  $D = \frac{AC}{B}$ . The unknown resistance is then obtained in terms of the known resistances.

**Wheatstone Transmitter.** See **Wheatstone Automatic.**

**Wiped Joint.** A plumber's joint for uniting two separate lead cable sheaths.

**Work, Electric.** See **Joule.**

### **CORRECTION SLIP TABLE.**

The month and year of issue is printed at the end of each amendment in the Correction Slips, and the number of the slip in which any particular amendment is issued can, therefore, be traced from the date. In the case of short corrections made in manuscript, the date of issue of the slip should be noted against the correction.

The Summary portions of the Correction Slips should be completed and affixed below in numerical order.

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**CORRECTION SLIP TABLE (contd.)**

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# LIST OF Technical Pamphlets for Workmen.

(Continued.)

## GROUP D.—*continued.*

18. Distribution Cases, M.D.F. and I.D.F.
19. Cord Repairs.
20. Superposed Circuits. Transformers. Bridging Coils and Retardation Coils.
21. Call Offices.
22. Units, Amplifying. (*Not on sale.*)

## GROUP E.

1. Automatic Telephony : Step by Step Systems.
2. Automatic Telephony : Coded Call Indicator (C.C.I.) Working
3. Automatic Telephony : Keysending " B " positions.

## GROUP F.

1. Subscribers' Apparatus. Common Battery System.
2. Subscribers' Apparatus, C.B.S. Part I—C.B.S. No. 1 System.
3. Subscribers' Apparatus. Magneto.
4. Private Branch Exchanges—Common Battery System.
5. Private Branch Exchange—C.B. Multiple No. 9.
6. Private Branch Exchanges—Magneto.
7. House Telephone Systems.
8. Wiring of Subscribers' Premises.

## GROUP G.

1. Maintenance of Secondary Cells.
2. Power Plant for Telegraph and Telephone Purposes.
3. Maintenance of Power Plant for Telegraph and Telephone Purposes.
4. Telegraph Battery Power Distribution Boards.

## GROUP H.

1. Open Line Construction, Part I.
2. Open Line Construction, Part II.
3. Open Line Maintenance.
4. Underground Construction, Part I—Conduits.
5. Underground Construction, Part II.—Cables.
6. Underground Maintenance.
7. Cable Balancing.
8. Power Circuit Guarding.
9. Electrolytic Action on Cable Sheaths, etc.
10. Constants of Conductors used for Telegraph and Telephone Purposes.

## GROUP I.

1. Submarine Cables.

## GROUP K.

1. Electric Lighting.
2. Lifts.
3. Heating Systems
4. Pneumatic Tube Systems.
5. Gas and Petrol Engines.