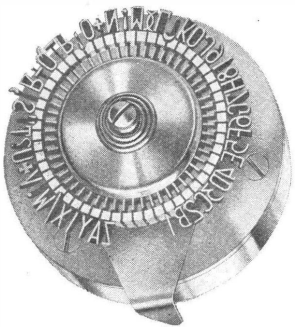
THE PRINTING TELEGRAPH REFERENCE BOOK

ERRATA.

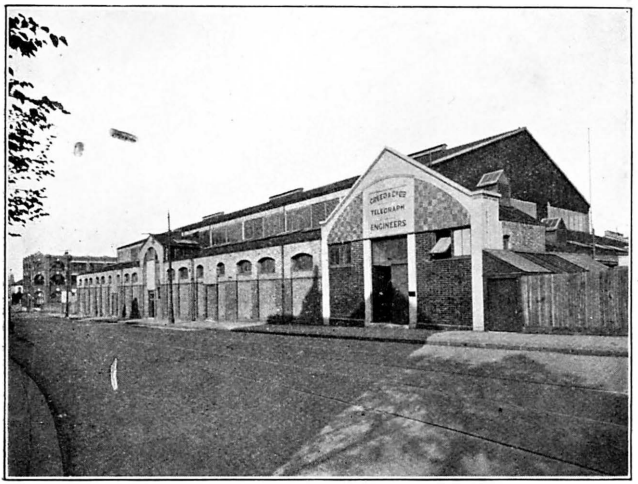
Pages 39, 41, 42, 44, 47.—Creed Transmitter spare parts should be prefixed by the reference No. 850, in place of 856.

Page 56.—Read under Transmitter (Creed Wheatstone): "From 50 to 200 words per minute. Changes of speed can be effected by turning," etc.

The Printing Telegraph Handbook.



CREED & COMPANY, LTD:
TELEGRAPH WORKS,
CROYDON,
ENGLAND.



Works and Offices: TELEGRAPH WORKS, CROYDON (near East Croydon Station), ENGLAND.
Telegrams: "Credo, Croydon." Telephone: 2121 Croydon (2 lines).
Fleet Street Offices: 36-38, Whitefriars Street, London, E.C. (Mechanicians only). Tel. No.; Central 6698.

Foreign Representatives:

Argentine: COLSON, BROOKHOUSE & PYNE, Buenos Aires.

Australia: AMALGAMATED WIRELESS (AUSTRALASIA), LTD., Sydney.

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Colombia: F. GOMEZ O., Bogotá.

France: JACQUES PERES ET FILS, Paris.

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Italy: SOCIETA ITALIANA MARCONI, Rome.

Japan: TOZER, KEMSLEY & MILLBOURN, LTD., London.

Norway: NORSK MARCONIKOMPANI, Oslo.

South Africa: ROGERS, JENKINS & CO., Capetown, Johannesburg and Durban.

Spain: JOSE GOROSTIDI, Madrid.

Sweden: SVENSKA RADIOAKTIEBOLAGET, Stockholm.

U.S.A.: JASON S. CREED, New York.

INTRODUCTION.

Undoubtedly the most interesting event in Telegraph circles during 1925 was the acquirement, by Creed & Co., Ltd., of the Murray Multiplex and other telegraph patents —a development which opens a new chapter in the history of British Telegraphy, and promises a future full of interest for Telegraph Engineers and Operators.

Mr. Donald Murray, the Inventor of the Murray Multiplex System, was born in New Zealand, trained as a farmer, became journalist, and finally concentrated on the development of telegraph machinery; his love of mechanical devices inspired him with a desire to operate the Linotype (a well-known composing and type-casting machine) by telegraph. This was followed by the Murray Automatic—a high-speed single channel telegraph system using the five-unit code. Still seeking the ideal, Mr. Murray produced his Multiplex—the best of all five-unit systems—which has become popular in India, Australia, New Zealand, Brazil, Russia, and with the British Press. Recently the Murray Multiplex has been designed for working on Baudôt circuits, and the automatic control of the units of this slower system will undoubtedly save it from that complete extinction, which is the certain fate of all hand-operated telegraphs with a low cadence-restricted output.

Mr. F. G. Creed, the Chairman and Managing Director of Creed & Co., Ltd., spent many years as a Cable Operator in South America, and his practical knowledge of telegraph requirements is of inestimable value in anticipating the demands of Modern Telegraphy. In 1896 the only high-speed automatic system in use was the Wheatstone; very speedy on the lines, but hampered at the stations by antiquated "punching" and decoding processes. Mr. Creed converted the Wheatstone system into a highly-efficient high-speed printing telegraph with his Keyboard Perforator, Simplified Transmitter, Receiving Perforator, and Printer. The "Creed" is directly responsible for the enormous network of newspaper private wires in Great Britain, and the ease with which the System can be worked has made it popular with the British Press, Cable and Radio Companies. Recently Mr. Creed has turned his attention to five-unit systems, and the editorial quiet of Fleet Street offices has been rudely disturbed by the advent of the Creed Direct Printer, a "start-stop" telegraph system for recording news in page printed form at eighty-five words per minute. Creed & Co., Ltd., are now manufacturing the units of the Creed System, the Murray Multiplex, and the Creed Direct Star-stop Printer at their Croydon factory, which is staffed by trained engineers and the finest of craftsmen. Customers will be able to equip their lines by choosing the System or Code most suited to their requirements.

This little booklet is primarily intended to be an alphabetical reference of Creed and Murray apparatus, but many other useful telegraph references have been included

A.J.P.

INDEX OF CREED REFERENCES.

INDEX OF MURRAY MULTIPLEX REFERENCES.

ACCUMULATOR ACID. See Hydrometer, Page 21.

ALTERNATING. A current which constantly alternates from a positive maximum to a negative maximum. The speed with which this change takes place is known as the Frequency: usually expressed in cycles per second.

AMPERE. The unit of measurement for current. The current which will flow through a circuit having a resistance of one ohm when urged by an E.M.F. of one volt.

AMPLITUDE. Largeness or extent. The arc through which a vibrating reed or tongue moves between contacts or studs.

BALANCING. For duplex working the actual line must be imitated by the artificial line as much as possible; signals will then be sharp and definite in both directions and maximum speeds easily attainable. First see that all relay contacts are clean and that the relay is set neutral so that the tongue will stay on either contact.

The balance should be carried out in the following order:—

1. Ask distant station for "R." (He puts the line to earth through a resistance equivalent to that of his battery).

2. Balance Resistance. (The Galvanometer needle should remain vertical when the key is depressed. If it dips in a spacing direction the rheostat resistance should be increased, and if to marking, the resistance requires decreasing. Ignore flicking and trembling movements for the time being.)

3. Balance capacity. (If, on depressing the key, the galvanometer needle kicks in a marking direction—increase the condenser capacity. If in a spacing direction—decrease capacity. If there is a double kick coinciding with the depression and release of the key, the timing resistances require alteration.)

4. Adjust the retardation and condenser coils. (A useful Post Office formula which can be employed as a starting point for adjusting the timing resistances is as follows:—Supposing the resistance of the line balances at 2600Ω. Dividing this quantity

by 100=26, and 26 × 7=182=retardation coil resistance; 26 × 21=546=first condenser coil resistance; and 26 × 35=910=2nd condenser coil resistance (if used). It must be understood, of course, that variations to these quantities will be caused by changes in the nature of the conductors, different gauge wires, cables, etc.)

The finer touches to the balance can be made by asking the distant station to cut in and run reversals, meanwhile working the key erratically and changing the smaller condenser and retardation plugs until all clicking and chattering has disappeared.

BAUDOT. A five-unit multi-channel system, invented in 1874 by M. Baudot, of the French Telegraph Service. The line time is equally divided between the different channels by suitable distributors at each end of the line, the brush-arms of which must revolve at synchronous speeds. The cadence speed of each channel is 30 w.p.m. Baudot distributor brush-arms can be revolved by means of the Phonic Wheel and Vibrator, and with the adoption of the Murray Code the channels can be equipped with keyboard perforators and automatic transmitters, thus admitting of higher speeds. See Codes (Baudot) Page 11.

BATTERY COILS. P.O. Pattern Coils of 50, 100, and 200Ω. Three plugs.

BICHROMATE CELL. A porous cell is placed inside a glass or earthenware container of larger diameter. In the porous cell a stout rod of zinc having an enlarged base is inserted, and in the outer vessel a carbon plate. The porous cell is then partly filled with dilute sulphuric acid and a small quantity of mercury, and the container with sulphuric acid and potassium bichromatic (K2 Cr2 O7). E.M.F. 2.14 volts. Internal resistance (quart size) 2 to 3 ohms.

BRIDGE DUPLEX. Used upon cable and lengthy land lines. The current divides through two resistance coils to the line and compensation circuits, between which the receiving apparatus is placed. Both signalling and reading condensers are used.

BRUSHES (FOR DISTRIBUTORS).

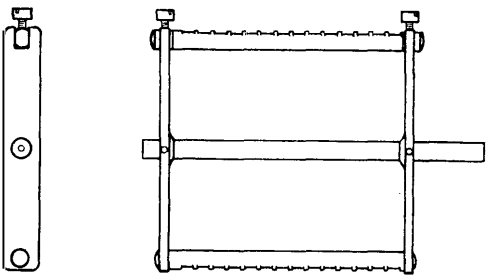
Copper Brushes require trimming daily. They should be closely examined for straggling wires and cut across with a pair of sharp scissors, making sure that the angle of the cut coincides with the plane of the segments.

Silver Brushes made from silver solder strip have proved very successful. The strip should project not more than ¼in. from the brush-holder and the end carefully bent to the proper angle with a

pair of small pliers. A backing strip of thin steel, shorter than the silver strip, should be placed over the brush before clamping it into position.

Steel Brushes work well provided the plateau surface is kept polished, but if this is not done ripple marks will soon develop.

Braided Copper Brushes. There is a difference of opinion about the performance of these brushes. If they are carefully examined and the ends trimmed, they will be found to make good contact and prove very satisfactory.



BRUSH FORMER.

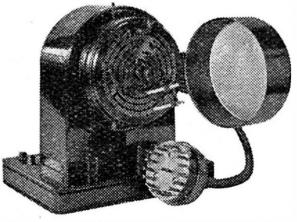
BRUSHES, HOW TO MAKE COPPER. These can be made on a frame cut with shallow slots as shown above. The slots are .14in. wide, with 1/32in. between each. The frame should be mounted in a lathe and copper or phosphor bronze wire of .007 diameter neatly wound into each recess (about 20 turns). When the slots are filled, the wire can be drawn taut by means of the two screws. Solder is then run along the top and bottom bar. Now slacken the screws and cut the wire through the solder into suitable lengths with a sharp pair of scissors. Creed & Co. Ltd. supply at small cost a frame similar to the above and suitable for winding 14 brushes at once.

CADENCE. In Baudot working; the warning signal given to sending operators to indicate that their keyboards are connected to line through the distributor segments and brushes. A similar signal is distributed in turn to the electro-magnets of Murray Transmitters in order to operate the tape-feed and the selecting needles.

CAPACITY. The capacity of a line or conductor refers to its property of retaining in suspension a charge of electricity. The quantity of electricity which a system of Conductors can hold at a given potential is a measure of the capacity. The unit of capacity, the Farad, is much too large for practical use, and the one-millionth part of this quantity, the Microfarad, is used for telegraph purposes. In artificial lines used for duplex working, the capacity of the line is imitated by using condensers constructed of alternate layers of tinfoil and paraffin-waxed paper. The tinfoil is connected to suitable metal segments controlled by plugs to vary the charge. See Condenser, Page 14.

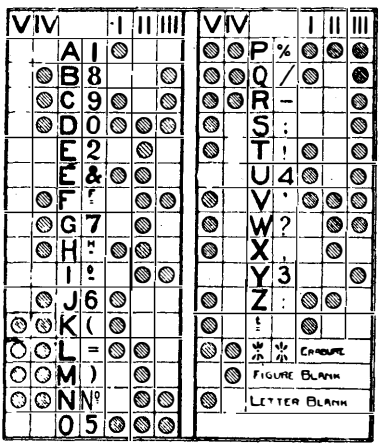
CAPACITY & RESISTANCE OF VARIOUS TYPES OF LINE,

Type of Line.	Type of Wire.	Gauge.	Capacity in m.f.s. per mile.	Resistance per mile in ohms.
Aerial	Copper	100-lb.	.0144	8.7873
,,	,,	150-lb.	.0147	5.8582
,,	,,	200-lb.	.015	4.3936
,,	,,	300-lb.	.0153	2.9291
,,	,,	400-lb.	.0156	2.1968
,,	,,	600-lb.	.0158	1.4645
,,	,,	800-lb.	.016	1.0984
,,	Iron	400-lb.	.0157	13.32
,,	,,	450-lb.	.016	11.84
G.P. Underground	Copper	40-lb.	.3	21.956
Screened cable	,,	40-lb.	.125 (Herbert's Telegraphy)	21.956



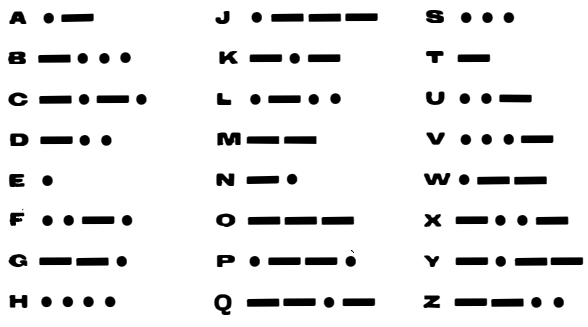
CLOCK-FACE COVERS FOR DISTRIBUTORS.

Creed & Co. Ltd. supply suitable clock-face covers for protecting the distributor plateaux and brush-gear from dust or being tampered with when working. Write for further particulars and prices.

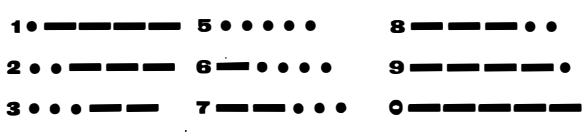


CODES (BAUDOT). M. Baudot devised his code long before the first typewriter was made. By using Murray type and inversion wheels the Murray code can be introduced on Baudot circuits, thus admitting of the use of Murray keyboard Perforators in place of the Baudot keyboard. The Murray type and inversion wheel can be interchanged with the Baudot type-wheel in a few minutes.

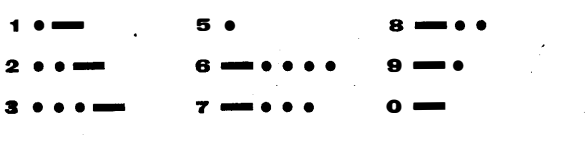
ALPHABET.



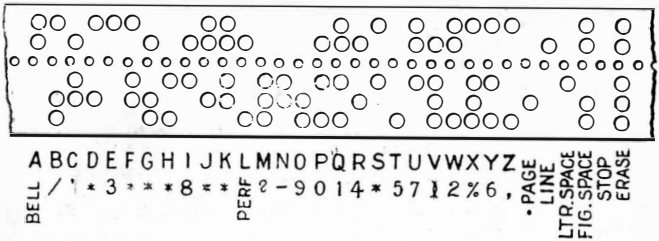
NUMERALS.



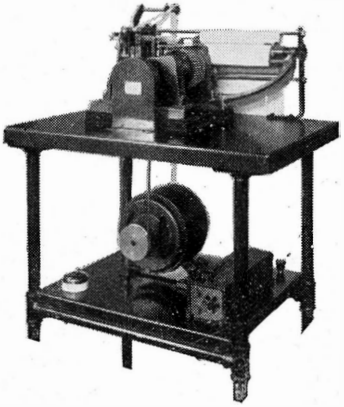
ABBREVIATED NUMERALS.



CODES (MORSE). The International Morse Code is in World-wide use, except the United States. It is arranged so that those letters most frequently used are the shortest.



CODES (MURRAY). The Murray Five-Unit Code is arranged so that the most frequently used letters are represented by the fewest holes in the paper tape. It has been adopted as the standard five-unit code by the British Post Office, the Western Union Telegraph Co., the Postal Telegraph Co., and in Australia, New Zealand, Canada, India and South Africa.



COLUMN PRINTER (CREED). The standard Creed Printer (Morse) can be arranged to print in column form on a web of paper by the addition of suitable paper feeding and printing carriage mechanism. The Carriage-return and Line-feed operations are controlled by one signal (— · · · —) followed by three centre holes, the latter being inserted to allow time for the carriage to return to the commencement of a line when running at high speeds. Keyboard Perforators used with the Creed column Printer require to be fitted with a letter counting device in order to warn the operator of the approach of the end of a line, which is done by the lighting of a ruby warning lamp. The Carriage Return signal is then punched, the pointer on the dial of the letter counter returns to zero, and a new line can be commenced. The speed of the Creed Column Printer is 100 words per minute.

COMMUTATOR. In dynamos, an arrangement for reversing the connections of the armature coils to the brushes at the moment when the E.M.F. in the coils reverses.

CONDUCTORS. No substance is a perfect conductor. Their order of merit is as follows:—Silver, copper, gold, aluminium, zinc, platinum, iron, tin, lead, mercury, carbon, acids, salt solution and water.

CONDENSERS. P.O. Pattern 7¼ M.F., subdivided into sections of 2, 1, .5, .25 and 2, 1, .5 M.F. Seven plugs.

P.O. Pattern 10¾ M.F. sub-divided into sections of 3, 2, 1, .5, .25, and 2. 1, .5, .5 M.F. Nine Plugs.

P.O. Pattern 11¾ M.F., subdivided into sections of 4, 2, 1, .5, .25, and 2, 1, .5, .5 M.F. Nine plugs.

P.O. Pattern Triple 39.375 M.F., subdivided in two sections, each 8, 4, 2, 1, .5, .25 M.F., and one section 4, 2, 1, .5, .25, .125 M.F.

CONDENSER COILS. P.O. Pattern, Total: 4050Ω, comprising coils of 50, 100, 200, 300, 400, 1,000, and 2,000Ω. Seven plugs.

CORRECTION (CREED). Morse signals are corrected on the Creed Receiver by means of a V-toothed wheel which is engaged by wedge-shaped corrector-rods moving in sympathy with the incoming signals. Solid on the same spindle and turning with the V-toothed wheel (corrector wheel) is the tape-feed wheel fitted with small pins, which engage the feed holes in the receiver tape and draw it forward. The paper feed pins and the V-teeth are in line with one another, so that the speed of the moving tape must agree with the distant stations transmitter speed. Should the speed differ, the wedge-shaped corrector rods slide down the faces of the V-teeth and retard or advance the feeding of the tape according to whether the signal speed is too fast or too slow. The tape-feed and corrector-wheel spindle is driven through a light friction clutch.

Creed Receivers have a margin of correction amounting to 30 % fast and 5% slow, but these values are influenced by the line conditions.

CORRECTION (MURRAY). The "Corrected" station's distributor brush arms should revolve 2% faster than the brushes at the "correcting" station. At the "corrected" station the distributor is provided with a small electro-magnet and armature which receives the correcting impulse sent out once every revolution by the sending station's distributor. This armature controls the movements of a pin which normally passes between the teeth of a star-wheel geared to the brush-arm mechanism. Any tendency on the part of the distributor to run fast or slow is checked by the pin impinging on the star-wheel teeth, retarding or advancing it the distance of one tooth, and thus re-setting the position of the brush-arms. The frequency with which this correcting operation is carried out is indicated by the movement of a small flag or bead.

COULOMB. The unit of quantity of electricity and may be defined as the quantity of electricity which would pass any given point in a circuit carrying an unvarying current of one ampere in one second.

360 Coulombs=one ampere-hour.

CREED SYSTEM, PRINCIPLES OF.

The Creed High-Speed Automatic Printing Telegraph is a development of the Wheatstone system, and provides for the transposition, at a high speed, of automatic Morse signals into Roman characters. At the sending station the telegrams are prepared on a Creed Keyboard Perforator (see pages 22 and 23), upon which an operator with a knowledge of the typewriter keyboard can prepare perforated Wheatstone slip at speeds up to 60 or more words per minute. This perforated slip is then passed through an ordinary Wheatstone Transmitter (or preferably a Creed Transmitter, see page 56), the mechanism of which is controlled by the perforations in the slip, and caused to send to the line corresponding Morse Code signals at any suitable speed, varying from 30 to 200 words per minute.

At the receiving station, suitable mechanism is provided for the reception of the signals and their reproduction in the form of a perforated strip by the Creed Receiving Perforator (see page 34). This received slip is identical in every respect to the original perforated slip prepared on the Keyboard Perforator, the centre-holes and signal perforations coinciding with the standard Wheatstone gauges. The received slip is either used for retransmission, or is passed through the Creed Printer (see page 29), which provides mechanism for feeding the tape forward letter by letter, selecting the type corresponding to the permutations, imprinting the message in Roman characters on a blank strip of paper and feeding the paper forward. Printing can either be in strip form, or in column form on a web of paper accommodating 60 or more characters to a line. If printed on a paper strip, this is cut into lengths and gummed by a semi-

automatic process on to telegram forms, and is ready for delivery. With column printing, the finished messages only need tearing off against the knife-edge provided.

The Creed System will work with great ease on extremely long and difficult circuits. Owing to its use of the Morse Code, the signals are easily read at any part of the line. The system is readily duplexed, and synchronism between the sending and receiving stations is not strictly necessary—the Creed Receiver providing a sufficient margin of correction to allow of a considerable difference in speed. This margin, however, is regulated by the nature of the line and its length.

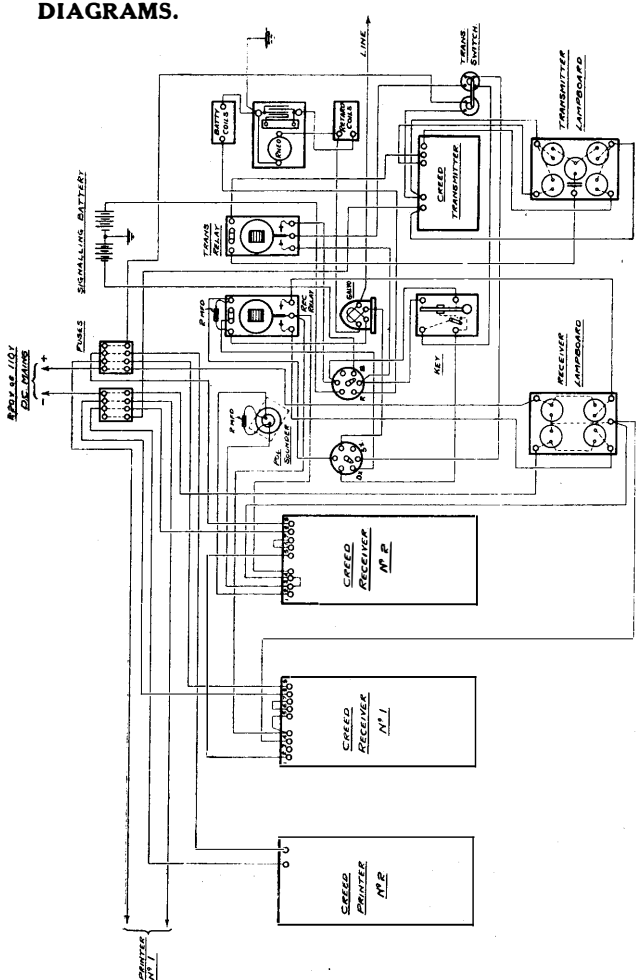
CREED SYSTEM, APPLICATION TO WIRELESS.

The Creed System will operate with conspicuous success on wireless routes, and many important European services are permanently equipped with Creed apparatus working at average speeds of 70 words per minute, the traffic being printed in Roman characters at the receiving stations at the same speed. The method of application is simple. At the sending station the perforated slip is prepared and passed through the Transmitter, which, instead of sending the signals to line, controls the medium for wireless transmission. If this is a Poulsen arc, the Transmitter operates by means of a local circuit, the high-powered compressed-air key (see Page —) used for short-circuiting the aerial inductance. If three-electrode valves are used for transmission, the Transmitter controls the grid circuits through a special highly-insulated relay. At the receiving station the incoming wireless signals are received and amplified in the usual manner, the anode circuit of the last valve being connected to a Creed Relay with 1600Ω coils, and the signals are passed on to an Undulator or Creed Receiver, the latter reproducing a replica of the sending station's perforated slip, which is transposed by the Printer, and the copy gummed up ready for delivery.

DANIELL CELL. A porous pot containing a cylindrical copper plate is placed in a glass jar. A cylindrical zinc plate is placed outside the porous pot, and the glass vessel partly filled with a solution of zinc sulphate ($ZnSO_4$). The porous pot is filled with copper sulphate ($CuSO_4$). E.M.F. 1.07 volts. Internal resistance 3 to 5 ohms. The same cell constructed in trough form is much used in telegraph offices.

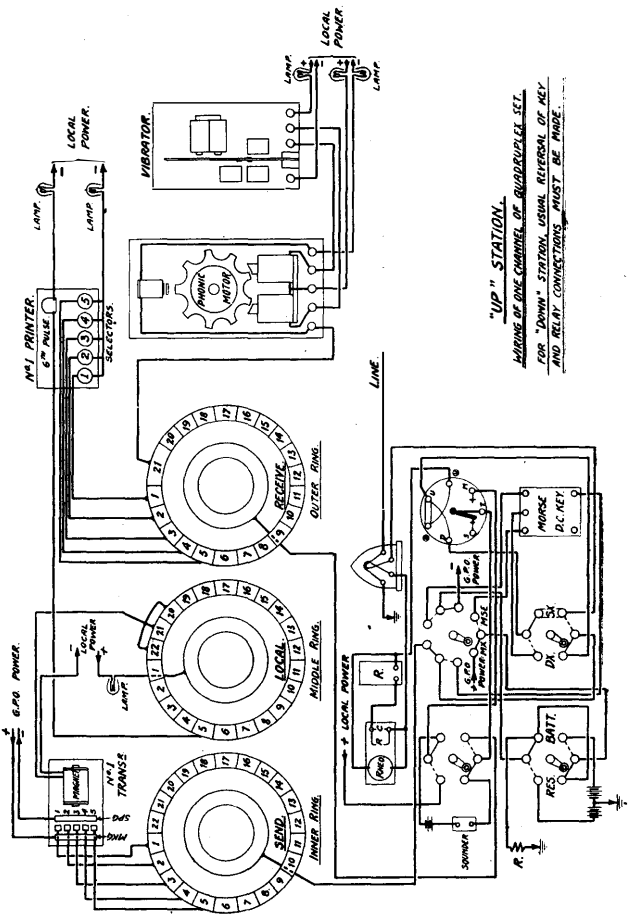
DEXTRINE, HOW TO PREPARE. Dissolve 5-lbs. Dextrine in 30-oz. Cold Water, and add 30-oz. Boiling Water. Strain through muslin rag.

DIAGRAMS.



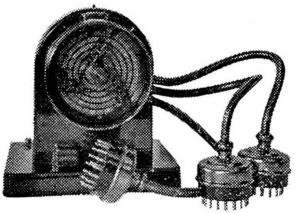
CREED DIFFERENTIAL DUPLEX (1925 design Receivers). For internal connection of Receiver see Page 35.

DIAGRAMS.



MURRAY MULTIPLEX (QUADRUPLE DUPLEX).

DIPLEX. The forerunner of the Quadruplex. One channel (A-side) duplex, and one channel (B-side) simplex.



DISTRIBUTOR (MURRAY). Mr. Donald Murray rightly describes Distributors as clocks or time dividers. In his "Press-The-Button Telegraphy" he states: "Synchronism assumes conspicuous importance in high-speed printing telegraphy because the time-dividing has to be very fine and precise. The minute hand of a clock takes one hour for a revolution, but the hands or contact brush-arms of multiplex distributor clocks may revolve as many as six times a second, or 21,600 times faster than the minute hand of an ordinary clock. . . . . It follows that owing to their extreme speed, they must keep 21,600 times better time than an ordinary clock."

The brush-arms of the Murray Distributor are revolved at a regular speed because they are controlled by a vibrating reed. The currents from the battery are alternately arranged to energise the electro-magnets of the phonic motor which, responding to the resultant alternate magnetic attractions of the teeth of the phonic-wheel, does not vary its speed unless the weights on the vibrator reed are moved.

In the Murray Distributor the Correction Magnet can be lifted out without disconnecting any wires, and the functioning of the correction mechanism is indicated by the movements of a small red bead.

See **Synchronism,** Page 48, and **Vibrator,** Page 59.

EDDY CURRANTS. When a conductor is subjected to a varying electric or magnetic field eddy currents are induced in it. These currents depend on the intensity of the field, its rate of change, the shape of the conductor, and its specific resistance, and they oppose the changes of field that induces them. The eddy current losses in conducting iron laminations can be calculated from the formula

$$W = 40.6 \frac{t^2 B^2 n^2 V}{10^{12}}$$ t=thickness of laminations

in inches. B =maximum flux density in lines per square inch. V =volume of iron in cubic inches, n =frequency.

E.M.F. Electro-motive-force. Electrical pressure. The unit of measurement for E.M.F. is the Volt.

ERRORS, INVISIBLE CORRECTION OF See Invisible Correction of Errors, Page 21.

FARAD. The unit of capacity, and represents the capacity of a condenser which at a pressure of one volt would be charged with one coulomb of electricity.

FIELD RHEOSTAT. A variable resistance inserted in the field or shunt circuit of an electric motor. Resistance introduced into the shunt weakens the field, thus reducing the back-E.M.F. generated in the armature; this causes an increase in the current taken by the armature, and the latter speeds up until the back-E.M.F. has risen to balance the applied-E.M.F. minus the armature drop.

FLUX. The total number of magnetic lines of force passing through a surface is called the **Total Flux** through the surface.

The number of lines passing normally through unit area (sq. cm.) is known as the **Induction** or **Flux Density.**

The **Flux Density** (B produced by any **magnetising Force** (H) is given by the equation

$$B = \mu H$$

where μ is the Permeability of the medium.

In air and other non-magnetic media, $\mu = 1$ (so that $B = H$), but in a magnetic medium, such as iron, μ is a variable quantity, dependent on the quality of the iron and also on the value of B.

Tables giving the values of B, H and μ are available in numerous text books.

FREQUENCY. The frequency with which an alternating current passes through a complete cycle. This can be ascertained by multiplying the speed of the alternator in revolutions per second by the number of pairs of poles with which the alternator is wound.

GALVANOMETER. An instrument for indicating the value of the flow of current. The fact that electricity passing through a conductor can be made to exert a magnetic influence in proportion to its strength is made use of in controlling the movements of a suspended needle or mirror. The scale readings are given in degrees. The galvanometer most commonly used on telegraph circuits is the "Differential," and a reading of from 40° to 45° should correspond with 20 milliamperes of current. Standard P.O. Pattern: 50Ω coils, 300Ω shunt.

HENRY, THE If a current change of 1 ampere per second produces a back e.m.f. of one volt across a coil, the coil has an inductance of one Henry. The Henry can also be expressed as the inductance of a coil which has 10^8 flux leakages per ampere. $\frac{Nn}{I\,10^8}$ where N=total flux caused by I=the current in amperes in a coil having n turns.

HEXODE. A six-arm multiplex circuit. Six channels.

HUGHES. A directly worked synchronous type-printing telegraph employing no code alphabet. The working currents are of equal duration, but are separated by unequal intervals of time. Much in use on the Continent. See Textbooks by Herbert, Crotch and others.

HYDROMETER. An instrument used for testing the specific gravity of liquids.

The specific gravity of the acid in an accumulator should not exceed 1210 when fully charged, and the cell should not be discharged so that the s.g. falls below 1180.

INDUCTION COIL. Small induction coils are much used in Telephony for transforming the low-voltage high-amperage current of, say, a microphone circuit, to the high-voltage, low-amperage current more suited to line transmission. In Telegraphy equal ratio induction coils are frequently used to enable a telegraph circuit to be superimposed upon a telephone pair without mutual interference.

INDUCTANCE. That property of an electric circuit in virtue of which it tends to resist change of rate of flow of electricity. It is due to the linkage with the electrical circuit of magnetic lines of force which, on the setting up of a current, grow outwards from, for example, the core of an electro-magnet and, in cutting across the windings, induce a back E.M.F. in opposition to the applied E.M.F., thus causing the current to rise to its final value slowly. On the diminution of the current it will be seen that the magnetic lines of force will cut the windings in the opposite direction, thus setting up an E.M.F. in the same direction as the applied E.M.F. and tending to prolong the flow of current. It is this E.M.F. caused by the collapsing flux which is responsible for the relatively high voltage spark noticed on breaking the circuit of an electro-magnet. It will thus be seen that Inductance causes in an electric circuit similar phenomena to those produced by inertia on mass in mechanics. (Carpenter.)

INSULATION. No substance is a perfect insulator. The order of merit is as follows:—Dry air, glass, ebonite, paraffin wax, india-rubber, gutta-percha, silk, wool, porcelain, oils, paper, marble. This order is, however, subject to variations in accordance with the condition of the material.

INTERPOLATOR. In several telegraphic codes (the Cable Morse Code, for example) the signals take the form of electrical pulses of unit length which may be either positive or negative, and are arranged in groups to form letters. If two or more of these signals are transmitted through a submarine cable in the same direction at above a certain speed dependent on

the characteristics of the particular cable, they lose their individuality and are recorded as one signal, two or more times the length of a unit signal. It is sometimes desirable to resolve these block signals into their separate beats, and the instruments which have been evolved to do this work are called Interpolators. Interpolators can be divided into three groups—mechanical, electro-mechanical and electrical. In the first, interpolation is effected by the rotation of a synchronous timing shaft, in the second by the discharge of a condenser through a timing resistance and relay, and in the third by oscillations generated in a valve circuit.

INVISIBLE CORRECTION OF ERRORS. Errors made on the Murray Keyboard Perforator can be instantly and invisibly corrected by means of a special ERASE signal used in connection with a backspacing key. No sign of the erasure appears on the Printers at the distant station.

ISOCHRONOUS. In telegraphy, refers to two sets of rotary apparatus running at identical speeds, but without phase relation. The Morkrum telegraph is an isochronous system.

JOULE. One Joule=one Watt second.

KEYBOARD PERFORATOR (CREED).

The Creed Keyboard Perforator is made of metal throughout. Power is obtained from a small electric motor, which by means of a pulley and belt constantly revolve a spindle carrying the active member of a single revolution clutch. The depression of a key locks the selected punches into the punching position and releases the clutch pawl, thus permitting the clutch to complete one revolution and actuate the shaft carrying a triple cam. Suitable cam levers feed forward the blank paper slip, which, passing between the die-plate and die, is forced over the locked punches, pressing back those punches not required by the selection. Slip is visible up to and including the last letter punched.

For Page or Column Printing a Letter Counter and warning lamp are added. This lamp lights up about ten letters before the end of a line and indicates to the operator that he must depress the CARRIAGE-RETURN key in order that the carriage on the distant stations printer may run back to the commencement of a line and feed up in readiness for the next line.

This Perforator is also designed to punch Cable Code.

KEYBOARD PERFORATOR (DIRECT PRINTER).

See under Printer (Direct). Page 30.

THE CREED KEYBOARD PERFORATOR
(with letter-counting attachment).

MURRAY KEYBOARD PERFORATOR (Model C).

KEYBOARD PERFORATOR (MURRAY). The Murray Keyboard Perforator is an electrically controlled machine fitted with the standard three-line typewriter keyboard. The keys operate certain groups of levers which select the various combinations of perforations to be punched in the tape. The work of cutting the perforations and feeding the tape forward is performed through the medium of an electro-magnet, the circuit of which is closed with the depression of any of the keys. The armature of this electro-magnet forces the punches through the tape. A back-spacing key is provided so that the tape can be drawn back letter-by-letter and allow erasures to be made by means of the ERASE key. These erasures are invisible on the receiving stations Printer. In Multiplex installations the Keyboard Perforator is allotted a position on the immediate right of the Murray Transmitter, an inch of tape separating the two machines. This admits of only three or four seconds' delay between perforation and transmission to the line.

K.R. K = capacity in farads.
R = resistance in ohms.
The KR of a line is its capacity × resistance value.

LAMPBOARD. Current from a generator used for telegraph purposes requires to be distributed according to the strength required. This is done by inserting carbon or tungsten lamp resistances of different values in the various circuits.

LAMP RESISTANCES.

Carbon Lamps Voltage and C.P.	Ohms Res. Hot.	Ohms Res. Cold.
250/8 ...	2933	4010
200/8 ...	1257	1970
200/16 ...	687	1220
110/32 ...	118	203
110/25 ...	157	263

Metal Filament.	Ohms Res. Hot.	Ohms Res. Cold.
110/40 watt	343	26
220/40 watt	1257	91

NOTE.—Lamps of the same rating frequently differ from one another, and these values should only be accepted as approximate.

LEAK. A parallel circuit to Earth from the main conductor through a fixed or variable resistance. The current required for operating each leak station is tapped from the main conductor through suitable shunted condensers, and its value is determined by the position of the station on the line.

LECLANCHE CELL. A porous pot containing a leaden capped carbon plate embedded in manganese dioxide (Mn0 2) is placed in a square glass jar shaped at one corner to hold a zinc rod. The jar is then partly filled with a saturated solution of salammoniac (NH4C1) E.M.F. = 1.5 volts. Internal resistance about 1 ohm (quart size).

LINE VOLTAGES. The standard British P.O. line voltages are 40 volts, 80 volts, and 120 volts. Not more than 120 volts may be applied to any line.

MICRO-FARAD. A millionth part of one farad.

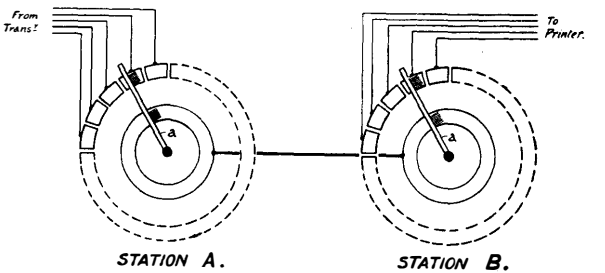
MILLIAMPEREMETER. An instrument for measuring rate of flow of current in thousandths of an ampere. (Synonymes—milliammeter, milammeter).

MILLI-VOLTMETER. An instrument for measuring electrical pressure in thousandths of a volt.

MURRAY MULTIPLEX, The.

The Murray Multiplex is an automatic system for printing the telegraphed message in Roman characters, and the apparatus includes the Murray Keyboard Perforator and Transmitter, the Vibrator and Phonic-motor Distributors used with printers of any suitable type. The system apportions the line to four or five channels consecutively for equal periods of time. Each channel is operated at a fairly low speed to suit the line conditions—say, from 35 to 60 words per minute—and is duplexed, so that a quadruple-duplex will provide for eight simultaneous transmissions—four in each direction. Punched slip is prepared on the Keyboard Perforator (see pages 24 and 25), and this is passed through the Transmitter (see page 57), which is joined to a quadrant of the Distributor. The Distributor brush sweeps over the segments of each quadrant and the five-unit signals are sent to line, being collected on a relay at the receiving station and apportioned to the various printing units by means of another Distributor.

The Multiplex principle is readily understood if the

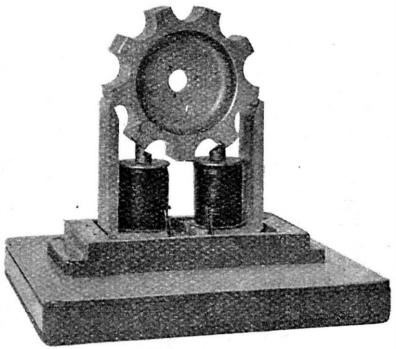


above diagram is studied. The Distributors at Stations A and B are represented by metallic rings divided into quadrants, each quadrant being sub-divided into five segments. These are traversed by the rotating brush-arms A, A, which are connected to the line, and arranged to revolve at uniform speeds and synchronise with each other (maintain phase relationship). This means that if Transmitter No. 2 at Station A is sending out a signal permutation at the instant the brush-arm is travelling over the five segments of quadrant No. 2 of his Distributor, the signals will pass through the line and the distant stations No. 2 printers, etc., providing the brush-arm at Station B is traversing the same segments at the same instant of time. The signal will then be recorded by the printer typewheel on the slip. With separate instruments on each channel, each working at, say, 45 words per minute, an aggregate speed of 45 x 4 or 180 words per minute will be obtained in each direction.

OHM. The resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice (0º C or 32º F) 14.4521 grammes in mass, of a constant cross sectional area, and of a length of 106.3 centimeters. It is the resistance offered by about two hundred yards of 100-lb. copper line wire or about 132 yards of 400-lb. iron line wire. The International Electrotechnical Commission have chosen the Greek character Ω as a sign for the Ohm. This should no longer be used for Megohm, which is now known by the combination MΩ.

OHMS LAW. The number of amperes flowing through a circuit is equal to the number of volts of electro-motive force divided by the number of ohms of resistance in the entire circuit.

ORIENTATION (MURRAY). The outer or Receiving ring of the Murray Distributor is movable, and the term "orientation" is used to describe the action of moving this ring in order to obtain the best position for receiving the signals from the line.



PHONIC WHEEL (MURRAY). The application of the Phonic Motor to the Multiplex Distributor has proved highly successful. It enables the speed of the Distributor to be varied from 120 to 360 revolutions per minute simply by changing the weight on the vibrator.

The Phonic Wheel has a concentric groove in the thickened portion filled with mercury and twisted iron wire. This gives increased stability to the wheel, and is a great improvement on the solid wheel, damping out any tendency to oscillate and producing an even fly-wheel effect.

Phonic Motors can also be applied to driving transmitters and other small powered apparatus demanding unvarying speeds.

See **Vibrator,** Page 59.

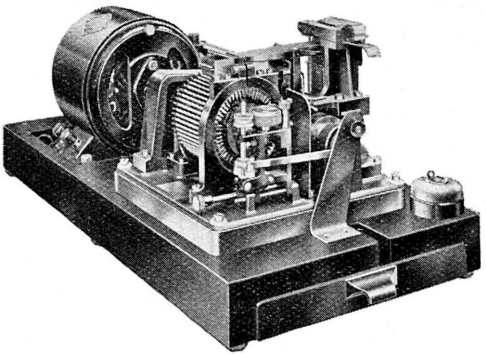
PLATEAU. Each Murray Distributor Plateau possesses six concentric rings; the three outer ones being divided into segments, and the three inner rings solid. The rings are numbered from the outer to the inner, and are connected up as follows:—Number I. (the outside ring) to the receivers—five segments for each receiver; number II. to the transmitters; number III. ("local" ring) operates the electro magnets of the transmitters, etc.

The brushes revolve and connect the plateau rings in pairs—I. to IV., II. to V., and III. to VI., thus joining the receiving and transmitting units to the line and connecting the battery to the different portions of the apparatus at the required moment.

PLATEAU, CLEANING OF. Polish up regularly with No. 1 Blue backed Emery paper (finish off with No. 00) to reduce ripple marks. Blow out between segments with a bicycle pump. Do not blow with mouth.

POTENTIAL. Implies the power or capacity to do work. Potential corresponds very closely to level as applied to water, and just as a flow of water takes place from a higher to a lower level, so does a flow of electricity or an electric current take place from a higher to a lower potential in its endeavour to restore electrical equilibrium. (Herbert.)

POTENTIOMETER. An instrument used for accurately measuring E.M.F. or current.



PRINTER (CREED STANDARD). The Creed Printer (1925 design) is the machine used with the Creed System for transposing the received perforated slip into Roman characters. It is mounted complete with its motor unit on a solidly constructed aluminium baseplate, and the necessary starting switch and controlling resistance have been incorporated in the design. The metal tape drawer has a recess for small tools.

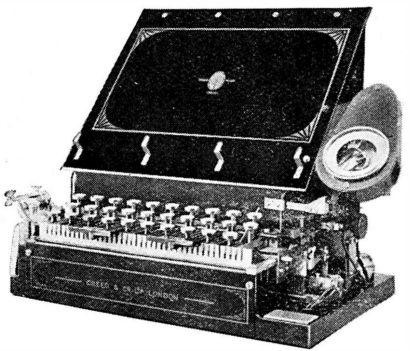
The operations of transposing and printing from the punched slip are not complicated. The punched tape is fed into the machine letter by letter, and as the letters of the Morse code each differ in length a measuring device is incorporated with the feed in order that the E (the shortest Morse permutation) may be fed and selected as easily as the cypher (the longest). This is accomplished by a rack and pinion feed working in conjunction with Space-stops, which limit the backward movement of the rack according to the length of each letter. This is known as a Differential Feed, and it is a special feature of all Morse Code telegraph machinery. With the feeding of each letter, needles or "selectors" are caused to engage the perforations in the tape. These selectors control a bank of circular combination combs. Suitable latches or bell cranks engage a selected slot cut across the series of combs, and the type-head stopped at any point with its selected character opposite the tape on the platen. A cam controlled hammer then strikes the type on the back and the impression is recorded.

A small ink roller inks the types as the type-head revolves.

A leaflet describing the action of the Printer in detail can be obtained from Creed and Co. Ltd.

PRINTER (CREED DIRECT START-STOP SYSTEM).

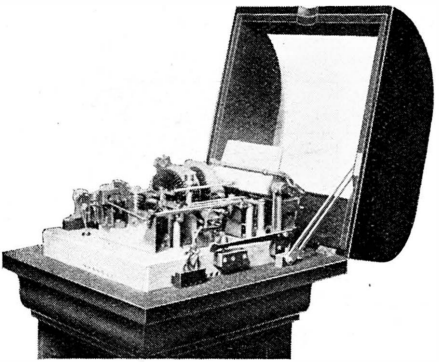
The apparatus used with the Creed Start-Stop System consists of three separate instruments, one of which, the automatic Transmitter, is used only where speeds are required that are beyond the capacity of a single keyboard Transmitter. They are:



The Keyboard Transmitter, with which is combined a slip perforator. This Transmitter can be used in three different ways: (a) to transmit, (b) to perforate slip, and (c) to transmit and perforate at the same time. The operations of transmission and perforation can be carried out at any speed of which the operator is capable. A very skilful operator can transmit for long periods at 50 or 60 words per minute, while speeds of 40 words a minute are easily obtained by the ordinary well-trained operator. In its mechanical construction this instrument consists of keys arranged in what is known as the international keyboard arrangement, which control selecting and transmitting mechanisms driven by a small electric motor. On the left-hand side of the instrument is a detachable perforating mechanism. The transmitting mechanism is on the right-hand side of the machine. Either or both can be used by the operator at will, and either of them can be readily detached from the machine if desired. A counting mechanism is provided, which lights a lamp about 10 letters before the end of the line of type, giving the operator time to finish the line or to divide a word conveniently. A key is provided, upon touching which the counter returns to Zero, and the Printer feeds up the paper and commences a new line. This instrument may be arranged to be driven from the same motor that drives the Printer which is used for reception on the same circuit, and to make its mechanical connection therewith and also its electrical connections with the line and battery, by the mere act of placing it on the table.

The Automatic Transmitter.—This instrument will transmit messages by means of the perforated slip at any speed of which the

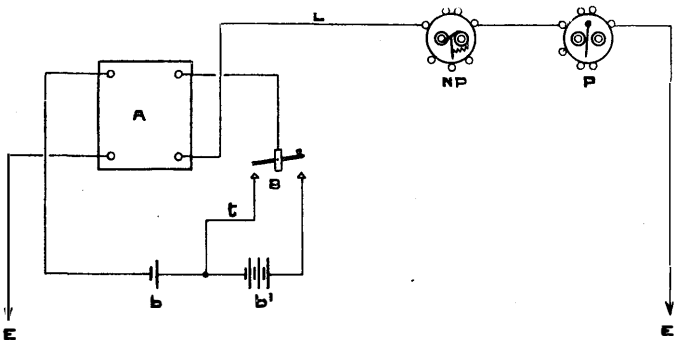
printer and the telegraph lines are capable. It is intended for use on very busy or difficult circuits. It consists of two parts: a frame-work, containing a motor which drives the mechanism, and the mechanism itself, which is easily detachable from the framework for the purposes of exchange or inspection.



The Printer.—This instrument works under the direct control of the line signals transmitted either from the Keyboard or from the Automatic Transmitter. Its ultimate speed is about 15 letters per second, or 150 words per minute, or 9,000 words per hour, and it can work equally well at any lower speed. The margin of strength and endurance, of course, increases rapidly as the speed is decreased. The present instrument is adjusted to work at the rate of 8.5 letters pr second, or 85 words per minute. The Keyboard Transmitter and the Automatic Transmitter are adjusted to work approximately at the same speed as the Printer. This speed adjustment is quickly and easily made by the mechanic or the operator himself by means of a small instrument called the Stroboscope. This instrument enables the operator to see instantly whether his instrument is running at the correct speed, and, if not, to adjust it. Its speed is fixed in the factory and is permanent. It is thus possible to ensure that the speed of instruments in every part of the country is identical. Only approximate synchronism is necessary because, as each letter is transmitted, the Printer only makes one revolution and then stops, so that any difference in speed between the Transmitter and the Printer is confined to a single revolution of the Printer mechanism and cannot accumulate. The Transmitter and Printer, therefore, cannot get out of step. Apart from the regulation of the speed, the Printer contains no other working adjustment. If desired, a speed-change gear of the motor-car type can be embodied in each instrument by means of which the Transmitter and Printer on any circuit can be quickly changed from a high to a low or intermediate speed, or vice versa, to accommodate the state of the line or the traffic. The fixed

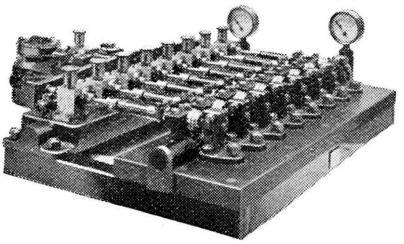
speed of the motor would remain unaltered. The Printer can be arranged to stand on a pedestal (which is the usual arrangement for Newspaper purposes) or to sit on the table as is usual in telegraph offices. The motor is separate from the Printer. The mechanical connection between the motor and the Printer, and the electrical connection of the Printer with the telegraph line and battery is made simply by placing the Printer on its pedestal or table.

QUADRUPLE DUPLEX. A four-arm multiplex circuit, four channels duplexed.



QUADRUPLEX (CREED). The Creed Quadruplex admits of the simultaneous automatic transmission at a high speed of four separate messages (two in each direction) over a single line connecting two stations. The principle of working is based on the fact that currents of electricity differ from each other in their strength and in their direction. Consideration of the line diagram above will make this quite clear. The non-polarised Relay NP works upon strength of current only. The armature does not respond until the incoming current is strong enough to overcome the tension of the spiral spring holding it in the spacing position, and furthermore, this relay is not affected by any directional change in the flow of current. The polarised Relay P works with change of direction, irrespective of the change in the strength of the current. With such an arrangement these two relays can be worked at the same time, but independently by sending out signals of a suitable strength to operate NP and a suitable direction to operate P. The two channels are known as the A and B sides, and the continued reversal of the current by the A key introduces a weakness known as the "B kick," which tends to split "'B's" signals. This has been overcome in Creed working by using a double Wheatstone transmitter, ensuring that both the A and B speeds are identical, together with a special condenser arranged to work in conjunction with the B Relay. Speeds: 240 words per minute in each direction.

QUINTUPLE DUPLEX. Five channels, duplexed.

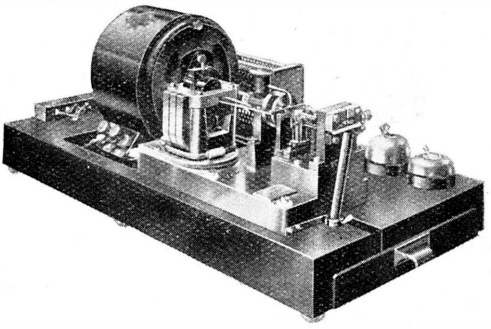


RADIO KEY (HIGH POWER). For controlling powers of, for example, 300 K.W. a combined electromagnetic and pneumatic engine is used, which functions as follows: Current from a D.C. source, controlled by the Wheatstone transmitter, energises a special type of electro-magnetic relay engine. This relay operates the valve of a small pneumatic engine, admitting air at a pressure of about twenty-eight pounds per square inch (2 K.gm/cm2) alternately on either side of a piston, which, in its turn, operates the valves of eight similar engines. On insulated extensions of the piston-rods of these engines are mounted eight large disc-shaped, silver faced, contacts which abutt against a set of similar fixed contacts. The arc is extinguished by the detonising action of the discs themselves, assisted by an air blast which is arranged to flow between the opening contacts.

For higher or lower powers, the number of engines and contacts is increased or diminished in proportion; it will thus be seen that there is practically no limit to the powers for which keys can be built.

The working speed attainable is about 120 words per minute with an engine pressure of twenty-eight pounds per square inch (2 K.gm/cm2).

RADIO KEY (LOW POWER). In stations of a few kilo-watts capacity there are seldom facilities for installing an air-compressor, and a key has therefore been developed, requiring no air, which will deal with any audio-frequency, or with direct current. It functions as follows: Current from a D.C. source, controlled by the Wheatstone transmitter, energises a small but powerful electro-magnetic engine. This engine is arranged to move a copper block into and out of contact with a slowly revolving copper disc. The copper block and disc form part of the L.F. circuit of the radio-telegraph transmitter, and a current is set up when contact is made. A strong magnetic field is provided across the area of contact in order instantly to blow out the arc which forms. The revolving of the disc ensures evenness of wear, and causes a cool surface to be presented to the copper block when making contact, thus keeping both contacts comparatively cool so as to assist in the rapid detonisation and extinction of the arc.



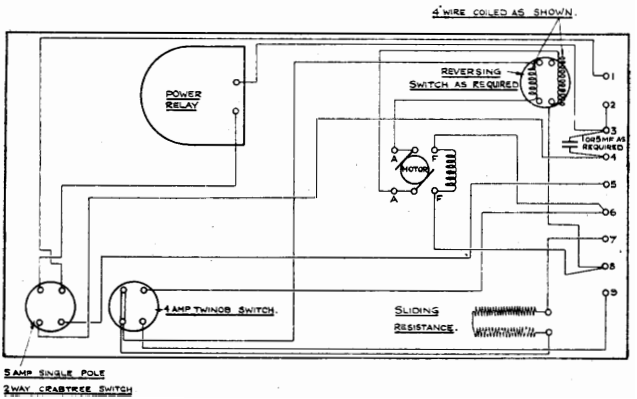
RECEIVING PERFORATOR (CREED).

The Creed Receiving Perforator (1925 design) is mounted complete with its motor unit upon a compactly designed aluminium baseplate. The necessary starting switches and resistances have been incorporated in the design, and a numbered terminal strip is conveniently placed at the back. The metal tape drawer contains a recess for small tools, etc. The polarising coils, which were a familiar feature of the earlier types of Creed Receiver, have been replaced by three large U-shaped permanent magnets, thus simplifying the circuit arrangements.

The action of the Creed Receiver is simple; the power relay extension controls the rotation of a double cam, by means of a friction clutch and suitable detents. The cam is released in a series of half-revolutions, one half corresponding to the spacing current, and the second half, the marking current. With reversals, the cam is regularly released in a series of half-revolutions, and the punches controlled by the cam record equally spaced perforations in the slip. It is easy to appreciate how these reversals can be broken up irregularly by Morse signals. Provided the speed of the cam is properly adjusted and the feeding of the paper controlled to agree with the speed of the distant station's transmitter, a correct replica of the original punched slip is readily obtained. This is then passed to the Creed Printer (Page 29) for transposition into Roman Characters.

A diagram of the connections of the Creed Receiver (1925 design) appears on Page 35.

Speed of Creed Receivers=200 words per minute.



RECEIVER CONNECTIONS.

FOR SINGLE SET.

(1) The mains are connected to terminals 8 and 9.
(2) The local line and earth (i.e. tongue of relay and mid point of potentiometer lampboard) are connected to terminals 3 and 4.
(3) A polarised sounder connected across terminals 1 and 2 will operate when receiver is switched off.
(4) Terminals 4 and 5 are shortcircuited.
(5) An additional field resistance can be inserted between terminals 6 and 7 if a higher speed is required than can be obtained with the resistance on the base.

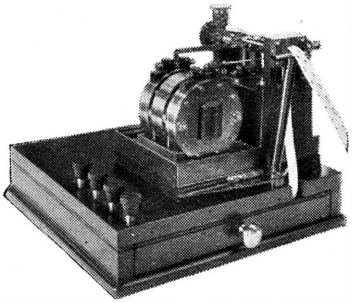
IMPORTANT.—Terminals 6 and 7 must be short circuited if no extra resistance is being used.

FOR DOUBLE SET.

(1) The mains are connected to terminals 8 and 9.
(2) Terminal 3 on both receivers is connected to the mid point of the lampboard.
(3) Terminal 4 on both receivers is connected to the relay tongue.
(4) Terminal 1 of No. 1 receiver is connected to terminal 5 of No. 2 receiver.
(5) Terminals 4 and 5 of No. 1 receiver are shortcircuited.
(6) A polarised sounder is connected across terminals 1 and 2 of No. 2 receiver.
(7) Terminal 2 of No. 1 receiver is not connected.
(8) Terminals 6 and 7 are for extra field resistance as in single set.

REVERSING SWITCH.

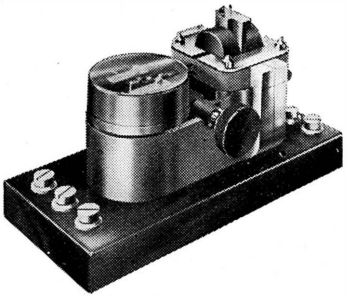
To connect this in the motor circuit for use with a slow speed attachment cut the two coils of wire shown on the diagram in the middle and take the ends through to the terminals of the switch, making sure that the two wires from the armature are diagonally opposite.



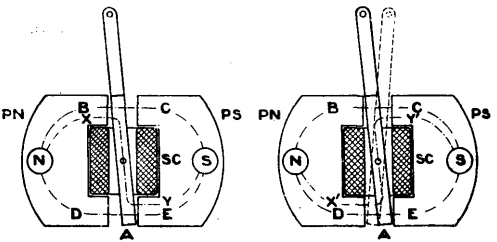
RECEIVING PERFORATOR (CREED CABLE CODE). The Creed Cable Code Reperforator is designed to selectively perforate holes in a paper strip in accordance with cable code signals. It will work satisfactorily over a large speed range provided that the received signals are not badly distorted and the speed of transmission is constant.

Two relays control the perforation of the paper slip, which is drawn at signal speed across the cutting ends of two punches. Both relays are in the magnifier local circuit, one being arranged to release an escapement mechanism which permits a cam to operate the punch hammer when either dots or dashes are being received, while the other selects either the dot or the dash punch in readiness to be driven through the paper.

Both the cam and the paper feed spindle are driven by a governed electric motor through suitable ratchet or friction devices. Correction is made in the same manner as in the Creed Standard Morse Receiver.



RELAY (CREED). The Creed Line Relay is of special use where sensitivity is required combined with robustness and stability of adjustment and short transit time. The Relay, when suitably wound, is admirably adapted for operation from Valve Amplifiers and for high speed Radio purposes.



The Relay consists of two permanent magnets, between the laminated poles PN PS, of which are placed the two signal coils SC. A flux is thus created tending to hold to one side a centrally pivoted armature A. When the current reverses, the direction of the flux changes as shown at X' and Y' and attracts the armature to the opposite side as indicated by the dotted lines.

For ordinary line purposes 25 plus 25 ohms coils are used, and a steady-value current of from 2 to 3 milliamperes.

For Radio Telegraphy, 1600, plus 1600 ohm coils, with an anode current change in the last valve of 0.2 milliamperes.

RELAY (GULSTAD). The Gulstad relay is similar to a line relay, but has two additional coils, which are arranged to vibrate the armature at dot frequency, while no signals are being received. It is therefore possible to transmit only the dashes and spaces of the Morse Code at the speed at which the dots would usually be lost, the dots being supplied by the relay itself. It can be worked on KR's up to 75 sec., and has on shorter lines operated at 200 w.p.m. with a line current of .5 m.a.

RELAY (NON-POLARISED). A relay in which the armature or armatures move independently of the direction of the current passing through its coils.

RELAY (POLARISED). A relay in which the direction of the movement of its armature or armatures depends upon the direction of the current.

RELAYING SOUNDER. A type of non-polarised relay similar in construction to a sounder.

REPEATERS. Long telegraph lines are usually divided into sections of 300/400 miles by the interposition of repeater stations, thus materially raising the maximum attainable speeds by renewing or relaying the original signals.

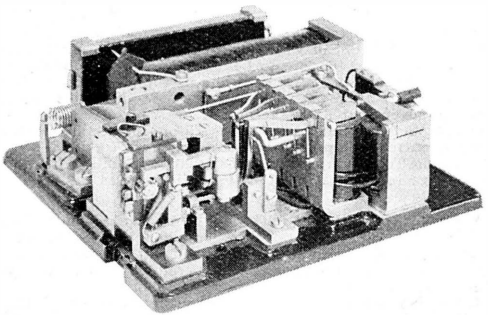
The Creed System uses the standard Wheatstone fast duplex repeater, but the Murray Multiplex has alternative means of repeating by rotating distributor methods known as channel repeating. The Wheatstone repeater has the disadvantage that it clips the signals with each retransmission, the loss being about 10% of a dash signal with each repeater in good adjustment, but with channel

repeaters the signals are retransmitted in as perfect shape as the original signals, a distinct advantage on very long lines using several repeaters.

A memorandum on Multiplex channel Repeating will be forwarded on receipt of a stamped and addressed foolscap envelope.

REPERFORATOR. A receiving instrument designed to reproduce the sending stations' signals in the form of perforations in paper slip. The Creed Receiver is a reperforator and its slip can be both used for actuating the Creed Printer or re-transmission over another line.

The Murray Reperforator is described below.



REPERFORATOR (MURRAY). A Receiving Perforator used in conjunction with the Murray Multiplex. It reproduces at the receiving station a perforated tape, which is an exact replica of the original tape prepared at the sending station, and thus provides means for tape retransmission. It consists essentially of five electro-magnetic selectors and a circuit-closing magnet for controlling the large punching magnet. The five selecting magnets select the punches according to received permutation, and the sixth magnet closes the circuit of punching magnet, which forces the punches through the paper. the case of long Multiplex circuits repeating into each other, the Reperforator has some advantages. The speed of two circuits need not be exactly the same, and it is possible to repeat from a Quadruple into a Triple or Double or vice-versa. A special feature is the fact that the Reperforator is under the control of the distant station's keyboard operator, who brings it into operation by using the key marked PERF. (— + — — +).

RESISTANCE. That property in various substances which obstructs the steady flow of current through them and wastes the energy of the current in heat. Resistance is measurable, and its standard of measurement is the Ohm. See also Capacity and Resistance of Line Wires, Page 10.

RESONATOR. A sounder screen.

RETARDATION COILS. A variable resistance totalling 1100Ω introduced between the Rheostat and condenser in the compensation circuit of a duplex set, and designed to time the charge and discharge of the condenser and so imitate the conditions existing upon the line.

REVERSALS. Alternations of current upon a Wheatstone line caused by running the transmitter without tape. A complete reversal or cycle from positive to negative is equivalent to one centre-hole in punched slip. On Murray Multiplex circuits reversals can be sent to line by depressing the switch on the Terminal Box.

RHEOSTAT. Easily adjustable resistances, in which the length of wire in circuit is controlled by suitable arms or plugs.

SPARE PARTS (CREED).

When ordering spares, please quote the serial number of the machine.

KEYBOARD PERFORATOR SPARES.

860/33	Space stop springs.	860/139	Centre hole punches.
/48b	Selector springs.	/141a	Die.
/73	Punch retaining plate.	/154b	Trunnions.
/86c	Spacing rack stop (front).	/156a	Spacing lever springs.
/113a	Pawl spring.	/168	Cam Rollers.
/89a	Space stops.	/180a	Returning bar spring.
/115b	Pawls.	/41b	Brake arm spring.
/116	Pawl Pin.	/361a	Spacing lever blade.
/138a	Punches.	/383	Spacing rack stop (back).

CREED TRANSMITTER.

856/18a	Rocking beam.	856/50	Pecker springs.
/48	Trunnion.	/51	Bellcrank springs.
/49a	Peckers.	/97	1¼ Driving ring.

CREED RECEIVER SPARES.

72[illegible]	Clutch friction spring.	720/25a	Corrector.
[illegible]	Clutch spindle.	/30a	Corrector spring.
[illegible]9	Detent.	720/33c	Tape Feed Spindle and collar.
720/18b and 21a	Punch connecting rod and nut.	720/44	Detent Plate.
720/19a	Punch connection.	/57	Detent Plate Yoke.
/20a	Punches.	/172	Die.
/22	Cam Rollers.	/175a	Corrector Rod.

CREED PRINTER SPARES.

740/9	Selector (spacing).	/51a	Actuating lever "B."
/10	Selector (marking).	/74	Type carriage clutch shoes.
/30	Spacing rack.		
/31	Spacing rack link.	/85a	Type retaining spring.
/34	Spacing rack guide plate.	/106	Bell cranks.
/36	Spacing rack link pins.	/107	Bell crank springs.
/40	Space stops.	/108a	Comb springs.
740/45a	Tape feed spindle.	/154	Platen.
/50a	Actuating lever "A."	/376a	Comb spring support.

SPARE PARTS (MURRAY).

KEYBOARD PERFORATOR.

MKP.B1	Selector combs.	E19	Feed punch hammer plate.
B-7	Bellcrank levers unit.	E30	Magnet coil (wound).
C-14	Key-buttons.	F10	Condenser 1 MF plus 100w. in series.
MKP.D-4	Punch block complete.	G8	Letter counter rack.
D11	Tape feed pawl.	G38	Warning lamp (state voltage.
D18	Ratchet wheel.	D-3	Star wheel spindle, complete.
D21	Feed hole die plate.	F2	Armature complete.
D27	Message hole die plate.	F-2	Contact spring.
D30	Interposing rod.	G-1	Counter actuating bar, complete.
E15	Feed pawl carrier.	G-2	Counter retaining bar.
D32	Feed hole punch.		
D31	Message hole punch.		
E15	Feed pawl carrier.		
E16	Message punch hammer plate.		

TRANSMITTER.

MTT. C2	Rachet feed wheel.	C-1	Tape feed spindle, complete.
G14	Feed pawl.	E-12	Magnet coils (wound).
B-5	Needle levers, complete.	E14	Armature.
B-6	Contact levers, complete.	F15	Bevel hook.
B-1	Contact screw, complete.	E16	Armature stop plate.
		G12	Lower terminal spring.
		G13	Upper terminal spring.
		D17	Cam roller.

DISTRIBUTOR.

MCD.B14	Correction star-wheel (15 teeth).	C-2	Correcting coil, complete (50w.).
B5	Correction star-wheel (complete with pinion).	C-3	Correcting magnet, complete.
C11	Correcting pins (manganese steel).	C-4	Correcting jockey spring, complete.
E4	Brush (silver alloy).	E-1	Brush bar, complete (fror .
E5	Guard strip.	E-2	Ditto (back).
B-2	Jockey, complete.		

VIBRATOR.

MVB.C-3	Contact spring, complete (silver).	D14	Weight "A."
C-4	Contact spring, complete (gold-silver).	D5	Weight "B."
D-1	Reed, complete without weights.	D15	Weight "C."
		E9	Magnet coil winding.
		SC1	Spark condenser .5mf. plus 300w. series.

SPARE PARTS (LISTE DES PIECES DE RECHANGE).

Indiquez le numéro des appareils en commandant les rechanges.

PERFORATRICE A CLAVIER CREED.

860/33	Ressort d'arret d' espacement.	/305	Ressort de levier de frein.
/48b	Ressort de selecteur.	/180a	Ressort de barre de rappel.
/139	Pioncon médian.	/89a	Arret d'espacement.
/425	Lame de levier d'espacement.	/112	Ressort de goujon de cliquet.
/154	Teton mobile.	/113	Ressort de cliquet.
/141a	Plaque coupante et plaque guide.	/115b	Cliquet.
/73	Plaque de retrait des poinçons.	/138a	Poinçon.
/33	Ressort d'arret d'espacement and de levier de combinaison.	/116	Goupille de cliquet.

TRANSMETTEUR CREED.

856/18a	Balancier.	/50	Ressort de chercheur.
/48	Teton mobile.	/51	Ressort de levier coude.
/49a	Chercheur.	/97	Rondelle d'entrainement.

RECEPTEUR-PERFORATEUR CREED.

720/5	ressort d'embrayage a friction.	/33	Arbre d'entrainement de la bande.
/6	arbre d'embrayage.	/22	Rouleau des cames.
/175	Tige de correcteur.	/20	Poinçons.
/18	Tige de raccord de poinçon.	/44	Plaque de détente.
/30	Ressort de correcteur.	/57	Joug de plaque de détente.
/25	Correcteur.	/9	Détente.
/172	Matrice.		

TRADUCTEUR IMPRIMEUR CREED.

740/9	Selecteur (espaçant).	/50a	Levier actionnant (A).
/10	Selecteur (marquant).	/51a	Levier actionnant (B).
/30	Crémaillere d'espacement.	/74	Emanchon d'embrayage du chariot la roue des types.
/31	Anneau de crémaillere d'espacement.	/85	Ressort de rappel des types.
/34	Plaque-guide de la crémaillere d'espacement.	/106	Levier coudé.
/36	Goujon d'anneau de crémaillere d'espacement.	/107	Ressort de levier coudé.
/40	Arret d'espacement.	/108a	Ressort de peigne.
/45	Arbre d'entrainement de la bande.	/376	Support de ressort de peugue.
		/154	Rondelle en caoutchouc.

SPARE PARTS (PIEZAS DEL RECAMBIO CREED).

Se le ruega indicar el numero serial de la maquina.

PERFORADOR DE TECLADO CREED.

860/33	Resortes (paradora de espacios).	/139	Punzones de alimentación.
/48b	Resortes (seleccionadora)	/141a	Matrices.
/73	Placa de retén (punzona).	/154b	Muñon.
/86c	Parada (cremallera espaciadora).	/156a	Resorte de palanca espaciadora.
/113a	Resorte del trinquete.	/168	Rodilla del excentrico.
/89a	Paradores de espacios.	/180a	Resorte (varilla de retorno).
/115b	Trinquete.	/361a	Lamina espaciadora.
/116	Chaveta del trinquete.	/383	Parada (cremallera espaciadora).
/138a	Punzones.		

TRASMISOR CREED.

856/18a	Palanca excentrica.	/51	Resortes de los palancas angulares.
/48	Muñon.	/97	Rueda de fricción.
/49a	Agujas.		
/50	Resortes de las agujas.		

RECEPTOR CREED.

720/5	Resorte del embrague.	/25a	Correctores.
/6	Husilla del embrague.	/30a	Resorte del Corrector.
/9	Parada.	720/33c	Husillo (Alimentación de
720/16b and 21a	Varillas de conexión (punzona).	and 31b	la cinta).
720/19a	Porta punzona.	720/44	Placas (Parada).
/20a	Punzones.	/57	Culata (Parada).
/22	Rodillo del excentrico.	/172	Matrices.
		/175a	Varilla del Corrector.

IMPRESOR CREED.

740/9	Seleccionadora (espaciadora).	/50a	Palanca accionadora "A."
/10	Seleccionadora (señaladora).	/51a	Palanca accionadora "B."
/30	Cremallera espaciadora.	/74	Zapatas del embrague.
/31	Palanca (cremallera espaciadora).	/85a	Resorte de retén (tipos).
/34	Placa guia (cremallera espaciadora).	/106	Palancas angulares.
/36	Chaveta (cremallera espaciadora).	/107	Restortes (palanca angulera).
/40	Paradores de espacios.	/108a	Resortes (retornar los discos).
/45a	Husillo (alimentación de la cinta).	/154	Platina.
		/376a	Varilla (resorte de lo disco).

SPARE PARTS (PIEZAS DEL RECAMBIO MURRAY).

PERFORADOR DE TECLADO MURRAY.

MKP.B1	Pienes (seleccionadora).	E15	Trinquete.
B-7	Palancas angulares (completo).	E16	Placa del martillo (punzones grandes).
MKP.D-4	Bloque punzonador.	E19	Placa del martillo (punzones alimentación).
D11	Trinquete (alimentación de la cinta).	Bobina	(magnetica).
D18	Rueda de trinquete.	F10	Condensador, 1μF + 100Ω.
D21	Matrice (agujeros de alimentación).	G38	Lampara.
D27	Matrice (agujeros grandes).	D-3	Husillo (Alimentación de la cinta).
D32	Punzone (alimentación).	E-2	Armadura.
D31	Punzone grande.	F-2	Resorte del contacto.

TRASMISOR MURRAY.

MTT.C2	Rueda de alimentación.	E-12	Bobina (magnetica).
G14	Triquete (alimentación).	E14	Armadura.
B-5	Agujas (completo).	E16	Placas de parada (Armadura).
B-6	Palanca de contacto.	G12	Resorte inferior.
C-1	Husillo (alimentación de la cinta).	G13	Resorte superior.
		D17	Rodillo del excentrico.

DISTRIBUIDOR MURRAY.

MCD.B14	Rueda de correction.	C-3	Iman de correction completo.
C11	Chavetas de correction (manganesa-acero).	C-4	Resorte del Jockey.
E4	Escobilla (aleacion de argento).	E-1	Soportes de las escobillas completo (frente).
E5	Bande de seguridad.	E-2	Soportes de las escobillas completo (detras).
B-2	Rodillo del Jockey completo.		
C-2	Bobina de correction completo (50Ω).		

VIBRATOR MURRAY.

MVB.C-3	Resorte del contacto (argento).	D14	Pesa "A."
C-4	Resorte del contacto (aleacion de argento y oro).	D5	Pesa "B."
		D15	Pesa "C."
D-1	Caña completo.	E9	Bobina (magnetica).
		SC1	Condensador .5 M.F. + 300Ω.

SPARE PARTS (PARTI DI RICAMBIO CREED).

TRASMETTITORE CREED.

Preghiera di indicare il numero della macchina per la quale si ordinano le parti di ricambio.

856/18a Braccio oscillante.
/48 Blocchetto.
/94a Stelo a cavita.
/50 Molla per stelo a cavita.
/51 Molla per uncino per campanello.
/97 Anello guida da m/m. 31

PERFORATORE A TASTIERA CREED.

860/33 Molla di arresto per spazi.
/48b Molla selettrice.
/73 Piastra di ritenuta dei punzoni.
/86c Cremagliera (anteriore).
/113a Molla per nottolino di arresto.
/89a Arresti di spazio.
/115b Nottolini di arresto.
/116 Perno per nottolino di arresto.
/138a Punzoni.
/139 Punzoni per foro centrale.
/141a Matrice.
/154b Blocchetto a perno.
/156a Molla per la leva degli spazi.
/168 Rondella.
/180a Molla per il ritorno della sbarra.
/41b Molla a braccio per manovelle.
/361a Leva a lamella per spazi.
/383 Cremagliera (posteriore).

RICEVITORE CREED.

720/5 Molla sagomata per frizione.
/6 Perno a vite.
/9 Arresto.
/18b e 21a Stelo di connessione dei punzoni.
/19a Connessione per punzoni.
/20a Punzoni.
/22 Rondella.
/25a Correttore.
/30a Molla per correttore.
/33c e 31b Alimentatore a collare con vite.
/44 Piastra di arresto.
/57 Giogo per piastra di arresto.
/172 Matrice.
/175a Stelo correttore.

STAMPANTE CREED.

740/9 Selettore (spaziatore).
/10 Selettore (indicatore).
/30 Cremagliera.
/31 Piastrina di collegamento per cremagliera.
/34 Piastrina di guida per cremagliera.
/36 Perni per piastrina di collegamento.
/40 Arresto degli spazi.
/45a Alimentatore rotativo.
/50a Leva di servizio "A."
/51a Leva di servizio "B."
/74 Arresto del carrello.
/85a Molla di ritenuta del carrello.
/106 Uncino del campanello.
/107 Molla dell'uncino per campanello.
/108a Molla per ruota dentata.
/154 Anelli di gomma.
/376a Supporto per la molla della ruota dentata.

SPARE PARTS (PARTI DI RICAMBIO MURRAY).

PERFORATORE MURRAY.

MKP.B1	Pettini selettori.
B-7	Unita di leve ad uncino per campanello.
C-14	Bottoni per tastiera.
MKP.D-4	Blocchetto completo per punzone.
D11	Nottolino dell' alimentazione.
D18	Ruota dentata.
D21	Piastra a cremagliera alimentatrice.
D27	Piastre per segnali.
D30	Stelo di interposizione.
D32	Punzone alimentatore.
D31	Punzone con fori segnalatori.
E15	Porta nottolino alimentatore.
E16	Piastra a martello per punzone segnalatore.
E19	Piastra a martello per punzone alimentatore
E30	Bobina del magneto (avvolgimento).
F10	Condensatore da 1 mf. piu 100 Hom in serie.
G8	Cremagliera contatrice delle lettere.
G38	Lampada spia (stabilire la tensione)
D-3	Ruota alimentatrice a stella completa.
E-2	Armatura completa.
F-2	Molla per contatti.
G-1	Sbarra completa per azionare il contatore
G-2	Sbarra completa per ritenuta del contatore.

TRASMETTITORE MURRAY.

MTT.C2	Ruota dentata di alimentazione.
G14	Nottolino di alimentazione.
B-5	Leve ad ago complete.
B-6	Leve di contatto complete.
B-1	Viti di contatto complete.
C-1	Alimentattore rotativo completo.
E12	Bobina del magnete (avvolgimento).
E14	Armature.
F15	Gancio a sghembo.
E16	Piastre di arresto dell' armature.
G.12	Molla terminale inferiore.
G13	Molla terminale superiore.
D17	Rondella.

DISTRIBUTORE MURRAY.

MCD.B14	Ruota a stella di correzione (15 denti).
B3	Ruota a stella di correzione (completa con pignone).
C11	Perno di correzione (acciaio al manganese).
E4	Spazzola (lega di argento).
E5	Striscia di sicurezza.
B-2	Cavalierino completo.
C-2	Bobina di correzione completa (50Ω).
C-3	1 magnete di correzione completo.
C-4	Molla completa per il cavalierino correttore.
E-1	Congegno a spazzola completo (anteriore).
E-2	Congegno a spazzola completo (posteriore).

VIBRATORE MURRAY.

MVB.C-3	Molla completa per contatti (argento).
C-4	Molla completa per contatti (oro argento)
D-1	Canna completa senza pesi.
D-14	Peso "A."
D5	Peso "B."
D15	Peso "C."
E9	Avvolgimento per bobina del magnete.
SC1	Condensatore smorzatore 5 mf. piu 300 Hom in serie.

SPARE PARTS (ONDERDEELEN).

Gelieve bij het bestellen van onderdeelen de toestelnummers op te geven.

CREED PONS MACHINES.

860/33 Veeren voor de arreteering van de papierbeweging.
/48b Veeren voor de kiezers.
/73 Stootplaat voor de ponsen.
/86c Arreteering voor het gestel van de papierbeweging (voorzyde).
/113a Palveer.
/89a Arreteeringsarmen voor voor de papierbeweging.
/115b Pallen.
/116 Palpennen.
/138a Ponsen.
/139 Ponsen voor de middengaten.
/141a Ponsplaat.
/154b Tappen.
/156a Veeren voor de hefboomen van de papierbeweging.
/168 Kraagbus.
/180a Veeren voor de terugzetrails.
/41b Veer voor de remarm.
/361a Bladhefboom voor de papierbeweging.
/383 Arreteering voor het gestel van de papierbeweging (achterzijde).

CREED ZENDER.

850/18a Balans.
/48 Tap.
/49a Stiften (aan de seinarmen).
/50 Veeren voor de stiften.
/51 Veeren voor de seinarmen.
/97 1¼ volgplaat.

CREED-ONTVANGER.

720/5 Wrijvingsveer voor de koppeling.
/6 Koppelas.
/9 Pal.
720/18b en 21a Ponsverbinder. Stang en moer.
720/19a Ponsverbinder.
/20a Ponsen.
/22 Kraagbus.
/25a Corrector.
/30a Correctieveer.
720/33c en 31b As voor de papierbeweging. Kraag.
720/44 Palplaat.
/57 Juk voor de palplaat.
/172 Ponsplaat.
/175a Correctiestang.

CREED DRUKTOESTEL.

740/9 Kiezers (ruststroom).
/10 Kiezers (werkstroom).
/30 Gestel voor de papierbeweging.
/31 Verbindingsstang voor idem.
/34 Leiplaat voor idem.
/36 Pennen voor de verbindingsstang voor idem.
/40 Arreteeringspennen voor de papierbeweging.
/45a As voor de papierbeweging.
/50a Koppelhefboom "A."
/51a Koppelhefboom "B."
/74 Koppelschoentjes voor de type-dragers.
/85a Veeren voor de typen.
/106 Krukvormige hefboomen.
/107 Veeren voor idem.
/108a Veeren voor de kam.
/154 Degel (drukplaat).
/376a Houder voor de kamveer.

SPARE PARTS (ERSATZ TEILE).

Bei Bestellung ist die Maschinenummer anzugeben.

CREED SENDER.

856/18a Wippe.
/48 Zapfen.
/49a Abfühlnadeln.
/50 Abfühlnadel Feder.
/51 Winkelhebel Feder.
/97 M.0.0315 Antriebring.
M.0.063 Antriebring.

CREED TYPENDRUCKER.

740/9 Sucher (Trenn).
/10 Sucher (Zeichen).
/30 Zahnstange.
/31 Zahnstange Zwischenglied.
/34 Zahnstange Führungsplatte.
/36 Zahnstange Zwischenglied Stifte.
/40 Abstandsbegrenzung.
/45a Papierführungs Achse.
/50a Arbeitshebel "A."
/51a Arbeitshebel "B."
/74 Friktionsschuh.
/85a Typen festhalternde Platte Feder.
/106 Winkelhebel.
/107 Winkelhebel Spiral Feder.
/108a Kamm Rückführungs. Feder.
/154 Walze.
/376a Sockel für Kamn federn.

CREEDEMPFANGER.

720/5 Frictionskupplungsfeder.
/6 Frictionskupplungsachse.
/9 Ausläsung.
720/18b und 21a Stanzstempelstossstange und Mutter.
720/19a Stanzverbindungen.
/20a Stanze.
/22 Excenter Roller.
/25a Korrectoren.
/30 Korrectoren Spiralfeder.
720/33c und 31b Papierführungsachse und Frictionskragen.
720/4 Auslöseplatte.
/57 Joch.
/172 Matrize.
/175a Korrectionsstange.

CREEDLOCHER.

860/33 Abstandschiene Federn.
/48b Tastenschienen Federn.
/73 Stempels Rückführungsplatte.
/86c Abstandstangebegrenzung (vorderseite).
/113a Sperrklinke Feder.
/89a Abstandbegrenzung.
/115b Sperrklinke.
/116 Sperrklinke Stift.
/138a Stanzstempel.
/139 Führunglöcher Stanzstemple.
/141a Matrize.
/154b Zapfen.
/156a Abstandhebel Feder.
/168 Excenter Rolle.
/180a Ruckfuhrungschienen Feder.
/41b Bremsehebel Feder.
/361a Abstandblattfeder.
/383 Abstandstange begrenzüng Rückseite.

SPEEDS (CREED RECEIVER). When working at slow speeds, say, 100 words per minute or under, the Receiver should be run about 5 per cent. faster than the Transmitter.

Working at higher speeds, good results are obtained by running from 5 to 10 per cent. faster than the Transmitter.

A sliding rheostat is connected in the field or shunt circuit of the motor, so that putting resistance "IN" will increase the speed.

To set the speed of the Receiver equal to the speed of the Transmitter, get the distant station to run Transmitter and put through at intervals a piece of blank slip of known length, say, 12 inches. When the Transmitter is running without tape, reversals of current are sent to line and the Receiver will perforate a series of dots, but when the 12 inches of blank tape is put through the Transmitter, a length of blank will appear on the tape issuing from the Receiver, its length being more or less than 12 inches according to the speed at which the Receiver is running. If the Receiver shows less than 12 inches blank, its speed must be increased, and vice versa, until it gives the same plus 5 per cent. (Up to 10 per cent. for high speeds.) There being exactly 120 feed holes in 12 inches of tape, the percentage of error is easily determined.

It is possible to adjust the speed while the line is being worked by altering the rheostat until the correct spaces are obtained between the letters and words on the punched tape. If spaces are lost between words, the Receiver is running too slowly. If spaces are gained between words, the Receiver is running too fast.

START-STOP LEVER (MURRAY). A device on the Murray Transmitter for regulating the feeding of the punched tape through the Transmitter. The use of the Starting and Stopping lever admits of placing the Transmitter very close to the keyboard, the actual distance being one inch. If the operator is lagging behind, the tension on the punched tape will stop transmission until the tape slackens.

STEEL BRUSHES. See Brushes, Page 8.

STEP-BY-STEP. The intermittent motion of the escapement-wheel and pallet of a clock is a "step-by-step" movement. In Telegraphy, the pallet is usually controlled by electro-magnets, and the counterpart of the clock escapement wheel is linked to the type-wheel, so that the types are revolved letter by letter. The Exchange Telegraph Company's tape machines are "step-by-step" telegraphs.

SYNCHRONISM (MURRAY). In order that the operation of the various sections of the Murray Multiplex may take place at certain definite moments, it is important that the distributor brush mechanism at each end of the line be arranged to synchronise or maintain phase relationship with each revolution. In practice, the brushes of one distributor are rotated slightly faster than the other. After several revolutions, the brush which is revolving faster, becomes "out of phase" with the other brush, and it is then that a current impulse (correcting impulse) operates to produce a retarding effect. The correcting impulse actuates an electro-magnet (the correcting magnet), the armature of which brings the correcting mechanism into operation, with the result that the faster moving brush receives a momentary check and the two distributors synchronise. The correcting mechanism operates only when the brushes tend to lose their phase relationship.

The station which sends this correcting current is termed the **correcting station,** and that at which the brush-arm is retarded is called the **corrected station.**

To obtain the best margin of correction the corrected station should run his distributor 2% faster than the correcting station.

See Correction (Murray), Page 14.

SYPHON RECORDER. The Syphon Recorder is a moving coil galvanometer, arranged to register a current time graph of weak cable code signals on a paper tape. The coil is connected to the inking syphon through a system of rein fibres, which amplify its movements. The Syphon is vibrated against the moving paper to reduce friction.

TWIST DRILLS, STANDARD SIZES OF

1	1.000	Z	.413	$\frac{5}{16}$	.3125	A	.234	16	.177	33	.113	51	.067
$1\frac{5}{16}$	.9375	$\frac{13}{32}$	.4062	N	.302	1	.228	17	.173	34	.111	52	.0635
$\frac{7}{8}$	.875	Y	.404	$\frac{19}{64}$	.2968	2	.221	18	.1695	35	.110	53	.0595
$1\frac{3}{16}$	.8125	X	.397	M	.295	$\frac{7}{32}$	.2187	19	.166	36	.1065	54	.055
$\frac{3}{4}$	.750	$\frac{25}{64}$	.3906	L	.290	3	.213	20	.161	37	.104	55	.052
$\frac{23}{32}$	.7187	W	.386	K	.281	4	.209	21	.159	38	.1015	56	.0465
$\frac{11}{16}$	.6875	V	.377	$\frac{9}{32}$	.2812	5	.2055	22	.157	39	.0995	57	.043
$\frac{21}{32}$	.6562	$\frac{3}{8}$	.375	J	.277	6	.204	23	.154	40	.098	58	.042
$\frac{5}{8}$	.625	U	.368	I	.272	7	.201	24	.152	41	.096	59	.041
$1\frac{9}{32}$	.5937	$\frac{23}{64}$	.3593	H	.266	8	.199	25	.1495	42	.0935	60	.040
$\frac{9}{16}$	.5625	T	.358	$\frac{17}{64}$	.2656	9	.196	26	.147	43	.089	61	.039
$1\frac{7}{32}$	.5312	S	.348	G	.261	10	.1935	27	.144	44	.086	62	.038
$\frac{1}{2}$	.500	$\frac{11}{32}$	.3437	F	.257	11	.191	28	.1405	45	.082	63	.037
$\frac{31}{64}$	.4843	R	.339	$\frac{1}{4}$	.250	12	.189	29	.136	46	.081	64	.036
$1\frac{5}{32}$	.4687	Q	.332	E	.250	$\frac{3}{16}$	.1875	30	.1285	47	.0785	65	.035
$\frac{29}{64}$	.4531	$\frac{21}{64}$	.3281	D	.246	13	.185	$\frac{1}{8}$	.125	48	.076	66	.033
$\frac{7}{16}$	.4375	P	.323	C	.242	14	.182	31	.120	49	.073	67	.032
$\frac{27}{64}$	.4218	O	.316	B	.238	15	.180	32	.116	50	.070	68	.031

BRITISH ASSOCIATION STANDARD SCREW THREADS.

B.A. Ser. No.	Dia. of Drilled Holes. Morse Twist Drills. Clearance. Dia.	Drill.	Tapping. C.I. Bs.Eb. Drill.	Steel.	Drill.	Nominal Dimensions in Thousands of 1in. Outside Dia.	Core Dia.	Pitch.	No. of Threads per inch.	Absolute Dimensions in Millimetres. Dia.	Pitch.
0	.242	C	.191	11	.196	9	.236	.189	.0394	25.4	6.0	1.00
1	.213	3	.169	18	.173	17	.209	.166	.0354	28.2	5.3	.90
2	.189	12	.147	26	.152	24	.185	.147	.0319	31.4	4.7	.81
3	.166	19	.128	30	.136	29	.161	.127	.0287	34.8	4.1	.73
4	.147	26	.113	33	.116	32	.142	.111	.026	38.5	3.6	.66
5	.136	29	.099	39	.101	38	.126	.098	.0232	43.0	3.2	.59
6	.113	33	.089	43	.093	42	.110	.085	.0209	47.9	2.8	.53
7	.1015	38	.078	47	.081	46	.093	.076	.0189	52.9	2.5	.48
8	.089	43	.067	51	.073	49	.086	.066	.0169	59.1	2.2	.43
9	.0785	47	.059	53	.063	52	.075	.056	.0154	65.1	1.9	.39
10	.070	50	.052	55	.055	54	.067	.050	.0138	72.6	1.7	.35
11	.0635	52	.046	56	.052	55	.059	.044	.0122	81.9	1.5	.31

WOOD SCREWS.

Guage. No.	Screw Dia.	Clearance Holes. Drilled.		Punched.	Tapping Drill.	Approx. Dia. of Head.	F.H.BS.	Standard List Lengths. R.H.BS.	F.H. in.	R.H. in.
1	.066	.078	47	.077	052	.134				
2	.080	.093	42	.088	.059	.164				
3	.094	.106	36	.101	.073	.184				
4	.108	.120	31	.115	.086	.215				
5	.122	.136	29	.134	.0995	.246				
6	.136	.149	25	.146	.110	.272				
7	.150	.166	19	.164	.125	.300				
8	.164	.180	5	.172	.136	.328				
9	.178	.196	9	.188	.147	360				
10	.192	.213	3	.212	.157	.384				
12	.224	.242	C	.240	.182	.440				
14	.250	.272	1	.269	.201	.500				

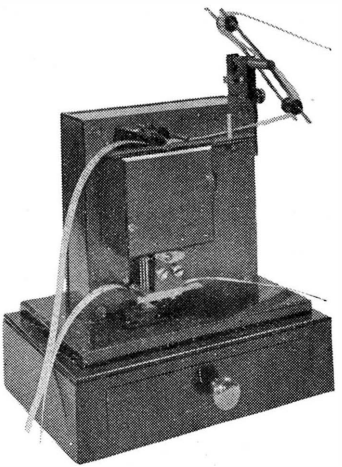
BRITISH STANDARD SIZES OF ANNEALED COPPER WIRES.

Superseded S.W.G. Size.	Standard Inch.	Diam. M /m.	Calculated Square Inch.	Sectional Area Square M/m.	Weight per 1,000 yards. Pounds.	Standard Resistance at 60° Per 1,000 yards. ohms.	Per lb. ohms.
47	.0020	.0508	.000005142	.002027	.03633	7642	210300
46	.0024	.0610	.000004524	002919	.05232	5307	101440
44	.0032	.0813	.000008042	.005189	.09301	2985	32090
42	.0040	.1016	.000012566	008107	.14533	1910.5	13146
40	.0048	.1219	.000018096	.011675	.2093	1326.7	6340
38	.0060	.1524	.00002827	.018241	.3270	849.1	2597
36	.0076	.1930	.00004536	.02927	.5246	529.2	1008.7
34	.0092	.2337	.00006648	.04289	.7688	361.2	469.8
32	.0108	.2743	.00009161	.05910	1.0594	262.1	247.4
30	.0124	.3150	.00012076	.07791	1.3966	198.80	142.35
28	.0148	.3759	.00017203	.11099	1.9895	139.55	70.14
26	.018	.4572	.0002545	.16417	2.943	94.35	32.06
24	.022	.5588	.0003801	.2453	4.396	63.16	14.366
22	.028	.7112	.0006158	.3973	7.121	38.99	5.475
20	.036	.9144	.0010179	.6567	11.772	23.59	2.004
18	.048	1.2192	.0018096	1.1675	20.93	13.267	.6340
16	.064	1.6256	.003217	2.0755	37.20	7.463	.2006
14	.080	2.0320	.005027	3.2429	58.13	4.776	.08216
12	.104	2.6416	.008495	5.4805	98.24	2.826	.02877

TAPE (PERFORATED).

1 word=6 letters (5 letters + 1 space).
1 letter=one tenth inch of tape (Mx).
12 inches Mx tape=120 feed holes.
12 ,, ,, ,, =120 letters.
12 ,, ,, ,, =20 words.
Wheatstone tape=5 words per foot.
Multiplex tape=20 words per foot.
Multiplex tape is to Wheatstone tape as 1 is to 2.75.
Wheatstone tape=.475 inch wide.
Multiplex tape=.6875 inch wide.
Mx tape limits=.684 inch to .689 inch inclusive.
One 8 inch coil of Mx tape .003" thick holds 25.000 words.
One 8 inch coil of Wheatstone tape .003" thick holds 5/7,000 words.

TERMINAL BOX (MURRAY). A conveniently arranged connection case providing means for plugging the flexible plateau connections to the line, battery, transmitters and receivers, etc. A switch is provided for sending alternating currents to the line when required. The Terminal Box also houses the condensers for reducing sparking on the plateau.



TRANSLATOR (CREED). This instrument is used in conjunction with the Creed Receiving Perforator for automatically producing another slip perforated with signals as used for automatic transmission on cable

circuits. The utility of such an instrument is, of course, at a cable station, where the one or more land-line feeders are worked with the unequal dot and dash system, and the cable with the equal positive and negative impulses.

Further particulars will be supplied on application.

TRANSFORMER. When an alternating current flows through any conductor an alternating magnetic field is generated in the vicinity of that conductor.

If another conductor (not necessarily in metallic connection with the first) be brought within the influence of the magnetic field, an alternating e.m.f. will be **induced** in the second conductor, and, if the ends of this second conductor be metallically connected, an alternating current will circulate therein.

This is the underlying principle of the transformer.

The simplest form of transformer consists of two coils of wire, wound on the same iron core. An alternating P.D. is applied to the terminals of one coil (known as the primary), and the resultant magnetic flux, cutting the conductors of the other coil (secondary) induces therein an alternating e.m.f.

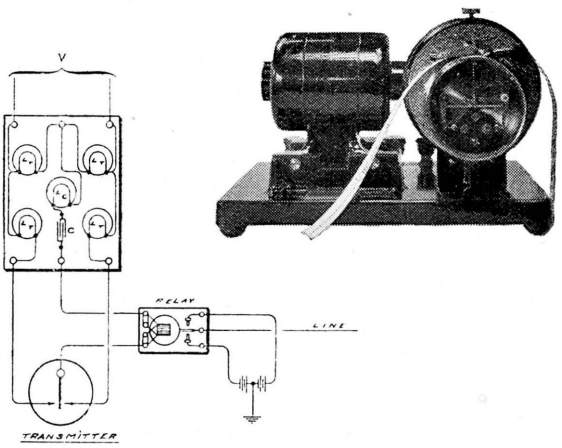
Neglecting losses, the primary and secondary voltages are directly proportional, and the currents inversely proportional to the numbers of turns in the two coils, i.e., if the primary have 100 turns and the secondary 1,000, and if the primary voltage be 100 and primary current 10 amperes, the secondary voltage will be 1 000, but the secondary current will only be 1 ampere.

A **stationary** magnetic field has no effect upon a **stationary** conductor. It is only when mutual displacement occurs (causing the "lines of force" to cut the conductor) that an e.m.f. is induced, the e.m.f. (E) in volts being given by the equation—

$$E = \frac{N}{10^8} \frac{dn}{dt}$$

where N = number of conductors in series (i.e., number of turns) and $\frac{dn}{dt}$ is an expression for the rate at which the "lines of force" move across the conductor system.

TRANSMITTER (CABLE CODE). Cable Code is an arrangement of the Morse Code in which positive and negative impulses of equal length replace the dot and dash elements of International Morse. In Cable Transmitters the two peckers must be arranged to rise together with the feeding of each centre-hole in the slip in order that a positive or negative selection may be made by the passage of one or other of the peckers through the signal perforations.

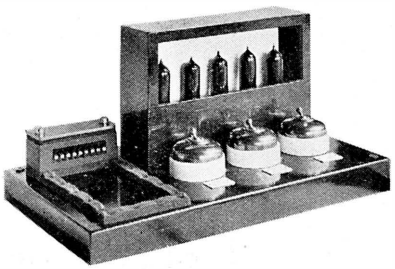


TRANSMITTER (CREED WHEATSTONE). The Creed Transmitter possesses the same range of speeds obtainable with the old motor-driven Wheatstone type, viz.: from 50 to 200 words per turning the knob or moving the slider for controlling the position of the small friction wheel in relation to the friction disc. For lower speeds than 50 a special friction wheel is supplied. This provides for a range from 15 to 75 words per minute. A diagram of the connections is shown above. The Relay and Lampboard are integral portions of the transmitter. The Relay is a Creed standard type and controls the line battery as shown. The lampboard admits of operating the relay in local circuit by using the same source of current supply as the motor. With this simple type of transmitter spare apparatus is unnecessary, as the contact adjustments are so simple as to be readily appreciated and regulated by any operator.

TRANSMITTER (DIRECT PRINTER). See (Creed Printer Direct Start-Stop System). Page 30.

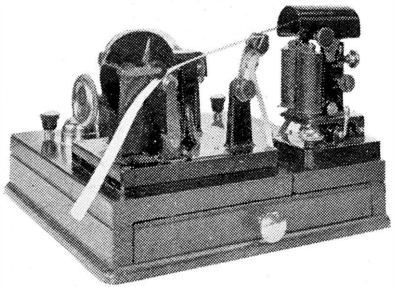
TRANSMITTER (MURRAY). The Murray Multiplex Transmitter should always be associated with its companion machine, the Murray Keyboard Perforator, as its proper position in a Multiplex circuit is on the immediate left of the Perforator, only one inch separating the two instruments. This allows of fifteen letters intervening between Perforation and Transmission, representing a delay of only three or four seconds—a very valuable feature. The tape is fed forward by electro-magnetically controlled pawl and ratchet mechanism, which receives its driving impulse from a segment on the Multiplex distributor. A special feature of this Transmitter is the starting and stopping lever, which serves for the manual and automatic control of the Transmitter. If the operator on the Perforator is lagging behind the Transmitter the tension on the loop of tape will depress the lever, and the feeding of the tape will cease, and only spacing currents will be sent to the line, until the tape slackens. These interruptions do not interfere with the printing at the distant station beyond causing the Printer to pause in sympathy with the Transmitter.

Speeds: Up to 60 words per minute.



TRANSMITTER TESTER (MURRAY). This provides a convenient method of adjusting the Murray Transmitter, and consists of five small lamps placed in circuit with the five contact levers. When these levers are correctly adjusted on both the marking and spacing sides the five lamps should flash regularly when the Transmitter is running without slip. With a piece of YRYRYRYR tape the flashes should alternate with perfect regularity.

TRIPLE-DUPLEX. Three channels, duplexed.



UNDULATOR (CREED). An Undulator is an instrument for recording, in graph form, incoming signals received from a telegraph line or by Wireless. The New Creed Undulator consists essentially of a special type of quick-period Galvanometer, whose pointer has been replaced by a very light syphon tube, with one end trailing on a moving paper ribbon and the other end dipping in an inkwell. The paper is fed forward steadily by a small electric motor driving through a variable gear and permitting the speed of the paper to be adjusted to the speed of the incoming signals.

The necessary apparatus is firmly mounted upon a metal base containing a tape drawer and a receptacle for small tools, spare syphons, etc. The inkwell and syphon are protected by a guard.

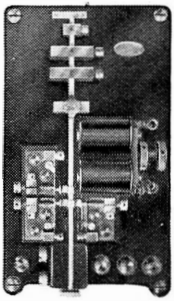
A minimum current of .5 of a milliampere is required for general working conditions, but for recording Wireless signals higher resistance coils (1600 ohms) enables it to be directly connected in the anode circuit of the receiver.

UNDULATOR INK, HOW TO PREPARE.

½oz. Aniline; 1 quart water; 6oz. Methylated Spirits. Heat water and put in Aniline, then stir till it boils, and cool. Strain through wash leather or filter paper and mix with spirit.

VEGETABLE PARCHMENT.

A pure parchment paper used for manufacturing slip for automatic telegraphs. It tears clean, possesses no grit or fibre and preserves the cutting edge of the punches.



VIBRATOR (MURRAY).

Mr. Donald Murray describes the Vibrator and Phonic Motor as an "electric pendulum and escapement wheel."

The Vibrating reed acts on the same principle as that governing the operation of the trembler bell and plays between two battery contacts which alternately transmit impulses to the two electro-magnets of the Phonic-Motor.

The speed frequency of the reed is governed by the position of the weights and a table shewing the positions of the weights, in relation to the marks engraved on the reed is appended hereto.

The resistance of the coils is approximately 20Ω each. The Vibrator should be fixed to a wall or screwed to a solidly constructed table. In the wall position the reed should point **upward.**

Amplitude of reed should not be more than 5/16 in. measured at the extreme end.

The connections are shewn on Page 18.

VIBRATOR SPEEDS.

The speed of the vibrator is altered by moving or adding to the weights.

Fine adjustment weights at zero—60 w.p.m. (other weights off).

A	weight	under	No. 1	mark—55.5	w.p.m.
,,	,,	,,	2	,, —54.5	,,
,,	,,	,,	3	,, —53.5	,,
,,	,,	,,	4	,, —52	,,
,,	,,	,,	5	,, —51	,,
,,	,,	,,	6	,, —50	,,
B	,,	,,	No. 1	,, —45	,,
,,	,,	,,	2	,, —42	,,
,,	,,	,,	3	,, —40	,,
,,	,,	,,	4	,, —38.5	,,
,,	,,	,,	5	,, —37	,,
,,	,,	,,	6	,, —35	,,
A	plus	,,	1	,, —44	,,
B	,,	,,	2	,, —41	,,
,,	,,	,,	3	,, —39	,,
,,	,,	,,	4	,, —37	,,
,,	,,	,,	5	,, —36	,,
,,	,,	,,	6	,, —34	,,
Two B	weights	,,	1	,, —37	,,
,,	,,	,,	2	,, —36	,,
,,	,,	,,	3	,, —34	,,
,,	,,	,,	4	,, —32	,,
,,	,,	,,	5	,, —30	,,
,,	,,	,,	6	,, —28	,,
C	weight	,,	3	,, —28	,,
,,	,,	,,	4	,, —25	,,
,,	,,	,,	5	,, —23	,,
,,	,,	,,	6	,, —20	,,

VOLT.

The unit for measurement of electro motive force (E.M.F.) represented by .6974 of the electrical pressure at a temperature of 15° C. between the poles of the voltaic cell known as Clark's cell.

VOLT-AMMETER.

An instrument which measures both the quantity and pressure of an electric current.

VOLTMETER.

An instrument for measuring electrical pressure (E.M.F.).

WATT.

The unit for measurement of power. Represents the rate at which work is done when one ampere flows through a conductor with a difference of potential of one volt across the ends of the conductor.

746 watts=one horse-power.

One Kilowatt=1.34 H.P.

LIST OF APPARATUS MANUFACTURED BY CREED & CO., LTD.

The following automatic telegraph units and accessory apparatus are now being manufactured at Croydon:—

Creed Keyboard Perforators.
,, Wheatstone Transmitters.
,, Receiving Perforators.
,, Standard Morse Printers.
,, Cable Code Receivers.
,, ,, ,, Printers.
,, Undulators.
,, Direct Printers.
Morse Keys, Sounders, and Galvanometers.
Murray Keyboard Perforators.
,, Transmitters.
,, Vibrators.
,, Phonic Motor Distributors.
,, Reperforators.
High Power Wireless Keys.
Creed Line Relays.
,, Wireless Relays.
,, Repeater Units.
Balancing Accessories and all kinds of Telegraph Resistances and Condensers.

It is hardly necessary to add that the materials used in the construction of Creed and Murray apparatus is of the best quality obtainable, and the workmanship and finish of the different units leave nothing to be desired. Every instrument undergoes a strict test in the factory before being despatched to the customer.

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