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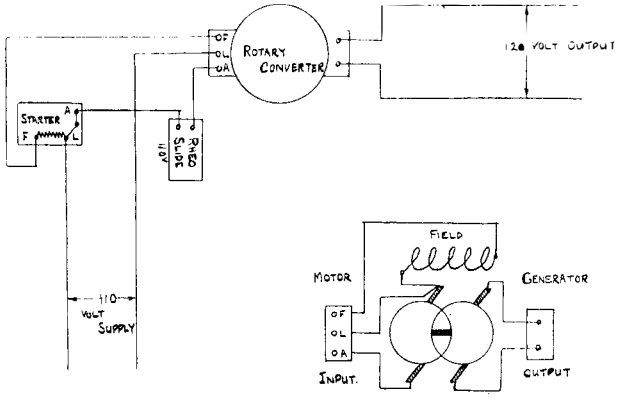
Post Office Electrical Engineers' Journal

LOOP WORKING FROM ROTARY CONVERTORS OR MOTOR GENERATORS.

J. H. HART, A.M.I.E.E., C.T.O.

IT has been the aim of all Telegraph Engineers to work circuits from power generators, but the conditions have, in most cases, compelled them to use Primary or Small Secondary Cells.



ROTARY CONVERTER D.C. FOR LOOP WORKING. FIG 1

Where small telegraph installations exist, the economic conditions are such that Primary Cells are without doubt cheapest. In other cases Secondary Cells hold sway, but there is, without question, a field for the Motor Generator to supply current for Telegraph purposes, particulary when Loop Circuits are installed. At the Central Telegraph Office, owing to space restrictions, the employment of Cells became a serious matter, and it was felt use might be made of machine units. An experiment was carried out during the War on TS-AB3, and use was made of a Rotary Convertor, rather large for the work required. The machine ran for three years without complaint and justified a further trial of machines more suitable for the purposes required. To this end three machines were obtained during the early part of 1924, one

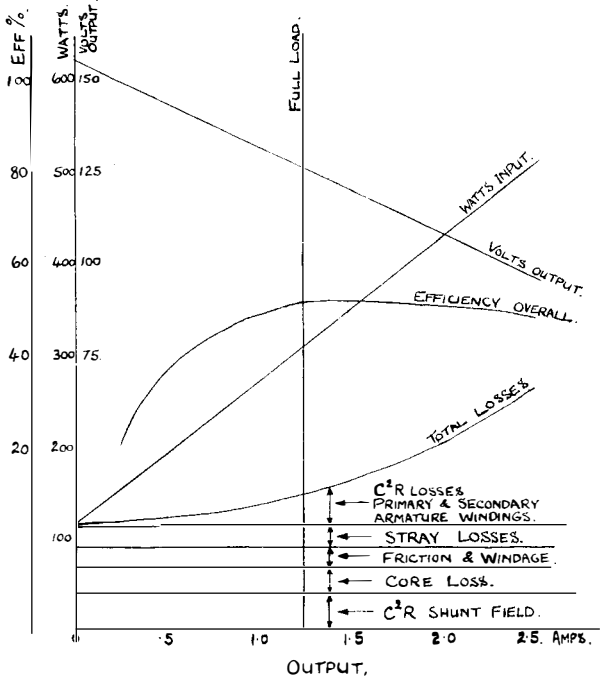


FIG. 2.—CHARACTERISTICS OF MACHINES IN USE.

from the Small Power Dynamo & Motor Co., of Manchester, another from Messrs. Ward & Goldstone of the same city, and a third from the English Electric Co. Trials and tests were made with these machines under varying conditions, and, ultimately, it was agreed that all new Loop installations should be worked by means of Rotary Convertors. At present 54 of these machines are in use, and, unless some new scheme of working is evolved, it would appear that the replacement of all Small Secondary Cells by Rotary Convertors or Motor Generators is not distant.

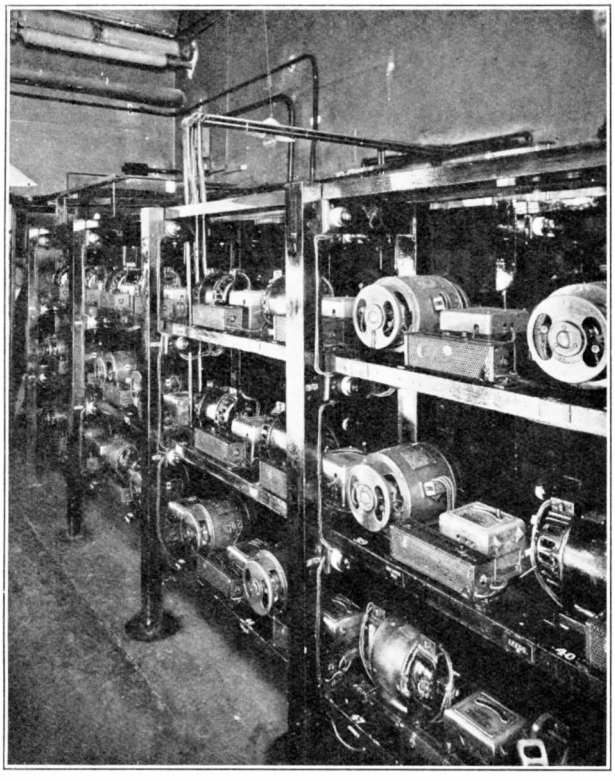


FIG. 3.—PART OF INSTALLATION AT C.T.O.

The machines are compact; there is no low insulation brought about by "creeping" of acid on the power leads, and the relative number of complaints of "Battery" failures has become proportionately less.

The types of circuit on which the machines work are as follows:—

Baudot Circuits ...	12.	Chiefly Autoplex.
Wheatstone—Creed ...	8	
Teleprinters (Duplex)	5	
Other circuits	7	

It will, of course, be appreciated that two machines are necessary where Telegraphs of the Baudot types are concerned.

A description of the type of machine used by the Post Office will be of interest. There is only one "Field" to the machine, but there are two insulated windings on the Armature and of necessity two Commutators for Motor and Generator respectively. A sketch of the connections is given in Fig. **1**.

The machines obtained, for the Central Telegraph Office, have a rated input of 110 volts D.C. and output of 120 volts at 1.25 amperes full load. A slow rotational speed has been aimed at, and they are run at 1,200 r.p.m. A characteristic chart of the machine which is in general use is given in Fig. **2**.

It may be asked why so large an output has been arranged for. One of the reasons is that a commercial machine that needed little change from the standard type of the makers was adopted; another is that stability of voltage conditions is essential.

A photograph of part of the installation at C.T.O. is given in Fig. **3**.

A further possible lay-out is given in Fig. **4**. This shows the machine askew which enables the commutators to be cleaned easily, if the machine is installed near a wall.

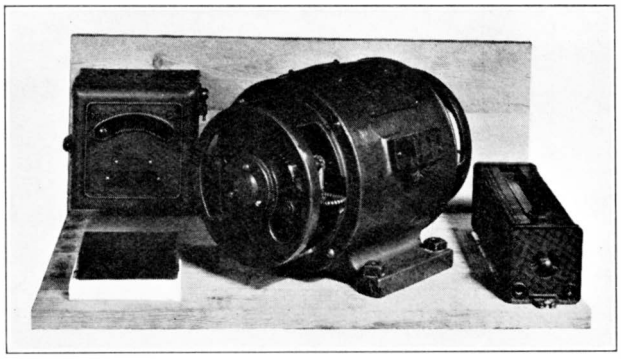


FIG. 4.—ALTERNATIVE METHOD OF MOUNTING MACHINES.

It will be of interest to state that the Cable Telegraph Companies also use Motor Generators, or Rotary Convertors for current purposes. The Eastern Telegraph Co. use a similar machine and the Western Union Co. use a Motor Generator which consists of three parts: (*a*) the Motor, (*b* and *c*) two Generators, one for Positive and the other for Negative supply. The latter machine is specially made for the Company.

TELEGRAPH REPEATERS. THE NEUTRAL RELAY.

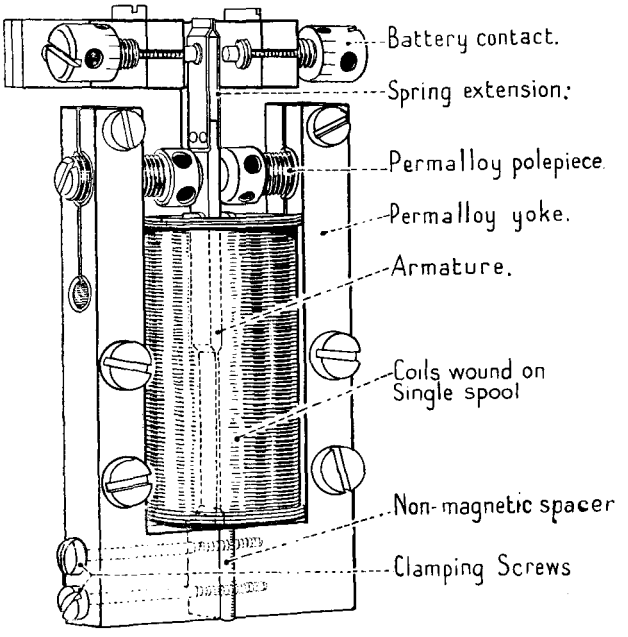
R. P. SMITH.

IN this Journal of July, 1926, Mr. E. Lack referred to the difficulties experienced in simplex working on fast speed telegraph repeaters and described a method of minimising the trouble. A simple and effective remedy has now been provided by the introduction of the Western Electric Relay F.A. 109, adjusted to function as a neutral relay for closing the automatic switch. Due to the method of construction, the armature of the Post Office standard relay cannot take up a neutral position between the polepieces of the electromagnets, consequently controlling springs are necessary when it is required to keep the tongue in a position clear of both battery contacts. The springs, however, result in a loss of sensitivity since their tension has to be overcome. The armature of the Western Electric relay is placed in a non-magnetic spacer at one end and then clamped between two yoke extensions of the permanent magnets as shown in the accompanying figure.

It acts in a similar manner to a vibrating reed, as the tongue extension is capable of taking up a neutral position between the two contacts when suitable adjustments are made. The yokes, armature, and polepieces of the relay are permalloy and the mass at the moving end of the armature is small; consequently the operating current required is low. A standard relay, fitted with spring extensions to the tongue has been adjusted to repeat signals at slow speed with an operating current of 0.043 mA and the W.E. Relay with 0.033 mA.

The permeability of permalloy is high at low induction densities and residual effects small, with the result that there is no polarising effect on the W.E. Relay when using the normal telegraph working currents. The standard relay is somewhat troublesome in this respect and close attention is necessary in fast speed Wheatstone working to counteract the variable bias arising from polarisation of the cores. The Research Section discovered that the defect was due to the method of annealing the cores of standard relays causing a carburized sheath to form round each. A new process, by which the cores are annealed in hydrogen gas has been adopted, giving good results. Cores annealed by the new method are stamped " GAS A " at the upper end, the marking is visible through the glass cover of the relay.

The Western Electric relay functions equally well either in a vertical or a horizontal position. It may be of interest to mention that a recent investigation of the operation of the standard relay showed its sensitivity to be greatest when the relay is in a horizontal position with the armatures pointing upwards. A relay adjusted



WESTERN ELECTRIC NEUTRAL RELAY.
The method of mounting the relay is not shown.

to repeat signals with a minimum current of 0.2 mA when in a vertical position will function equally well with 0.12 mA when in the horizontal position stated. If the relay is in a horizontal position with the armatures pointing downwards, it is slightly less sensitive than in a vertical position. The explanation appears to be that the spindle has a clearance in its two bearings giving room for movement, particularly in the case of relays that have seen considerable service,

where the play may amount to several mils. In the horizontal position, with armatures pointing upwards, the spindle rests in the bearings above the poles of the permanent magnet, consequently, the armatures are at a point where the magnetic field is more intense than when the armatures and spindle fall to the opposite side of the bearing.

The contacts of the Western Electric relay tongue are attached to two nickle-silver springs rivetted to the armature; the springs are bent at the free end to rest upon one another with a certain pressure. Under these conditions the make and break of the contact is remarkably accurate, and chattering is reduced to a minimum, rendering the relay particularly useful from the telegraph repeater point of view. It has been found, experimentally, that the relay will function quite satisfactorily as a neutral relay when transmission is at the speed limit of a given line.

The coil ends of the Western Electric Relay are terminated on pins carried by the base of the relay. The instrument is intended for panel mounting on a rack, a mounting block fitted with spring contacts being employed to engage the pins on the relay when it is placed in its working position. When the relay is used for a Telegraph repeater in this country a small wooden box fitted with standard relay terminals carries the mounting block. Permanent connection is made between the terminals and springs by wiring inside the box.

The availability of a highly sensitive neutral relay opens up a prospect of economy in other directions. Where a line relay has a Creed or Wheatstone receiver in its local circuit a voltage is required on the spacing and marking contacts, hence, during periods when the circuit is idle, current is wasted. If a neutral relay were employed, there would be no current in the local circuit during idle periods, economy in current would result, and the necessity for a switch in the spacing battery lead would be avoided.

THE MENDONCA D'OLIVEIRA GOVERNOR FOR BAUDOT DISTRIBUTORS.

THIS Governor, known as Distributor, Baudot, No. 4, is based on the principle of a slipping clutch. That is to say, somewhat more power than that required is provided for driving the instrument, which has a device to release the drive as soon as the speed begins to exceed that required and also to restore the drive as soon as the speed has dropped to the correct value. This de-clutching and clutching action soon adjusts itself to a more or less partial slipping action, just taking sufficient grip to drive the mechanism at its correct uniform speed. On this account the voltage of 110 usually applied to the driving motor can be allowed to vary between 70 and 120 without causing sufficient variation of speed to interfere with correct working.

The driving unit consists of a cast iron frame C (Fig. 1), containing a small A.C. or D.C. motor M rated at 1/20th H.P., 3500 revolutions. The drive is transmitted by means of a twisted cotton belt, which can be tightened when necessary by an adjusting nut working on a screw from one side of the plate supporting the motor, the other side of the plate being hinged to the main frame C.

An extension of the main axle A passes through and is keyed to a steel sleeve F. Two hollow steel arms EE are pivoted at DD on a cross-arm forming part of the steel sleeve F. The other ends of the arms are fitted with cylindrical wooden friction pieces which are pressed on to the conical extension of the pulley P by two pairs of strong steel springs SS. The cone and pulley are free on the axle A, but are driven by the twisted cotton belt.

The power of the motor is thus transmitted through the clutch and governor to the axle A and its extension, which gears with the intermediate wheel of a standard Baudot Distributor train placed on the main frame C. The speed of the governor can be varied by adjusting the tension of the springs SS, by altering the position of the friction pieces on the cone, and

by altering the position of the sliding weights W (Fig. **2**).

For checking the correct adjustment of the tension of the springs SS, two bosses are provided at the ends of the governor arms. When this has been done, it may still be necessary to slightly alter the positions of the weights W to obtain a final small adjustment. During these adjustments the position of the wooden friction pieces should be half-way along the face of the cone. There will then be a speed range by means of the adjusting screw R, of approximately fifteen revolutions of the Distributor brush arms, on each side of the normal speed.

When the motor is started the governor rotates at the same speed as the pulley P. As the speed increases, the centrifugal force acting on the governor arms in opposition to the springs SS, also increases, thereby reducing the pressure of the friction pieces on the cone. At a critical speed, the friction pieces commence to slip, thus preventing any increase of speed of the distributor brush arms. So long as the speed of the motor does not fall below this critical value, it may vary fairly considerably above it without causing any difficulty.

The governor enables a constant speed to be maintained, but does not overcome the necessity for the use of the usual Baudot epicyclic correcting gear, which is required to keep two distributors in correct phase relationship.

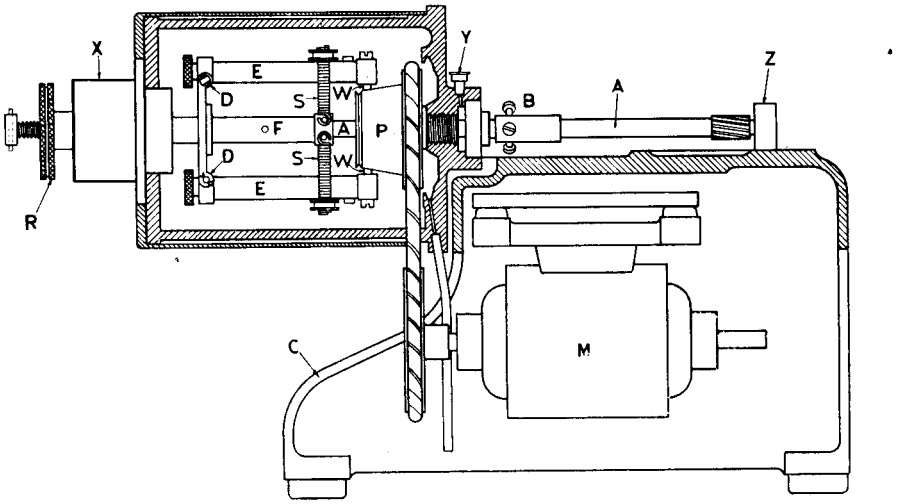


Fig. 1.—Distributor, Baudot No. 4.

The advantages of the Mendonca D'Oliveira governor are as follows:—

1. It is a self-contained unit.
2. It is unaffected by variations in the power supply of approximately 40%.
3. Small variations of speed can be made without stopping the distributor.

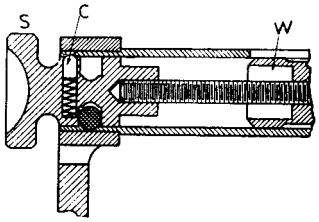


Fig. 2.

A number of these governors have been purchased to replace phonic-wheel distributors, the driving reeds of which are rather susceptible to small changes of the driving voltage.

METROPOLITAN AND NATIONAL EXCHANGES.

W. R. Tyson, B.Sc., A.M.I.E.E., and F. E. Tetlow.

AN interesting ceremony was performed on Saturday, August 13st, 1929, when the new METropolitan Director exchange was cut into service in the presence of Col. Sir Thomas Purves, Engineer-in-Chief, G.P.O.; Col. A. G. Lee, Assistant Engineer-in-Chief, G.P.O.; W. F. Benoist, President, Automatic Electric Inc.; E. A. Mellinger, Director A.T.M. Co.; G. W. Moore, Director and Manager A.T.M. Co.; A. F. Bennett, Chief Engineer, A.T.M. Co.; and other distinguished visitors. NATional Director exchange, which is in the same building, was opened on the 7th September. Approximately 3,300 lines were brought into service in each case at these initial transfers. The manual exchanges being relieved are City, Central, London Wall, Clerkenwell and Avenue.

The exchanges are housed in a specially designed building in Wood Street, having a capacity for three ten thousand line units. The third exchange, which is not as yet required, will be called Empire. The equipment was manufactured and installed by Messrs. Automatic Telephone Manufacturing Co., Ltd., and installation of the main equipment was commenced in March, 1928, the installation covering approximately fifteen months. To allow of early termination of external cables, the Main Distributing Frames were installed in advance.

Building. The building has six floors and a basement. The floors are of reinforced concrete, those supporting heavier apparatus having the slabs reinforced by $4\frac{3}{4}$in. by $1\frac{3}{4}$in. filler joists at 2′ 0″ centres supported on 16in″ by 6″ by 62 lbs. concrete-filled I beams across the building, and 12″ by 8″ by 65 lbs. concrete-filled I beams along the building.

The layout of the floors is as follows:—

Basement. Cable Chamber. Yard. Stores.

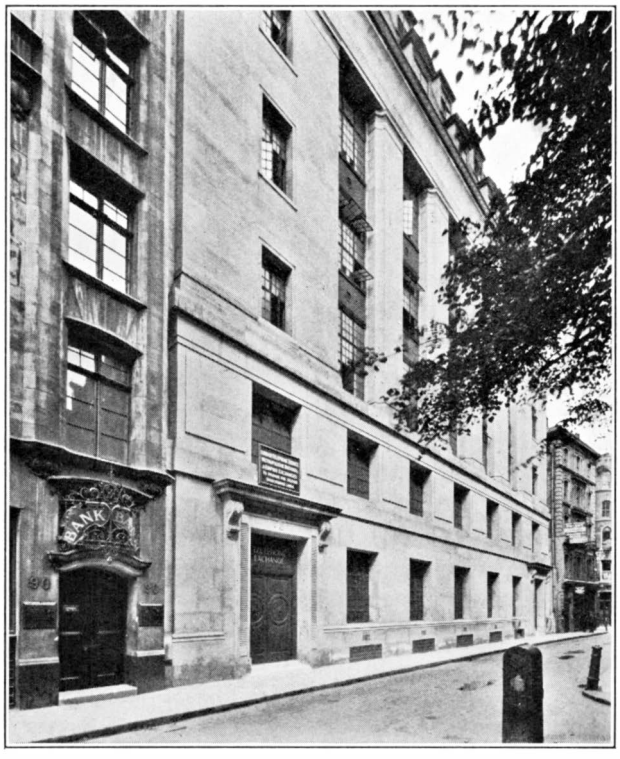


Fig. 1.—Front of Building, Wood Street.

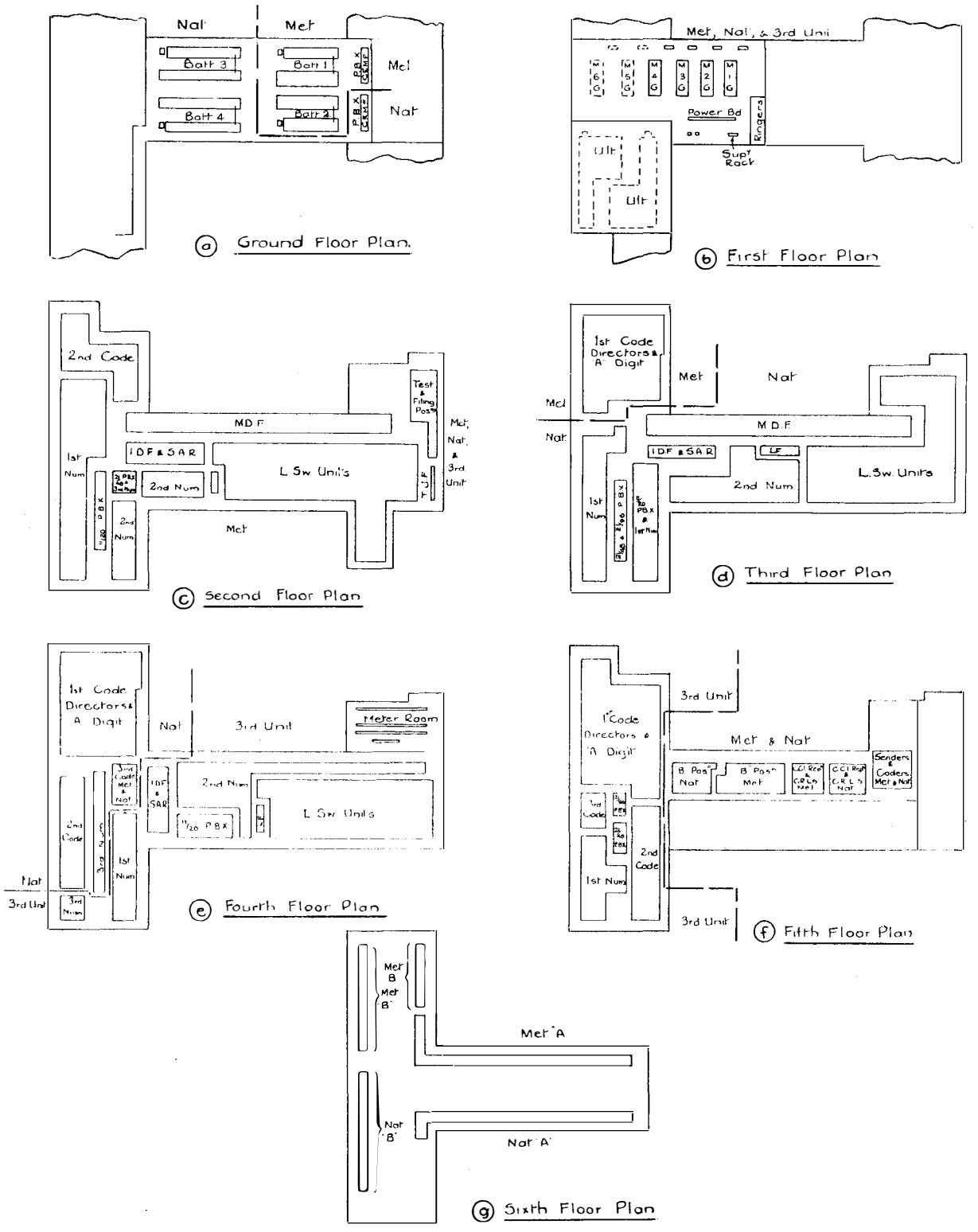


FIG. 2.—METROPOLITAN AND NATIONAL EXCHANGES. SKELETON FLOOR PLANS.

Ground Floor. Metropolitan and National Batteries. Stores.

First Floor.—Metropolitan and National Machines and Power Board. Ultimately Empire Machines, Power Board and Batteries; Lineman's Rooms and Offices.

Second Floor. Part M.D.F. for MET, NAT and EMP, MET IDF, Line Switch and Final Selector Units, Group Selector Racks and Miscellaneous Equipment. Metropolitan, Nationpolitan and National and (ultimately) Empire. National Directors, First Code Selectors, etc. Room for Empire IDF, Line Switch and Final Selector Units, and Numerical Selectors. A Centralised Service Observation Desk and Equipment for Observations on all London exchanges has also been installed on this floor by the Department.

Fifth Floor. Metropolitan, National and (ultimately) Empire Junction Apparatus Racks, CCI

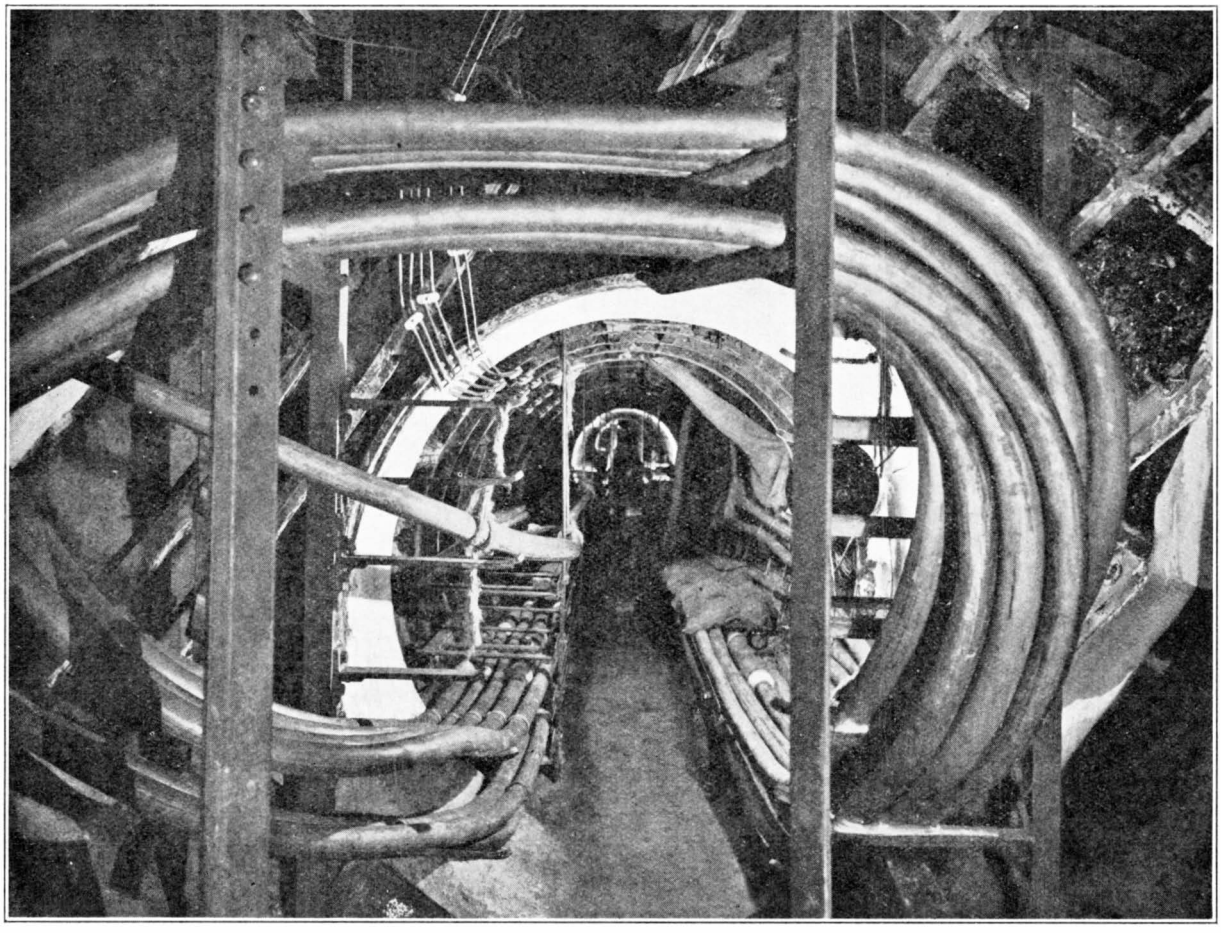


FIG. 3.—CABLE TUNNEL.

al and (ultimately) Empire Test Desks and Test Jack Frames.

Third Floor. Remainder of M.D.F. for MET, NAT and EMP, NAT IDF, Line Switch and Final Selector Units. Numerical Selector Racks and Miscellaneous equipment, Metropolitan Directors and First Code Selectors.

Fourth Floor. Subscribers' Meters for Metro-

Repeaters, Coders, Senders and Service Interception equipment. Offices.

Sixth Floor. Manual Equipment ("A" and keysender "B" positions, and Supervisor's Desks).

Fig. **2** gives an indication of the layout of equipment on the various floors.

A description of the tunnel through which

cables are brought into the exchange is contained in the I.P.O.E.E. Journal for April, 1926 (Vol. 19, page 43), under the title "Guildhall Exchange Tunnel." (It was originally intended that Metropolitan exchange should be called "Guildhall"). From the cable bearers at the head of the tunnel, cables are taken through vertical pipes laid in the wall of the building, to trenches on the second and third floors for the Main Distributing Frames.

throughout the building, the pump and fan rooms being in the basement.

Main Distributing Frames. As indicated above, there are two Main Distributing Frames, one on the second floor and one on the third floor. The Frame on the second floor accomodates on the Exchange Side all junctions incoming to and outgoing from the three exchanges, and all the Metropolitan subscribers' lines. On the third floor, accommodation is pro-

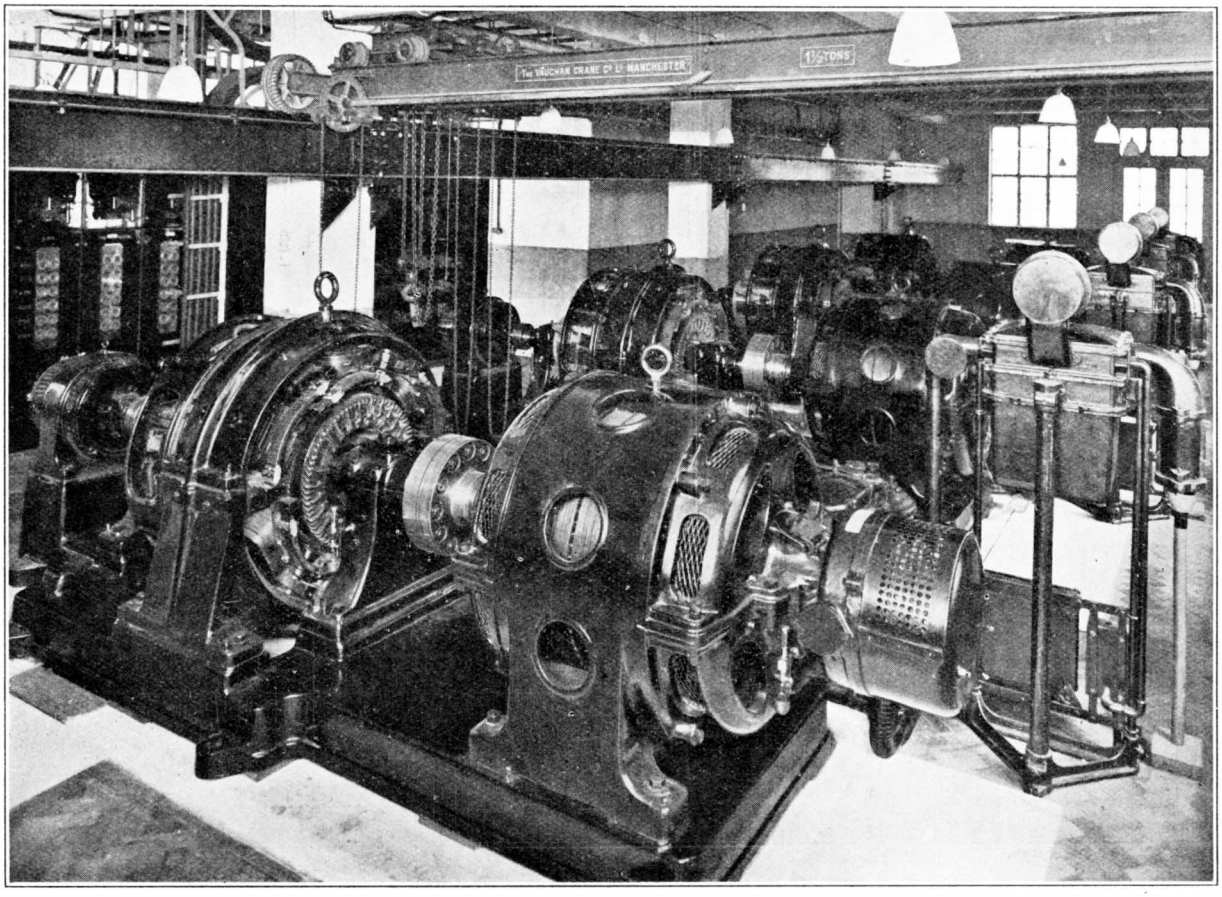


FIG. 4.—MOTOR GENERATORS.

Access to the building for apparatus is afforded by a large goods entrance in Silver Street and a goods lift, capable of carrying 6 tons, carried the equipment to the yard in the basement, whence it was lifted to apparatus entrances on each floor by means of a 5 HP. 30 cwt. electric hoist working to a jib fixed over the apparatus entrances.

The plenum system of ventilation is used

vided initially for National subscribers' lines, and provision is made for extending the frame to serve the Empire subscribers' lines. The second frame is vertically above the first, and pipes are run through the floor (one pipe per MDF vertical) for jumpers running between the two frames. Additional jumper rings are interpolated in suitable positions to facilitate the running of such jumpers. The first MDF has

177-200/220 circuit verticals, giving a length of almost 100 feet, and is served by four travelling ladders on each side. The second MDF has an initial length of 115-200/220 circuit verticals, with provision to grow as long as the first MDF., and is served at the outset by two travelling ladders on each side.

Test Desks. The Test Desks for Metropolitan and National, and space for those for Empire are situated on the second floor near to the commencement of the M.D.F. Initially, there are fourteen Testing Positions and seven filing positions for the first two exchanges. These are arranged as follows:—

Subscribers' Testing. The Metropolitan and National Subscribers' Test Desks are in one suite; there are Five Testing positions and Two Filing Sections particular to each exchange; the central Filing Section of the suite is common to both exchanges. Standard testing facilities are provided. Arrangements have been made for any Test Clerk to have access to subscribers' lines on both exchanges.

Junction Testing. Two Testing sections and one Filing Section are provided and are common to both exchanges.

Advice Note Testing.—Two Testing sections and one Filing Section are provided common to both exchanges. Eighty circuits for testing new subscribers' lines are taken from these positions and multiplied at intervals along both M.D.F.'s.

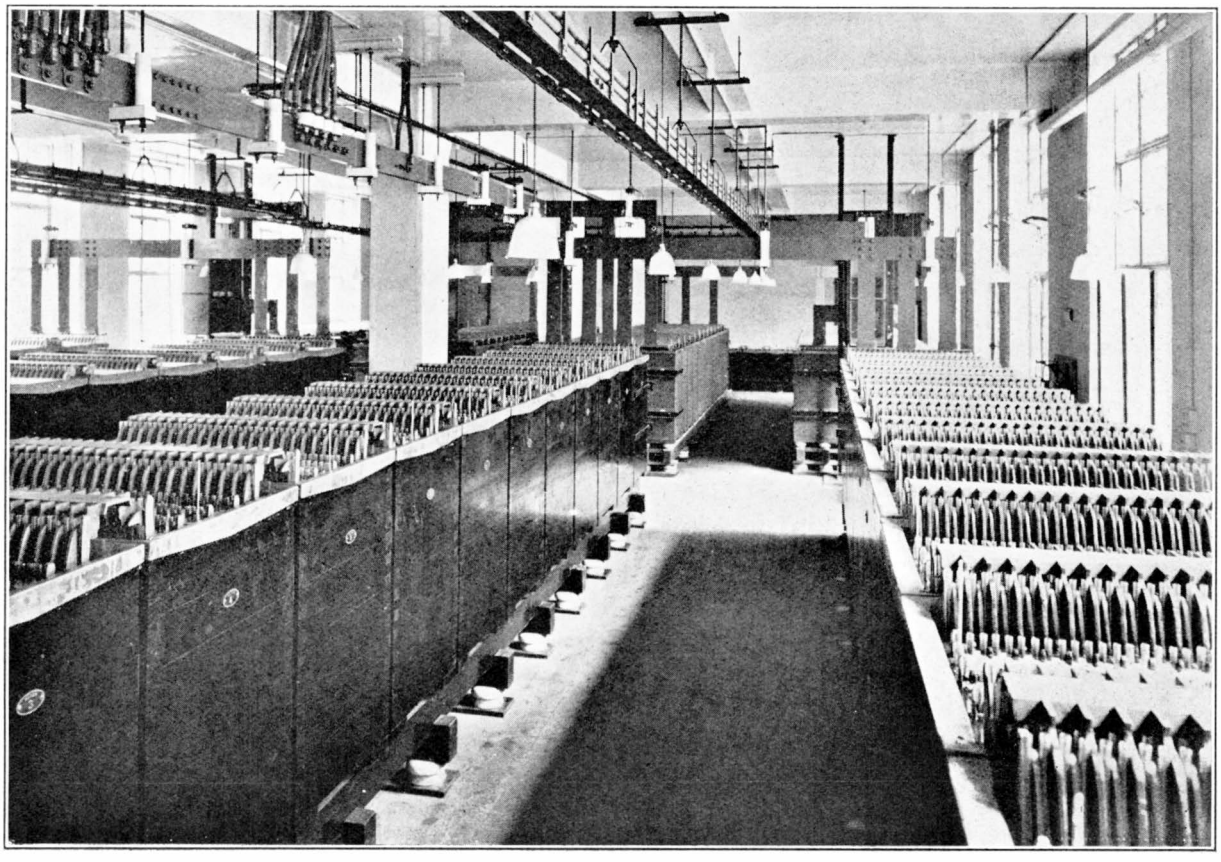


FIG. 5.—BATTERY ROOM, SHOWING BUSBARS AND CABLES.

A Test Jack Frame of 6 bays, having a capacity of 4000 tapping jacks for outgoing junctions, is installed between the Subscribers' Test Desk and Junction Test Desk. There is space for 3 more bays for the Empire Outgoing Junctions when required.

Power Plant. The power supply to the building is 11,000 volts, three-phase, 50-cycle A.C.

This is transformed down to 400 volts at a sub-station situated in the basement. Four motor generator sets (two for each exchange), each consisting of an autosynchronous motor direct-coupled to a D.C. generator, have been installed for charging the batteries. The manufacturers are Messrs. Crompton, Parkinson & Co. The motors are 400-volt, 3-phase, 50-cycle and can be adjusted by means of direct coupled exciters to give unity power factor at any load. The generators each have an output of 1600 amps at 57 volts. The speed of the sets at full load is 600 r.p.m. and guaranteed efficiencies are 82% at full load and 78% at half load. Space has been left for two further similar motor-generator sets required for Empire.

Four batteries of 10,000 ampere-hours at the 9 hour discharge rate, each consisting of 25 cells, have been provided. The two for Metropolitan were manufactured and installed by the D.P. Battery Co., and those for National by the Alton Battery Co. The cells are over four feet in height, and the total weight of the four batteries is 210 tons when filled with acid.

Normally, one common power discharge lead serves both exchanges, and will also ultimately serve Empire. Provision has been made on the power switchboard for running one or more machines in parallel with one or two of the batteries in case of unforeseen demands.

An overload circuit-breaker with delay feature has been provided in circuit with each main battery and will function in case of a serious short-circuit.

Connections between batteries and the power switchboard is by means of heavy copper bus-bars, and the distribution fuseboards serving the automatic plant are fed by V.I.R. cable.

A 400-volt supply-driven ringer, and a battery-driven ringer are supplied for each exchange. These were manufactured by Messrs. Newton Bros., Derby. In case of breakdown of the supply-driven ringer through any reason, facilities have been provided for automatic changeover to the battery-driven ringer. The output of the ringers is 4 amps. at 75 volts with a rise to 95 volts at no load, and the guaranteed effiiciences are 60% at full load and 50% at half load.

In addition to the A.C. supply to the building there is a 200 volt D.C. supply for working the lifts.

Automatic Plant.

The following is a list of the main items of the Automatic equipment:—

	Metropolitan.			National		
	Racks	Banks and Wiring	Switches	Racks	Banks and Wiring	Switches
Subscribers' Rotary Lineswitches ...	95	9500	9500	91	9500	9500
P.B.X. 2-10 Final Selectors		2296	1827		2096	1572
P.B.X. 11-20 Final Selectors	2	240	136	4	660	308
P.B.X. over 20 lines	22	100	78	7	300	235
Test Final Selectors	—	104	104	—	114	112
Trunk Offering Final Selectors ...	—	100	100	—	103	101
Test Distributors	1	12	11	1	12	11
Trunk Offering Distributors		10	10		10	10
1st Code Selectors	9	1340	1277	10	1560	1460
A digit Switches	1	180	167	1	190	165
Directors	15	280	246	16	280	238
2nd Code Selectors	7	1400	1257	7	1400	1277
3rd Code Selectors	4	480	306	(included with Metropolitan)		
1st Numerical Selectors	12	2280	1868	13	2480	1903
2nd Numerical Selectors	10	1700	1606	11	2040	1668
3rd Numerical Selectors	1	80	55	2	300	180
C.C.I. Repeaters and Coder R.L.S. ...	11	1080	992	7	700	610
Coders	2	80	80	2	80	64
Sender (4 digit)	2	80	74	2	60	60

The subscribers' Multiples are: Metropolitan —10200, National—10400.

Owing to the large number of P.B.X's. to be served by the exchanges, the whole of the final selectors on the Line Switches and Final Selector units are of the P.B.X. 2—10 type, which caters for single lines and small P.B.X's. up to 10 lines; the multiple is split in the standard man-

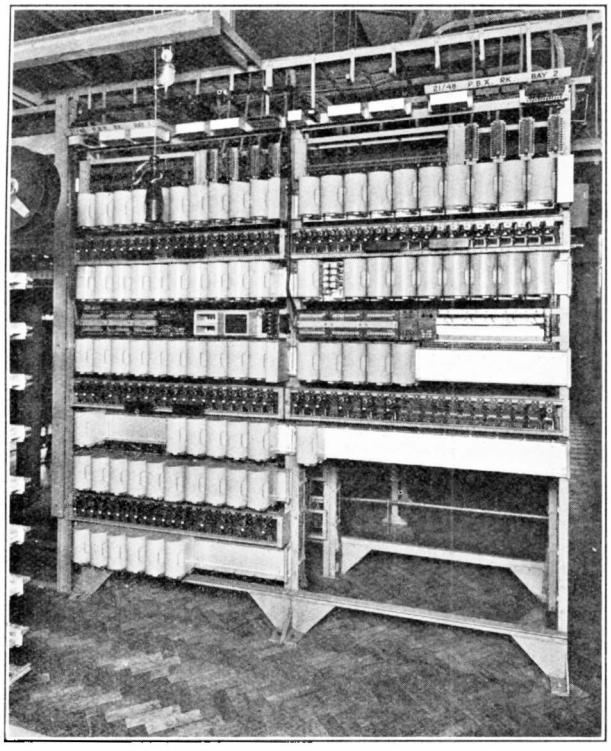


FIG. 6.—P.B.X. 21—48 FINAL SELECTOR RACK, SHOWING UNIVERSAL PRESSED STEEL CHANNEL TYPE SHELVES.

ner to allow for temporary growth of a P.B.X. over 10 lines without changing the subscriber's number. The number of P.B.X's. over 10 lines on National being abnormally large, it was found necessary to fit 4 of the Line Switch units with rotary line Switches on each side, the whole of the 800 switches on these units being cabled to the I.D.F. for cross-connections to the relevant large group final selectors.

The First Code Selectors are of the 10-circuit per level type; the whole of the Group Selectors have 20 circuits per level. These switches are all fitted on the well-known double sided type racks.

It will be noticed that Third Code Selectors for both exchanges have been accommodated on common racks. This is so that outgoing junction *via* Third Codes may be in common groups. These junctions are, for the most part, small groups to the more distant exchanges, and the commoning therefore provides for one larger junction group instead of two smaller junction groups and since the former has a larger traffic carrying efficiency than the latter, an economy in switches has been effected. This commoning of groups has made it possible to route many junctions direct instead of *via* Tandem.

To provide for testing auxiliary lines (*i.e.*, lines outside the ordinary numbering) an auxiliary Test Distributor is fitted for each exchange.

The P.B.X. 21—48 final selectors each consist of a relay set associated with a 50-point Rotary Line Switch, the P.B.X. 21—96 Final Selectors each consist of a relay set associated with two 50 point Rotary Line Switch in tandem. These are fitted on single-sided racks, fitted with the new A.T.M. pressed steel channel type shelves, which can be universally employed for mounting all types of automatic jack-in switches and relay sets (see Fig. **6**). The Department is proposing to adopt the idea of pressed steel channel type shelves as standard for all jacked-in Automatic equipments. The apparatus for junctions incoming from Manual Exchanges to Key-sender "B" positions, and C.C.I. Repeaters and Coder Rotary Line Switches are similarly mounted on single-sided racks.

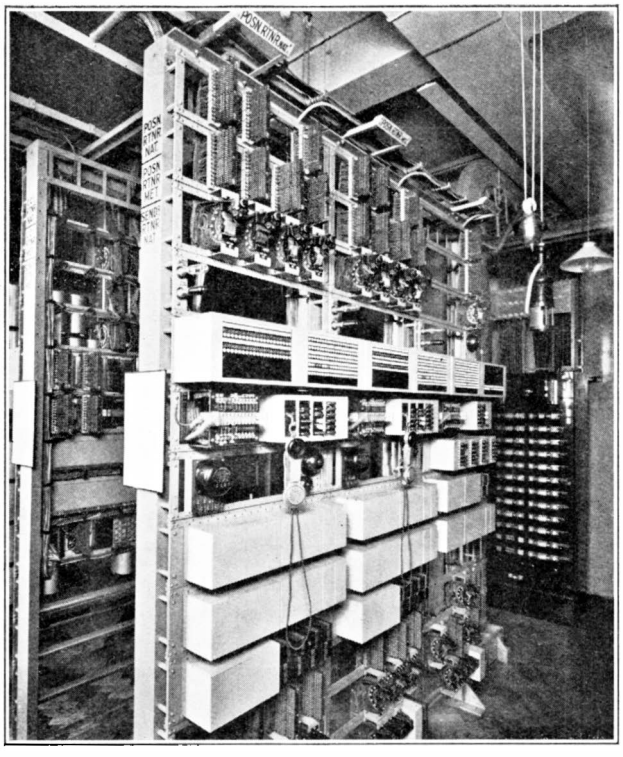


FIG. 7.—AUTOMATIC ROUTINERS, FIFTH FLOOR, SHOWING FEEDER FUSE-BOARD FOR THIS FLOOR.

It is of interest to note that since the Junction Apparatus, C.C.I. Repeaters, Coders and Senders for both Metropolitan and National are concentrated in a comparatively small space on the 5th Floor, there are no fewer than 8 Automatic Routiners (one per exchange for each of the above types of equipment) on this floor. It is unusual to find so many Routiners in such a small area.

Alarm Scheme. To facilitate the rapid tracing of faults, a comprehensive system of floor alarms has been installed on the so-called "Geographical" basis. Each floor is divided into a number of main sections and sub-sections; a main section covering roughly 2500 square feet of floor area and a sub-section roughly 700 square feet. When a fault occurs (such as the blowing of a fuse, or the abnormal holding of a switch) the following conditions are set up:—

(1) A lamp centrally situated in the particular sub-section affected will glow.

(2) A bell situated in the section affected, rings.

(3) A panel centrally situated on the floor on which the fault occurs, is illuminated, and shows which main section is affected.

(4) A floor lamp panel multipled over all floors except the affected one, is illuminated, and shows to maintenance officers on other floors that a fault exists on the floor indicated.

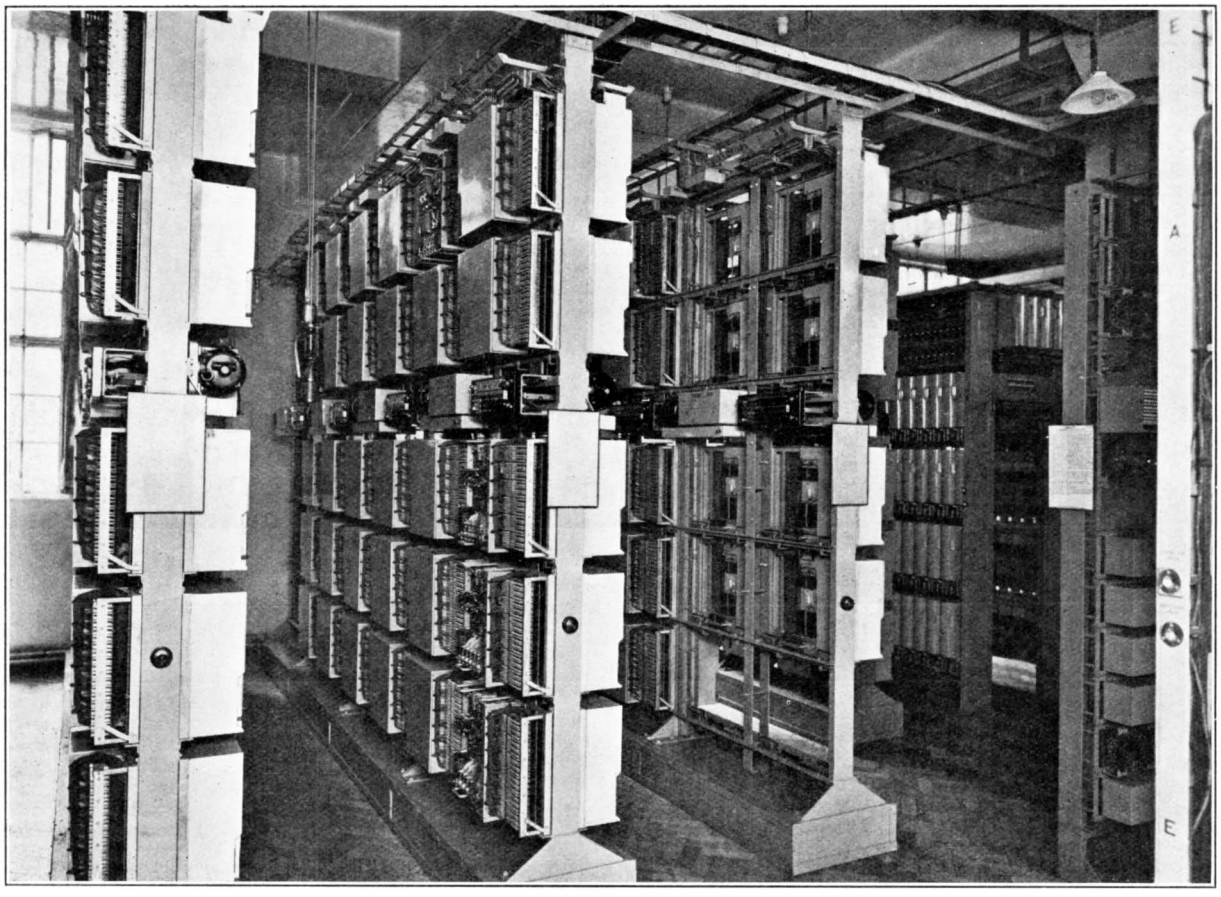


FIG. 8.—METROPOLITAN DIRECTORS.

(5) A floor alarm bell rings on all floors.

On each automatic rack a number of pilot lamps are fitted which indicate the type of fault and the particular shelf on which the fault exists; in certain circumstances the supervisory lamp on the faulty switch or relay set will also glow, so that when a fault has been traced to a specific subsection, it is a comparatively easy matter to locate it.

By means of a Key on the Test Desk, alarms can be extended to the Manual Board during slack periods and at night time, and another Key on the Test Desk provides for cutting off the floor bells during busy periods when maintenance officers will be on all floors, and allowing only the section bells to ring. The visual signals are not affected.

Manual Equipment. The Manual Equipment installed initially is as follows:—

	Metropolitan	National
Service P.B.X. positions ...	1	—
Supervisor's positions	3	—
Enquiry & Interception positions	42	42
Keysender " B " positions ...	31	21
Supervisor's Desks	2	1
Fault Operator's Tables ...	1	1

The Service P.B.X. and Supervisor's positions shown under heading " Metropolitan " will serve both exchanges. The remaining Manual equipment is of the standard Director exchange type, and presents no unusual features.

This installation is of particular interest since it is the largest Automatic undertaking of its kind installed in this country as yet. It has only been possible to give a brief description of the installation; there have been many problems of a widely varied nature that have had to be solved, but their interest is particular rather than general and their description does not, therefore, come within the scope of this article.

Thanks are due to Messrs. Automatic Telephone Manufacturing Company, Ltd., for the loan of the photographs.

TELEGRAPH AND TELEPHONE PLANT IN THE UNITED KINGDOM.

TELEPHONES AND WIRE MILEAGES, THE PROPERTY OF AND MAINTAINED BY THE POST OFFICE IN EACH ENGINEERING DISTRICT, AS AT 30TH JUNE, 1929.

No. of Telephones owned and maintained by the Post Office.	Overhead Wire Mileages.				Engineering District	Underground Wire Mileages.			
	Telegraph.	Trunk.	Exchange.	Spare.		Telegraph.	Trunk.	Exchange.	Spare.
638,958	526	3,968	52,307	125	London	24,937	79,742	2,464,143	120,512
83,309	2,153	21,021	67,296	2,411	S. East	4,055	54,471	227,825	27,235
86,688	4,483	31,385	59,455	3,511	S. West	21,322	13,426	166,240	58,522
68,636	6,096	38,556	62,191	4,471	Eastern	24,308	41,572	139,714	67,420
101,403	8,645	45,369	60,723	3,955	N. Mid.	32,114	55,932	255,926	106,843
84,931	4,819	30,340	74,799	4,368	S. Mid.	12,265	25,359	205,998	86,362
60,268	4,830	29,924	54,722	3,601	S. Wales	5,905	27,250	129,012	71,317
109,680	7,945	26,467	51,854	4,441	N. Wales	13,897	40,846	287,529	61,587
164,422	1,469	15,726	44,104	3,006	S. Lancs.	14,277	80,137	498,227	51,300
96,551	6,219	29,196	47,916	3,342	N. East	13,256	45,725	249,430	74,092
66,667	3,913	23,836	39,001	2,819	N. West	8,812	35,252	173,751	30,965
49,383	2,564	16,183	26,140	2,655	Northern	5,487	19,185	117,570	43,797
22,348	4,543	8,609	13,710	537	Ireland N.	137	2,330	45,999	1,560
68,799	5,422	26,949	38,934	1,218	Scot. East	5,412	14,308	158,737	44,655
91,209	7,253	24,438	43,686	1,078	Scot. West	12,360	26,047	227,981	34,969
1,793,252	70,880	371,967	736,838	41,538	Total	198,580	561,582	5,348,082	881,136
1,765,927	70,723	372,339	728,332	41,458	Figures as at at 31st Mar., 1929.	197,156	552,088	5,279,791	883,312

CALL-INDICATOR OPERATION BY MEANS OF AN ORDER-WIRE.

D. A. CHRISTIAN
(Of Siemens Brothers & Co., Ltd.).

IN a previous issue of the Journal (Vol. 21, Part 2) a method was described for handling calls from manual to automatic exchanges by means of an order-wire, but without the co-operation of a telephonist at the automatic exchange. The use of an order-wire also provides an extremely economical and efficient means of handling calls in the reverse direction, that is, from automatic to manual exchanges. As this method of operation is somewhat similar, while at the same time forming a natural contrast to the previous method it is hoped that a short description may interest readers of the Journal.

In the previous article the subject was introduced by a consideration of the possible methods, from the operating point of view, of handling calls of the class concerned. This was useful since the arrangement described involved a different method of operation from that previously used. In the present case such a consideration is not necessary, since exactly the same method of operation is provided as is already in use in the London Call-Indicator equipments.

The system of order-wire call-indicator working is perhaps most easily understood by drawing an analogy with ordinary manual order-wire working, and this will be done in the following paragraph, which very briefly outlines the method.

The impulses from the subscriber's dial (or from the director in a director area) route the call *via* the ordinary selectors to a link (or trunk) which has associated with it a coder-finder. (See Fig. 1.) The coder-finder searches and extends the call to a free coder. The remainder of the impulses are received by the coder. So far the operation is exactly the same as in the system in use in London. The coder may be considered as an " A " operator, who receives the number required by the calling subscriber. The coder, like the " A " operator, now makes connection with the order-wire and passes the number as a code over the order-wire to the " B " position. The number appears at the " B " position on a lamp display, which is precisely the same from the operator's point of view as those at present in use. The " B " operator selects any free junction cord circuit and after making the usual engaged test inserts the plug in the multiple jack of the required subscriber. For the moment it may be supposed that the number of the junction thus assigned is now transmitted back over the order-wire, as a code, to the coder. The coder, in like manner to an " A " operator, then directs the call by means of appropriate impulses, which it sends to the junction selector, to the outgoing end of the assigned junction. The junction selector in this case would be a two-motion switch stepping under control of the impulses on both vertical and rotary directions.

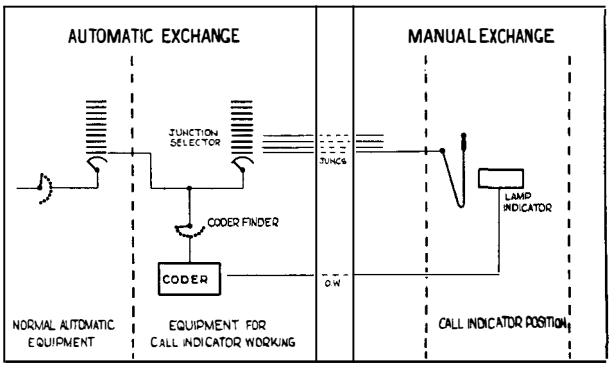


FIG. 1.

Actually it is not necessary to transmit the number of the assigned junction back to the originating exchange and the method, in practice, deviates slightly from manual operation in this respect. In the case of a single order-wire and call-indicator position, the junction selector becomes a 50 point rotary switch and the coder merely receives a signal from the manual end that a junction has been assigned. On receipt of this signal, the coder starts the junction selector searching and since only one junction can be assigned at a time the junction selector will automatically find it.

It will be appreciated that the difference between automatic and manual working which permits the above deviation is the speed of search of the automatic switch, which enables a complete search to be made over the entire group before a succeeding assignment could possibly be given.

So far it has been assumed, for the sake of simplicity, that only one order-wire and one call-indicator position is required to deal with the traffic between the two exchanges concerned, but the application of this method of operation to cases in which several call-indicator positions are required presents no difficulty, and, moreover, the same group of coders may be arranged to handle traffic to call-indicator positions at several different manual exchanges if this is required.

The precise switching arrangements required to meet the conditions of different areas and numbering schemes, of course, vary and each case must be studied separately if maximum efficiency is to be attained; a representative case has, however, been selected for purposes of illustration and the method of operation for this is more fully described below.

The case chosen is that of an automatic exchange which routes calls direct to three different manual exchanges, the junctions to which would be normally accessible from the levels of a second selector in the automatic exchange, say, from levels " 61," " 62 " and " 63 ": the traffic to the first manual exchange requires the use of three call-indicator positions and that to the other two one position each.

An elementary diagram showing arrangements suitable for the above case is shown in Fig. **2**.

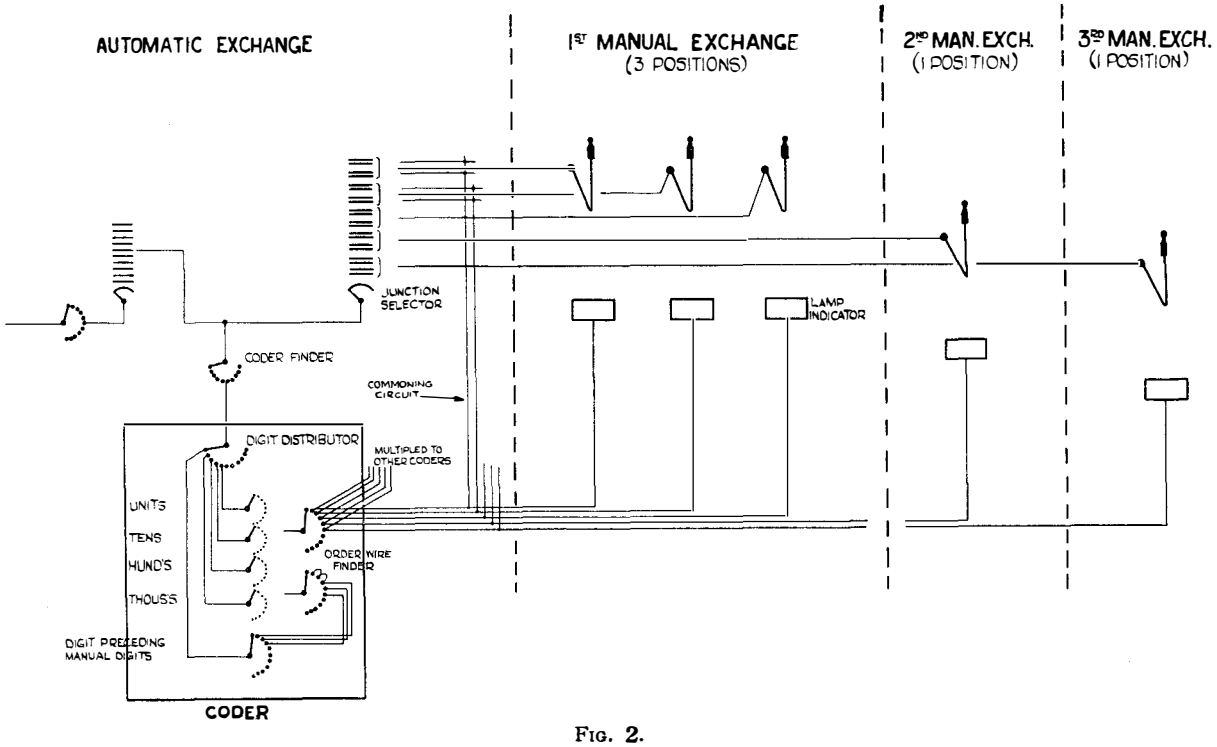


FIG. 2.

The usual subscribers' line switch and first selector are shown at the left of the diagram. From level " 6 " of the first selector are indicated links going to junction selectors, and with each link is associated a coder finder which gives access to a group of coders. The junction selector is the usual type of 20-link intermediate selector with simultaneous search on both sets of wipers, having in addition incorporated in it the ability to step up and search a succeeding level, if no free outlets are found in the first level searched. This action is the same as that incorporated in the Siemens type P.B.X. Final Selectors for large groups. The arrangement permits a search over 40 outlets in a very short space of time.

The action of a call to, say, the first manual exchange will now be described. The subscriber dials " 61 " followed by the number required in the manual exchange, which we may assume to be " 2345." The first digit (6) raises the first selector to the sixth level, whereupon a free link to a junction selector is obtained: the coder-finder searches and obtains a free coder. The second digit (1) is now received on the single-motion switch shown at the bottom in the diagram of the coder. The digit distributor steps and the manual digits (2345) are received on the thousands, hundreds, tens and units switches as indicated. When the units digit has been received, the order-wire finder switch in the coder searches for a free order-wire, but in doing so it is constrained by the position of the switch which has received the digit preceding the manual digits to test only on those order-wires leading to the manual exchange required. We may assume that the first order-wire to this exchange is engaged and that the order-wire finder has made connection with the second order-wire. Codes corresponding to the manual digits are now transmitted practically instantaneously over the order-wire and the number (2345) appears on the lamp indicator at the manual position. The operator now selects any free junction plug on her position and after making the usual engaged test inserts it into the multiple jack required. This action sends a signal back over the junction selected, which finds its way to the coder, *via* the commoning circuit indicated in Fig. **2**, and which indicates to the coder that a junction has been assigned. The coder on receipt of this signal sends a train of impulses, the number of which is determined by the position of the order-wire finder switch, which raise the junction selector to level 7, whereupon search over level 7 (and if necessary over level 8) enables the assigned junction to be found and the through connection is completed. The coder is now released and is ready for further use.

The levels of the junction selector from which the various junction groups are taken have no numerical association with the digits dialled to obtain the particular exchange. The impulses transmitted by the coder to raise the junction selector to the required level are arranged as required by means of local strapping in the coder.

Different requirements with respect to the size and number of manual exchanges served will chiefly influence the arrangement for routing the call to the particular junction group. The switching arrangements adopted for this purpose are, however, quite flexible and may consist of any combination of switches desired; for instance, outgoing preselectors may be incorporated or the junction selectors may consist of two ranks of selectors, as circumstances dictate: the coder impulsing circuits being, of course, arranged to suit.

In the above description of the action several features have been omitted for the sake of clarity and to these reference may now be made.

The calls are handled in strict succession in the order of their arrival; by arrival being understood the reception of the units digit in the coder. This is accomplished by providing a group of marker switches for each manual exchange served, which associate themselves in turn with the coders immediately the last train of impulses has been received. Immediately a coder receives its full complement of digits, it thus, in effect, takes its place in a queue for the particular exchange required. The coders then take their turn in being served by the group of order-wires serving the wanted exchange, each order-wire as it becomes free takes the next coder waiting for its exchange. The calls are thus distributed over the positions in the manual exchange which serve each automatic exchange. Arrangements can be provided which show in the manual exchange how many calls are waiting for attention at the particular automatic exchange.

The method of giving the busy signal to the calling subscriber when the called line is found engaged is particularly simple. On finding the called number engaged, the operator momentarily depresses a key, which is common to the position. The depression of this key passes the same signal to the waiting coder as does the action of inserting one of the junction plugs into the multiple; the signal in this case passing back over the order-wire. The coder is thus informed that a junction has been assigned when, in fact, no assignment has been made. The call is consequently directed to a selector level in which it can find no outlet in a condition to be picked up, and the junction selector therefore reaches the busy contact at the end of the level and busy

signal is given to the calling line. Since the various circuits act in their normal manner during the above operation, no extra complication is involved in providing the facility. It may also be noted that a junction is not held during the period in which the busy signal is applied.

All the usual facilities appertaining to the junction or cord circuits, such as supervision, automatic ringing or flashing recall can, of course, be provided as required. The junction circuit in fact differs only from an ordinary manual order-wire junction circuit in the provision of means to pass back the assignment signal to the outgoing end when the plug is inserted in a multiple jack.

Calls requiring assistance are simply dealt with by plugging the junction through to a service line terminating at a position where the necessary assistance can be given. During slack periods, the operator can herself speak to the calling subscriber by plugging into a jack associated with her telephone circuit and, after obtaining the necessary information, the junction plug can be withdrawn from this jack and inserted in the required multiple jack.

An interesting feature is the simplicity with which a breakdown service can be provided should a fault occur on the order-wire. The order-wire is dispensed with entirely and the operator pre-assigns a junction by inserting any junction plug in the jack associated with her telephone. The action of the various circuits now proceeds exactly as already described up to the point where the coder sends the code signal to the manual exchange. Since the order-wire is disconnected, the signal is, of course, ineffective, but due to a junction being already assigned the coder now receives the usual signal to direct the call to the junction group; which it does. The call now finds the preassigned junction and since this junction is connected through to the operator's telephone circuit, the operator can ask for the number required and then transfer the junction plug to the multiple. A click signal is given in the operator's telephone when a call thus arrives.

In this description, which deals only with the general arrangements involved in Order-Wire Call-Indicator Operation, no reference to the circuit arrangements has been made and no circuit diagrams illustrated; these are in fact quite incidental to the general scheme. They involve no point of particular interest in circuit design and would be of use only to a minority of readers of the Journal. The amount of apparatus required, particularly at the manual exchange is, however, an important feature of this method of call-indicator working and details of that required for the arrangement shown in Fig. **2** are given in the following list:—

	Relays.	Single Motion Switches.	Two Motion Switches.
Automatic Exchange—			
Coder Finder ...	5	2	—
Coder	10	8	—
Junction Selector...	3	—	1
Outgoing Junction Circuit	4	—	—
Outgoing Order-wire Circuit ...	4	—	—
Manual Exchange—			
Position Circuits ...	32	—	—
Junction Circuit ...	7 + one retard coil	—	—

In conclusion it may be useful to summarise the most important and interesting features of the scheme.

(*a*) No automatic apparatus is required at the manual exchange.

(*b*) Apart from the junction circuits themselves, only thirty-two relays are required at the manual end for each call-indicator position.

(*c*) The junction circuits are quite simple, since in addition to the ordinary supervisory signals only the assignment signal is passed over them.

(*d*) The code signals are simple because they are confined to the order-wire, and it is therefore economically possible to provide four conductors to transmit them.

(*e*) Coders may be arranged in a common group serving several manual exchanges.

(*f*) Calls are distributed to the call-indicator positions, serving the particular automatic exchange, in rotation.

(*g*) It is not possible to distribute calls from more than one automatic exchange over

a common group of call-indicator positions, but this is not possible in manual-to-manual operation and although advantageous, should not, except in special circumstances, be essential.

(*h*) Busy signal is given from the automatic exchange without holding a junction engaged.

(*i*) Reasonable breakdown operation can be given even if the order-wire is entirely disconnected.

The writer is indebted to Messrs. Siemens Brothers & Co., Ltd., in whose laboratories this scheme was developed, for permission to publish the above description.

[*The system described in the foregoing article is not used by the British P.O. Department.—Eds., P.O.E.E. Journal.*]

A NEW C.B. MICROTELEPHONE.

A. J. Aldridge, E. J. Barnes, E. Foulger.

INTRODUCTION.—In August, 1927, the Research Section was asked by the Engineer-in-Chief to design a microtelephone which would be equal to any instrument of that type then available, and which would not infringe any existing patents.

Extensive tests of microtelephones from all sources had been carried on for many years, but the results were generally far inferior to those obtained with the fixed solid back transmitter and Bell receiver of the P.O. standard pedestal telephone.

General features of the proposed instrument. The requirements which it was desired the instrument should meet were:—

Electric and Acoustic.—

(1) Sending efficiency should not be more than 1.4 d.b. worse than P.O. basic standard.

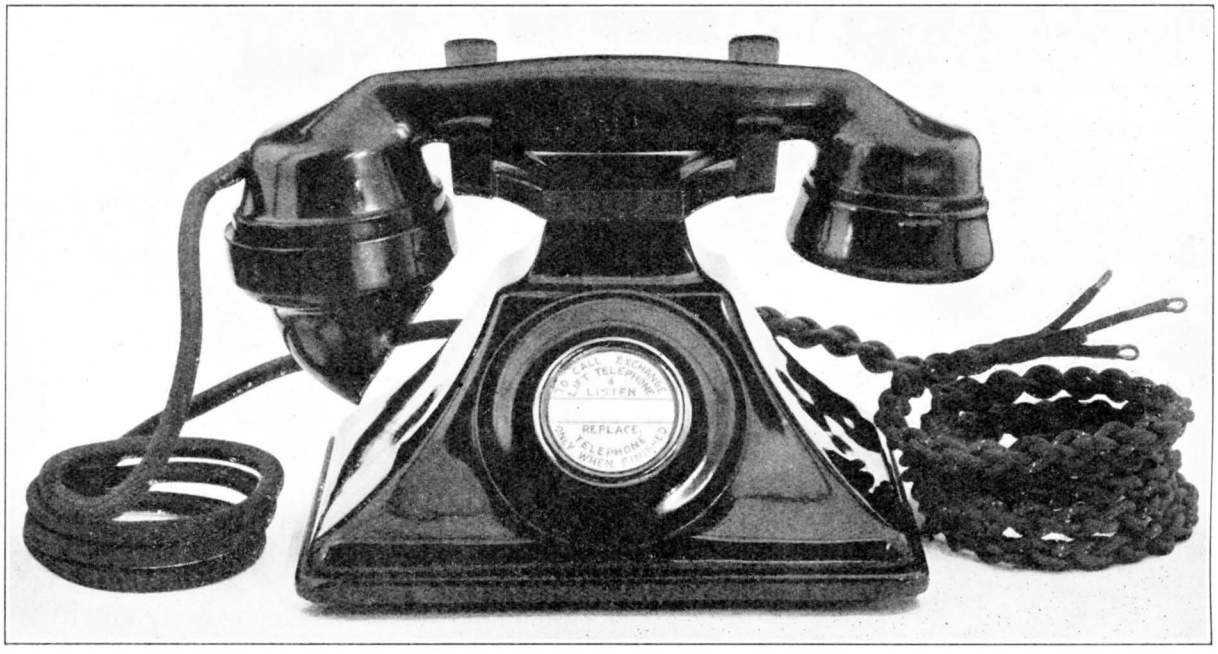


Fig. 1.—The new C.B. Microtelephone.

(2) Receiving efficiency should not be more than 1 d.b. worse than Department's standard.

(3) Articulation should be 10%, or more, better than standard.

(4) Frying and packing should not be worse than on the No. 1 C.B. Transmitter.

(5) The instrument should be capable of use without serious change in efficiency when used in any practicable position.

(6) The instrument should not " howl " on a short local line.

These desiderata are rather severe, but it was considered advisable to work to them if possible.

be self-contained on the lines of the No. 1 transmitters, as this has been found in the past to be a good design.

(3) The mouthpiece should be hygienic and easily cleaned.

(4) The instrument should be robust, of pleasing appearance and not easily interfered with by the subscriber.

Transmitter Design.

A large number of model transmitters were made up, mainly by using parts of the No. 1 C.B. transmitter. The points which were

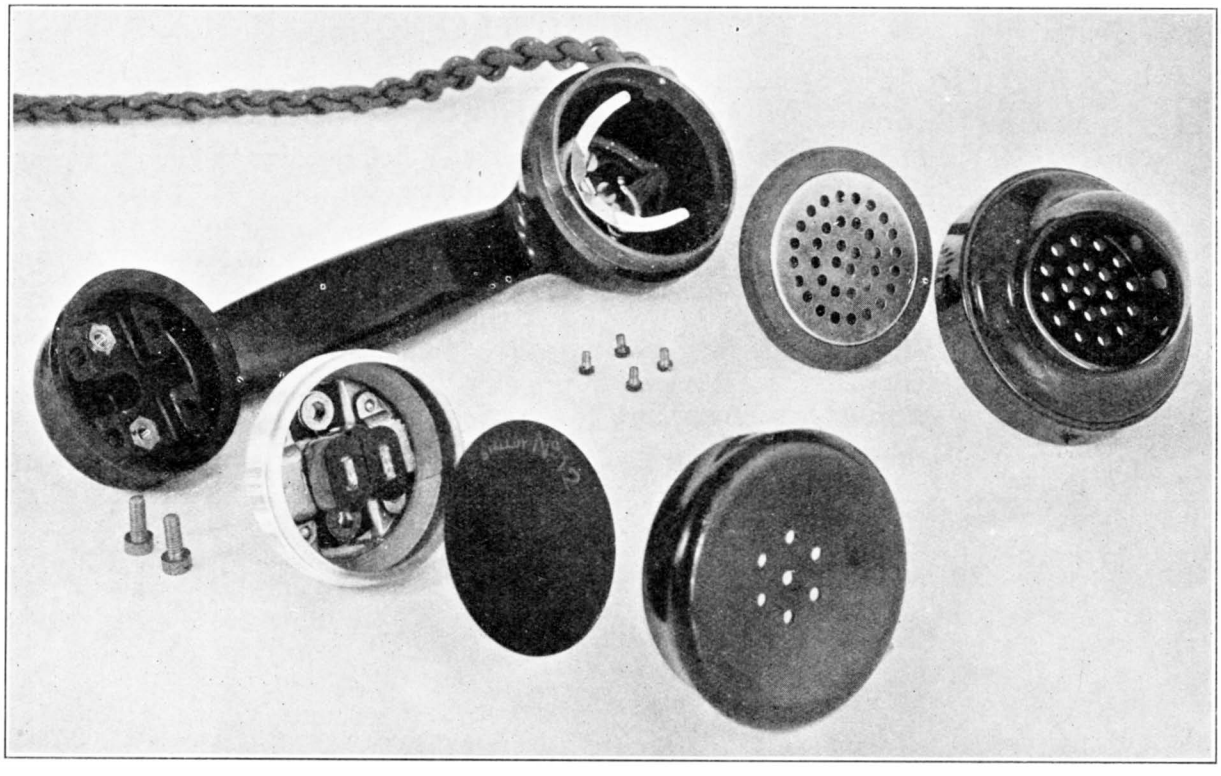


FIG. 2.—THE HAND-SET ASSEMBLY.

Several patterns of headgear type receivers giving good transmission efficiency were known and no difficulty was expected in adapting any of these for this purpose. Attention was therefore mainly concentrated upon the transmitter and the following mechanical points were kept in mind:—

(1) Transmitter and Receiver should be of " inset " type for ease of replacement.

(2) The granule chamber should preferably

chiefly kept in mind were means to enable the transmitter to work in any position, the reduction in the sharp resonance of the No. 1 Transmitter, and the improvement in efficiency by reduction of the weight of the moving parts.

The most satisfactory model consisted of a granule chamber made up in cylindrical form, the end away from the diaphragm being closed with a mica diaphragm and electrode, identical

with that in the No. 1 transmitter except that the excess brass present was very considerably cut down. This moveable electrode was connected with the diaphragm by means of an insulated bolt passing through the granule chamber. The other electrode was in the form of a gold-plated ring fixed about half-way down the chamber.

Satisfactory performance was obtained with transmitters of this type as regards maintenance of efficiency when used away from the vertical, but it was soon found that when the diaphragm was reduced to a size suitable for use in a microtelephone the sending efficiency fell away seriously. This was remedied by the use of a coned diaphragm of thin aluminium with an annulus of thin surgical silk to reduce the stiffness. This diaphragm was later replaced by one consisting of two opposed cones, between which the annulus was clamped. This produced a more rigid piston and also eliminates the difficulty of attaching the annulus to the cone. The silk annulus was also later replaced with one of thin aluminium foil. The result is a stiff, piston type diaphragm, with a very flexible edge; the weight of the whole moving system is under two grammes as against 7.8 grammes for the No. 1 type transmitter.

Shape of Handle. The first handles made were of triangular section with rounded edges, the handle itself sweeping into a more or less hemispherical boss carrying the transmitter, and into a similar but smaller boss carrying the receiver. After considerable discussion, and the examination of various different experimental models, a shape was finally adopted which is very similar to that of the A.T. & T. Co's. instrument.

The length of the handle was based upon fresh measurements of a large number of heads, and is actually 5″ between the centre of the earpiece and the nearest point of the transmitter case. The inside of the mouthpiece is a nearly cylindrical tube with a bore of about $1\frac{3}{8}$″. The transmitter inset itself is provided with a perforated metal guard, the holes in which are out of line with the holes in the grid at the base of the mouthpiece, so that there is no possibility of objects being pushed on to the diaphragm. The plane of the opening of the mouthpiece is at an angle of about 45° with the line of the handle, so that a shorter handle is possible than would otherwise be the case without causing the lips of a long-headed user to touch the instrument.

Complete Test of 5 C.B. Microtelephones. Six complete handles (somewhat different in shape from the final models) were made up in ebonite and fitted with transmitters and receivers. The receivers were of the Sterling Telephone 1A pattern and no special steps were taken at this time to ensure that they were the best obtainable. Five instruments were submitted to test, the other being kept apart for demonstration if required.

The following is a summary of the results obtained, each transmiter being tested in the handle by 20 speakers to obtain a reliable average. All tests were made on Standard C.B. 300-ohm local:—

Volume efficiency, head in normal position.	1.5 d.b. Worse than Standard.
Range between instruments	0.3 d.b. to 2.7 d.b. Worse than Standard.
Receiving efficiency	2.5 d.b. Worse than Standard.
Range	0.2 d.b. to 6.2 d.b. Worse than Standard.
Articulation	6% Better than Standard.
Range	8% Worse — 22% Better than Standard.
Naturalness (Ease of recognising a voice)	Errors reduced to 75% in comparison with No. 1 C.B.
Resistance	61 ohms.
Range	54-77 ohms.
Frying	Passes specification for No. 1 transmitter at any angle up to 45°.

The "naturalness" test was made because it was felt the articulation figures did not fairly represent the improvement. It is well known that a receiver, for example, when used as a transmitter, is very articulate but the tone is

unnatural, being thin and reedy. The "naturalness" test was made by twelve observers, well-known to one another, each reading to each of the others a short passage. The observer was required to name the reader. It was found that on the average with the No. 1 transmitter 33% mistakes were made, whereas with the new transmitter 25% mistakes were made.

A microtelephone fitted with a good transmitter and a good receiver showed no tendency to "howl" on a 35-ohm local.

It will be seen that these transmitters are superior to the average supplies of No. 1 C.B. transmitters (last 3 sample batches were 2.4 d.b. worse than Standard) in both volume and articulation.

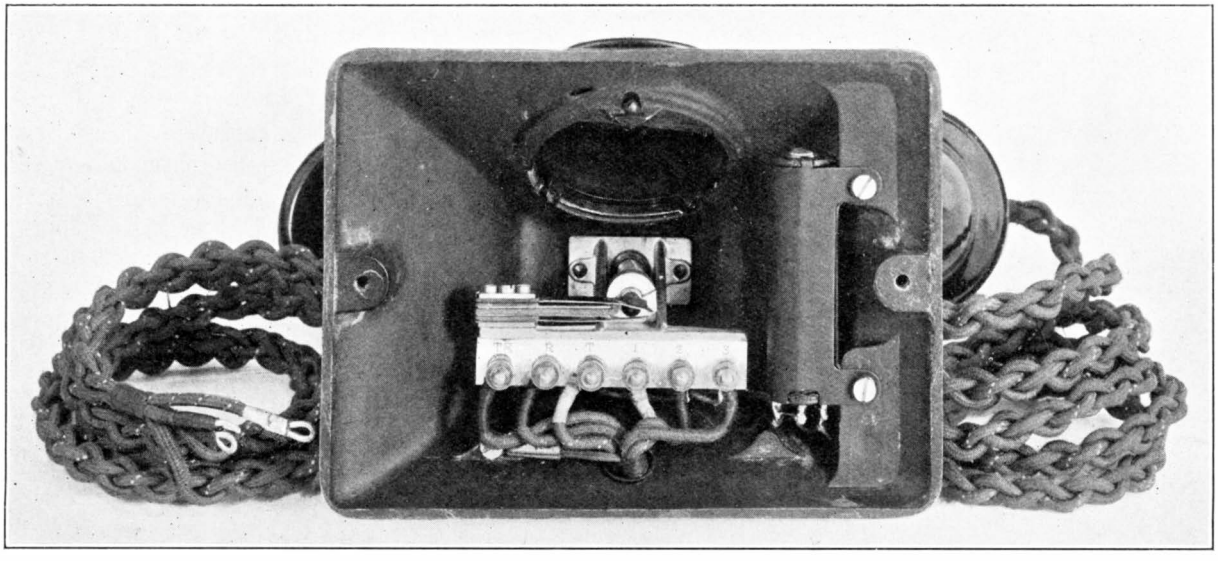


FIG. 3.—VIEW UNDER BASE OF CRADLE.

Life Test. Four of the transmitters were subjected to the usual life test of 30,000 operations and the following table gives the complete results after this:—

EFFICIENCY TESTS AFTER 30,000 OPERATIONS.

Transmitter No.	Head Vertical. Effcy. d.b. 11 Observers	Resis. Ohms	Articulation	Head at 45°. Effcy. d.b. 11 Observers	Resis. Ohms	Articulation	Head Horizontal. Effcy. d.b. 3* Observers	Resis. Ohms	Articulation
B	0.4W	72	4% B	0.8B	104	8% B	1.9B	140	Not tested
C	0.3B	96	10% B	0.7B	113	7% B	0	159	16% B
D	0.6W	78	1% B	0.4B	117	10% B	3.6W	157	3% B
E	1.4W	71	6% B	1.0W	95	3% B	0.4B	184	4% B
Mean	*0.5W*	*79*	*5% B*	*0.2B*	*107*	*7% B*	*0.3W*	*160*	*8% B*

* *The results obtained with the three observers have been corrected to allow for the fact that they were not average.*

The transmitters had thus somewhat improved in efficiency but the resistance had risen. This rise may be the cause of the improved efficiency.

Efficiency and articulation were well maintained, *at any rate up to the 45° position. Tests* were made in the 90° position as a matter of interest, but the position is only reached in practice with very considerable discomfort.

The resistance is high, particularly in posi-

tions away from the vertical position, but this latter is not of great importance in a microtelephone for the reason that the transmitter is almost certain to be put into a vertical position before being put into the "use" position. This would cause the supervisory signals to be operated and these will then remain operated for any position of the transmitter. Steps were, however, taken to reduce the resistance.

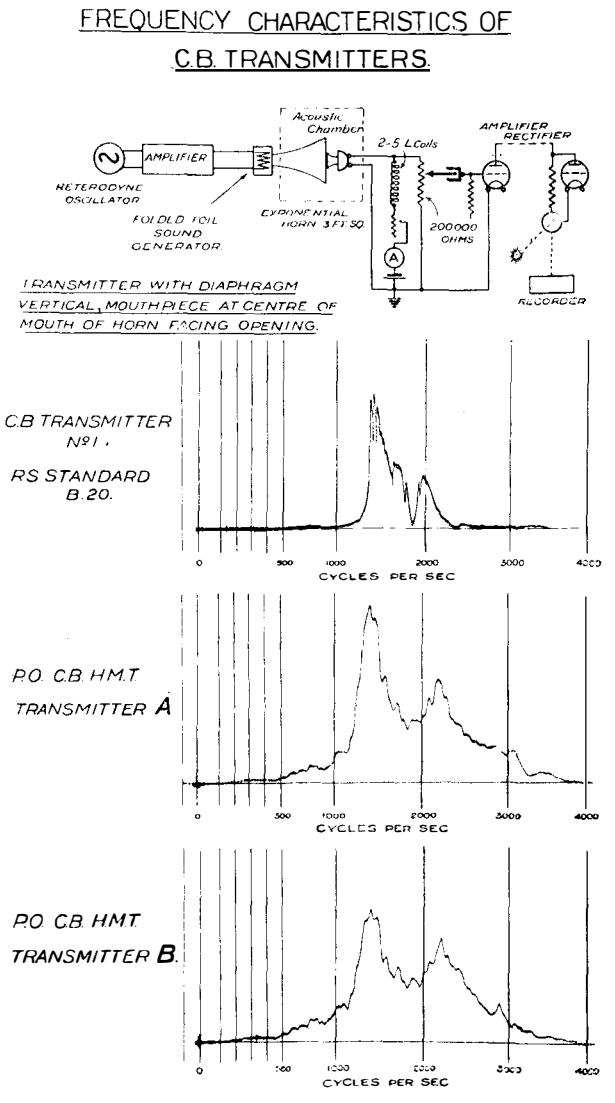


FIG. 4.

Mechanical Test. Three transmitters were taken from the handles and mounted in a wooden frame which could be raised one quarter of an inch and then dropped on to a block of wood.

The frame was dropped 50,000 times, and volume and resistance tests were then again made.

An average reduction in efficiency of 1.4 d.b. was obtained.

Frequency Characteristics. Frequency characteristics of two of the transmitters with a representative No. 1 C.B. transmitter for comparison are given in an accompanying figure. It will be seen that the characteristic is a considerable improvement over that of the No. 1 Transmitter.

Reproducibility. It was found that if proper precautions were taken in manufacture and assembly, different transmitters gave very similar efficiencies, and a transmitter could be dis-assembled and re-assembled without appreciable change in efficiency.

Manufacturing Development. These results were considered so satisfactory that steps were taken, under the usual Departmental procedure, to obtain Provisional Protection. The Department then approached Messrs. Siemens Bros., with a view to their taking up the provision of commercial models, as it had been found that that Company had been developing a microtelephone and had reached about the same position as the Department. Tests of Messrs. Siemens transmitter, which was of quite different design, gave results almost identical in all respects with those obtained with the Department's transmitters. It was therefore decided to make certain small mechanical modifications with a view to the use of either transmitter in a common handle. Messrs. Siemens Bros. were given an order for a considerable number of each pattern with a view to both types being given a commercial trial.

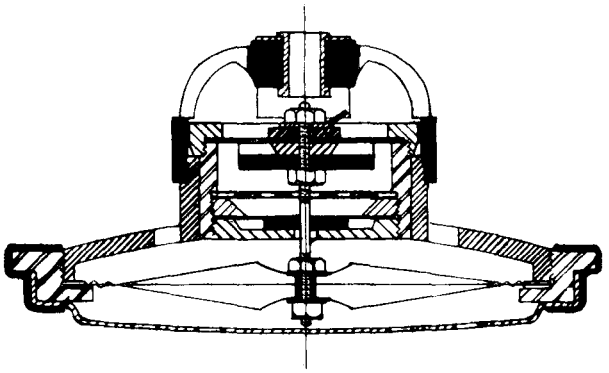


FIG. 5.—P.O. TYPE TRANSMITTER.

Particulars are given in the accompanying drawings and photographs of the complete instrument, and of both the P.O. and Siemens pattern transmitter, either of which can be used in the one handle.

A short description of each transmitter is given.

P.O. Transmitter. The diaphragm receiving the sound is a double cone aluminium piston, the two cones being riveted together with a perforated ebonite rivet, and clamping between them an annulus of aluminium foil. The outer edge of this is strengthened by two thin brass rings cemented to it. These form the clamping surface. Through the ebonite centre rivet a small bolt is passed to which the piston is bolted. The bolt passes (insulated) through the granule chamber and carries the moveable carbon electrode. This is polished and is of the same size as the front electrode of the No. 1 Transmitter but it has no brass backing. Clamped to it, as shown, is the mica diaphragm which closes the side of the granule chamber remote from the piston diaphragm. The other electrode is an annular ring of brass, gold-plated, and perforated with a number of holes. These holes allow of free granule movement and cause a lower resistance than occurs with a solid electrode. They also render more easy the filling in of the granules. It will be seen that both electrodes are almost completely embedded in granules and that as the transmitter is turned over on its back more and more of the granules are carried by the moveable electrode. This ensures the maintenance of good working in any position.

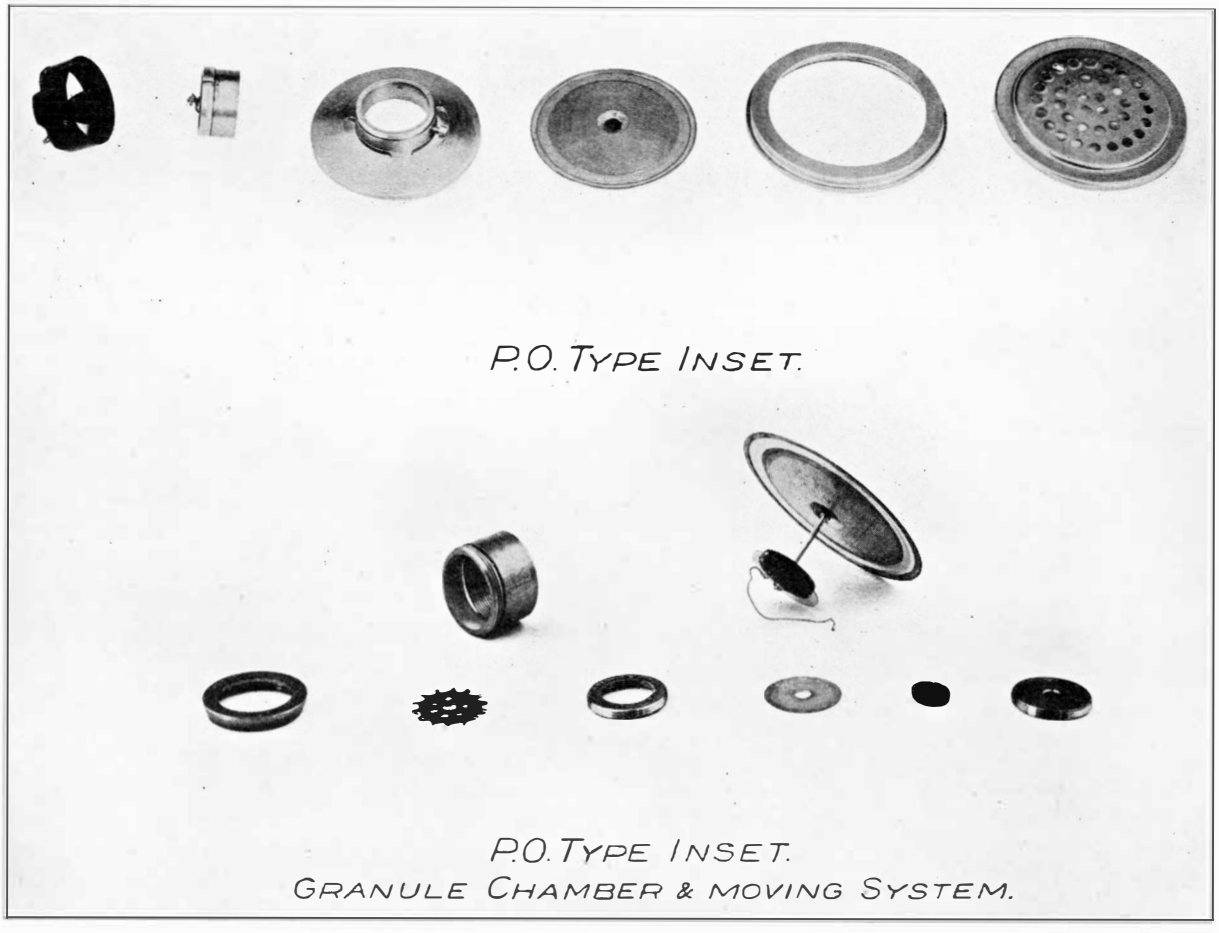


FIG. 6.

Siemens Transmitters (*Patent No.* 308630). The diaphragm receiving the sound is a single corrugated aluminium cone. Attached to the centre is a small aluminium cylinder, the other end of which carries one electrode (carbon). This cylinder projects into the granule chamber as shewn. The other electrode, also of carbon,

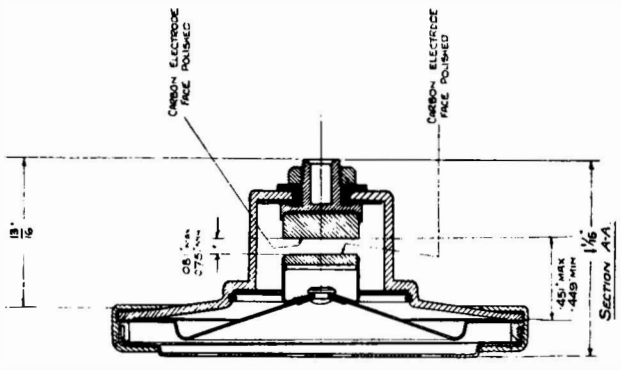


FIG. 7.—SIEMENS TYPE TRANSMITTER.

is mounted at the base of the granule chamber, which of such a size that the two electrodes are correctly spaced apart at about the centre of the chamber. The granules are prevented from escaping by annuli of silk clamped in the granule chamber and forming a sliding fit on the cylinder attached to the diaphragm. It will be seen that in this pattern also both electrodes are almost completely embedied in granules in any position of the transmitter.

Both transmitters are made up as insets, contact being made in the same way in each, viz.: by plug and socket for one connection and springs on the case in the other.

Receivers. The only special points about the receivers are the provision of a substantial aluminium case, giving a good seating for the diaphragm, and the use of a straight cobalt steel magnet. The receiver is attached to the handle by two clamping screws which also form the terminal connections.

Side Tone and Extraneous Noise. The high efficiency of these instruments produces very considerable side tone, and also renders any noise in the room very distressing. It was agreed that some form of anti-side-tone circuit was essential, and the most effective arrangement was considered to be one which had been brought out by Messrs. Siemens. This consists in the addition of a small subsidiary, two-winding induction coil, one winding being connected across the receiver terminals and the other across the transmitter, and so connected that the subsidiary output from the transmitter into the receiver is in opposition to the normal transmitter output into the receiver.

The inherent effect of this coil is to reduce the sending efficiency by about 2 d.b. but this is almost exactly compensated for by the fact that in practice when the side tone is reduced the voice is somewhat raised in volume. Reception efficiency is reduced by about 0.5 d.b. The side tone and extraneous noise are reduced by from 7 to 10 d.b. The subsidiary coil is mounted in the base of the cradle. The instrument is connected to the Bell Set No. 1 by the usual three conductor cord and can be used

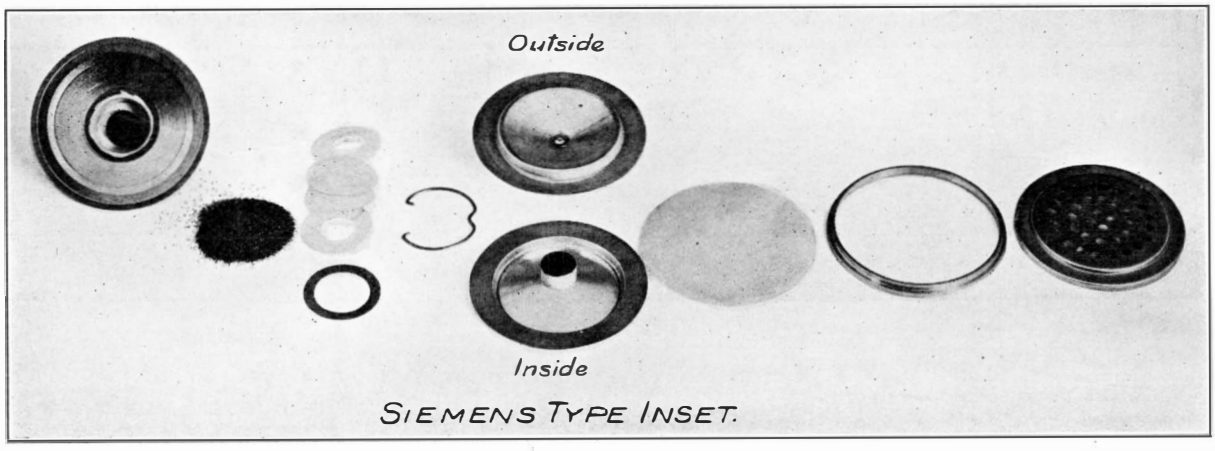


FIG. 8.

interchangeably with Telephones Nos. 2, 124, etc.

Performance. A number of difficulties have been experienced in testing these instruments. These are due:—

(1) To the large differences obtained in efficiency with different speakers due to:
  (*a*) Size of head.
  (*b*) Shape of head.
  (*c*) Character of voice.
(2) The effect of the side tone.
(3) The effect of the presence of the instrument on the head in its relation to the picking up of the sound vibrations, other than directly on the diaphragm.

In normal transmission testing the receiver at the sending end is not held to the head, but in this case it must play some part. The use of a guard to fix the distance of the speaker is inadmissable, partly, because it eliminates the effect of any communication of sound down or from the handle and, partly, because a man with a large head will produce much side tone and will therefore tend to reduce his voice more than will a man who produces less side tone.

The method finally adopted to determine the efficiency is to use 20 speakers, each man holding the microtelephone to the head in the normal way. The anti-side-tone coil is in use, and the microtelephone receiver also alive. ●n the standard circuit a transmitter and receiver, as nearly as possible each equal to standard, are used, and the receiver held on the ear when speaking. Several microtelephones were thus standardised against the usual standards and used subsequently as substandards to calibrate other microtelephones. For this calibration, substandard and test microtelephones were each fitted with wire guards at approximately the average speaking distance and the guards spoken to close up as to a No. 1 C.B. transmitter.

Four P.O. instruments were selected as substandards, the sending allowance of the complete instrument, obtained as outlined, being in each case 0, in terms of the Department's standard.

A number of instruments of each pattern (constructed by Messrs. Siemens Bros.) have now been tested and the following Table gives the results.

All results are in terms of the Department's Standard transmitter or receiver.

Trans.	No. tested	Allowance in d.b.		Resistance * ohms	
		Mean	Range	Mean	Range
P.O.	25	1.5 Better	0.2 Better—3.5 Better	47	39—55
Siemens	45	1.5 Better	0.1 Worse—3.4 Better	45	35—60
Receivers	70	0.9 Worse	1.0 Better—3.7 Worse		

* These figures include the anti-side-tone coil.

The articulation of both types of transmitter is distinctly superior to that of the No. 1 C.B. transmitter, but it is difficult to give a quantitative statement of the amount. Results have been obtained with these samples varying from 4% Better to 45% Better. The figure depends upon the observers making the test, upon the conditions of the test and upon the circuit conditions. For example, a direct test between a No. 1 C.B. transmitter and the microtelephone on the working circuit does not necessarily produce the same relative articulation efficiency as is obtained by a test of each instrument against a distortionless circuit. The two patterns of transmitter are found to give practically identical results, and probably an average figure of about 15% better than standard is about right.

All the transmitters are satisfactory as regards frying when the microtelephone is held on the head, the latter being vertical. About 20% exceed the allowable amount when the head is held at 45°, and most are unsatisfactory when the head is held with the line through the ears vertical. This position is only reached with very considerable discomfort.

Tests have also been made of the possibility of sparking occuring in the transmitter whilst being lifted from or replaced on the switch-hook.

With the Siemens type of transmitter it was found impossible to produce a disconnection in the transmitter whilst the switch-hook contacts were closed.

With the P.O. type a disconnection could only be produced when the microtelephone was replaced on the cradle in a very violent manner. With neither type did the resistance rise to any very high values when the microtelephone was handled normally.

It should be mentioned that since the preliminary samples have been obtained, various minor modifications have been made in the P.O. inset. These should result in an even better transmitter.

THE MECHANICAL TESTING OF TRANSMITTER AND RECEIVER EFFICIENCIES.

A. HUDSON, B.Sc., A.C.G.I.F.C., A.M.I.E.E.

INTRODUCTION. — The present method used by the British Post Office of testing transmitters for volume efficiency, whether for factory acceptance tests or laboratory precision tests, involves the co-operation of at least two observers. One observer talks in some standardised manner into, first, the test transmitter, and then into a standardised transmitter, the necessary circuit alterations being made by means of suitable relays. The other observer listens to the output from the two transmitters in turn and either adjudges which is the better of the two, as in factory acceptance tests, or carries out an elaborate balancing test with a third observer with the object of assessing the exact difference between the two transmitters, and hence determining the efficiency of the transmitter under test in terms of the Department's standard transmitter.

The object of the mechanical test is to replace the talker by an electro-acoustic convertor actuated by some form of oscillator, and the listener by some form of value voltmeter so that the whole test may be made by one man in a fraction of the time required by the laborious laboratory tests and with the same accuracy.

At first sight it would appear that such a method should be capable of giving very great accuracy, as the whole of the elements of the test are subject to exact calibration and specification. Such, however, is not the case, owing to the fact that the results to be of value must give, within fairly narrow limits, the same result that would be obtained by a laboratory speech test.

The Research Section has developed a mechanical test which has achieved a considerable amount of success in this connection, by ensuring that the speech test should be copied in almost every particular, if the same result is to be obtained by the mechanical test.

Oscillator.—The voice of the talker is replaced by a moving coil loud speaker of special construction. This is actuated by a modulated rhythmic oscillator. The rhythmic oscillator ranges from 100 to 1,600 cycles per second at 250 rhythms per minute. This rhythmic frequency is then modulated by a fixed frequency of 180 cycles per second. The 180 cycles per second is filtered at a later stage, so that finally three frequencies, apart from harmonics, are present in the resultant noise at any one moment. The result is a sound which, apart from transients, can be said to possess the same essentials as speech. A considerable number of tests shows that this type of sound has a great superiority over a rhythmic oscillator producing a pure note.

Voltmeter. — The listener is replaced by a special valve voltmeter or amplifier rectifier set, which is connected to the output side of the repeating coil on the present standard transmitter testing circuit.

The amplifier has incorporated in it a tuned circuit, so that its frequency voltage characteristic follows the same curve as a receiver on an ear; the rectifier has a " straight line " voltage output characteristic.

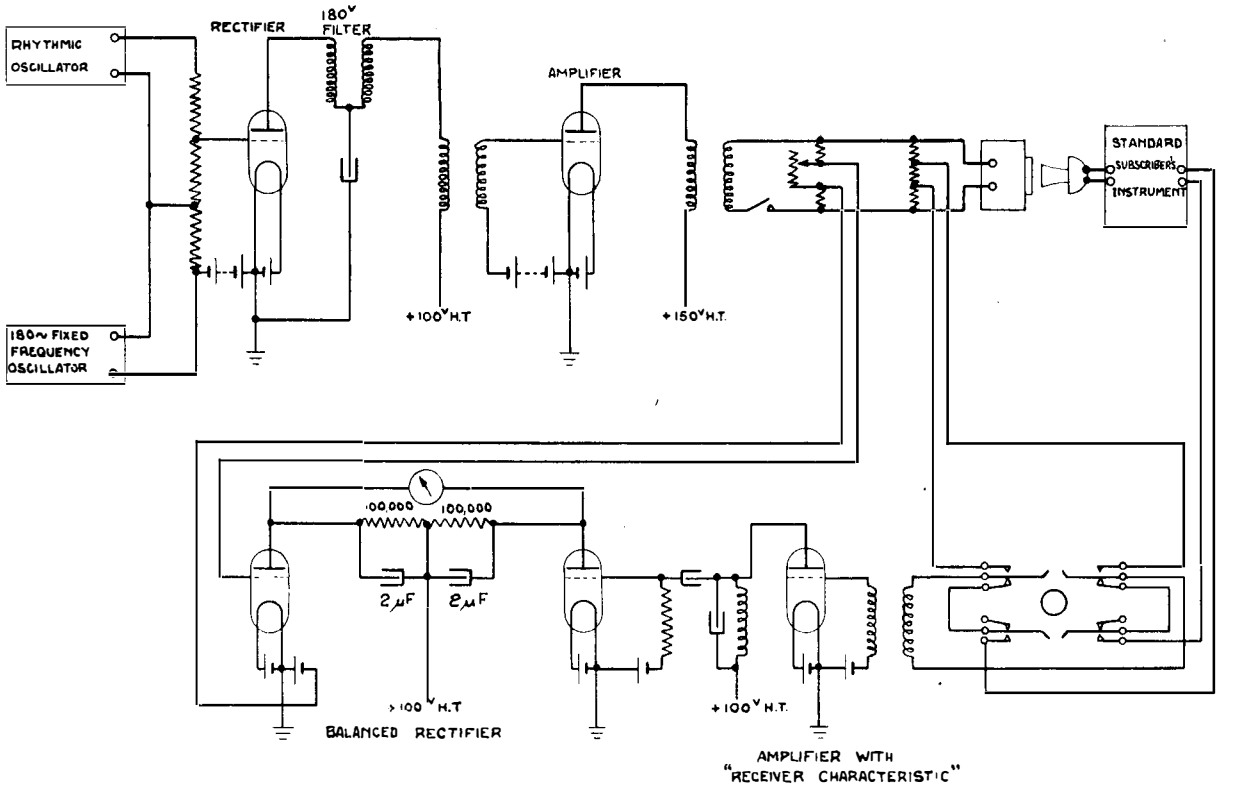
The standard method of testing a transmitter is to compare it with another, a standardized

transmitter. The same principle, namely, that of comparison with some form of standard, has been kept in the rectifier circuit, as may be seen from the schematic diagram.

The output from a transmitter, after amplification, is applied to an anode bend rectifier. At the same time a given proportion of the A.C. voltage applied to the loud speaker is taken to another anode bend rectifier. The anode circuits are each fed with plate current through 100,000 ohms shunted by 2 μF. condensers. The two anodes are connected to opposite terminals of the measuring instrument, hence the instrument will only read the difference in potential of the two anodes. If the two A.C. inputs are equal, no deflection is obtained. If, on the other hand, they differ, a deflection is obtained in one direction or the other, the difference being readily expressed in S.M. by means of a special scale on the instrument.

The current taken from the loud speaker input circuit is arranged to be of such a value that if a Department's standard transmitter be placed under test, the resulting deflection is nil. Then, if the transmitter under test is either better or worse than Department's standard the instrument needle will read accordingly, the exact efficiency being read off directly.

Calibration.—In a set designed for the use of the Test Section, the Department's standard transmitter is replaced by a potentiometer in parallel with the loud speaker; a key is provided so that this voltage may be applied to the amplifier rectifier in place of the output from the test transmitter. The balancing voltage is made adjustable, so that zero deflections may be given by a test transmitter of any required efficiency, better or worse, than Department's standard transmitter. This facility much increases the ease in making acceptance tests, since with a centre zero instrument all corrections for acceptance figures, etc., can be made once for all. Under these conditions the only apparatus that is not given a routine check is the loud speaker.



ROUTINE TESTING SET FOR TRANSMITTERS AND RECEIVERS.
Schematic Diagram showing Balanced Rectifiers.

The only simple method of checking the loud speaker is to place a standard transmitter in the test position (two or more being used) and to compare the figure obtained with the figure given by the potentiometer check. If there be any discrepancy, it may be adjusted by altering the distance between the transmitter mouthpiece and the loud speaker.

It is hoped that a new arrangement of the loud speaker diaphragm now under design will be sufficiently stable to need only occasional calibration by acoustical methods. By this means the method will eventually become independent of the Department's standard transmitter, its place being taken by the voltage to acoustical pressure ratio determined from tests of standard transmitters.

Results.—The results obtained by this method show a close approximation to those obtained by speech testing when both the No. 1 C.B. transmitters or the new C.B. microtelephones are tested. The errors, under the test conditions, are of the same order as the actual calculated speech test errors.

A recent batch of transmitters, 39 in number, gave an average difference between speech and mechanical tests of 0.65 S.M. with a maximum of 1.9 S.M. Another batch of 136 transmitters gave an average difference of 0.98 S.M. with a maximum of 2.9 S.M. In a large number of batches of transmitters, making 301 in all, an average of 1.0 S.M. is obtained with a maximum of 3.5 S.M. These results should be compared with the best obtained from a method employing a simple rhythmic oscillator and ordinary type valve voltmeter, which under the best conditions gave an average difference of 2.5 S.M. with a maximum of 6.5 S.M.

Application.—The most immediate field of application for a test of the nature described above is in testing bulk supplies of transmitters. The method in use at present leaves much to be desired from the point of view of both reliability, cost of performing the test and strain on the operators.

The new method gives the efficiency of the transmitter within 1 S.M. on the average, so that it will be possible readily to select transmitters for zoning purposes. One operator only is required to use the set, and as no adjustments are necessary once the set is in going order, no large amount of technical skill is required. The test occupies approximately 24 seconds, including a test of transmitter resistance. Assuming that good arrangements are made for feeding the set it may be possible to attain speeds of testing of the order of two transmitters a minute. It should be remembered that this speed may be kept up for long periods at a time, as the efficiencies obtained will not suffer in accuracy due to fatigue on the part of an operator; so that it will be possible to test 600 or 700 transmitters per day per set as against the present figure of 250.

Receiver Testing.—The method described here can also be used for testing receivers. A dummy ear with a mouthpiece attachment, such as is used in conducting *in situ* tests on subscribers' instruments, is placed on the receiver under test and then applied to the loud speaker in exactly the same manner as would be the transmitter. The rest of the test then proceeds in exactly the same manner, additional amplification being provided so that the same standard voltage that is used for transmitters may be used for receivers.

The accuracy of the test is approximately the same as for transmitter testing, when a pure tone rhythmic frequency is used. Further tests are being made with the modulated oscillator, and the indication is that greater accuracy still may be expected.

Testing C.B. Microtelephones. — The possibility of testing both the transmitter and the receiver on the one set quickly, and with no circuit changes beyond throwing a key allied with the great difficulty of making satisfactory speech tests, make this type of testing set of great advantage in the testing of C.B. microtelephones and it is probable that one will actually be used in making the acceptance tests of the new C.B. microtelephones.

THE ANGLO-IRISH AND MANX (1929) SUBMARINE TELEPHONE CABLES.

W. T. PALMER, B.Sc., Wh.Ex., A.M.I.E.E.

EARLY in June of this year the Isle of Man was placed in telephonic communication with England, and thus with the outside world, by means of a lead-covered, continuously-loaded, paper-core submarine cable of length 58.69 nauts. This submarine cable was laid between Port Grenaugh (Isle of Man) and Norbreck (near Blackpool) by the C.S. " Faraday " of Messrs. Siemens Bros. & Co., Ltd., Woolwich, by whom the cable was manufactured. It is linked with Port Erin Repeater Station from Port Grenaugh by 7.81 nauts. of land cable of similar construction to the submarine cable, except that the latter has two lead sheaths and is armoured with galvanised iron wires whilst the former has only one lead sheath. (See Fig. 1). The sea cable is also linked from Norbreck to Blackpool Repeater Station by a length of 2.60 nauts. of similar land cable, the joints at Norbreck and at Port Grenaugh being " switched " for the purpose of minimizing the cross-talk. The total length of the paper-core cable from Blackpool to Port Erin is thus 69.1 nauts. The total diameter of the land cable is 1.12 inches and its weight is 5.5 tons per naut., while the total diameter of the submarine cable is 2.3 inches and its weight is 21.5 tons per naut.

There are four quads (16 conductors) and a single central stranded conductor, each conductor being wound with special iron wire, to increase its inductance, and insulated with three wrappings of paper. The centre wire and earth-return circuit is intended as a speaker circuit. Three of the quads are used for communication between England and Ireland and the fourth quad contains circuits for the Isle of Man.

The circuits for Ireland pass through the Repeater Station at Port Erin and are continued in two unloaded, four-wire, balata-insulated cables, similar to each other in construction, also manufactured by Siemens Bros., and laid by the C.S. " Faraday " about the middle of June this year between Port Erin and Ballyhornan in Northern Ireland. (See Fig. 1). For half a naut. at each shore-end gutta-percha is substituted for balata for mechanical reasons. This type of cable has been used principally because of the unfavourable nature of the sea-bed and the adverse channel currents likely to be encountered.

The overall weight of each balata cable is 10.3 tons per naut., the dielectric being approximately 150 lbs. per naut. and the conductor 160 lbs. per naut.

The electrical characteristics of the above cables, taken from tests made after laying, are as follows:—

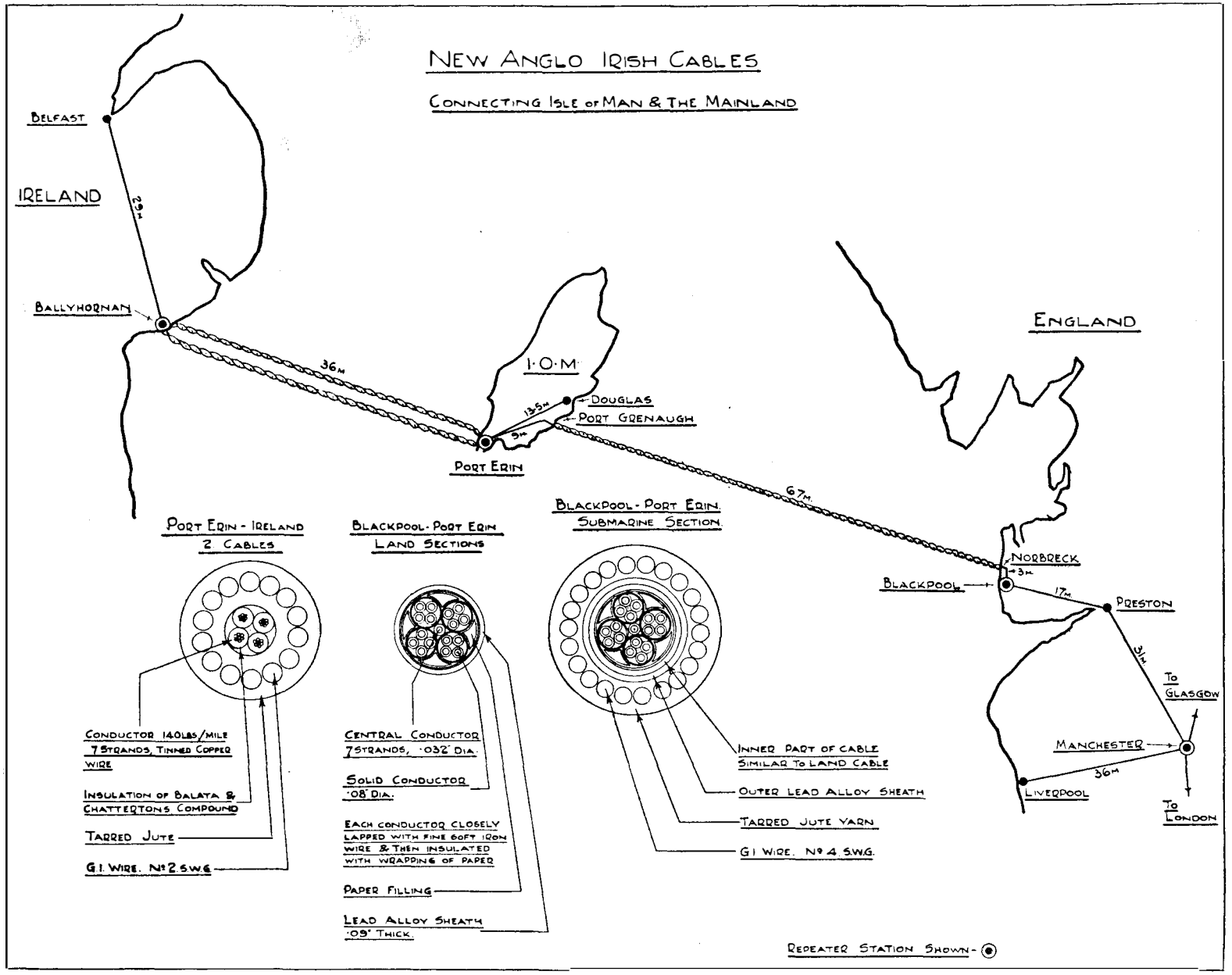

NEW ANGLO IRISH CABLES
CONNECTING ISLE OF MAN & THE MAINLAND
BELFAST
IRELAND
29M
BALLYHORNAN
36M
I·O·M
DOUGLAS
PORT GRENAUGH
13·5M
9M
PORT ERIN
67M
ENGLAND
NORBRECK
3M
BLACKPOOL
17M
PRESTON
31M
To GLASGOW
MANCHESTER
36M
LIVERPOOL
To LONDON
PORT ERIN - IRELAND
2 CABLES
CONDUCTOR 140LBS/MILE
7 STRANDS, TINNED COPPER WIRE
INSULATION OF BALATA & CHATTERTONS COMPOUND
TARRED JUTE
G.I. WIRE. Nº 2 S.W.G.
BLACKPOOL - PORT ERIN
LAND SECTIONS
CENTRAL CONDUCTOR
7 STRANDS, ·032" DIA.
SOLID CONDUCTOR
·08" DIA.
EACH CONDUCTOR CLOSELY LAPPED WITH FINE SOFT IRON WIRE & THEN INSULATED WITH WRAPPING OF PAPER
PAPER FILLING
LEAD ALLOY SHEATH
·09" THICK.
BLACKPOOL - PORT ERIN
SUBMARINE SECTION
INNER PART OF CABLE
SIMILAR TO LAND CABLE
OUTER LEAD ALLOY SHEATH
TARRED JUTE YARN
G.I. WIRE. Nº 4 S.W.G.
REPEATER STATION SHOWN -

FIG. 1.

Blackpool-Port Erin Continuously-Loaded Paper-Core Cable.

D.C. Tests.

From measurements made one month after laying, and with the cable terminated on Trunk Test Tablets at each end, the results obtained are :—

Average insulation resistance from tests on each of the 17 wires, against the others earthed, after 1 minute's electrification and with 220 volts
= 40,000 megohms per naut.

Average conductor resistance of 16 wires
= 19.7 ohms per naut. loop.

Conductor resistance of centre wire
= 8.74 ohms per naut.

Average side circuit capacity
= 0.094 μF. per naut. loop.

Average phantom circuit capacity
= 0.270 μF. per naut. loop.

A.C. Tests.

(*a*) *Transmission Efficiency and Distortion.*

The mean A.C. constants of all pairs and phantoms were calculated from measurements at a frequency of 800 c.p.s. and a testing current of 1 mA. The results are given in Table I.

Table I.

BLACKPOOL-PORT ERIN SUBMARINE TELEPHONE CABLE.
MEAN A.C. CONSTANTS AT f = 800 C.P.S.
LENGTH OF CABLE = 69.1 NAUTICAL MILES.

Circuit.	Characteristic Impedance, vector ohms.	Attenuation, Constant Neper per naut. loop.	Propagation, Constant per naut. loop.	Effective Resistance, ohms per naut. loop.	Inductance, mhys. per naut. loop.	Capacity, μF. per naut. loop.
	$Z_0\lvert\phi_0$	β	γ/θ	R	L	C
Mean of 8 pairs	$377\lvert 8°50'$	0.0287	$0.171\lvert 80°20'$	20.4	12.2	0.090
Mean of 4 phantoms	$155\lvert 9°23'$	0.0348	$0.201\lvert 80°\ 2'$	10.3	5.9	0.258
Centre wire-earth return (tested from Port Erin)	$246\lvert 8°\ 9'$	0.0254	$0.184\lvert 82°56'$	—	—	0.145

From Table I. it will be seen that each side circuit is equivalent to approximately 18.5 M.S.C. and each phantom circuit to 22.5 M.S.C. The centre wire-earth return circuit is equivalent to nearly 16.5 M.S.C., but it forms a bad speaker circuit owing to noise produced from extraneous sources, of which the principal is that part of the Blackpool Tramway System which runs parallel with the land portion of the cable for nearly two miles towards Norbreck.

The variation of attenuation with frequency for a selected pair is given in Fig. 2 together with the corresponding variation for a selected phantom circuit. From these curves the total distortion from f = 400 c.p.s. to f = 2000 c.p.s. is

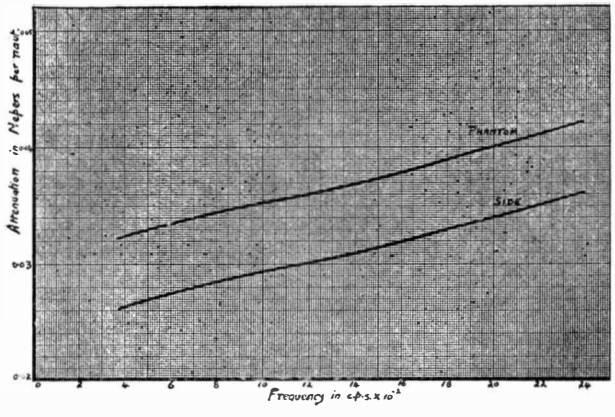


Fig. 2.—Attenuation - Frequency Characteristics for Side and Phantom Circuits : Blackpool-Port Erin Cable.

found to be about 5 M.S.C. for the side circuits and 5 M.S.C. for the phantom circuits.

(*b*) *Uniformity of Electrical Constants.*

The characteristic impedance of each side circuit was measured over a range of frequency from 300 c.p.s to 3000 c.p.s and they all have similar characteristics. A typical example of the variation of the impedance components with frequency is given in Fig. **3**, the dotted curve being that calculated for an imaginary cable having a perfectly uniform distribution of resistance, capacity and inductance throughout its length equal per naut. to the mean constants per naut. for that circuit obtained by measurement on it. It is interesting to note that the slight undulation of the measured characteristic about the hypothetical mean is roughly of a periodicity equal to 2000 c.p.s., which indicates a reflection effect at a distance of about $7\frac{1}{2}$ nauts. from Port Erin, *i.e.*, where the sea and land cables are joined. This effect is largely brought about by the difference in temperature between land and sea causing a difference between the electrical constants of the land and sea portions of the complete cable and its magnitude will vary with the season of the year.

Fig. **4** shows the impedance components plotted against frequency for one of the phantom circuits (taken from tests made on the four phantoms), all of which are similar in shape. It will be seen that the electrical constants of all circuits in the quads are satisfactorily uniform, as far as these characteristics are concerned.

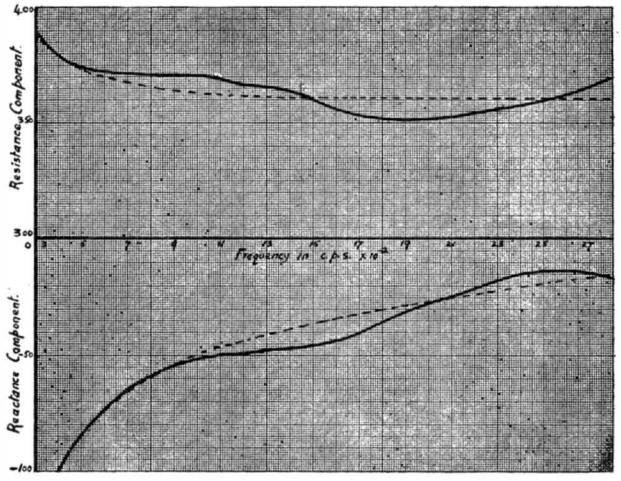


FIG. 3.—TYPICAL IMPEDANCE-FREQUENCY CHARACTERISTICS FOR SIDE CIRCUITS OF THE BLACKPOOL-PORT ERIN CABLE.

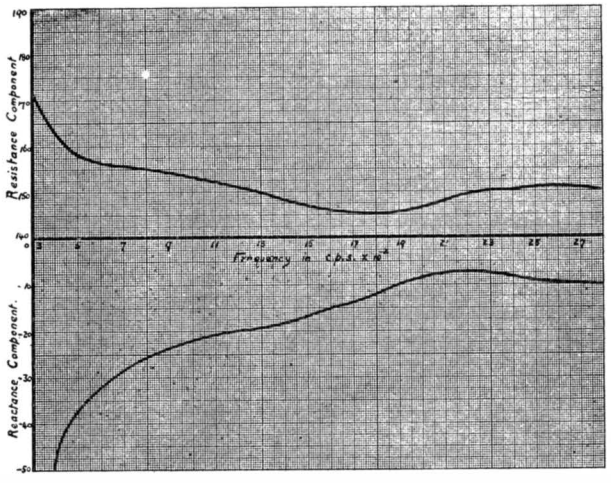


FIG. 4.—TYPICAL IMPEDANCE-FREQUENCY CHARACTERISTICS FOR PHANTOM CIRCUITS OF THE BLACKPOOL-PORT ERIN CABLE.

(*c*) *Interference between Circuits.*

Cross-talk measurements were made on an equivalent current basis with the P.O. apparatus, using a Western Electric Cross-Talk Meter, which expresses the induced current in millionths of the inducing current. The meter readings obtained with speech as the source of disturbance are given in Table II. together with particulars of the testing conditions.

TABLE II.

BLACKPOOL-PORT ERIN CONTINUOUSLY-LOADED CABLE.
CROSS-TALK WITHIN QUADS MEASURED WITH P.O. APPARATUS.

Meter readings taken with the distant end of cable closed through repeating coils by its characteristic impedance. Meter in parallel.

AB ≡ red-white pair of the quad.
CD ≡ blue-white pair ,, ,, ,,
\+ ≡ phantom circuit ,, ,, ,,

Source of Disturbance—Speech.

Tests from Blackpool Repeater Station.					Tests from Port Erin Repeater Station.				
Speak on		Listen on			Speak on		Listen on		
Quad	Cct.	AB	CD	+	Quad.	Cct.	AB	CD	+
Red	AB	—	100	250	Red	AB	—	70	200
	CD	100	—	300		CD	70	—	160
	+	350	350	—		+	350	200	—
Blue	AB	—	70	350	Blue	AB	—	100	200
	CD	70	—	500		CD	100	—	250
	+	500	700	—		+	300	400	—
White	AB	—	100	500	White	AB	—	100	200
	CD	100	—	700		CD	100	—	300
	+	700	1000	—		+	300	450	—
Green	AB	—	70	350	Green	AB	—	80	250
	CD	70	—	300		CD	80	—	200
	+	550	450	—		+	450	300	—

In Table III. these results are expressed in népers, after a correction made to allow for the difference in impedance between the disturbed and disturbing circuits and the terminal apparatus.*

TABLE III.

BLACKPOOL-PORT ERIN CONTINUOUSLY-LOADED CABLE.
CROSS-TALK WITHIN QUADS EXPRESSED IN NEPERS—
After correction to allow for end apparatus and different circuit impedances.
Source of Dsiturbance—Speech. Conditions of test as for Table II.

Tests from Blackpool Repeater Station.					Tests from Port Erin Repeater Station.				
Speak on		Listen on			Speak on		Listen on		
Quad	Cct.	AB	CD	+	Quad	Cct.	AB	CD	+
Red	AB	—	9·4	8.7	Red	AB	—	9.8	**8.8**
	CD	9.4	—	8.6		CD	9.8	—	**9.2**
	+	8.7	8.7	—		+	8.7	9.2	—
Blue	AB	—	9.8	8.2	Blue	AB	9.4	9.4	**8.8**
	CD	9.8	—	7·9		CD	—	—	**8.7**
	+	8.3	8.0	—		+	8.9	**8.6**	—
White	AB	—	9·4	7·9	White	AB	—	9.4	8.8
	CD	9.4	—	7·5		CD	9·4	—	**8.6**
	+	8.0	7·7	—		+	8.9	**8.5**	—
Green	AB	—	9.8	8.2	Green	AB	—	9·7	**8.7**
	CD	9.8	—	8.6		CD	9·7	—	**9.0**
	+	8.2	8.5	—		+	8.5	8.9	—

* *See paper by Dr. A. Rosen, Journal I.E.E., page 349, Vol. 64, August, 1926*

The cross-talk readings obtained, using the P.O. apparatus and W.E. Cross-Talk Meter, when speaking on the centre wire and earth circuit and listening on the other circuits of the cable, are shown in Table IV., expressed in népers. *The cross-talk between circuits of the different quads* is greater than 1●.5 népers in all cases.

TABLE IV.

CROSS-TALK BETWEEN CENTRE WIRE-EARTH RETURN CIRCUIT AND THE QUAD CIRCUITS.

Expressed in népers. Meter in parallel. Circuits closed by their characteristic impedances at the distant end.
Source of Disturbance—Given in Column No. 1.

Speak on Centre Wire—Earth Return At :—	Listen in											
	Red Quad			Blue Quad			White Quad			Green Quad		
	AB	CD	+	AB	CD	+	AB	CD	+	AB	CD	+
Blackpool (Reed Hummer)	8.2	7.8	8.1	9.2	7.6	7.6	8.1	7.8	7.1	7.8	8.1	7.1
Port Erin (Speech)	8.5	8.5	7.8	8.7	8.7	7.8	8.9	8.7	7.6	8.9	8.7	7.8

PORT ERIN-BALLYHORNAN BALATA-INSULATED CABLES. NO. 1 (NORTHERN) AND NO. 2 (SOUTHERN).

The data given is that obtained from tests on No. 1 Cable except for the case of insulation resistance, the corresponding figures obtained for No. 2 Cable being the same in the other cases.

D.C. Tests.

Average insulation resistance of each wire of No. 1 Cable, to remaining wires earthed, tested with 5● volts after 1 minute's electrification and corrected to 75°F.

= 7●● megohms per naut.

Average insulation resistance of each wire of No. 2 Cable, to remaining wires earthed, tested with 5● volts after 1 minute's electrification and corrected to 75°F.

= 900 megohms per naut.

Average conductor resistance of each wire

= 7.0 ohms per naut.

Average capacity of each wire to the other wires earthed

= ●.315 μF. per naut.

A.C. Tests.

(*a*) *Transmission Efficiency and Distortion.*

The mean A.C. constants calculated for $f=800$ c.p.s. for the side and phantom circuits are shown in Table V.

TABLE V.

PORT ERIN-BALLYHORNAN BALATA CABLES.
MEAN A.C. CONSTANTS AT $f = 800$ C.P.S.
LENGTH OF EACH CABLE ≒ 32 NAUTICAL MILES.

Circuit	Characteristic Impedance	Attenuation Constant per naut. loop.	Propagation Constant per naut. loop.	Effective Resistance, ohms per naut. loop.	Capacity μF. per naut. loop
	Z_0 vector ohms	β	$\gamma\|\theta$	R	C
Side	$149\|27°52'$	0.056	$0.116\|60°55'$	14.5	0.156
Phantom	$70.4\|32°32'$	0.059	$0.120\|60°34'$	7.5	0.340

From this table it will be seen that each side circuit is equivalent to approximately 17 M.S.C. and each phantom circuit to nearly 18 M.S.C.

The variation of the attenuation constant with frequency can be seen from Table VI., and these figures give the total distortion from $f = 400$ c.p.s. to $f = 2000$ c.p.s. as approximately 6 M.S.C. for the side circuit and 7.5 M.S.C. for the phantom circuit. It is interesting to compare the above values for M.S.C. with the corresponding values for the paper-core loaded cable which is more than twice the length of each of the unloaded balata cables and has a much smaller conductor.

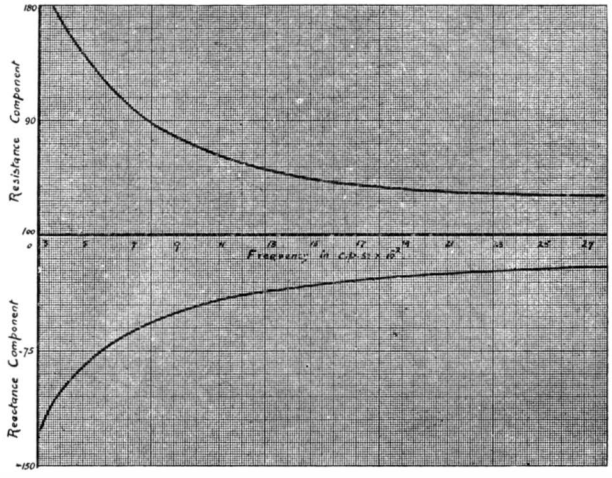


FIG. 5.—TYPICAL IMPEDANCE-FREQUENCY CHARACTERISTICS FOR SIDE CIRCUITS OF THE BALLYHORNAN-PORT ERIN BALATA CABLES.

TABLE VI.

PORT ERIN-BALLYHORNAN BALATA CABLES.
EXAMPLE OF CHANGE OF ATTENUATION CONSTANT WITH FREQUENCY.

Frequency c.p.s. f	Side Circuit. Attenuation Constant. Népers per naut. loop. β.	Phantom Circuit. Attenuation Constant. Népers per naut. loop. β.
400	0.044	0.046
800	0.054	0.059
1200	0.059	0.066
1600	0.063	0.070
2000	0.064	0.071
2400	0.067	0.075

(b) *Uniformity of Electrical Constants.*

The characteristic impedance of each side and phantom circuit was measured over a range of frequency from 300 c.p.s. to 3000 c.p.s. and Fig. 5 is a typical example of the variation of the impedance components with frequency for the side circuits, while Fig. 6 is a corresponding example for the phantom circuits. All these curves are smooth curves, showing that the cables have practically an absolutely uniform distribution of electrical constants.

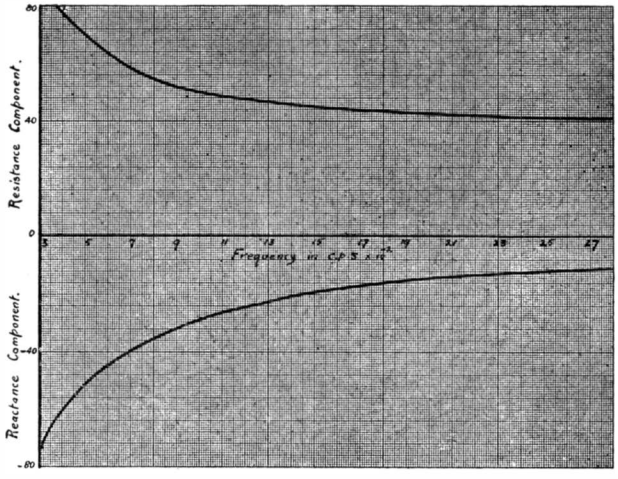


FIG. 6.—TYPICAL IMPEDANCE-FREQUENCY CHARACTERISTICS FOR PHANTOM CIRCUITS OF THE BALLYHORNAN-PORT ERIN BALATA CABLES.

(c) *Interference between Circuits.*

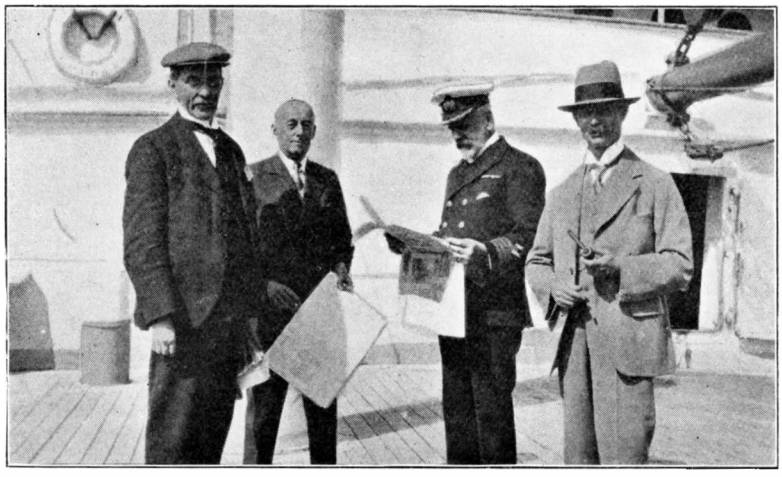
Cross-talk measurements were made with speech as the source of disturbance in the same manner as those on the Blackpool-Port Erin continuously-loaded cable and a summary of the results taken from Port Erin is as follows—all the readings obtained being also corrected and converted to népers:—

Maximum side-to-side cross-talk units obtained with speech = 40 ≒ > 10.5 corrected népers.

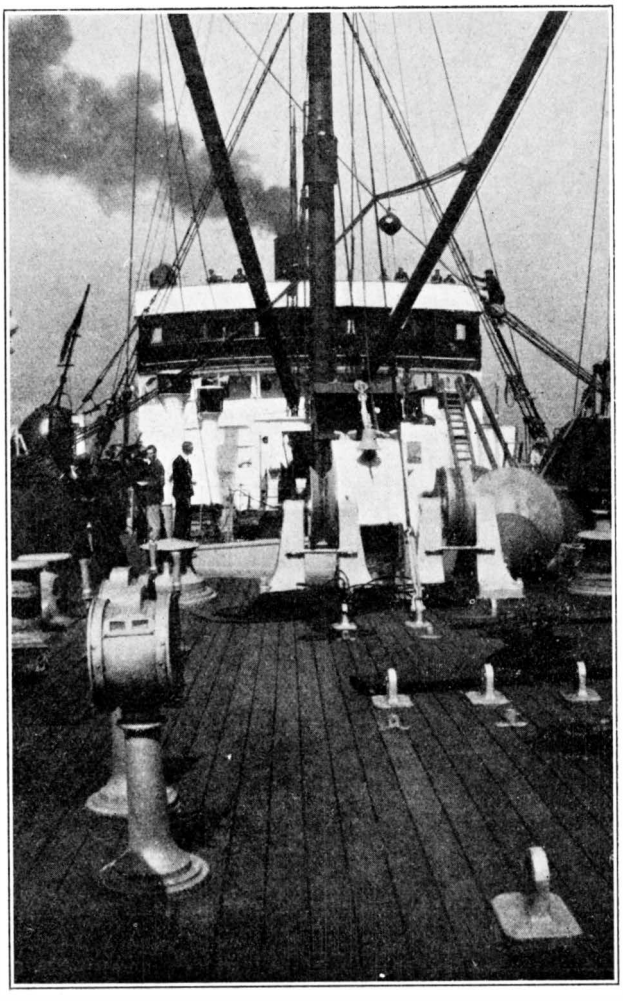
Maximum phantom-to-side cross-talk units obtained with speech = 300 ≒ 9.0 corrected népers.

Cross-talk between circuits in the two different cables obtained with speech < 20 units ≡ > 11.0 népers.

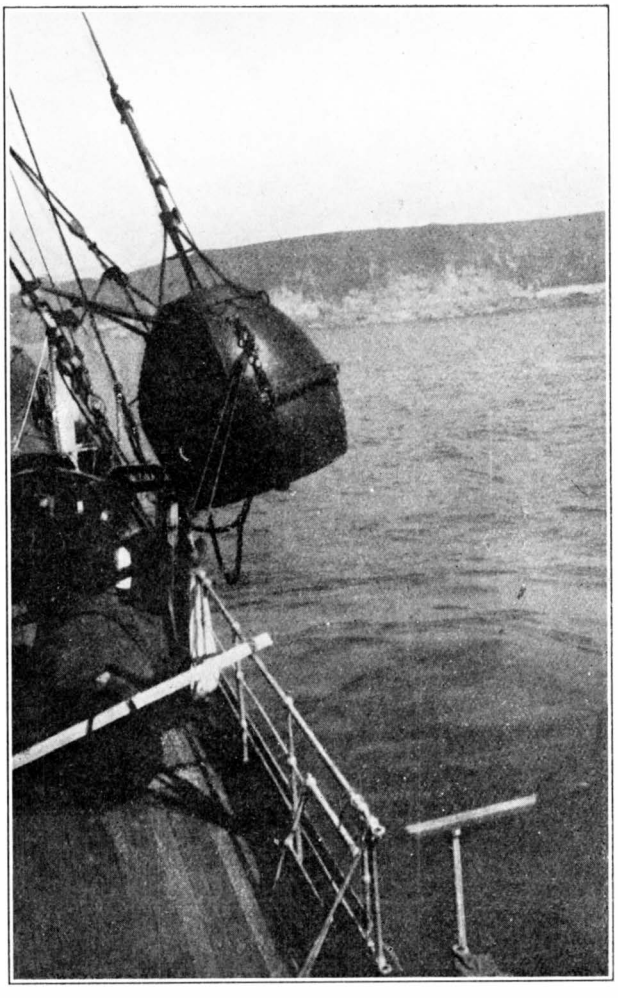
In conclusion, some interesting photographs are given on pages 203, 204, and 205, showing various operations during the laying of these submarine cables and taken by Messrs. Siemens Bros. representative on board the C.S. "Faraday."



Mr. Medlyn. Mr. Dudley Stuart. Captain Bourdeaux. Mr. De Lattre.
ON BOARD "FARADAY."

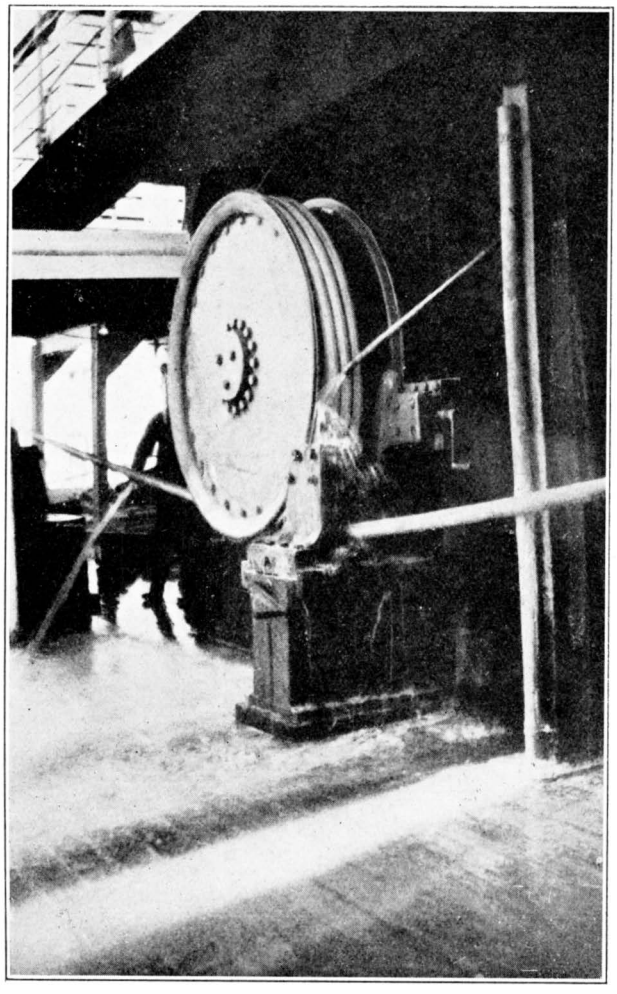


DECK OF "FARADAY."

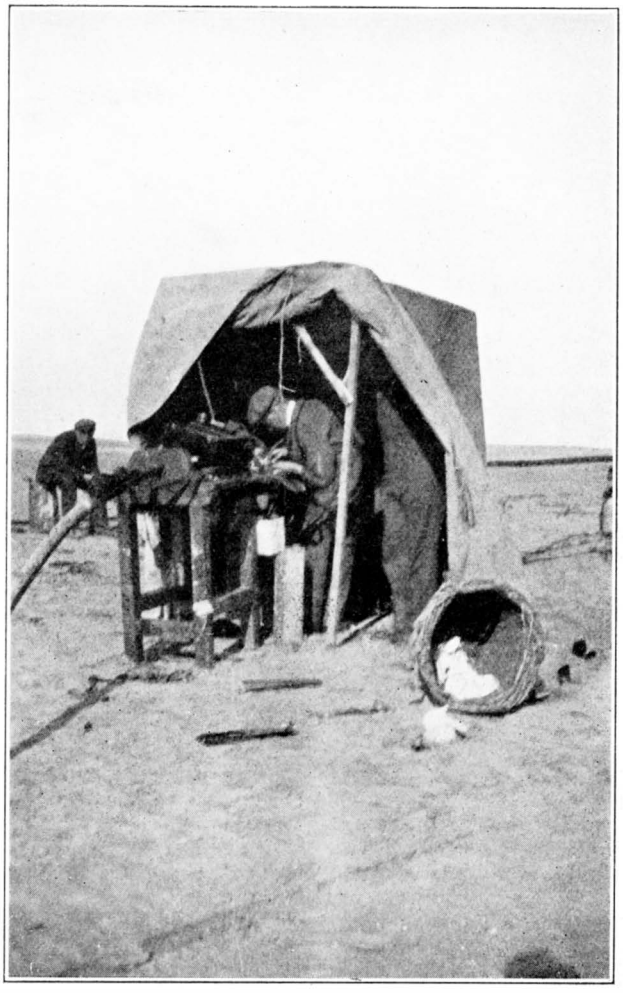


LOWERING A MARK BUOY.

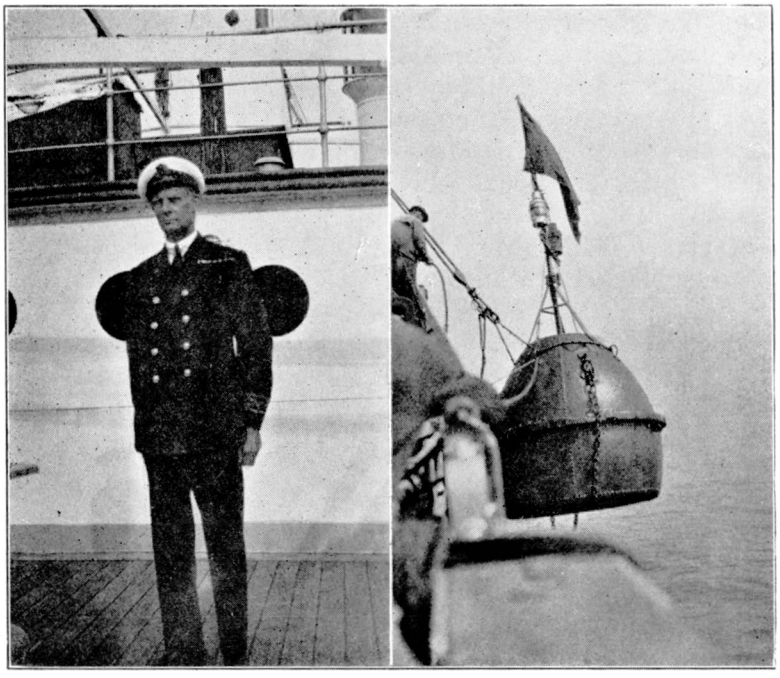
C.S. " Faraday " off Port Grenaugh.



Cable passing round Drum on " Faraday."



Making Joint on Beach at Norbreck.



CAPTAIN ALLAN, OF C.S. "FARRADAY." LOWERING A MARK BUOY.

MECHANICAL AIDS TO WORKS OF UNDERGROUND CABLING.

J. R. M. ELLIOTT.

THE increasing uses to which motor vehicles are being utilized throughout the country, and their profitable application to engineering operations open out possibilities for extending the employment of mechanical aids to our works of external construction.

The initial outlay and the high charges for petrol associated with motor vehicles may in the past have hindered progress in this direction, and whilst it may be necessary to exercise caution in expenditure on mechanical appliances the time has arrived when their use may with advantage be extended on works of external construction, particularly those of a heavy character such as underground cabling operations.

Some months ago, an extensive programme of underground cabling was contemplated in the Northern District, and special investigation was made locally into methods of carrying out the work in the most economical manner. Important factors in the cost of this class of work are usually the operations associated with drawing in cable, local haulage of drums, setting them up on jacks, and moving forward from point to point the various items of plant and tools. The motor winches, limited in number, for loan to Districts, were all in use at different centres at the time, and there was no guarantee that our demands in this direction could be met when cables came to hand, in which case the normal course would have been to pursue operations with hand winches. Necessity is the mother of invention, however, and consideration was focussed on the possibility of introducing mechanism for the purpose, which could be coupled to the engines of the lorries accompanying cabling gangs. At the same time, it was considered that if a suitable float could be constructed for conveying the drums of cable from

the Goods Station, or other point of delivery, to the manholes where the cables were required, and if this vehicle could be towed by the lorry, a good deal of manual work would be eliminated, and the ineffective costs would be cut down.

Efforts were first directed to the design and construction of a float, and before long a vehicle, which has since come to be known as a " Cable Bogie " was evolved and built in the local workshops. The problem was not without its difficulties. In the first place, the vehicle had to be designed for the conveyance of weights in the neighbourhood of $3\frac{1}{2}$ tons; it had therefore to be strongly built; the clearance between the body and the ground had to be as little as possible; from time to time, modifications and refinements were applied in the workshop until the carrier met all the conditions likely to be encountered in the District.

A second bogie, embodying all the latest improvements, was recently introduced and is in regular use. Fig. 1 shows the constructional details.

The bogie consists essentially of a low float with facilities for loading the cable drums for transport and jacking them up for paying off the cable when placed in position over the manhole. The leading dimensions were fixed by consideration of the size of the largest cable drum likely to be used.

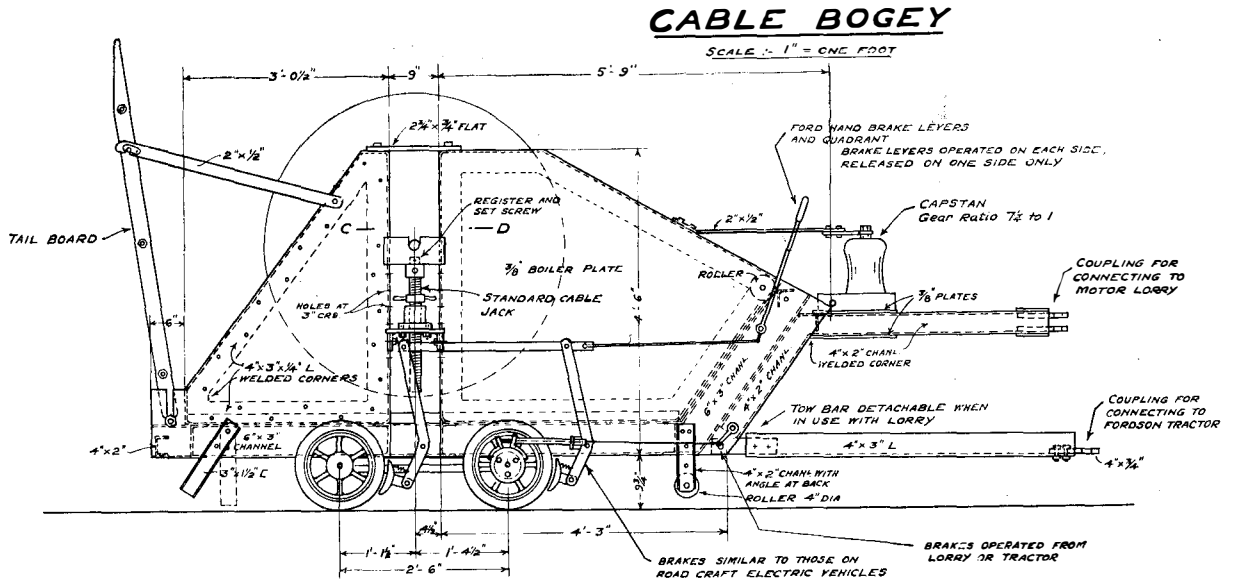


FIG. 1.—CONSTRUCTIONAL DETAILS.

the forecarriage had to be high enough to be coupled to a 3-ton lorry; the body had to be of sufficient width to receive the widest drums without transgressing the Police regulations; the tyres had to be of solid rubber to permit a trailing speed of 10 miles per hour; the overall dimensions had to be restricted to permit it being placed on footpaths; and it had to conform to the regulations in the matter of brakes and other adjuncts.

When the completed bogie was brought into use, each thoroughfare seemed to bring its own particular trouble. By concentration of careful study on individual requirements, as they arose

The framework of the floor consists of 6" × 3" channels, the actual flooring being 2" planks made into two removable sections. The sides of the bogie which carry the jacks are in two parts, constructed of $\frac{3}{8}$" boiler plate stiffened round the edges with 4" × 3" angles. The vertical angles of the sides form guides for the castings made to take the ends of the spindles and also take the seatings of the jacks. A series of holes spaced 3" apart in the flanges of these angles gives a ready method of adjusting the height of the jack to suit any particular drum. Standard cable jacks adapted, as required, to suit the bogie are used. The tail board, which

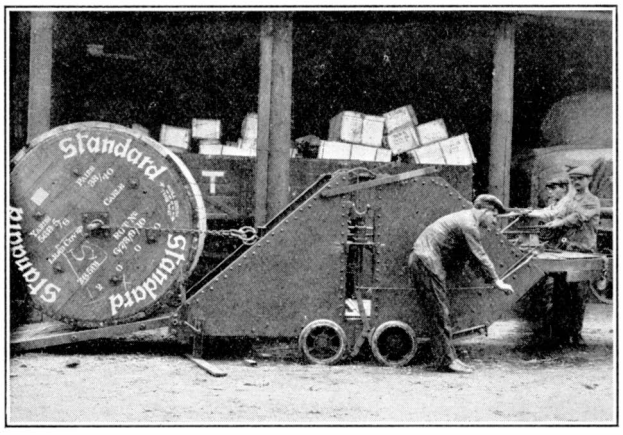


FIG. 2.—LOADING DRUMS AT GOODS STATION.

is of heavy construction to withstand the wear and tear to which it is subjected, is made of 3″ planks with a R.S.J. as a centre stiffener and channel iron round the edges. The tailboard is hinged to the back by means of slots in an extension of the plate forming the sides. When lowered, this tailboard forms a ramp up which cable drums are drawn on to the bogie, by means of a hand worked capstan operated by worm-gear of $7\frac{1}{4}$ to 1 reduction.

The axles are fixed, and to keep down expense old Ford axles coupled with compression couplings have been used. To facilitate loading of drums on to the lorry, the floor level is kept as low as possible consistent with safety and steel cast wheels of 12″ diameter with phosphor bronze bearings and solid rubber tyes have been used. The wheel base is only 2′ 6″ and this avoids undue wear and tear on the tyres when cornering. A 4″ diameter steel roller is secured at the front end to take any jolt which may occur from unevenness of the road surface.

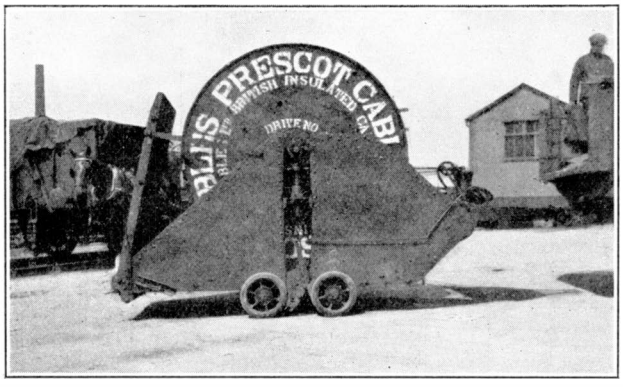


FIG. 3.—BOGIE LOADED AND READY TO BE COUPLED TO LORRY.

Two sets of brakes are provided. One set is operated from levers on either side of the front end which applies all four brakes with the one action, the brakes acting on the tyres. The other set, on the band brake principle, operates on the two front wheels only, and is so placed that by connecting up a cable they may be operated from the towing lorry. When a Fordson tractor is employed for towing purposes a special coupling, which is removable, as shown in Fig. **1**, is used.

The heaviest drums of cable issued can be drawn on to the bogie by three men, two of whom operate the hand worked capstan and the third the guiding tackle. Fig. **2** shows a loaded drum, weighing $2\frac{1}{2}$ tons, being drawn up the tailboard, which, when let down, is used as a ramp. The brakes are very effective, and when applied

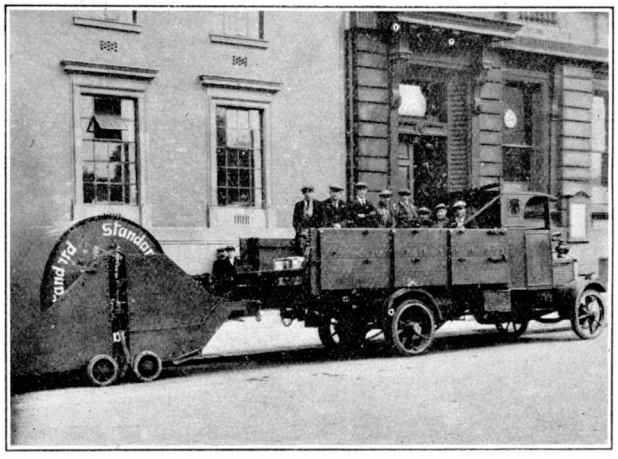


FIG. 4.—LOADED BOGIE COUPLED TO LORRY.

they dispense with the necessity for anchoring the vehicle. The short struts or feet at the rear, the off side one of which is shown in the photograph, prevent tilting as the load approaches the body, and when the drum is housed on the adjustable jacks the struts are thrown out of use by giving them a quarter turn and clamping them with the small handle shown.

Fig. **3** shows the bogie loaded and ready to be coupled to the lorry. This operation is effected by backing the lorry to the bogie and inserting a coupling pin. Fig. **4** shows the bogie coupled to the lorry, which has on board the cabling gang and the essential plant and tools, the combination being ready to move off to the site of work.

For placing the bogie in position for paying off on a footpath, 4½ feet lengths of 6″ channel iron are placed as a track for the wheels, in order to distribute the weight and thus avoid damage to the pavement. The bogie is then tugged into position by a rope from the lorry like a ship being berthed by a tug boat; Fig. **5** shows the drum ready for paying off. The brakes are applied, the wheels are in the channel iron, both front and rear feet are let down to steady the vehicle, and the jacks are suitably raised to lift the drum clear of the floor. In this case the cable is to be paid off through an aperture in the floor, but when necessary the tailboard can be detached to permit of the cable being paid off clear of the vehicle, as in Fig. **6**. Where it is not convenient to take the bogie on to the footpath it can be placed on the road.

In cases where more than one length is contained on a drum, re-battening for transport to another site, and taking the battens off again on arrival there is avoided, and much ineffective time is thus eliminated. The cost of a bogie is about £120.

For the purpose of ascertaining the extent of the saving in costs by the use of the bogie, records were carefully kept and figures for six consecutive weeks ended 28th September last year were obtained and are shown in Schedule A.

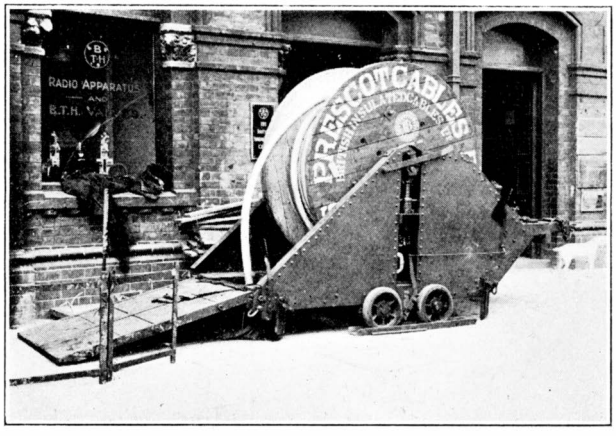


FIG. 5.—BOGIE WITH DRUM IN POSITION OVER MANHOLE ON WIDE FOOTPATH.

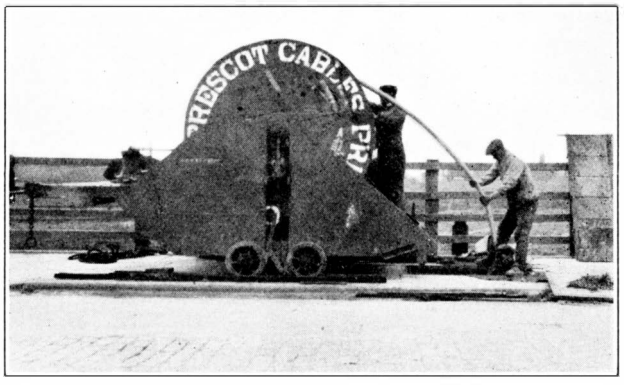


FIG. 6.—PAYING-IN FROM BOGIE ON NARROW FOOTPATH.

CABLE DRUM CARRIAGE IN CONJUNCTION WITH 3 TON LORRY.

Schedule showing Actual Costs as compared with Provincial Average Rates.

Dargue's gang. Schedule A

	Week Ending 24th Aug., 1928.		Week Ending 31st Aug., 1928		Week Ending 7th Sept., 1928		Week Ending 14th Sept., 1928		Week Ending 21st Sept., 1928		Week Ending 28th Sept., 19	
Length & Type of Cable	Yds. 5101 38/40 Gp.2		Yds. 498 50/10 Gp.1 1069 54/40 Gp.3		Yds. 3028 38/40 Gp.2 2023 54/40 Gp.3		Yds. 4474 54/40 Gp.3		Yds. 273 122/40 Gp.3 2492 54/40 Gp.3		Yds. 213 38/10 Gp. 414 38/40 Gp. 1397 122/40 G	
	Actual M.Hrs.	P.A. Rates	Actual M.Hrs.	P.A. Rates	Actual M.Hrs.	P.A. Rates	Actual M.Hrs.	P.A. Rates	Actual M.Hrs.	Rates P.A.	Actual M.Hrs.	P.A Rat
Effective Manhours :												
Cable drawn in	196	696	113	311	203	993	211	1100	151	680	227	42
Ineffective Time	103	196	33	70	98	267	38	148	70½	162	86	14
Total M. Hrs.	299	892	146	381	301	1260	249	1248	221½	842	313	56
	at 1/3¾	at 1/3¾										
Cost at Average Rate	£19 12 0	£58 11 0	£9 11 0	£25 0 0	£19 15 0	£82 14 0	£16 8 0	£82 0 0	£14 11 0	£55 5 0	£20 10 0	£37
Cost of 3 ton Lorry	£9 10 0		£6 0 0		£12 12 0		£14 7 0		£9 10 0		£8 18 0	
Estimated Cartage		£9 0 0		£8 0 0		£13 15 0		£12 16 0		£7 11 6		£7 1
Total	£29 2 0	£67 11 0	£15 11 0	£33 0 0	£32 7 0	£96 9 0	£30 15 0	£94 16 0	£24 1 0	£62 16 6	£29 8 0	£44 1
Net Saving	£38 9 0		£17 9 0		£64 2 0		£64 0 0		£39		£15 8 0	

The costs for the 3 ton lorry are those taken from the official returns, and the costs for cartage are estimated sums based on similar work prior to the advent of the bogie. The P.A. rates shown were those in force at the time of the trial. It will be seen that for one gang alone the net saving for the period under review amounted to the sum of £238 8s. 0d.

The 3 ton lorries are not always available for cable gangs, and during one period when all the lorries were in use for their legitimate purposes of transporting stores, a Fordson Tractor, the hire of which was less than a 3 ton lorry, was used successfully for towing the bogie. The use of a Fordson made it necessary to fit a special coupling of a temporary character. The photograph shows also the roller under the front end of the bogie, which is essential when the vehicle is being wheeled from the roadway to the footpath, in order to take the weight of the end protruding over the latter.

The economy which was effected by the use of the bogie encouraged the efforts which were being made in designing and constructing a capstan to be operated by the engine of a 3 ton Albion lorry. The drive for the capstan, a detailed drawing of which is shown in Fig. **7**, is taken direct from the propeller shaft by a chain drive through a lay shaft and worm gear. A dry ferrodo clutch operated by a foot pedal is used for the final drive to the worm gear, this being so arranged that the capstan is disconnected unless the foot pedal is depressed.

Two 4″ × 3″ R.S.Js. secured to the longitudinal frame members carry the capstan mounting and also the bronze bearings for the lay shaft, while a 5″ × 3″ angle iron secured to the floor carries the bearings for the clutch shaft and for the pedal. The 4″ × 3″ R.S.Js. are only 7″ centres, so that no trouble is experienced from frame distortion. The capstan itself was cast to suit requirements, a steel sleeve being inserted at the top and bottom to take the roller bearings used. A standard 1½″ thrust ball bearings takes the weight of the capstan.

In operation the engine of the lorry is set to run at a speed of about 325 r.p.m., and the chain drive and worm reduction gives a capstan speed of 13 r.p.m., that is, a drawing-in speed of about 27 ft. per minute. The engine clutch is not disconnected while driving the capstan, but the engine runs in neutral gear. The foot pedal clutch for operation of the capstan is designed to slip at a maximum of 8 h.p. with normal pressure on the foot pedal, so that at the speed given the pull is more than sufficient to deal with the heaviest cable without in any way overloading the engine.

After taking the bogie into the required position for paying off the cable, the lorry proceeds to the drawing-in points. One man, the lorry driver, who watches the signals from a distant point, controls, with his foot, the starting clutch. Withdrawal of his foot releases the clutch and the capstan instantly stops. A second man is in charge of the rope, which in passing from the duct to the capstan, rides over the roller at the back of the lorry. In this case it has been possible to place the lorry immediately over the manhole, but sometimes the conditions are such that the lorry has to operate some distance away.

The hand brake of the vehicle is sufficient to anchor the lorry against the heaviest strain. When necessary a man is stationed in the manhole to keep an eye on the rope as it emerges from the duct or pipe, and the rate of drawing-in is dependent upon the celerity with which the petroleum jelly can be applied to the cable at the distant end. The speed of the bollard can be adjusted by varying the throttle control of the engine. The cost of constructing and fitting a capstan is about £30. The lorry is used for the accommodation of plant, stores and tools, and this enables the footpath to be kept clear of the usual paraphernalia associated with a cabling gang. In busy thoroughfares this is a matter of some importance as the obstruction to traffic is minimised. At the outcoming end a cable guard only is necessary, as the lorry is used for storage, and, similarly, at the paying-in end a cable-guard only, in addition to the bogie, is required.

In shifting to a new site, the men are conveyed in the lorry and are saved the laborious task of packing up and pushing a handcart. They are thus less fatigued and are ready to resume operations immediately on arrival at the next point. A tool cart is unnecessary and the ineffective time usually inseparable from packing up at the end of a day's work and seeking a safe place for storage purposes is avoided.

For the four consecutive weeks ended 16th November last year, special records were kept of the costs associated with the gang using a lorry fitted with a capstan, and a comparison between the figures obtained and the standard rates which prevailed at the time are given in Schedule B.

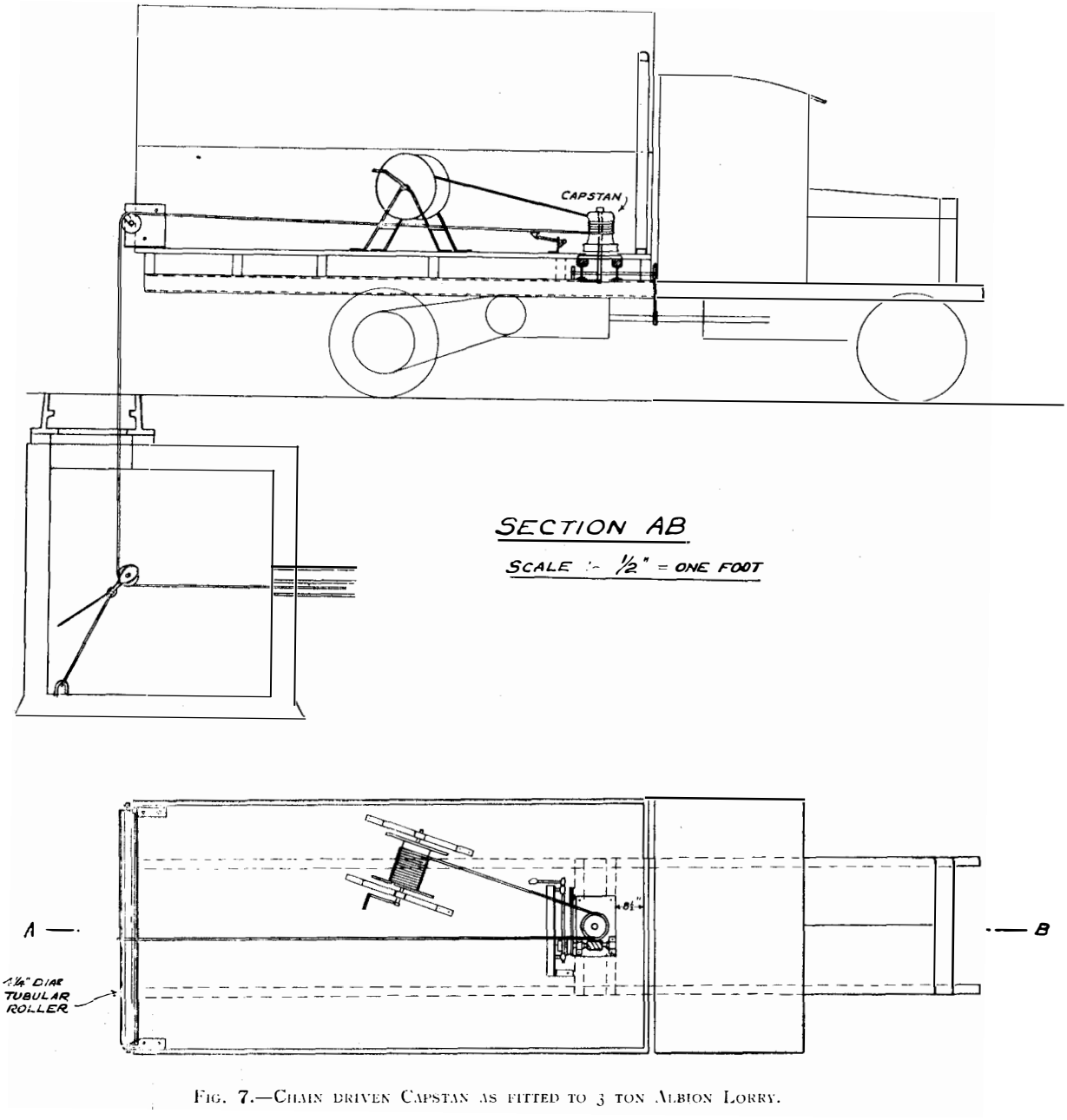


FIG. 7.—CHAIN DRIVEN CAPSTAN AS FITTED TO 3 TON ALBION LORRY.

3 TON ALBION LORRY FITTED WITH CAPSTAN.

Schedule showing the Actual Costs associated with the gang using the 3 Ton Lorry as compared with the Standard Rates.

R. T. Hall's gang. Shedule B.

	Week Ending 26th October, 1928.		Week Ending 2nd November, 1928.		Week Ending 9th November, 1928.		Week Ending 16th November, 1928.	
Length of Section and Type of Cable ...	Yds. 97 200/6½ Gp.2 97 300/10 Gp.3 145 400/10 Gp.3 60 500/10 Gp.3 1719⅜ 800/6½ Gp.3 697 800/10 Gp.3		Yds. 109½ 300/6½ Gp.2 114 500/6½ Gp.3 263 600/6½ Gp.3 631½ 800/6½ Gp.3 331½ 1000/6½ Gp.3 528½ 800/10 Gp.3		Yds. 382 800/6½ Gp.3 251½ 400/10 Gp.3 191 800/10 Gp.3		Yds. 31 300/6½ Gp.2 192 400/6½ Gp.3 211 **500/6½ Gp.3** 31 800/6½ Gp.3 188 400/10 Gp.3 285 500/10 Gp.3 439 800/10 Gp.3	
	Actual M.Hrs.	Standard Rates.	Actual M.Hrs.	Standard Rates.	Actual M.Hrs.	Standard Rates.	Actual M.Hrs.	Standard Rates.
Effective Manhours:								
Cable drawn in ...	321	555	232	386	84	165	**169**	273
Ineffective Time ...	210	189	69	131	18	56	120	93
Total M.Hrs. ...	531	**744**	301	517	102	221	289	366
Cost at Average Rate of 1/3⅜=	£34 0 0	£48 0 0	£19 10 0	£33 0 0	£6 10 0	£14 0 0	£18 10 0	£23 10 0
Cost of 3 ton Lorry ...	£6 10 0		£7 10 0		£5 10 0		£7 0 0	
Estimated Cartage ...		£4 0 0		£5 0 0		£3 0 0		£5 0 0
Total Cost	40 10 0	£52 0 0	£27 0 0	£38 0 0	£12 0 0	£17 0 0	£25 10 0	£28 10 0
Net Saving ...	£11 10 0		£11 0 0		£5 0 0		£3 0 0	

The drums were delivered at the various manhole sites by the Railway Company and cartage on that account is not therefore taken into consideration. The net saving for the period under review amounted to £30 10s. 0d.

The rope used for drawing in the heavier types of cable is impregnated with oil for preservative purposes, and when stress is applied this oil exudes and becomes a source of trouble, in consequence of the convolutions on the capstan slipping even with the maximum number of turns wound on the bollard. The delay which ensues increases the cost of the work, this additional expense being out of all proportion to the comparatively small saving due to preservation of the rope. To obviate this drawback, steel hawsers of 1″ diameter are used, but care is taken, by frequent inspection of the strands, to see that needle ends are not formed. In order to avoid handling the hawsers in taking the turns from the bollard of the capstan a hand worked Hawser Winder is used, as shown in Fig. 8. This arrangement dispenses with the operation of flaking or coiling the wire and forms a compact and tidy method of dealing with the hawser as it leaves the capstan.

Emptying of manholes. The clearing of water from manholes is often a source of expense, particularly if adequate facilities for pumping or bailing are not available. To provide means for rapid emptying of manholes, a pump designed and constructed in the local workshops is fixed

FIG. 8.—STEEL HAWSER AFTER LEAVING THE CAPSTAN BEING COILED ON HAWSER WINDER.

on the 3 ton lorry and is driven by the engine of the vehicle. This pump, which is of the plunger type, is capable of lifting 1,500 gallons of water per hour, and by its aid a manhole of average proportions filled with water can be emptied in less than two hours. The pump is shown in action in Fig. **9**, whilst details of its construction are shown in Fig. **10**. It consists of a cast iron cylinder of 3″ bore securely mounted to the off-side member of the Albion lorry. Working in the cylinder is a 3″ bronze piston coupled to an eccentric sheave which is fitted on the carden shaft of the lorry by means of a strap and a connecting rod giving a stroke of 3″. A bronze head containing an inlet and an outlet port of 1″ × ½″ is mounted on the cylinder. Operating on these ports are two valves which enable a stream of water to be pumped, the suction being sufficient to permit water to be drawn from a depth of 20 ft. It will readily be understood that a pump of this description, working without intermission, enables a manhole to be cleared of water in less time than is the case with a hand worked pump. The cost of constructing and fitting a pump of this kind is about £12. The labour associated with bailing or with the work-

FIG. 9.—PLUNGER PUMP IN OPERATION.

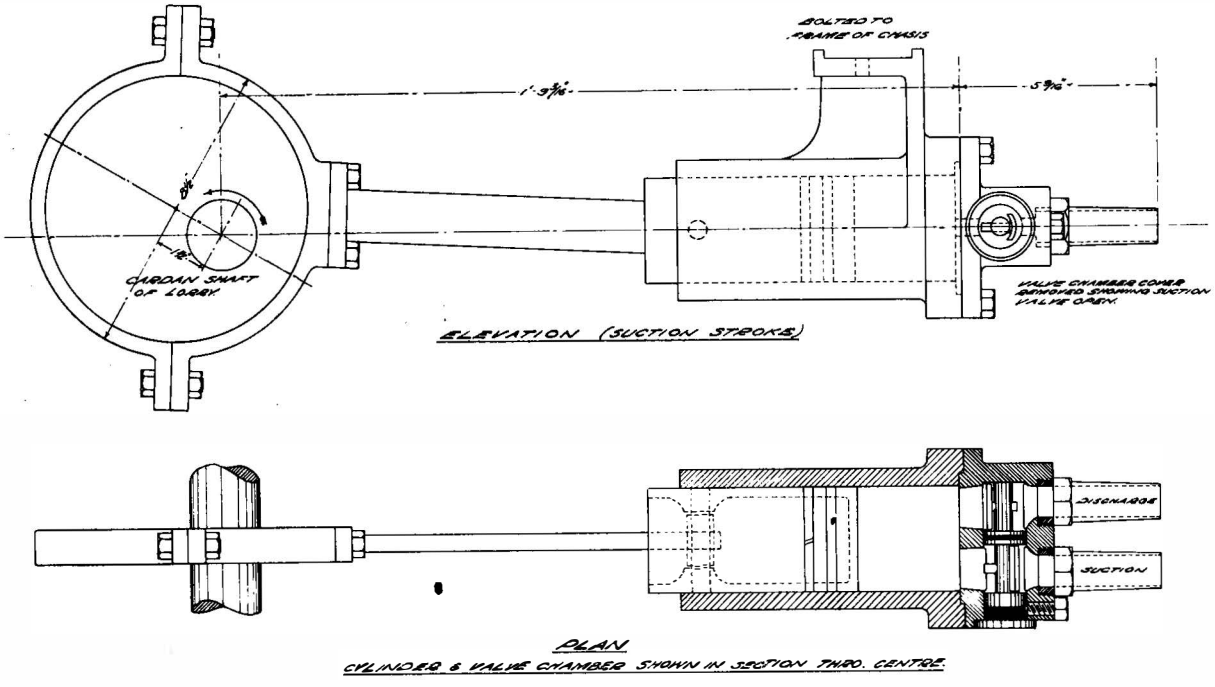


FIG. 10.—MOTOR DRIVER PUMP FITTED TO 3 TON ALBION LORRY.

ing of a hand pump of any description requires great physical effort and when the quantity of water to be cleared is considerable, the operation becomes an arduous task. The amount of ineffective time which may be expended in the process is often a factor of some importance and the energy required to keep a hand pump in continuous operation has an exhausting effect on the men engaged.

The introduction of these mechanical aids were at first regarded with suspicion by the gangs who had to operate them, due no doubt to fear of fewer personnel being required, but after becoming more accustomed to their use workmen soon appreciated the extent to which they were relieved from the more laborious aspects of their work; and when Foremen found that their daily output was increased with less manual effort, the original antipathy disappeared and now the use of the appliances is regarded by gangs as an essential portion of their equipment.

[*The methods described in the foregoing article have been carried out in the Northern District, but it should be understood that they should not be regarded as the approved standard practice of the Department.—Editors, P.O.E.E. Journal.*]

DAMAGE TO POST OFFICE CABLES BY FIRES IN LONDON SUBWAYS.

THE London Engineering District has been particularly unfortunate of late, owing to the number of serious breakdowns of cables due to fire and explosion. Most readers of this Journal are aware of the innocuous nature of telephone cables and will not have been deceived by the misleading headlines in the newspapers, such as " Fire in Telephone Subway," " Another Telephone Fire," etc. Those who are unacquainted with the facts may, however, be led to imagine that telephone cables are a source of danger, and it may be of some interest to describe the damage that was done by the fires in the Victoria Embankment subway, the steps taken to restore service, and the verdict of the Coroner's jury, which, in accordance with the usual practice when fires occur in the City of London, sat to investigate the cause and to suggest preventive measures.

Probably not many persons are aware of the existence of a large system of subways under the streets of the Metropolis. From time to time a man may be seen descending with a safety lamp, but there is nothing to indicate that he is not entering a sewer or jointing chamber.

The subways referred to are not for the purpose of providing a safe walking place for pedestrians, but for the accommodation of pipes, cables and services of various undertakers. It is possible for a duly authorised person to walk from the Mansion House to Westminster Bridge, a distance of two miles, without coming to the surface.

In addition to the subway under Queen Victoria Street and the Victoria Embankment, there are pipe subways under Holborn Viaduct, St. Bride Street, Shaftesbury Avenue, Charing Cross Road, Kingsway, Commercial Road and other places. The total length of the subways is about seven miles. Most of the subways are owned by the London County Council and the remainder by the City of London Corporation.

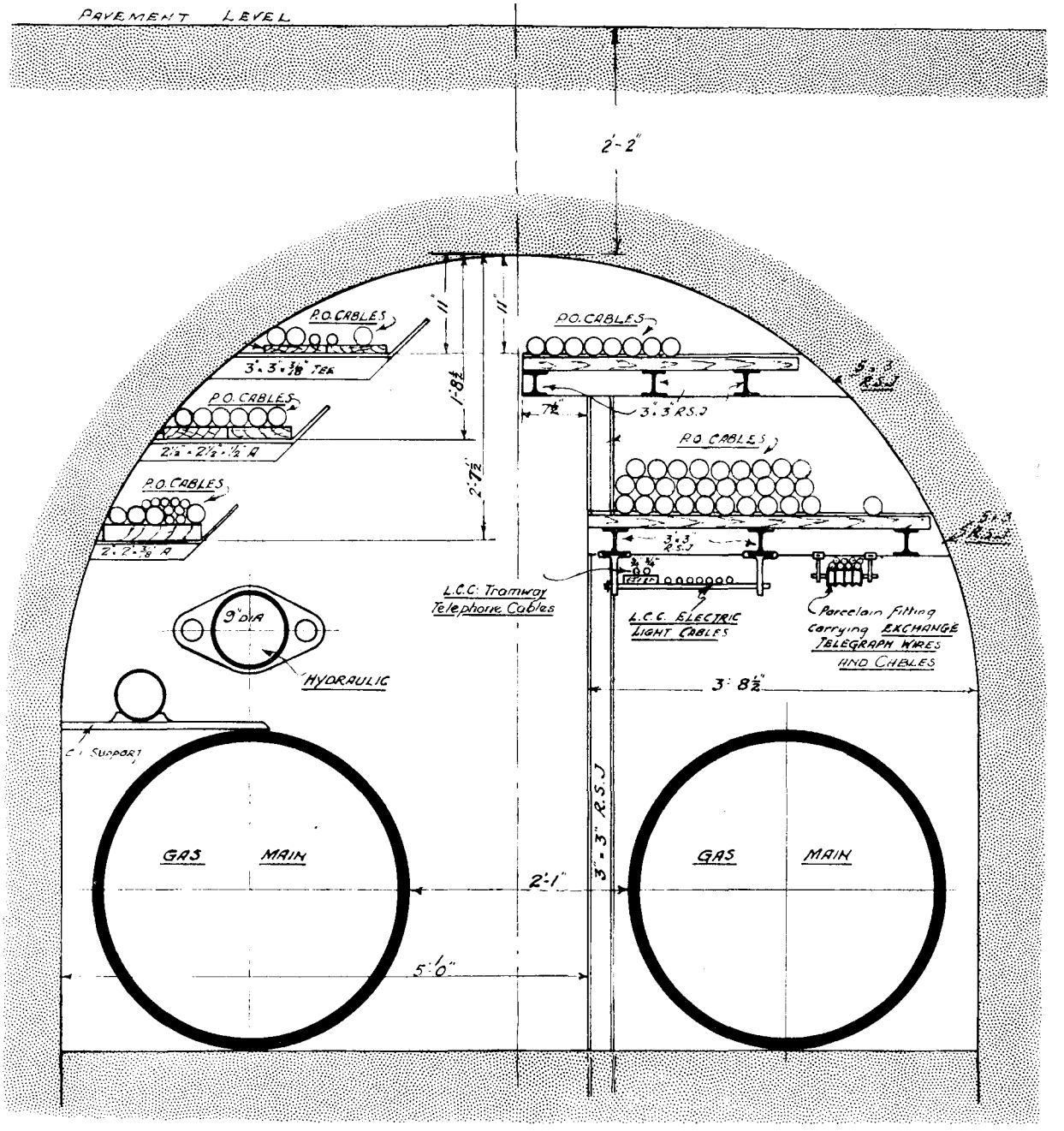
The subways vary in size. The subway under the Victoria Embankment is 9 feet wide and 7′ 6″ high. Fig. 1 shows a typical section of this subway.

These subways are extended as opportunity occurs. When the large underground station was constructed under the open space opposite the Royal Exchange and Mansion House, a pipe subway was constructed underneath the station with laterals opposite the various thoroughfares which radiate therefrom. A similar subway has recently been constructed under the new station at Piccadilly Circus.

There is no doubt that the subways serve a useful purpose, and in fact are more useful than could possibly have been foreseen at the time when the scheme was originated. In those days horsed omnibus and hansom cabs were the usual modes of conveyance and much less travelling was done. Nevertheless, the necessity for re-

ducing the interruptions to traffic due to pipe-laying operations was then held to be sufficient to justify the expense involved in the provision of pipe and cable subways.

The introduction of motor traffic has enormously increased the number of vehicles using the roads and a blockage due to road operations can now cause much greater dislocation than was the



SECTION THROUGH SUBWAY LOOKING FROM BLACKFRIARS TOWARDS CHARING CROSS.

FIG. 1.—TYPICAL SECTION OF VICTORIA EMBANKMENT SUBWAY.

case in the days of horse traffic. Although there is inherent possibility of quick motion in a modern vehicle, the occurrence of a few street repair operations soon nullifies that advantage and makes it desirable to resort to walking, if a comparatively short distance only has to be covered. It is not surprising, therefore, that some authorities would like to have subways in every street and to forbid all street openings for the purposes of laying mains. Opinion is not unanimous upon this point. Apprehension is felt in some quarters about the existence in the same subway of high and low tension electric light mains, gas mains up to 36″ diameter, hydraulic mains carrying water compressed to 750 lbs. per square inch and telephone cables. All but the latter can cause interruption of the others if a failure occurs.

Until recently, however, there has been no trouble, although some of the subways have been in existence for over 50 years, and during almost the whole of that time the above types of plant have existed together in the same section of subway.

A contributory cause of the recent trouble was the great Thames flood which occurred on January, 1928, when the tide was abnormal, not only in its height, but in the measure that it exceeded the previous highest tide. Up to that time the highest tide previously recorded was in 1881, which exceeded the previous highest tide in 1875 by 3 inches, whereas the tide in January, 1928, exceeded that of 1881 by no less than 11 inches. Pepys refers to a flood which occurred in December, 1663, " 7th. Up betimes and it being a frosty morning walked on foot to White Hall. . . . At White Hall I hear and find that there was the last night the greatest tide that was ever remembered in England to have been in this river; all White Hall having been drowned, of which there was great discourse." It is recorded of a flood in 1791 that " boats came through the passage of Old Palace Yard from the Thames and round up to Westminster Hall Gate." Neither of these tides is reckoned to have exceeded 15 ft. 8 inches above ordnance datum, whereas in January, 1928, the tide was 18 feet 6 inches above ordnance datum.

In contrast to these floods it may be mentioned that in 1717 the river fell so low that persons are said to have walked across it.

It will be remembered that in January, 1928, the basements of many houses were flooded and several persons were drowned. The water entered the Thames Embankment subway and most of the plant was submerged. The huge gas mains floated and the joints drew, causing a serious leakage of gas; water penetrated a number of telephone cables, and some cables which were used by the London County Council to supply light to the Victoria Embankment were badly damaged. Repairs were put in hand by the various undertakers. Some of these repairs were effected in a temporary manner and the permanent repairs and replacements, which can only be carried out in short sections, are now being executed.

The first intimation of further trouble in the subway was received shortly after 8.30 p.m. on Saturday, September 8th, 1928, when it was reported that a number of junctions to certain exchanges were out of order. This was quickly followed by an intimation that all communication between certain exchanges had ceased. A rapid mental review of the exchanges affected indicated that there was only one section of route where circuits to all these exchanges could be interrupted at the same time, and this was on the Victoria Embankment. This inference was confirmed by a subsequent report that a fire was raging in the subway.

A visit was made to the spot, but, although the flames had been subdued, the heat was so intense and the danger so great that the fire brigade officials would not permit anyone but firemen equipped with special apparatus to descend. When permission was ultimately given, it was found that over sixty telephone, telegraph and electric light cables had been completely destroyed for a distance of about 60 yards. Some tons of melted lead from the sheaths were lying on the racks and ground. Molten lead had also got between the conductors and had welded the cables into a solid mass. Figs. **2** and **3** will show the state of the subway. Cables can be seen with all the lead sheath burnt off.

It was evident that the restoration of circuits in the subway would be very difficult as the masses of metal, which had formerly been cables, would have to be sawn away in sections. As soon as advice was received that the breakdown was serious, the emergency officer at the Con-

troller of Stores had been advised by telephone that demands would be made for lengths of cable and a broad indication was given of the types of cable that would probably be required. This officer promptly called out his special staff with vehicles, and by the time that a survey of the damage had been made, he was ready to commence loading. The cables were ordered forward and a plan of operations prepared.

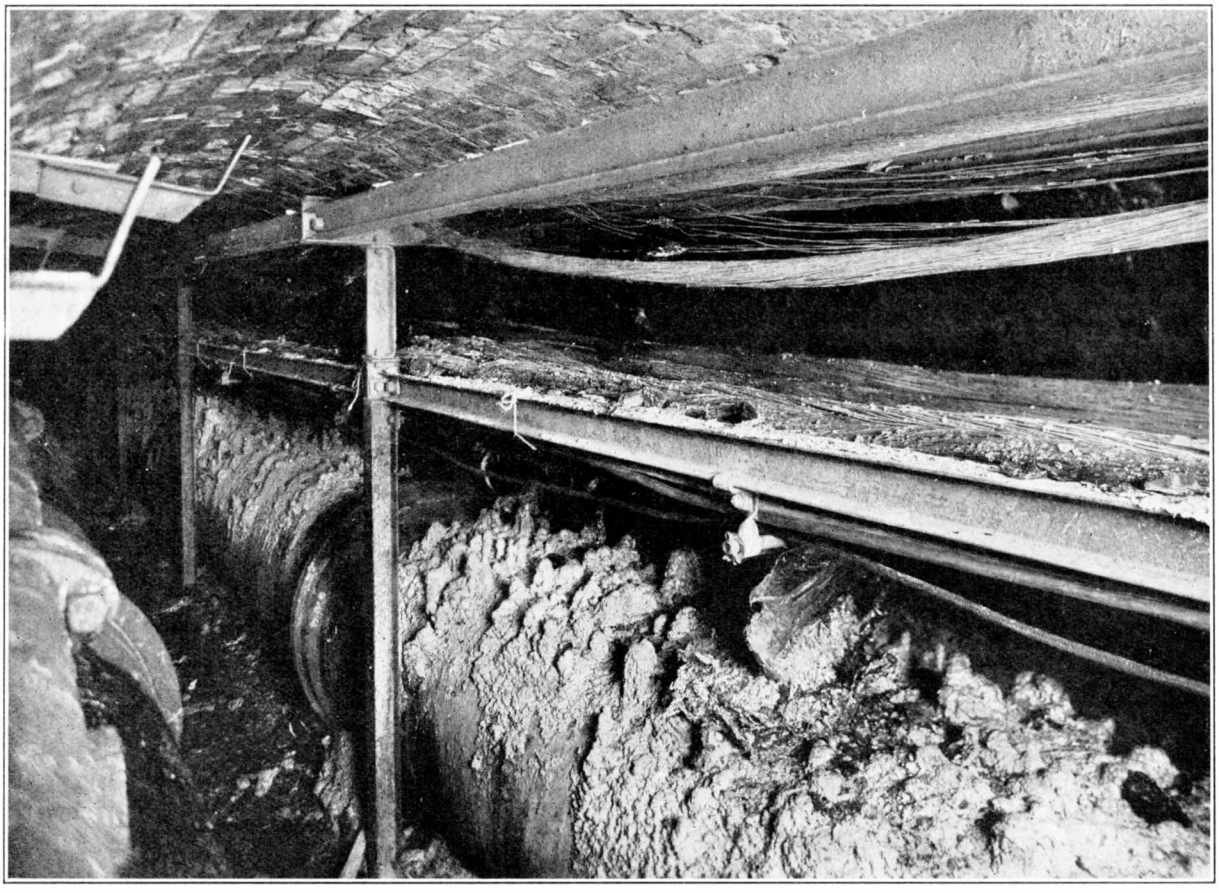


FIG. 2.—VICTORIA EMBANKMENT SUBWAY. DAMAGE CAUSED TO CABLES IN SEPTEMBER, 1928, FIRE.

Examination of the records showed that the 46 telephone and telegraph cables destroyed carried 2,872 working junctions to 43 London exchanges, 130 Trunks to Provincial towns and foreign countries, 85 telegraph circuits and 1,500 subscribers exchange lines. In addition, a large number of private wires, power leads, ringing leads, etc., were affected. Steps were at once taken to divert as many circuits as possible to alternative routes. By Monday, the 10th of that month, 79 trunk and 750 junction circuits had been provided by alternative routes. Progress after this was somewhat slower, owing to the fact that in many cases double, triple and even quadruple changes had to be made in order to free a circuit between the desired points. The alternative routes were in some cases very circuitous and the speech efficiency was necessarily reduced, but speech could be obtained and this was better than nothing. Altogether about 1600 circuits were provided by alternative routes. Arrangements were also made to provide additional circuits at certain exchanges which were being used as lending junction centres by other exchanges. The work involved in providing alternative circuits can perhaps be gauged by the fact that over 4000 diversions were carried out on the exchange distributing frames, apart from those effected in jointing chambers. By the end

of the week the number of circuits out of order had been reduced to 850. Owing to the provision of additional circuits on existing routes, the careful consideration given to the order of restoration and the diversion of telephone traffic, it was possible by this time to provide a service which was almost normal.

While the provision of alternative routes was being effected, the damaged cables were being withdrawn, the subway reconditioned and new

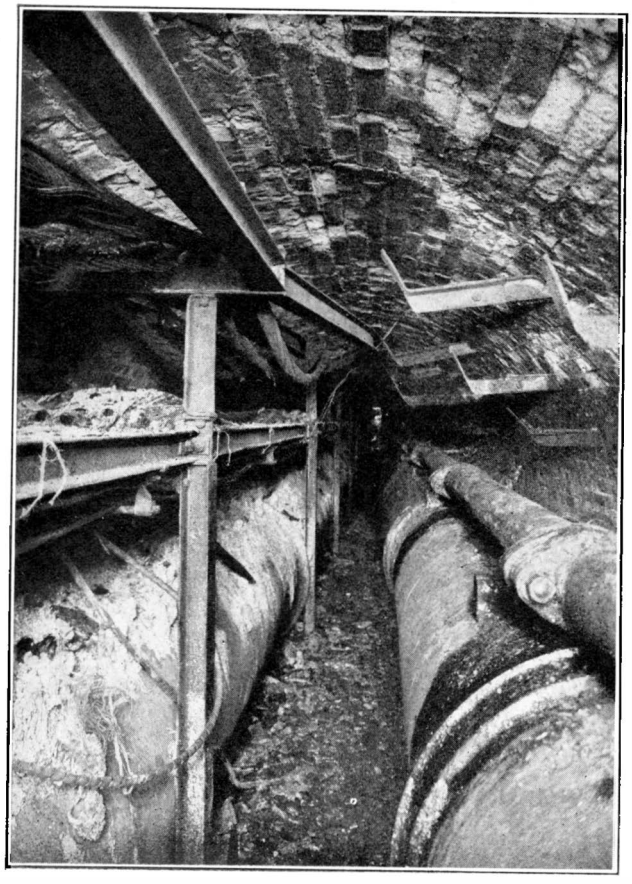


FIG. 3.—SEPTEMBER, 1928, FIRE. ANOTHER VIEW OF THE DAMAGE.

cables drawn in and jointed. Each undertaker was, of course, anxious to get plant restored, and owing to the limited space available there was much congestion, but with mutual goodwill and co-operation it was possible to make good progress. As each junction cable was restored, the circuits which had been diverted to circuitous routes were transferred to the direct cable. The whole of the destroyed cables were replaced and brought into use within a month of the disaster. Fig. 4 shows the repair work in hand.

The finding of the jury was that the fire was due to a defective cut-out box on the L.C.C. lighting cable, which had been damaged by the floods previously referred to, and it was recommended that the whole lighting system should be replaced by a modern method. This recommendation was accepted by the London County Council and a scheme was prepared for making the Embankment one of the finest lighted thoroughfares in the world.

Before the new scheme was completed, a further serious fire occurred in the Victoria Embankment subway at 9.35 p.m. on June 6th, not many yards from the scene of the previous fire. Owing to the prompt action of the Fire Brigade the fire was subdued before it had spread so far as on the previous occasion, but, nevertheless, much dislocation was temporarily caused to the telephone service. Twenty large cables containing junction and subscribers' circuits were completely destroyed and also a number of small cables containing private wires and miscellaneous circuits. Altogether about 3300 working circuits were affected, of which 985 were subscribers' lines. The method of restoration was similar to that adopted on the previous occasion, and by Tuesday, the 11th June, all the subscribers' lines had been restored and the number of other faulty circuits reduced to 540. As 300 additional circuits had been provided to junction lending circuits and the plan of restoration included deferment until the last of the least important circuits, the Controller, L.T.S., was able to report on the 12th June that a satisfactory service was being given on all routes. All the cables were replaced by June 18th and the diverted circuits were then restored to their original route.

A further enquiry was held by the City coroner and a jury. The verdict was that the fire was occasioned by sparking at a defective porcelain connector on the L.C.C. lighting cables. The cables which were held by the Coroner and jury to have been the cause of the fire on each occasion have now been thrown out of use.

Between the periods of the above fire there occurred a gas explosion in Holborn, which resulted in the complete wreckage of a Post Office tube containing telephone cables only. In this case not only was great damage caused to the

telephone cables in the tube and the plant of other undertakers under the road, but considerable damage was also caused to private property. Much prominence has been given to this matter, and it is not proposed to describe the method of restoration, which was similar in principle to those already mentioned. Neither can full information be given as to the actual steps taken to provide alternative routes. It must suffice to say that duct routes were linked up by short lengths of conduit, manholes were enlarged to embrace adjacent pipe routes and cables were linked up at points, some of which were three miles away from the scenes of the breakdown so as to make it possible to make the fullest use of all spare circuits available. Alterations were made at a number of exchanges so as to permit of junctions being worked in tandem and the limited number of circuits on the gradings at automatic exchanges were rearranged so that the greatest availability could be secured.

A number of smaller disasters have also occurred due to explosions, water main bursts and road subsidences, and in some cases the telephone plant has been affected. The fact of the matter is that the telephone system in London has grown to such an extent that there are very few streets of any importance that do not contain telephone conduits and cables, so that when any serious damage occurs to a road there is almost sure to be some telephone plant in the vicinity which is liable to be injured. Telephone cables and conduits are sufficiently robust to withstand any ordinary disturbance, but explosions, fires

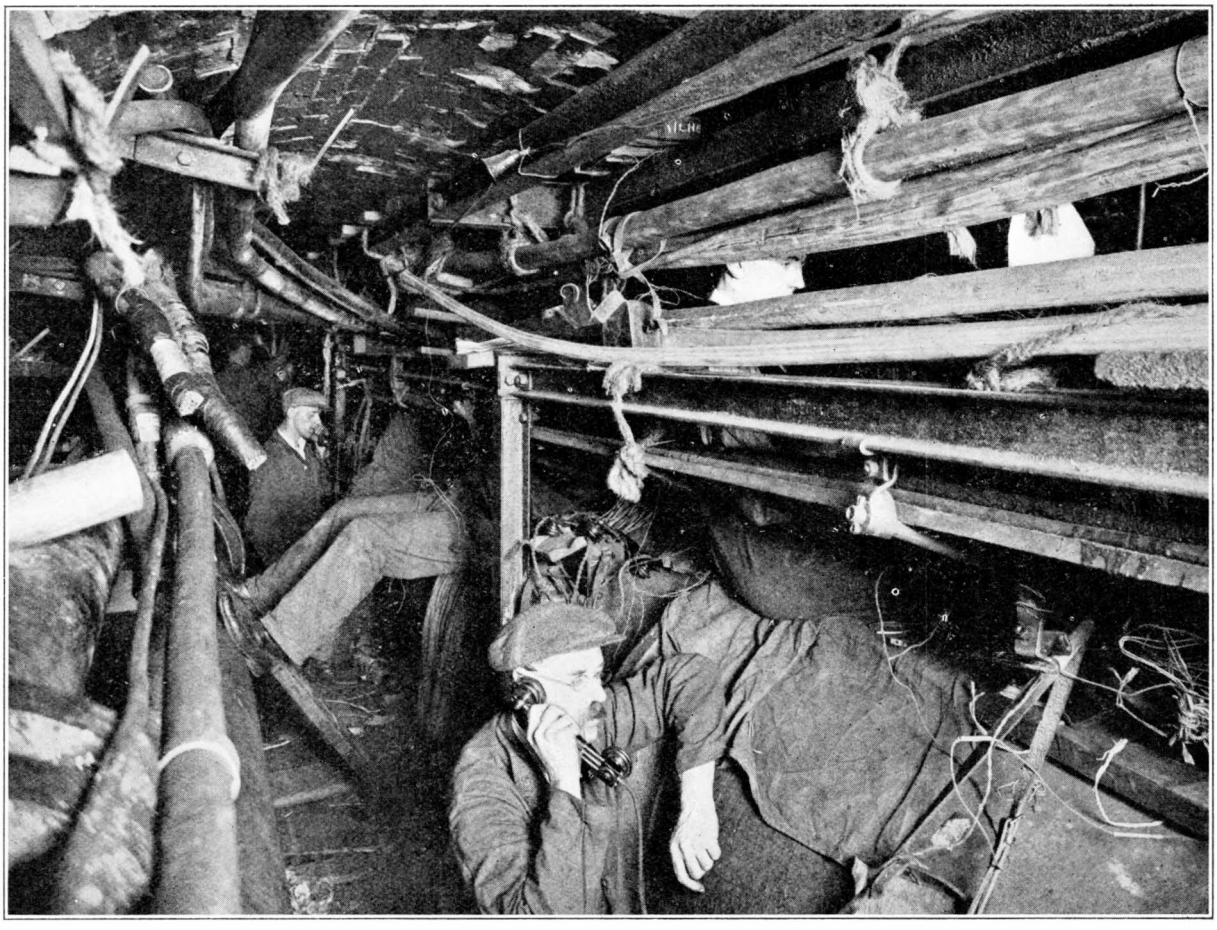


Fig. 4.—Victoria Embankment, September, 1928, Fire. Repair work in progress.

and pneumatic drills are in a different category, and it would not be practicable to provide plant which would be quite immune from injury by these agencies.

So far as is practicable the junctions which connect exchanges are divided between alternative routes and the extent of the possible dislocation of traffic due to breakdown thus reduced. There are many cases, however, in which alternative routes cannot be provided. Cable ducts must follow the roads and there may not be an alternative route, or, if it exists, it may be so circuitous that not only would the cost be prohibitive but its adoption would involve a serious degradation of efficiency.

It is only natural that as the brunt of the restoration work falls upon the engineer he should give great attention to the matters of avoiding breakdowns and limiting dislocation of traffic. No simple rules can be laid down and each case must be considered on its merits. Careful selection of routes, close supervision of construction work and a good organisation for dealing with emergencies are, of course, essential.

J.G.H.

SUBSIDENCE OF IMPORTANT CABLE ROUTES: BOUGHTON HILL, NEAR CANTERBURY.

FOLLOWING the very bad weather conditions of the winter of 1927-8, a subsidence occurred in the embankment at the foot of Boughton Hill, near Canterbury.

A two-way duct carrying two very important cables was involved. The cables were (1) a recent 160 pr/40 PCMT. L. and B. cable, serving the Canterbury Repeater Station, and thence the Continent; (2) an older cable PC. 8 pr/150 MT + 24 pr/100 MT + 42 pr/70 MT + 5 pr/40 T, feeding chiefly the East Kent areas and also partly in use for Continental circuits. A loading coil manhole existed in the area of the subsidence.

Examination of the duct line showed that the ducts had been considerably displaced. Although only about 20 yds. of duct were involved, a downward displacement of 5 ft. and an outward displacement of 2ft. 6in. had taken place. Trial holes showed all ducts broken at the sockets, whilst the cable (1) mentioned above had pulled over the loading coil stubs in the manhole, and cable (2)—which was straight through in the manhole—had moved several inches. A joint about 130 yds. down the hill from the manhole also showed several inches movement up the hill, whilst a joint 200 yds. distance up the hill showed a similar displacement of the cable down the hill. At a joint 30 yds. from the manhole cable (2) was found to be pushing its sleeve into the duct.

The subsoil in the area of the subsidence is largely a mixture of sand and clay saturated with water.

Attempts to lift the duct and cable had to be abandoned, due to the risk of the embankment, and with it, the road giving way. The road is the important main London-Dover road (Watling Street).

The necessity for keeping the cables intact, however, was also of great importance. Cable (2) had already split its sheath close to the manhole and a wiped patch inserted. (Fortunately this defect was found in good time, as water was dripping on the sheath barely an inch away). Although cable (1) had not broken down, it was in a precarious condition, and it was decided at short notice to erect a 100 pr/10 cable on an existing trunk route for 300 yds. to clear the area of the subsidence and its possible extensions. 40 prs. were left in a normal condition through the L.C. manhole and 100 prs. were diverted to the small gauge aerial cable, thus missing the manhole.

Cable (2) was also wholly diverted to a similar length of the same class of cable. Cable (2) was not loaded at the manhole.

The Road Authorities took the subsidence in

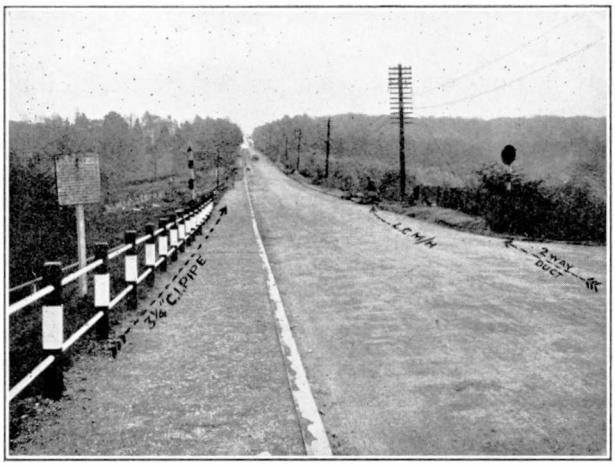


FIG. 1.—GENERAL VIEW OF BOUGHTON HILL.

hand and inserted a ferro-concrete kerb 3 feet deep, 18in. thick at the bottom, tapering to 6in. at the top. Drainage was also effected and the embankment remade.

The stability of the underground cables have been watched since the latter work was done and movements of the cables have been continuously recorded.

The aerial cables (ordinary underground types) have had a trying experience including a hurricane and extremely unusual variations of temperature, but fortunately no trouble has been experienced. The same remarks do not, however, apply to cable (1) in which two of the L.C. stub sheaths have split under strain but have been made good by local efforts without withdrawing the pots. Fortunately, by watching the manhole the defects came to light early enough to admit of repairs being effected before the breakdown stage.

The rapid growth of Continental services combined with the unsatisfactory transmission conditions set up by the aerial cables have latterly made urgent the necessity of restoring the original cables.

The subsoil conditions do not permit deep trenching and necessitated the abandonment of ducts and cables in the area of the subsidence. The ducts were replaced by 2-3¼in. steel pipes laid shallow close to the kerb, and securely concreted to the latter, from the manhole for a distance of 80 yards up the hill. A ferro-concrete jointing box constructed at this latter point embraces both ducts and steel pipes. The concreted pipe gives additional strength to the kerb and any future subsidence affecting the cables in this length will be visible. New cables of similar type to the old were drawn into the steel pipes.

The question of interference with the important Continental services during the diversion work arose, and instructions were given to carry out the diversions over the Whitsun holiday period. The repair work was rather complicated.

Cable (1) was split into 5 stubs at the L.C. manhole. All stubs were much displaced and, in addition, Cable (2) pressed hard against them under heavy strain. 40 pairs of cable (1) were working through the manhole and the remaining 100 pairs in the aerial cable. A balanced joint also existed 30 yds. from the manhole under the new pipe line and in the abandoned length. In addition, it was demanded that no disturbance must arise on working circuits.

The scheme adopted was as follows:—

(1) A speaker circuit was provided between the scene of operations and Canterbury Repeater Station.

(2) It was decided to save the L.C. Stub connecting cables. This necessitated making a joint close to the pothead in a very difficult position. It was also decided not to rebalance the section.

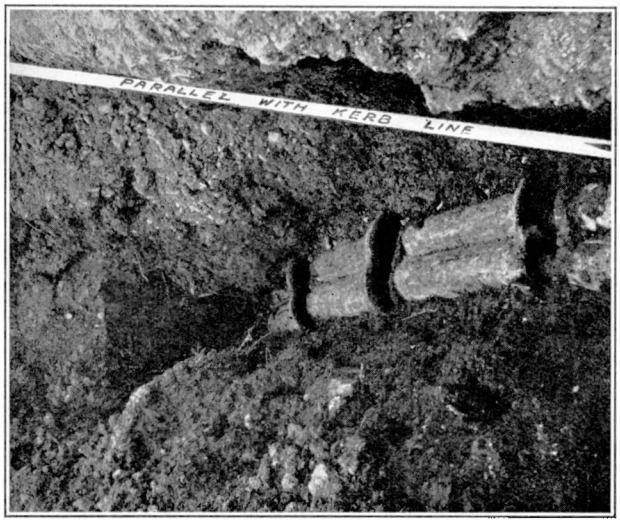


FIG. 2.—BOUGHTON HILL. STATE OF DUCTS ABOUT 20 YARDS FROM MANHOLE.

FIG. 3.—BOUGHTON HILL. DUCTS NEXT TO MANHOLE AT BOTTOM OF HILL.

(3) The cable pairs were divided into groups to suit working conditions. Unfortunately, these groups did not correspond with loading coil stubs nor with the normal order of jointing in a cable of this type. The circuits working in a group were temporarily transferred to other groups. The wires thrown spare were tapped out and numbered at the Canterbury end of the faulty section and connected to corresponding pairs in the new section of cable, but at the L.C. manhole crosses had to be made equivalent to those existing in the standard joint cut out. This complicated matters considerably.

(4) On completion of one group the working circuits were transferred and successive groups dealt with in a similar manner. Close co-operation between the London Trunk Exchange and Canterbury Repeater Station and the staff at Boughton Hill was maintained throughout and each circuit transferred to the repaired cable was thoroughly tested by London before acceptance. The fact that the work was carried out without a hitch and without causing a single interruption on a working circuit reflects the greatest credit to the staff employed on the work.

Cable (2) was dealt with in a more simple manner. The new length of cable was joined into the existing cable at each end of the new pipe line under the usual M.T. jointing conditions. The lengths thus jointed were numbered out at each of the aerial cable ends. Diversions were effected at the latter points in conjunction with Canterbury Repeater Station.

The abandoned cables from the manhole to the first joint 30 yds. away have been securely clamped at each end by special fittings to retain the strains taken before the diversions to the new cables, so as to reduce the risk of any further subsidence due to the removal of any support given by the cable.

The photographs show a general view of the hill, the condition of the subsided duct line and a distorted kerb further up the hill on the opposite side. On this side of the hill it will be necessary to make good, eventually, a composite cable, which is at present interrupted by an overhead cable. In this case a 3¼in. C.I. pipe is involved. A number of subsidences have taken place on this side of the hill in recent years, and the exact position and condition of the pipe have yet to be determined.

H.R.J.D.

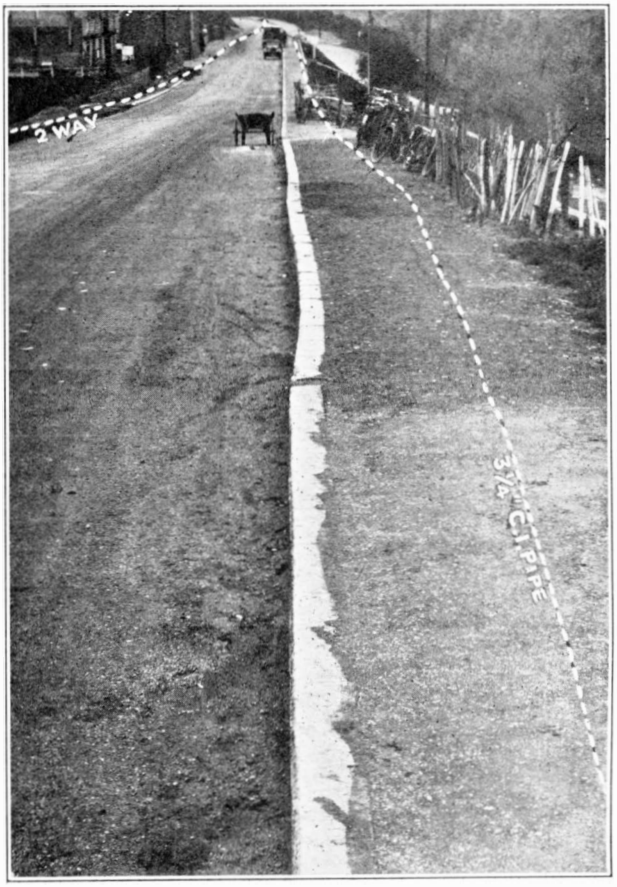
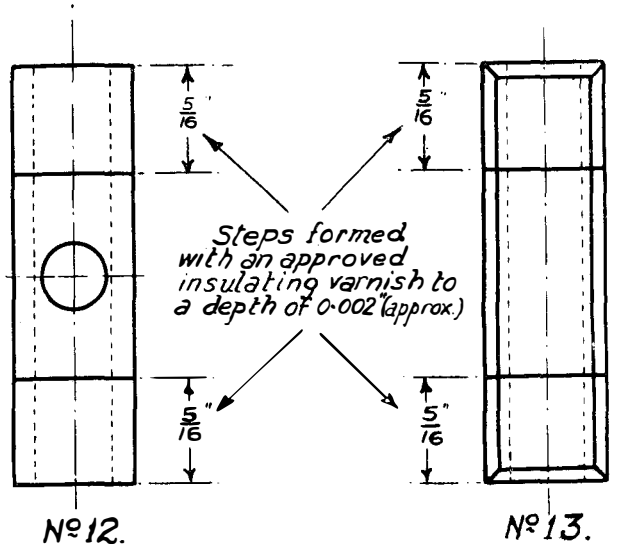


FIG. 4.—BOUGHTON HILL. VIEW SHOWING DISTORTION OF KERB LINE.

AN IMPROVED LIGHTNING PROTECTOR.

THE standard carbon lightning protector, consisting of two grooved rectangular carbon blocks with a mica separator, so extensively used on telephone circuits, has proved in service a very efficient unit in protecting the apparatus from damage but it has several very troublesome defects. Unless the spring clips grip the protector, the mica has a tendency to slip, resulting in a contact between the line and earth carbons. The line carbon has a recess 2 to 3 mils deep ground out of the carbon block, which has the effect of removing the hard natural skin on the carbon, leaving a more or less loose surface which is readily disintegrated by line discharges during thundery weather and resulting in intermittent earths and loss of insulation.



THE NEW TWO-UNIT PROTECTOR.

The faults due to these defects are easily remedied at the exchange end, but in the case of out stations considerable travelling time is incurred.

The grinding of so small an amount as 2 to 3 mils in the line carbon is a difficult operation and in consequence the manufacturing tolerances have had to be increased, thereby reducing the efficiency of the protector.

The necessity for removing the defects mentioned above has received attention for some time, but as the number of protectors of this type in use runs into millions, it was essential that any new type should be subjected to exhaustive test and prolonged trial in service before adoption.

A new two-unit protector, interchangeable with the three-unit protector, has been devised which overcomes the objections detailed and has been standardised by the Department. The two carbon units will be known as Carbons, Protector, No. 12 (a plain carbon) and No. 13 (a chamfered carbon).

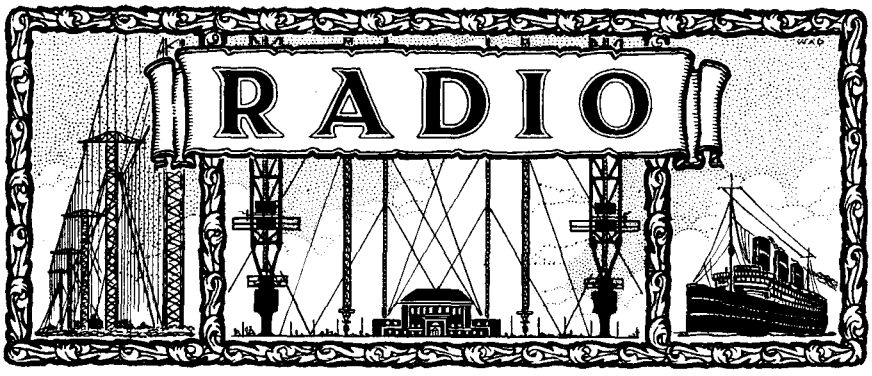
In the new protector the active surfaces of both carbons are flat and are first sprayed with a varnish of collodion base containing sufficient fusible gum to cause fusion on sparking, but the amount is not sufficient to affect the puncturing voltage. The effect of this coating is to make the active surface self-sealing, preventing or at any rate sealing any disintegrated carbon dust produced in the manufacture.

Instead of a mica separator, the portion of the active surfaces of the carbon blocks are coated at each end with a thin layer of varnish of a cellulose acetate base possessing a high electrical insulation when dry. The varnish dries nail-hard and is non-hygroscopic. The two blocks are tested to discharge at 500 to 750 volts D.C. and must test " Infinity " with a 250 volt D.C. megger. The varnish must show no indication of softening or sticking after heating to a temperature of 212°F. for one hour. It will be seen that the number of units has been reduced from three to two and the efficiency of the protector increased.

The protector has received a thorough trial in the British Islands, and favourable reports have been received from the Telephone Authorities of a number of tropical countries, particularly where severe thunderstorms are experienced in combination with very humid atmospheric conditions.

The new potector was devised by the P.O. Engineering Department and has been developed on a manufacturing basis by Messrs. Ericsson Telephones, Ltd., Beeston, Notts.

F. McC.



ALLOCATION OF WAVE BANDS ACCORDING TO WASHINGTON CONVENTION.

Frequencies in Kilocycles per second (Kc/s)	Approximate wavelengths in metres.	Services.
10—100	30,000—3,000	Fixed services.
100—110	3,000—2,725	Fixed services and mobile services.
110—125	2,725—2,400	Mobile services.
125—150[1]	2,400—2,000[1]	Maritime mobile services open to public correspondence exclusively.
150—160	2,000—1,875	Mobile services.
160—194	1,875—1,550	(*a*) Broadcasting. (*b*) Fixed services. (*c*) Mobile services. The conditions for use of this band are subject to the following regional arrangements:— All regions where broadcasting stations now exist working on frequencies below 300 Kc/s (above 1,000 m.) — Broadcasting Other regions — Fixed services. Mobile services. Regional arrangements will respect the rights of other regions in this band.
194—285	1,550—1050	(*a*) Mobile services. (*b*) Fixed services. (*c*) Broadcasting. The conditions for use of this band are subject to the following regional arrangements:— Europe: (*a*) Air mobile services exclusively. (*b*) Air fixed services exclusively. (*c*) Within the band 250-285 Kc/s (1200-1050 m). Fixed services not open to public correspondence. (*d*) Broadcasting within the band 194-224 Kc/s (1550-1340 m).
1,550—1050	194—285	Other regions: (*a*) Mobile services except commercial ship stations. (*b*) Air fixed services exclusively. (*c*) Fixed services not open to public correspondence.
285—315	1,050—950	Radiobeacons.
315—350[2]	950—850[2]	Air services exclusively.
350—360	850—830	Mobile services not open to public correspondence.
360—390	830—770	(*a*) Direction Finding. (*b*) Mobile services on condition that they do not interfere with direction finding.
390—460	770—650	Mobile services.
460—485	650—620	Mobile services (except damped waves and radio telephony).
485—515[3]	620—580[3]	Mobile services (distress, calling, etc.).
515—550	580—545	Mobile services not open to public correspondence (except damped waves and radio telephony).
550—1,300[4]	545—230[4]	Broadcasting.
1,300—1,500	230—200	(*a*) Broadcasting. (*b*) Maritime mobile services, wave of 1,365 Kc/s (220 m.) exclusively
1,500—1,715	200—175	Mobile services.
1,715—2,000	175—150	Mobile services. Fixed services. Amateurs.
2,000—2,250	150—133	Mobile services and fixed services.
2,250—2,750	133—109	Mobile services.
2,750—2,850	109—105	Fixed services.
2,850—3,500	105—85	Mobile services and fixed services.

Frequencies in Kilocycles per second (Kc/s)	Approximate wavelengths in metres.	Services.
3,500—4,000	85—75	Mobile services. Fixed services. Amateurs.
4,000—5,500	75—54	Mobile services and fixed services.
5,500—5,700	54—52.7	Mobile services.
5,700—6,000	52.7—50	Fixed services.
6,000—6,150	50—48.8	Broadcasting.
6,150—6,675	48.8—45	Mobile services.
6,675—7,000	45—42.8	Fixed services.
7,000—7,300	42.8—41	Amateurs.
7,300—8,200	41—36.6	Fixed services.
8,200—8,550	36.6—35.1	Mobile services.
8,550—8,900	35.1—33.7	Mobile services and fixed services.
8,900—9,500	33.7—31.6	Fixed services.
9,500—9,600	31.6—31.2	Broadcasting.
9,600—11,000	31.2—27.3	Fixed services.
11,000—11,400	27.3—26.3	Mobile services.
11,400—11,700	26.3—25.6	Fixed services.
11,700—11,900	25.6—25.2	Broadcasting.
11,900—12,300	25.2—24.4	Fixed services.
12,300—12,825	24.4—23.4	Mobile services.
12,825—13,350	23.4—22.4	Mobile services and fixed services.
13,350—14,000	22.4—21.4	Fixed services.
14,000—14,400	21.4—20.8	Amateurs.
14,400—15,100	20.8—19.85	Fixed services.
15,100—15,350	19.85—19.55	Broadcasting.
15,350—16,400	19.55—18.3	Fixed services.
16,400—17,100	18.3—17.5	Mobile services.
17,100—17,750	17.5—16.9	Mobile services and fixed services.
17,750—17,800	16.9—16.85	Broadcasting.
17,800—21,450	16.85—14	Fixed services.
21,450—21,550	14—13.9	Broadcasting.
21,550—22,300	13.9—13.45	Mobile services.
22,300—23,000	13.45—13.1	Mobile services and fixed services.
23,000—28,000	13.1—10.7	Not reserved.
28,000—30,000	10.7—10	Amateurs & experiments.
30,000—56,000	10 —5.35	Not reserved.
56,000—60,000	5.35—5	Amateurs & experiments.
Above 60,000	Below 5	Not reserved.

[1] The wave of 143 Kc/s (2,100 m.) is the calling wave for mobile stations using long continuous waves.

[2] The wave of 333 Kc/s (900 m.) is the international calling wave for air services.

[3] The wave of 500 Kc/s (600 m.) is the international calling and distress wave. It may be used for other purposes on condition that such use does not interfere with calls and distress signals.

[4] Mobile services may use the band 550 to 1,300 Kc/s (545-230 m.) on condition that such use does not interfere with the services of a country which uses this band exclusively for broadcasting.

NOTE.—It is recognised that short waves (frequencies from 6,000 to 23,000 Kc/s approximately—wavelengths from 50 to 13 m. approximately) are very efficient for long distance communications. It is recommended that as a general rule this band of waves should be reserved for that purpose in services between fixed points.

WIRELESS ECHOES OF LONG DELAY.

A. J. GILL, B.Sc., M.I.E.E., M.I.R.E.

SOME of the most interesting phenomena in connexion with the propagation of short-wave radio signals are the echo effects. These are of two distinct kinds, the first of which may be termed normal echoes and the second "long delay" echoes. The first or normal echoes are due to the passage of the wave round the world one or more times, and have usually been observed with stations using directional transmission. As a result the reception of a signal by a receiving station is followed by the reception of a number of more or less weaker signals at definite time intervals after the main signal. If the transmission conditions are suitable, these echo signals may be sufficiently powerful to interfere with reception and cause jamming. Sometimes, conditions are favourable for transmission round the world in both directions along the great circle containing the transmitting and receiving stations. In these circumstances two series of echoes can occur, one series propagated in one direction round the world and the other series in the opposite direction. If we call the time of transmission between the transmitting station and the receiving station t_1 by the shortest normal path, and t_2 by the opposite path, then $t_1 + t_2$ will be the time of transmission round the world and will be about 1/7 second. The main signal will then be received in a time t_1 by the positive direction, while the first echo will appear at a time t_2 by the negative direction. A second echo will appear in a time $2t_1 + t_2$ in the positive direction, while a third echo will appear in a time $t_1 + 2t_2$ in the negative direction, and so on.

The production of one or more of these echoes has been reported at different times by a number of observers and their appearance is explained

by the favourable conditions for transmission at the time of their appearance.

The second class of echo, the long delay type, is of much rarer occurrence and up to the present has only been observed from the omnidirectional Dutch Station P.C.J.J. (Hilversum) working on 31.4 metres. These echoes appear several seconds, and sometimes minutes after the main or direct signal.

They were observed first in September, 1927, by Mr. Jorgen Hals at Oslo. Hals observed a normal echo at 1/7 sec. after the signal and an abnormal echo of about 1/10th or 1/20th the strength of the other at a time interval of about 3 seconds. Later, these echoes were observed simultaneously at Oslo and at two stations at Eindhoven, Holland. The echoes then appeared at time intervals of as much as 30 seconds after the signal.

In February, 1929, Mr. Hals observed echoes having a retardation of as much as 4 minutes 20 seconds; this corresponds to a transmission path of 52,000,000 miles.

Various explanations have been offered as to the cause of these echoes. Some, as for example, Störmer, Pedersen, and Wagner assume the echoes to be due to the waves being reflected from or propagated along bands of electrons distributed in the interplanetary space. Others, for example, Van de Pol, Appleton and Von Ardenne have suggested that the echoes may be due to particular conditions existing along the paths of the rays in or bounded by the ionised part of the earth's atmosphere.

Ardenne suggests that the rays travel round the world a large number of times at the normal velocity before descending. This involves the assumption that the attenuation of their path is almost zero. Appleton and Van der Pol on the other hand suggest that the delay may be due to the group velocities of the waves being very small under certain conditions of ionisation of the medium.

Dr. P. O. Pedersen has now written in English a monograph on the subject of these echoes in which he examines mathematically the possibility of the echoes being due to slow rate of propagation in the vicinity of the earth.* He shows that radio waves are propagated in an atmosphere consisting solely of electrons, without suffering any loss, but that such an atmosphere could not exist without the presence of positive ions. In these circumstances, the radio waves in consequence of the collisions between the electrons and the necessarily existing positive ions would be so greatly attenuated that the long delay echoes cannot have travelled a considerable part of the time in such an atmosphere. He then examines the possibility of the waves being reflected from ionised bands out in space. He shows that waves longer than 70 metres can neither penetrate out into space nor from outside penetrate the upper ionised layer and come down to earth. He also shows that the most favourable wave-length for such penetration will be somewhere about 30 metres.

His final conclusions are that:—

(1) Echoes delayed more than 10 seconds cannot be due to propagation entirely within the earth's atmosphere nor outside this in a medium so densely crowded with electrons that the group velocity of the waves is decreased to small values.

(2) Echoes delayed up to 30 or 60 seconds are probably due to propagation along or reflections from "Störmer" bands of electrons within the magnetic field of the earth.

(3) Occasionally echoes may be obtained with such great delay that those bands of ions to which the echoes are due must be located at such great distances from the earth (more than, for example, 25,000,000 miles) that they are outside the space in which the magnetic field of the earth exerts any appreciable direct influence.

Dr. Pedersen's work is of great interest and importance on the subject of these long delay echoes and should be consulted by all dealing with the subject.

A point of interest in observations of these echoes is that the echo always has exactly the same wave-length as the signal. This suggests that the reflections occur at a surface which has no velocity relative to the earth otherwise a Döppler effect would be introduced, causing a change in wave-length.

* *"Wireless Echoes of Long Delay." By P. O. Pedersen; Copenhagen. Andr. Fred. Host & Son. Kr. 2.40.*

NOTES & COMMENTS

WE have to thank the Superintending Engineers of the Districts and their staffs for the hearty way in which they have responded to our request for particulars of difficult and interesting works carried out in their districts. Several articles of this nature appear in the present issue, but it is regretted that owing to lack of space some of the material has had to be carried forward. This position will soon straighten itself out and we trust to be able to continue as a feature of this journal to publish details of constructional and maintenance operations carried out under abnormal conditions.

Part 1 of the current volume is now out of print, but most back numbers are available and can be had on application to the Managing Editor.

FARADAY ELECTROMAGNETIC CENTENARY.

The arrangements initiated by the Royal Institution for the celebration of the Centenary of Faraday's discovery of electro-magnetic induction have already been announced. At the representative meeting held at the House of the Institution on February 5th, 1929, the formation of two committees was agreed to, and these committees are now at work. The first, consisting of representatives of the Royal Society, the British Association, and other scientific societies, as well as the Royal Institution, is concerned with the purely scientific aspects of Faraday's work in relation to the proposed celebrations; the second committee, which has been called together by the Institution of Electrical Engineers, consists of representatives of the principal organisations of those industries which have risen in the past hundred years upon the scientific foundation of Faraday's discoveries, and is dealing with the industrial aspects of the celebrations.

The two committees are working in close co-operation; the preliminary discussions which have taken place indicate that the significance of the Centenary is very widely appreciated and that the celebrations are likely to arouse world-wide interest and support. The dates have now been fixed, and the proceedings will commence in London on Monday, September 21st, 1931. Further, an intimation has been received from the British Association that their Centenary Meeting will be held in London during the week commencing September 23rd, 1931. These two Centenaries, with important electrical conferences and other events which are to take place about the same time, will thus conjoin to make the year 1931 a memorable one in this and every country where the genius of Faraday has borne fruit.

At the recent City and Guilds of London examination in Telegraphy, a candidate was unable to answer the questions and occupied himself by writing them out in full, and then gave a short essay on the constitution of the Govern-

ment, terminating with the following confession :—

" I am writing all this nonsense as I am feeling dull with this book and pen. This is the result of not preparing the subject as I am laden heavily with work. Work alone does not matter but it is the worries and troubles that make one mad. Many of us do not realise until we come to the examination hall the folly of our not preparing the subjects with due care and energy. For all my troubles I am a big fool. So dear examiner, please forgive me for writing all this rubbish for I mean nothing after all. You need not go through this book and unnecessarily waste your very precious time. Just put a big " O " and finish off your duty and I shall be quite satisfied."

The foregoing may be of use not only to future examinees but also to some of the teachers.

THE EXAMINER.

MEMORIAL PANELS TO THE LATE MR. W. E. TWELLS.

Close upon one hundred persons were present at a simple yet impressive ceremony at the Holy Trinity Parish Church, Merton Road, on Wednesday evening, when two panels in the chancel were dedicated by the Vicar (the Rev. Alfred Thompson) to the memory of the late Mr. Walter Edgar Twells, for many years connected with the church and for several years people's warden, as well as superintendent of the Sunday School. The dedicatory tablet bears the following inscription : " To the dear memory of Walter Edgar Twells, born 27th February, 1873; died 21st April, 1928. Some time a warden in this Church." On the other tablet is a biblical quotation.

Wimbledon Borough News, 21.6.29.

The General Electric Co. (Peel Conner Telephone Works) has received an order for a further 100 Rural Automatic Exchange Units. This firm supplied the first 100 of these units, which are now almost all installed and working, and co-operated with the Department in the development of the apparatus known as " Unit Auto No. 5."

A description of this unit, together with photographs, appeared in the July issue of the Journal.

Mr. W. H. Peak, O.B.E., has recently resigned his position as Managing Director of The Relay Automatic Telephone Company Ltd., and he is succeeded by Major W. Burningham White and Mr. B. B. Johnson as Joint General Managers. Mr. Johnson has been Chief Engineer of this Company for many years, and Major Burningham White, who created the Sales Organisation, was General Sales Manager.

The Telegraph and Telephone Age of July 1st, 1929, announces the immediate establishment of a radio-telegraph system serving fourteen strategic cities in the United States, by the Radio Corporation of America Communications, Inc. The stations will be at New York, Chicago, San Francisco, Los Angeles, Seattle, Denver, New Orleans, Kansas City, Detroit, Cincinatti, Cleveland, St. Louis, Boston, and Washington. It is hoped to extend the system to a total of 29 cities. The establishment of the new service will give the inland cities direct connection with the wireless network radiating from New York and San Francisco to 22 foreign countries. Three million dollars have been set aside for the initial expenditure.

CANADIAN NATIONAL TELEGRAPHS TAKES OVER LAND LINES OF WESTERN UNION IN MARITIME PROVINCES.

Commencing with July 1st the Canadian National Telegraphs acquired and now operate the land mileage of the Western Union Telegraph Company in the Maritime Provinces of Canada, it is announced by W. D. Robb, Vice-President in Charge of Telegraph and Telephone services of the Canadian National Railways. Before this purchase the Canadian National Telegraphs had 153,066 miles of wire in service and operated 1,943 telegraph offices within the Dominion. The acquisition of the Western Union property in Canada adds to this 6,670 miles of wire and 188 offices, giving a total of 159,736 physical miles of wire under opera-

tion, and 2,131 offices. In addition to this physical mileage of wire, the Canadian National System has its carrier-current channels across the Dominion, on which twelve channels can operate at the same time in each direction, thus obviating the necessity for thousands of miles of individual mileage of wires. Up to the time of closing this new deal the commercial telegraph business on the lines of the former Intercolonial Railways had been operated by the Western Union Telegraph Company. The purchase of their property, Mr. Robb stated, gives to Canadian National Telegraphs complete control of all commercial telegraph facilities on the lines of the Canadian National System from Nova Scotia to British Columbia, and thus finally rounds out a complete transcontinental system. A few of the principal cities which will now be served by Canadian National facilities direct are Halifax, Sydney, New Glasgow, Truro and Yarmouth in Nova Scotia, Saint John and Moncton in New Brunswick, and Charlottetown, Prince Edward Island.—*Telegraph and Telephone Age.*

CANADIAN WIRELESS INDUSTRIES.

According to a preliminary statement issued by the Dominion Bureau of Statistics at Ottawa, the production of complete radio sets, parts and batteries in Canada during 1928, reach a value of $12,768,024, or 45 per cent. above the total of $8,789,171 reported for 1927.

In 1928 an output of radio sets or parts was reported by 45 different firms of which 39 were in the electrical supplies industry, 5 in the musical instruments industry and 1 in the furniture industry. This survey, however, does not include the great number of small custom workers who assemble or build to order, only those classed as manufacturers have been included. Complete sets were made in 14 different plants and the output numbered 81,032 sets worth $7,486,127, as compared with the corresponding total of 47,500 sets worth $3,748,622 in 1927. Vacuum valves were manufactured in 4 different factories; the number made was 1,556,917 and the value was $2,043,473. Batteries, storage and dry cell, said to be manufactured for radio purposes, were produced in 16 establishments and the value totalled $2,456,065 as against $2,572,993 for 1927. Battery eliminators were reported by 7 concerns and the output amounted to 3,219 worth $77,541. Other lines of production included transmitters, transformers, loud speakers, panels, condensers and other miscellaneous parts.

As reported to the Bureau by Mr. Lynn W. Meekins, United States Trade Commissioner at Ottawa, the exports to Canada of radio sets and parts from the United States during the Calendar year 1928, had a value of $5,264,642 and included the following items:—radio transmitting sets and parts, $255,434; radio receiving sets, $2,449,666; radio tubes, $173,843; receiving set components, $1,280,602; receiving set accessories, $1,105,097.

Radio licenses are issued by the Department of Marine and Fisheries. During the fiscal year ended March 31st, 1929, licenses were issued to 296,756 persons including 472 to the blind, as compared with 268,055 licenses issued in the preceding fiscal year. Ontario led all Provinces with a total of 144,842 and Quebec was next with 49,812. Registrations in the other Provinces in order were as follows:—Saskatchewan, 27,386; British Columbia, 23,480; Manitoba, 20,496; Alberta, 14,973; Nova Scotia, 8,611; New Brunswick, 6,289; Prince Edward Island, 756 and the Northwest Territories, 111.

Transmitting licenses were issued to 1,146 stations during the fiscal year, the following classes being included:—private commercial broadcasting; amateur broadcasting; limited coast; public commercial; experimental; private commercial; training school; amateur experimental; aircraft and ship.

We have been requested by the Relay Automatic Telephone Company to give notice to the effect that their telephone number at Marconi House, Strand, W.C.2, has been changed to "Temple Bar 1117."

HEADQUARTERS NOTES.

EXCHANGE DEVELOPMENTS.

The following works have been completed:—

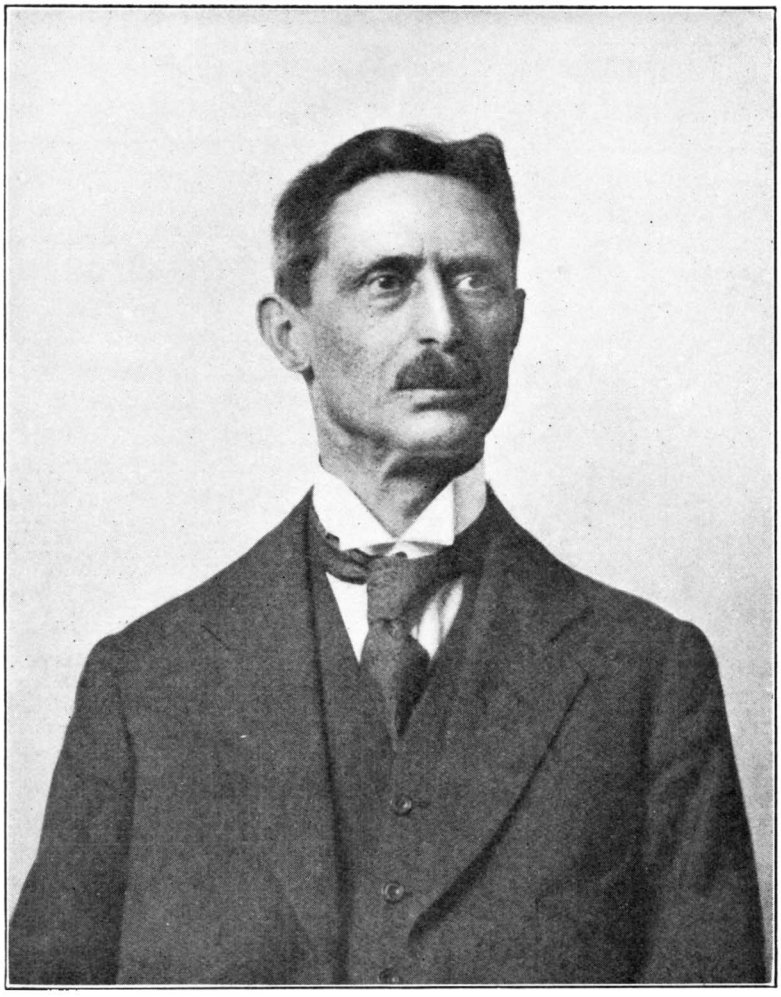
Exchange.	Type.	No. of Lines.
Aldridge	New Auto.	135
Archway	,,	3200
Beckenham	,,	3000
Bloxwich	,,	230
Colchester	,,	1140
Edgeware	,,	1300
Maida Vale	,,	7500
Reliance	,,	2700
Walsall	,,	1740
Epsom (Advance)	Auto Extn.	300
Kirkcaldy	,,	540
Bramhall	New Manual	1040
Canford Cliffs	,,	820
Parkstone	,,	1580
Southborne	,,	1880
Derby	Manual Extn	1060
Greenwich	,,	1080
Wednesbury	,,	440
Cheshire Sanatorium	P.A.B.X.	20
East London Rubber Co. ...	,,	50
Hazell Watson & Viney ...	,,	30
Kent Educn. Committee ...	,,	30
London Express	,,	40
Midland Bank, Ltd.	,,	670
Synthetic Ammonia	,,	100
Stalybridge Corpn.	,,	30
Tanganyika Concessions ...	,,	20
United Glass Bottles	,,	30
Yarmouth Corporation ...	,,	30

Orders have been placed for the following works:—

Exchange.	Type.	No. of Lines.
Ashton-on-Ribble	New Auto.	540
Blackpool (North)	,,	790
Blackpool (South)	,,	1745
Fulwood	,,	560
Granton	,,	1220
Gulliver	,,	4370
Leyland	,,	420
Portobello	,,	690
Preston	,,	3790
Castleton	Auto Extn.	100
Cowley	,,	200
Headington	,,	200
Southampton	,,	410
Whitworth	,,	100
Boscombe	New Manual	2300
Dorchester	,,	540
Farnborough	,,	780
Loughton	,,	1012
Eastbourne	Manual Extn	2120
Ramsgate	,,	440
Cerebos Salt Co.	P.A.B.X.	30
Cheltenham Corporation ...	,,	30
Co-op. Wholesale	,,	70
Hazell Watson & Viney ...	,,	30
Hunt & Winterbottom ...	,,	20
Hyde Co-op. Society	,,	20
International Paint Co. ...	,,	30
Shaw & Co.	,,	30
United Glass Bottle Co. ...	,,	30

MR. A. L. De LATTRE, I.S.O., M.I.E.E.

Mr. A. L. De Lattre entered the service at Birmingham in July, 1886, and was transferred to the Superintending Engineer's Office in September, 1891. Two years later he was promoted to Headquarters, where he immediately took up the duty of personal secretary to Sir John Gavey. He was closely associated with the work of valuing the Trunk Line Plant of the National Telephone Co. and later, prior to the complete transfer of the Company's undertaking to the State on 1st January, 1912, he was responsible for the labours of over 200 officers who were engaged for nearly two years in making an inventory of the plant. He had thus obtained an intimate knowledge of the Trunk system, in the development of which he has always taken the keenest interest. Mr. De Lattre was appointed Technical Officer in 1898, and in 1903 he was sent to Leeds as Assistant Superintending Engineer, where he introduced the Unit Maintenance Cost system and revised the Construction costing methods. Much useful information was obtained by these returns which proved of great value during the Arbitration Court proceedings



Mr. A. L. De Lattre.

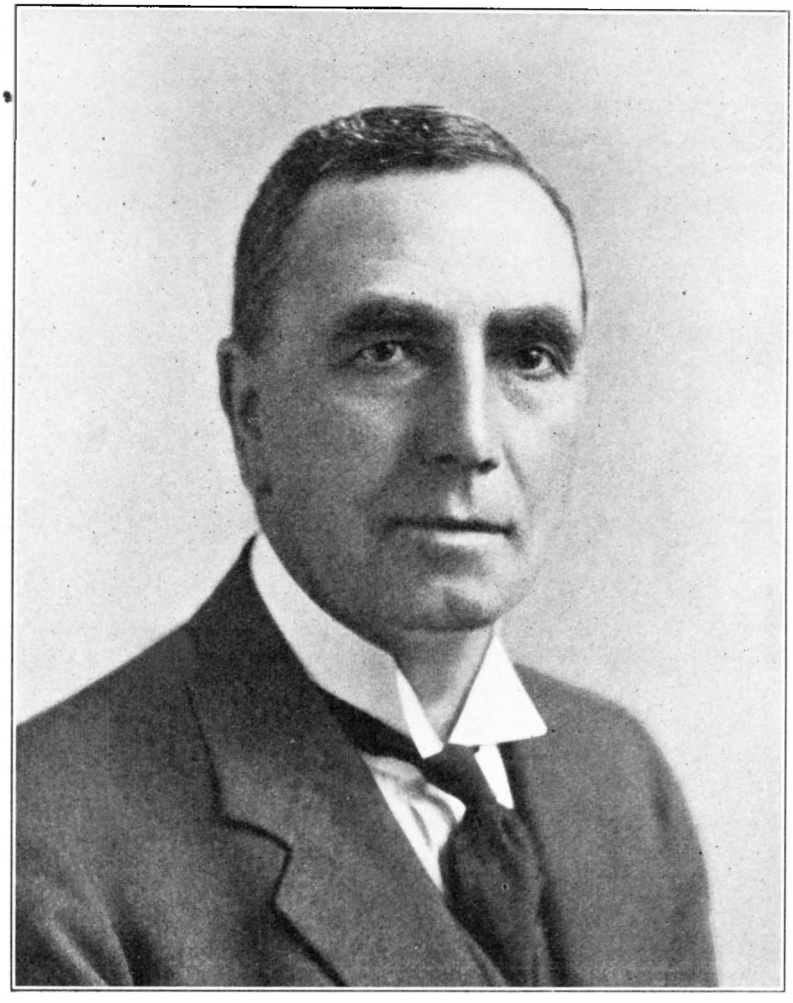
in 1912. After less than four years at Leeds, Mr. De Lattre returned to Headquarters to take charge of the Survey Section and later the Main and Local Lines Section. During the War his staff was seriously depleted, but the work of the provision of emergency lines and the operations of the submarine cable fleet, which at one time included six vessels, was energetically carried out, and after the Armistice the extensive line construction programme was pushed through under his enthusiastic supervision.

In 1921 Mr. De Lattre succeeded Mr. A. J. Stubbs as Assistant Engineer-in-Chief, and in this year's Honours List he received the honour of the Imperial Service Order.

Arrangements have been made for the presentation to Mr. De Lattre of a souvenir, but a date had not been fixed at the time of going to press and an account of the proceedings must therefore be deferred.

We wish Mr. De Lattre good health and many years of happiness in his retirement.

MAJOR H. BROWN, O.B.E., M.I.E.E.



MAJOR H. BROWN.

MAJOR BROWN succeeded Mr. De Lattre as Assistant Engineer-in-Chief as from the 1st September, 1929. So far as most of our readers are concerned Major Brown needs little in the way of introduction. A brief outline of his official and military career was given in the July, 1928, issue of this Journal on the occasion of his promotion to Superintending Engineer as from 1st June, 1928. He was at that time engaged, in conjunction with an Accounting Officer, on the special work of investigating methods and costs of construction in this country and he has continued on this work ever since. These duties have brought him into personal touch with a very large number of engineering officers of all grades.

During last autumn, Major Brown paid an official visit to the United States of America for the purpose of examining the organisation and methods of construction and maintenance followed in that country by leading Telephone and Telegraph Administrations. In the General Order announcing Major Brown's promotion, it is stated that he will act primarily as an efficiency engineer in charge of works organisation, output and costs. He will, therefore, continue to be actively associated with the lines of investigation which have kept him so busily occupied during the past few years.

MR. E. J. IVISON, M.I.E.E.

MR. E. J. IVISON.

By the retirement of Mr. E. J. Ivison on March 31st last, the Engineer-in-Chief's Office lost one of its most popular and able Staff Engineers.

He was born on December 15th, 1868, and entered the C.T.O. on 6th February, 1886. Here he stayed until November 4th, 1892, when he resigned from the service to take up an unestablished position in the Electric Light Branch at Mount Pleasant. His outstanding abilities were very soon recognised, for on the 20th August, 1894, he was appointed a Sub-Engineer at Holloway Factory and three years later he was selected for the vacant Sectional Engineer's position at Northampton. On the 5th November, 1901, he was appointed 1st Class Engineer in charge of the Victoria Section, in connection with the introduction of manual common battery working in London. He was transferred to the staff of the Telephone Section in the Engineer-in-Chief's Office on the 11th January, 1907, and from that time, until his appointment as Staff Engineer in charge of that Section on 1st August, 1921, he ably filled the post of Assistant Staff Engineer under his three predecessors, Messrs. W. Brown, A. W. Martin and W. M. France.

It can therefore be truly said that, during the whole of his career, he has been very closely connected with every phase of telephone development.

The presentation of a silver tea and coffee

service and autograph album took place in the Deputation Room, G.P.O. (North), and it is a rare occasion for such a large gathering to assemble and for such a pleasant and breezy atmosphere to prevail throughout the whole of the proceedings.

Col. Sir Thomas Purves, in making the presentation, said:

" The gap Mr. Ivison leaves behind him is a big and conspicuous one and one that causes a good deal of repercussion and reverberation. It is no disparagement to his able successor to say that he leaves a vacant place that will be very difficult to fill; he has been one of the Nestors of the Engineering Department, and his ability and his work have won him the respect of everyone of us. His character has won our very real and true affection. Never, in the course of the very many years I have known him, have I heard anybody say a disparaging or an unkindly thing about him, which I think is a very great thing indeed to be able to say about any man.

" I have sometimes wished that it might be possible to take the brain of a man like Mr. Ivison and transfer it ready stuffed with all kinds of wisdom and experience, most precious to the Department, to the head of some young stripling, ready to get a supply of young blood and to go on evolving in harmonious development. But I have no doubt that Mr. Ivison's views as to what he proposes to do with his brain are quite different! "

Words of affection, appreciation and goodwill were also spoken by Messrs. De Lattre, Shaughnessy, Medlyn, Bailey, Major Batchelor, Messrs. Hart, Hedley, Anson, Gibbon and O'dell.

Space is not available for the whole of Mr. Ivison's lengthy and witty reply, but the following extracts demand reproduction:—

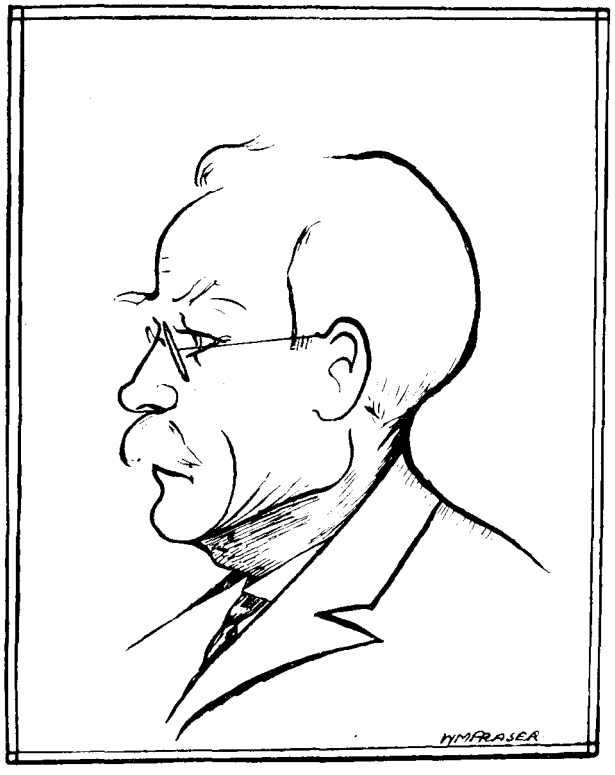
" With regard to all the kind words you have said to me to-day, I do not know how I am to reply. It has occurred to me that, possibly, if some of those kind words were said to a man when he was half way through—say about 40 years of age—whether they would make any difference to his career and would egg him on to greater things. But the experience of my early days rather tends to show that it would not be the right thing to do. When I went out (after Mr. Shaughnessy's experience) as a Sectional Engineer, at the salary of £150 a year—I had a very enjoyable time—I took out, amongst other things, a very heavy gang of men in charge of a foreman, who was a bit of a martinet, and the S.E. of the district went out with me on one occasion to visit them. Mr. Woods was the S.E., a very sincere man, and he told the foreman on this occasion that he thought a foreman, if he were any good at all, should encourage his men. I saw the foreman a few days later, and he seemed rather peeved about something. ' Well,' he said, ' this is a fine thing. I have to say to those chaps ' Jack; you have done a good day's work to-day.' Well, he goes home to his missus and says ' I must have been a blank fool; I shan't work so hard to-morrow.' So, after all, the praise is perhaps best when one has finished.

" I noticed in the paper the other day a revised version of the old joke which used to be built up round the P.O. Engineering Service, which I might repeat. Mr. Turner might like to have it filed in the Construction Section. The scene was an open manhole and a jointer's mate. An elderly and humble member of the Salvation Army, whose daily vocation seemed to be collecting washing, went up (as a daily good deed) to the jointer. ' My boy; do you know where Satan is? ' ' No,' said the man; ' but I will ask my mate,' and he proceeded to do so as follows: ' Bill; do you know where Satan is? There's a bloke here that's brought his dinner.'

" As regards what Mr. Bailey said regarding one's future prospects, there was a little incident at the Holloway Factory, when Mr. Stubbs came to see us and brought with him a tall young man, whom he introduced as Mr. Purves. Nobody there seemed to know him, and Mr. Catley, our senior officer, took Mr. Stubbs aside and said ' Who is Mr. Purves? ' Stubbs, in his characteristic way, said ' Not to know Purves is to argue oneself unknown.' That was a bit of persiflage. It must be a very insignificant person, at any rate, who has not heard of Col. Purves. I should like, it I may, at this juncture, to express my very sincere appreciation of the kind treatment he has always shown me and, I am perfectly certain, to the whole of his staff. I cannot let the occasion pass without saying that."

Our many readers who have been privileged to know Mr. Ivison will wish to join us in wishing him many happy years and the best of good health in his retirement.

MR. J. H. FOSSETT, B.Sc., M.I.E.E.



Mr. J. H. Fossett.

The retirement of Mr. J. H. Fossett on the 30th June last, on reaching the age limit, breaks another link with the pioneer days of electric lighting and power in the Post Office. Mr. Fossett entered the Service on the 16th February, 1891, and was placed in charge of a shift in the old G.P.O. (E) Electric Light engine room; that this was no sinecure job may be gathered from the fact that in those days one frequently worked in singlet and trousers in a temperature of 100°F. or more, endeavouring to maintain the supply of " juice " from the old two-pole dynamos which were prone to give elaborate firework displays on the slightest provocation and from locomotive boilers which were apt to send over steam accompanied at times by quantities of water with dire results on the working of the Willans high-speed engines and, incidentally, on the Shift Officer's temper.

However, Mr. Fossett successfully survived these hectic times, and, after spending four months in Edinburgh at the end of 1896 supervising the installation of E.L. in the Edinburgh G.P.O., was transferred to Cardiff at the end of 1896 where he supervised the installation and setting to work of the steam electric light and power station at Cardiff H.P.O., becoming a Second Class Engineer in December, 1897.

After spending two years at Cardiff Mr. Fossett was transferred to the Engineer-in-Chief's Office as Technical Officer in October, 1898; working in this capacity with Mr. H. R. Kempe, and under the late Mr. M. F. Roberts he dealt with the whole of the electric light and power work, including pneumatics, with conspicuous success at a time when there was very little past experience to go by and when the various branches of power work were not so highly specialised as they are in these days.

Mr. Fossett was created 2nd Class Staff Engineer in November, 1904, and Asst. Superintending Engineer in July, 1906, in which capacity he served in the Ireland, Scotland West and Met. Power Districts and eventually returned to the Engineer-in-Chief's Office in September, 1918, where he remained till the date of his retirement.

During this latter period he was responsible for the introduction of automatic working on street pneumatic tubes and also for the design and equipment of the automatic pneumatic tube centre at the War Office. This installation, which necessitated a large amount of original work, was the first of its kind in this country and, as far as is known, in any other country, and besides effecting some thousands of pounds annual saving resulted in a very much improved service to the telegraph offices in the neighbourhood. The working has been so satisfactory that it has been decided to adopt similar apparatus for the C.T.O. tube installation; other installations are also contemplated.

A keen walker and outdoor enthusiast, Mr. Fossett should find no lack of congenial occupation in his retirement and his friends will wish him many years of good health and happiness.

LONDON ENGINEERING DISTRICT.

Mileage Statistics.

During the three months ended 31st March, 1929, the following changes have occurred:—

Telegraphs.—A nett decrease in open wire of 15 miles and a nett increase of 81 miles in underground.

Telephone Exchanges.—A nett increase in open wire of 427 miles and a nett increase of 19,247 miles in underground.

Telephone (Trunk).—A nett decrease in open wire of 18 miles and a nett increase of 4,545 miles in underground.

The total single wire mileages at the end of the period under review were:—

Telegraphs	26,215	miles.
Telephone Exchanges ...	2,517,225	,,
Trunk	84,904	,,
Spares	120,637	,,

Number of Telephones. — The following figures show the changes in the number of exchange lines, extensions and stations during the three months ending and the totals at 30th June, 1929:—

	Increase.	Total.
Exchange Lines ...	6,840	370,066
Extensions ...	6,926	315,520
Stations	12,306	623,894

Telephone Exchange Progress.

New Automatic Exchanges.—The following exchanges have been opened during the past three months:—

Exchange.	*No. of equipped lines.*	*Manufacturer.*
Beckenham	3,000	Siemens.
Reliance	2,700	General Electric Co.
Maida Vale	7,500	Siemens.
Edgware	1,300	General Electric Co.
Fulham	7,500	Standard T. and C.
Metropolitan	9,500	A.T.M.
National	9,500	A.T.M.
Mitcham	1,480	Siemens.
Flaxman	9,900	General Electric Co.
Hendon	4,200	A.T.M.

Two New Manual Exchanges have been opened, viz.: — Emberbrook (Ferry Road, Ditton) on the 31st July. Equipped for 1,660 lines.

Stanmore C.B. No. 1 on the 18th September. Equipped for 800 lines.

Exchange Transfer (Manual). — Chancery Manual Exchange was transferred from 55, High Holborn, to 329, High Holborn, on the 27th July. 1,279 Subscribers and their associated Junctions were affected. The "Chancery" and "Terminus" subscribers are now accommodated on manual equipment made spare by the opening of Holborn Automatic Exchange.

Exchange Extension.—The capacity of the Greenwich Exchange has been extended by 1,200 equipments.

C.C.I. Extensions.—The rapid increase in the number of Automatic Exchanges is necessitating a revision of the C.C.I. provision at many Manual Exchanges. At the moment the C.C.I. positions are being increased at Grosvenor, Abercorn, Speedwell, Brixton and Langham, whilst preliminary steps are in hand for early extensions at 27 Exchanges.

Fire at Sidcup Exchange.

Elsewhere in this Journal reference is made to the unfortunate accidents to external plant in the London District. Since the article was written, there has been another serious disaster, but on this occasion it was the internal plant that was affected. On the evening of Saturday, August 10th, a fire occurred on premises adjoining the Sidcup Telephone Exchange and spread to the roof of the exchange. When the fire was extinguished it was found that the telephone switchboard had been completely destroyed. Men and material were quickly mobilised and a rapid survey made to ascertain how and where a temporary exchange could be established. Careful examination indicated that space on the ground floor of the burnt building could be cleared and made fit to accommodate switch sections. A temporary roof was formed of waterproof material, and the work of installation commenced at once. A number of the most important lines, such as those serving fire stations, police, ambulance and hospitals, were connected to adjacent exchanges up to the limit of the available circuits. These were put through in a few hours. Work proceeded continuously in the provision of the new switch-

board, and within six days the whole of the circuits had been restored in such a manner that the work looks as if it had been deliberately planned and was intended to serve for several years. As there were 1,200 working subscribers and a large number of junctions this was no mean achievement, and the Sectional Engineer (Mr. A. Warner) and his staff well earned the commendation they received.

The attached extract from the "Sidcup and Kentish Times" indicates that when subscribers and the Press are allowed to know something of the work involved in restoring service after a disaster and the strenuous efforts made to shorten the period of dislocation appreciation takes the place of criticism.

"A Word of Praise.

"The general public of Sidcup and Chislehurst will, we feel sure, extend a word of praise to the General Post Office engineering staff and General Post Office traffic workers for re-instating the dislocated telephone service at the Sidcup Exchange within a short period of seven or eight days. Last Saturday week the upper part of the building in Station Road, Sidcup, was devastated by fire and a vital section of the plant, the switch-board, impaired beyond use.

"It says much for the engineering staff that emergency lines were linked up with Eltham Exchange within a few hours after the outbreak and a partial service thus resumed. A new switch-room had at once to be prepared on the ground floor, and an entirely new switch-board erected and connected with the power plant. This was most intricate and painstaking work which must be seen to be appreciated. Work normally taking many weeks to do was accomplished in a little over a week, and in cramped conditions which rendered the task extremely difficult.

"In the near future a new and more spacious building is to be erected at the rear of the premises in Station Road, and Chislehurst is also to have its own Exchange.

"Apart from the engineering staff, a word of praise should be given to our telephonists in a most trying time. Throughout the past ten days they worked heroically and unremittingly. Normally they put through from 120 to 140 calls an hour, which gives some idea of how frequently the service is required. Any subscriber interested in the work of the Exchange is at liberty to pay a visit during the coming week."

Retirements and Transfers.

Many changes in personnel have recently taken place in the District and others are pending. If an officer who left the District two or three years ago were to return in the course of the next few months he would be astonished at the changes in the Sections. Messrs. Appleby and Wells have retired and their positions in charge of the Centre External and North East External Sections respectively have been taken by Messrs. Mitton and Jones. Mr. Aspinall has been promoted to take charge of the North West External Section. Mr. Steed has retired and his position as Sectional Engineer at the Central Telegraph Office has been taken by Mr. Deane. Mr. Phillips, Assistant Engineer in the West External Section has retired, and Mr. Watkins, another well known Assistant Engineer, has been promoted Executive Engineer at Bangor.

All those who have retired have spent many years in the London District and their loss will be keenly felt. They have fully earned their period of rest, as their tenure of office has included some of the most strenuous years in the history of the Engineering Department. Those of us who remain behind to carry on the work hope that our late colleagues will have many years of quiet enjoyment and that they will not forget those whom they inspired by their good example.

Telephone Order Tables.

At the request of one of the large stores in the West End three mahogany tables, each 13 feet long, have been supplied and fixed. On each table is fitted telephone keys and answering equipment for 10 order clerks, who will receive orders for goods and answer enquiries from customers.

Telegraphs.

In connection with the introduction of the Totalisator at Race Meetings 55 baseboards have been equipped for teleprinter working. Special cases have also been made to facilitate transport.

Batteries.

The District Staff has just completed the installation of two 10,000 ampére-hour batteries at the City Exchange in replacement of the original lead tank batteries of much smaller capacity.

LOCAL CENTRE NOTES.

MANCHESTER H.P.O. WAR MEMORIAL.

SOUTH LANCS. CENTRE.

Manchester Post Office Staff War Memorial.—Coincident with the opening of the new public office at the Manchester Head Post Office in March last, a memorial was dedicated to those members of the Post Office Staff who gave their lives in the Great War. The memorial consists of a bronze group by Mr. J. Ashton Floyd, A.R.C.A. (Sc. Lond.), in which Peace is symbolised by a woman of noble form and serene countenance, pressing forward with her message to the peoples of the world and leading a youth and a maiden, the rising generation, to an era that knows not War. They tread under foot, as

they pass, the Sword, Helmet and the Shield. The message is summed up in the motto:—"Strive for enduring peace."

Visit to works.—On July 3rd, a party of about 60 members paid a visit to the Shipbuilding and Engineering Works of Messrs. Cammell Laird & Co., Ltd., Birkenhead. The visit was thoroughly enjoyed and the facilities granted for inspecting this Company's excellent organisation were greatly appreciated.

SOUTH EASTERN DISTRICT.

Honour for S.W.2 Officer.—The following extract from the "Hastings and St. Leonards Observer" of the 15th June, 1929, refers to Mr. C. A. Jezzard, who is a skilled workman at Hastings:—

"The first warrant officer in the whole of the R.N.V.R. throughout the British Empire, Signal-Boatswain C. A. Jezzard, has been awarded the M.B.E. in the birthday honours list recently issued.

"Mr. Jezzard, who is a son of Mr. Walter Jezzard, J.P., joined the R.N.V.R., Hastings Sub-Division, in January, 1909, under Lieut. Breeds. He was called upon for war service in August, 1914, as a Yeoman of Signals and served with the Mediterranean and the Ægean Fleets. During hostilities he was promoted to Chief Yeoman of Signals. The R.N.V.R. was reorganised after the war, with Lieut.-Commander John Bray in charge of the Hastings Sub-Divisions.

"Mr. Jezzard has the further distinction of becoming the first Signal-Boatswain in August, 1923, and being the first R.N.V.R. officer to be awarded the M.B.E. He will attend the Prince of Wales' investiture at St. James' Palace on July 9th. The Prince will act for His Majesty the King."

On the 1st October, 1929, Mr. T. Cornfoot, Assistant Superintending Engineer, is due to take over the control of the North Ireland District. Mr. J. H. M. Wakefield, Executive Engineer, Guildford, will succeed Mr. Cornfoot at Croydon.

Telephones.—The abnormally high rate of increase of telephones in the District, which has been maintained for several years, still continues. During the Quarter ended 30-6-29 the % increase on total stations in the District was 3.1, this rate being the highest in the country.

Exchange Transfers.—Deal Exchange, with 680 stations, was successfully transferred from Magneto to C.B. on the 13th July, 1929.

Work in connection with the transfer of the Maidstone Area, from C.B., C.B.S. and Magneto, to Automatics is in hand. The Area comprises the following Exchanges:—Maidstone, Bearsted, Hunton, Otham, Wateringbury, Aylesford, Boughton Monchelsea, and Barming.

Cables.—The new loaded and balanced cable, Chichester to Portsmouth, is nearing completion.

Two new 14 pair continuously loaded cables will shortly be laid from Canterbury Repeater Station to Dumpton Gap, and Sandgate respectively, for connection to proposed submarine cables.

Reflectors for Overhead Line.—Trial is being made of reflectors on poles as a warning to traffic. If these reflectors are satisfactory the painting of poles will be much reduced.

NORTH OF IRELAND CENTRE.

GEORGE LASLETT.

The 1st July, 1929, marked the retirement from the Service of Mr. George Laslett, Sectional Engineer, Belfast.

With very genuine regret we record the official passing of our old friend, for his sterling qualities of heart and mind had endeared him to us all.

Mr. Laslett's service extended over 46 years. Entering the Service at Folkestone it was not long before he found his way to the Central Telegraph Office, London, where he was employed from 1891 to 1897. He then entered the Engineering Department as a Sub-Engineer, successively holding the appointments of Engineer Second Class in the old Met. District, London, being transferred to Met. South on division of the District and subsequently Executive Engineer, Londonderry and Belfast.

During his long service in Ireland he passed through many stirring periods and saw important changes in the Administration, not the least of these being the partition of the Six Counties from the rest of Ireland and the formation of the Northern Ireland District.

On the occasion of his retirement Mr. Laslett was entertained by the Members of his Staff and

many friends at a smoking concert when he was presented with a silver tea service.

Major G. H. Comport, M.C., M.I.E.E., R.E., Superintending Engineer, presided and in making the presentation referred in feeling terms to the loss he personally sustained on Mr. Laslett's departure from the Service. After referring to Mr. Laslett's ability as an Administrator and the feeling of confidence and respect in which he was held by all ranks he went on to review the many large works with their associated difficulties (many of which were peculiar to Northern Ireland) accomplished since he (Major Comport) took charge of the District and which had been executed under Mr. Laslett's control.

After observing that Mr. Laslett was going away in splendid health with many years of life in front of him, in asking his acceptance of the memento of the occasion he said he hoped he and Mrs. Laslett would be spared for a very long time to enjoy a well-earned leisure and in that leisure he wished them peace and good health.

Many of those present paid tributes of the excellent qualities possessed by the guest and to the loss they personally would feel at his retirement. In particular Mr. Davidson referred to his close association with Mr. Laslett, extending over 17 years, and to the fact that during all that time the most cordial relations had always existed.

Mr. Laslett, in responding, thanked the company for their kind expression of good wishes and for the handsome present of which they had made him recipient. He wished also to thank the Staff of all ranks for their loyal support and said that he felt he had always been served conscientiously and well.

NORTH WALES CENTRE.

Mr. George Richardson.

On his retirement from the position of Executive Engineer of the Birmingham (Internal) Section on the 30th June last, Mr. Richardson was within a few weeks of completing his forty-seventh year of Post Office service.

Mr. Richardson's official career began in the Telegraph Department at Hull in August, 1882, and he served at that office until December, 1895, when he was appointed 2nd Class Junior Clerk at the Superintending Engineer's Office of the old South Midland District, which was at that time located at Birmingham. In 1897 he was promoted to a 1st Class Junior Clerkship in the Superintending Engineer's Office at Newcastle-on-Tyne, and in 1901 on his promotion to a 2nd Class Engineership he was transferred to London to take part in the Post Office scheme for the telephoning of London.

After six years' service in the old Central Metropolitan District, Mr. Richardson was transferred to the Telephone Section of the Engineer-in-Chief's Office where he stayed until 1909, when he was promoted to a 1st Class Engineership, and placed in charge of the Birmingham Section. A year later he was withdrawn from sectional duties to take part in the important work incidental to the transfer of the National Telephone Company's plant to the Post Office. This work occupied two years, and on its termination at the end of 1912 he resumed his duties as Sectional Engineer at Birmingham.

Mr. Richardson's administrative ability and tactful personality, which have always been characteristic of him, found ample scope during this transition period in the task of amalgamating the Post Office and the Company's staffs. His success in this direction is gratefully remembered by those who served under him at that time, and during the succeeding years.

Mr. Richardson combined an unvarying urbanity with a very strong devotion to official duties, which he not merely practised himself but impressed upon the staff under his supervision. He set a very high standard in this respect, and was at all times available for consultation with any of his subordinates when difficulties arose. This close personal contact with his staff went far to arouse the esteem of his assistants, who recognise the value of the training they received at his hands.

Mr. Richardson's extra-official activities should not go unrecorded. In his earlier days in London as an Engineer he was a member of the original committee of the Society of P.O. Engineers, and he also served on the Council of the Institution of P.O. Electrical Engineers. His interest in the North Wales Centre of the I.P.O.E.E. has always been keen, both as a member of the committee, and as a ready participant in the discussions at the meetings. Latterly, he served on the committee of the

South Midland Centre of the Institution of Electrical Engineers. From 1914 to the end of his service he also did much unobtrusive work in connection with the Post Office Relief Fund.

It is a pleasure to be able to record that Mr. Richardson is retiring from the service in the best of health, and being a man of varied interests it is extremely unlikely that his retirement will be spent in inactivity. In taking leave of him, his staff, his many friends in other Districts, and, it must be added, in other Public Departments in Birmingham, salute him with affectionate regard and wish him every happiness for the future.

At a largely attended smoking concert arranged in his honour, Mr. Richardson was presented with a silver tea and coffee service. Mr. R. A. Weaver, Superintending Engineer, in making the presentation, spoke of his knowledge of Mr. Richardson so far back as 1896, and stated that he would be recognised as a good example of a type of officer who had played a memorable part in the history of the Post Office Engineering Department and as a colleague whose conduct had been based on the highest standard of duty. Many other speakers including Mr. G. W. Billingham, his close colleague in Birmingham for many years, and Mr. C. W. Piggott (Traffic Superintendent), also paid eloquent tributes to Mr. Richardson's striking personality and sterling qualities.

A.E.S.

NORTH MIDLAND CENTRE.

Mr. F. G. Browne.

A successful and enjoyable evening was spent on the 26th July, when a representative gathering of members of the Coventry Section Staff expressed their good wishes to Mr. Browne at a smoking concert held at the Railway Hotel, Coventry, on the occasion of his retirement.

The chair was taken by Mr. H. Kemp, Sectional Engineer, and high tribute to Mr. Browne's capacity and industry, combined with an ability to appreciate the other man's point of view, which gained him great popularity and esteem, was paid by speakers representing every grade in the Section. Mr. Kemp referred specially to the important and arduous work done by Mr. Browne in connection with the inauguration of the Coventry Automatic Exchange for which he took the principal responsibility.

During the evening a presentation was made and this (at Mr. Browne's request) took the form of a microscope.

Mr. Browne's Official career is given in the following details:—

1884	Assistant to Postmaster at Pontypridd.
1887	Acting Telegraphist, Bristol.
1888	Telegraphist, Bristol.
1890	S. C. & T., Birmingham.
1899	Junior Clerk S.E.'s Office, Birmingham.
1902	Sub-Engineer, Northampton.
1907	2nd Class Engineer, Northampton.
1911	Assistant Engineer, Leamington and, later, Coventry.

In 1910 Mr. Browne spent 11 months in the Construction Section of the E/C.'s Office and was then employed on the Inventory of the ex-N.T. Co.'s plant until October, 1912.

G.F.P.

ANNUAL REPORT ON THE POSTS AND TELEGRAPHS DEPARTMENT, FEDERATED MALAY STATES, YEAR, 1928.

The following extracts were taken from the report for the year 1928:—

Telegraphs.

During the year 428,834 telegrams were despatched and 454,438 telegrams were delivered, being a decrease of 9.6 per cent. in the telegrams despatched and a decrease of 10.2 per cent. in the number delivered, as compared with 1927. The revenue shows a decrease of $32,153 or 6.5 per cent. from that of 1927. The value of telegrams sent free of charge for Government Departments was $50,468, a decrease of $9,086.

Telegraph facilities were extended to the new

post offices at New Town, Ipoh, and Tanjong Tualang. An additional quadruplex set and an automatic duplex Wheatstone set were installed in the Kuala Lumpur office and were of material assistance in disposing of telegraph traffic at times of pressure.

At the larger telegraph offices increased use has been made of typewriters for the reception of telegrams, with improving results. Telegrams are typed direct from sound from the telegraph instrument, and, as the operators become expert at reading the telegraph instrument and using the typewriter simultaneously, not only is there more rapid reception but a much more business-like copy of the message is delivered to the addressee. A departmental typewriting class was instituted early in the year and has been successful in turning out a number of competent telegraphists.

By arrangements with the Eastern Extension Australasia and China Telegraph Company, Limited, regulations were again issued for the acceptance at any telegraph office in the Federated Malay States of "Christmas and New Year Greeting Telegrams" for a long list of countries, at rates which approximated to one-quarter of the ordinary charges.

Telephones.

The number of subscribers to the telephone system on the 31st December, 1928, was 4,534, an increase of 531 as compared with 1927. In addition there were 2,177 extension lines, extension bells, private circuits, private bell or alarm circuits and tell-tale clock circuits maintained by the department, as compared with 1,871 in 1927.

The revenue derived from telphones was $1,196,884, an increase of $134,322 over 1927. The trunk revenue amounted to $384,914, an increase of $67,534 as compared with the previous year.

Thirteen new public telephone exchanges were opened in the course of the year. On 31st December, 1928, there were 59 public exchanges in the Federated Malay States.

There were 90 public telephone call boxes available at post offices and postal agencies throughout the country.

The average number of originated calls per direct exchange line per day was 11.3, a decrease of about 8 per cent. as compared with the average figure for 1927.

The average total numbers of originated calls per day throughout the Federated Malay States during the year were:

Local calls	41,000
(increase over 1927, 2 per cent.)	
Junction calls	2,800
(increase over 1927, 180 per cent.)	
Trunk calls	4,300
(decrease from 1927, 4.4 per cent.)	
Total originated traffic... ...	48,100
(increase over 1927, 5.3 per cent.)	

The approximate total originated telephone traffic during the year was as follows:

Local calls	11,972,000
Junction calls	817,600
Trunk calls	1,255,600
Total originated traffic ...	14,045,200

During the year the junction system of operating non-local calls, that is, giving connection on demand, was introduced in the Ipoh, Klang, Kuala Lumpur and Seremban districts, effecting a material improvement in the telephone service on short-distance inter-exchange traffic. The large increase in the number of junction calls and the decrease in the number of trunk calls in the year under review was due to the introduction of this junction system of working.

Development studies were made in a large number of existing and proposed telephone exchange areas in the course of the year, for the purpose of estimating plant and equipment requirements. A comprehensive estimate of future trunk and junction requirements was also made.

The plans of the new building to accommodate the proposed Kuala Lumpur automatic exchange were approved and the specification for the exchange was prepared and despatched to the Crown Agents in the latter part of the year.

The "Rural Automatic Unit" referred to in paragraph 45 of the report for 1927 arrived in the country at the end of the year and arrange-

ments were well in hand to bring it into service at Dengkil, Selangor, early in 1929.

An automatic private branch exchange was established in the Federal Secretariat building to serve 25 extensions. Experiments on other automatic units were made during the year.

Arrangements have been made for the "Carrier current" system of telephony to be introduced between Kuala Lumpur and Ipoh, and the necessary apparatus arrived in the country towards the end of the year. This system will permit a considerable economy in line plant to be effected and will enable the northward trunk traffic to be handled more expeditiously than can be done at present.

Engineering.

On the 31st December there were 2,926 miles of telegraph and telephone lines and 23,691 miles of overhead wire in the Federated Malay States, of which 20,555 miles were telephone wires. In addition there were 121 miles of underground cables containing 11,428 miles of wire single line. These figures do not include the poles and lines maintained for its own use by the Railway Department. The Posts and Telegraphs Department also owns and maintains 123 miles of line and 612 miles of wire in Johore. It also maintained in 1928 two miles of pole line for Kedah, 900 miles of wire for Johore and 24 miles of pole line in the Dindings.

The underground system was considerably extended and strengthened during the year, a total additional cable mileage of over 19 miles having been laid, giving an additional single wire mileage of over 1,520 miles.

Wireless.

Seventy-four temporary licences for the use of wireless receiving apparatus were issued during the year, and two experimental transmitting licences.

The British official news broadcast from the wireless station at Rugby in England, received at Penang Wireless Station and transmitted from Penang by land-line for delivery to the local newspapers on payment of a monthly fee, averaged 21,390 words a month.

The two ½-kliowatt short-wave wireless sets referred to in paragraph 59 of my report for 1927 were put into operation early in the year and tests were carried out between Kuala Lumpur and Singapore and Penang and between Kuala Lumpur and various places in Pahang. These tests showed that continuous-wave low-power transmissions could be relied upon to maintain a regular internal telegraph service but the sets did not yield telephonic results of sufficient dependability at the distances required. The experiments were carefully logged and the results tabulated and recoded.

The wireless station at Port Swettenham, and a number of wireless sets which had been used on launches engaged in the prevention of rubber-smuggling, were taken over from the Customs Department on the 23rd July. The Port Swettenham station has been put in good order and at the close of the year arrangements were in train for the inauguration of a Ship-to-Shore Radio Service early in 1929.

With the two ½-kilowatt sets and with certain of the ex-Customs sets, expeditiously converted to short-wave working, the following temporary wireless stations were installed against the contingency of floods in Pahang:

Kuala Lumpur (Petaling Hill); Kuantan (Mobile); Kuala Lipis; Kuala Pahang; Temerloh; and Mentakab.

The floods came, and the land-line between Raub and Kuantan was unworkable from the 24th to the 31st December. During this period the whole of the Pahang Coastal and the Trengganu traffic was sent by wireless between Kuala Lumpur and Kuantan. Nine hundred and fifteen messages were so dealt with, and a large number of Government messages were also cleared between the other emergency stations. Plans for the economical consolidation of this provisional flood-proof communication scheme were in preparation at the close of the year.

CURRENT LITERATURE.

The Journal of the Institution of Electrical Engineers, Vol. 67, No. 390, June, 1929.

The Construction of the " Grid " Transmission System in Great Britain. Johnstone Wright and C. W. Marshall, B.Sc., Members. The paper gives an outline of the chief constructional features of the system of high-voltage transmission lines being constructed under the provision of the 1926 Electricity Act. The main supply is 3-phase, 132,000 volts between phases, 50 cycles per second. Maps and certain constructional drawings are given.

The Development of the Oxide-Coated Filament. B. Hodgson, O.B.E., B.Sc., Ph.D., L. S. Harley, B.Sc. (Eng.), Associate Member, and O. S. Pratt, B.A. Paper reviews the development, describes in outline present day manufacturing practice, and indicates the most recent views on electron emission from alkaline earth oxides.

The Operation of Several Broadcasting Stations on the same Wave-length. Captain P. P. Eckersley, Member, and A. B. Howe, M.Sc. Consideration is given to the advantages to be derived from and the means whereby the operation of several stations may be attained.

Vol. 67, No. 391, July, 1929.

Voice Frequency Telegraphs. W. Cruickshank, Member. The paper discusses the position of telegraphs in this country, comparing it with those of Germany and the United States. Multiplex A.C. transmission is considered and the limits to its use determined. The various systems in use are described and proposals are advanced for its wider adoption in this country. The main arguments against its adoption are economic, but some technical criticism is included.

Report of the Council for year 1928-29, presented at the Annual General Meeting, 9th May, 1929.

Discussion on " Overhead Electrical Lines " at Western, Liverpool, Scottish, East Midland Centres and author's (W. B. Woodhouse) reply.

Discussion on " The Attenuation of Wireless Waves over Land " and Mr. R. H. Banfield's reply.

Vol. 67, No. 392, August, 1929.

The Fifth Faraday Lecture, " How Electricity does Things." Ll. B. Atkinson, Past-president.

Electrical Insulating Papers for the Manufacture of Power Cables. T. N. Riley, D.S.C., M.Sc., Member, and T. R. Scott, D.F.C., B.Sc., Associate Member.

The Prevention of Ionization in Impregnated Paper Dielectrics. S. G. Brown, F.R.S., Member, and P. A. Sparing, M.Sc., A.I.C.

An Investigation of Short Waves. T. L. Eckersley, B.A., B.Sc.

A Portable Radio Intensity-Measuring Apparatus for High Frequencies. J. Hollingworth, M.A., D.Sc., Member, and R. Naismith, Associate Member.

The Action of a Reflecting Antenna. L. S. Palmer, Member, and L. Ley K. Honeyball.

Discussion on the " Grid " Transmission System from No. 390.

Journal of the American Institution of Electrical Engineers, June, 1929.

Standard Voltage A.C. Network. John Oram. A description of the Dallas (Texas) underground lighting and power network.

Railway Train Signal Practice. P. M. Gault.

Electrical Wave Analysers for Power and Telephone Systems. R. G. McCundy and P. W. Blye. The paper describes two types of analysers. The telephone circuit analyser operates over frequency range from 75 to 3,000 cycles and measures harmonic currents as low as 0.05 microampere and voltages down to 0.005 millivolt, even in the presence of fundamental and other harmonics relatively large.

Interconnection in the South West. Geo. A. Mills, Member. Eight States, 720 miles by 810 miles, are now connected by a continuous transmission system, operated at 60,000 volts or more.

Bare Wire Overhead Distribution Practice. M. C. Miller.

Illumination Items. Light Therapy. Report on use of Incandescent Lamps in Motion Picture Photography.

July, 1929.

Master Reference System for Telephone Transmission. W. H. Martin and C. H. G. Gray. The system described is the Master Reference System of the Bell System for the expression of transmission standards and the ratings of the transmission performance of telephone circuits. A replica of this system installed in Paris has been adopted as the Master Reference System of the International Advisory Committee on Long Distance Telephone Communication in Europe and thus provides a common reference for American and European ratings.

Telephone Circuits for Programme Transmission. F. A. Cowan. Networks of telephone circuits extensively used in the transmission to broadcasting stations are described. The general requirements for satisfactory transmission are enumerated and the maintenance of the networks is discussed. A plan of the Bell System Programme network, covering 31,350 miles, is given.

Meeting Long Distance Telephone Problems. H. R. Fritz and H. P. Lowther, Jr. A discussion of the problems as solved in the Southwestern Bell Telephone Company's area.

August, 1929.

The Engineer, Practical Idealist. President's Address. R. F. Schuchardt.

Telephone Transmission Networks. T. E. Shea and C. E. Lane. A brief resumé of the nature of telephonic signals is given, and a basis for the design of networks to transmit them is provided. Networks and apparatus must give efficient transmission, low distortion, good impedance balance, stability, low reflection, must not cross-talk into associated circuits and must have desirable impedance characteristics to cover a wide frequency range.

Trans-Atlantic Telephone Cable. The new cable will yield only a single telephone circuit, the main length being about 1,800 nautical miles. It will be continuously loaded with "perminvar" and insulated with "paragutta." It is hoped to cope with an attenuation of about 150 decibels for the higher frequencies. To make two-way operation possible, voice-operated switching mechanisms will be required at the two terminals.

BOOK REVIEWS.

"Les Appareils Transporteurs Mecaniques de Bureau." By J. Jacob. 230 pp. Published by M. M. Dunod, 92 Rue Bonaparte (VI.), Paris.

This book, written by the Engineer-in-Chief of the French Postal and Telegraph Services, covers comprehensively the various methods of transporting messages, letters, documents and parcels in buildings, a subject on which comparatively little has been written hitherto.

Although dealing largely with the necessities of the postal services, the work is by no means limited to these, but deals also with cash handling systems in shops, and generally with the subject of internal transport in offices and stores. Choice of system is discussed and details of erection and maintenance given.

After dealing with spiral and straight chutes where the motive power is gravity, and simple devices controlled by hand, catapult or electric motor, a large section of the book is devoted to pneumatic house tubes and their auxiliary plant. Methods of arranging the tubes are shown and the power units described, while consideration is given to various methods of economising power.

Wire, rope, and moving belt conveyors are also fully dealt with, while, in the final chapters of the book, conveyors and chutes are considered especially in connection with the simplification and reduction of work in Sorting Offices, examples being given of actual and projected installations.

Owing to the illustrations with which the book is amply provided, the book is easy to follow without any profound knowledge of French, full details of apparatus being given as well as general arrangements.

T. McG.

"Engineering Electricity." By Ralph G. Hudson, S,B. Chapman & Hall, Limited. 214 pages. 12/6 nett.

This book contains an outline of the basic principles of electrical engineering, both A.C. and D.C., applied particularly to electrical machinery. It has been written particularly for engineers who, while being desirous of becom-

ing thoroughly acquainted with the fundamental principles of the subject, cannot study it in detail. Descriptive matter is reduced to a minimum, but about 40 pages are devoted to photographs of apparatus, machinery and switchgear by which their mode of construction is well illustrated. A large number of useful problems together with answers are also included. The keynote of the book is brevity, and it is therefore likely that it would prove useful for the purposes of quick revision prior to examination of medium standard in Electrical Engineering.

H.C.J.

We have to acknowledge the receipt of the following publications:—

From International Standard Electric Corporation: Two copies of a translation into English of the C.C.I. Proceedings in Paris, 11th to 18th June, 1928.

From Siemens Bros.: Pamphlet 508*a*, Siemens Neophone. A description of the new C.B. microtelephone developed and manufactured by the Company. Details of this instrument are published elsewhere in this issue. Pamphlet 510*a*, Small Rural Automatic Equipment No. 26.

A Report of the Gemuntelejken Telephone Service, Rotterdam, for the year 1928.

A Similar Report from the Danish Telephone Companies, Copenhagen, for 1928.

From Eversheds and Vignoles: A pamphlet covering the firm's new Bridge Meg Resistance Tester. As the Meg evolved from the Megger, so has the Bridge Meg Tester been developed from the former. The instrument is self-contained and is assembled in an aluminium alloy case which can be carried in the hand or slung over the shoulder. Its range is from 0.01 ohm to 100 megohms. No external resistance is required when the instrument is used on "Bridge." The switches are of new design and are very compact and efficient. Only two terminals are fitted.

From Bureau of Standards: Code for Protection against Lightning.

THE INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS.

Provisional Programmes of Centres for Session 1929-30.

LONDON CENTRE.

Dates to be fixed later.

A. B. HART, M.I.E.E.
Chairman's Address.

A. SPEIGHT, A.M.I.E.E.
"The Development of Automatic Routiners in the British P.O."

E. S. RITTER, M.I.E.E., D.F.H.
"Picture Telegraphy."

J. N. HILL.
"Critical Methods of Investigation as applied to the Study of Telephone Area and Plant Layout."

A. C. TIMMIS, B.Sc., A.M.I.E.E.
"Carrier Current Telephony."

A. MORRIS, A.R.C.Sc., M.I.E.E.
"Telephone Cable Circuit Interference."

J. A. M. OWEN and J. A. S. MARTIN.
"Composited Telegraph and Telephone Working."

Informal Meetings.

1929.
22 Oct. Chairman's Address.
26 Nov. H. Y. STARKEY.
To be announced later.
1930.
28 Jan. W. C. BURBRIDGE.
"Some Development Heresies."
25 Feb. A. MILLER.
"London Building Acts."
25 Mar. W. A. WILLIAMS.
"Thoughts on Staff Efficiency."
22 Apl. E. J. BARNES.
"Loud Speakers."

NORTHERN CENTRE.

1929.
16 Oct. A. S. RENSHAW. *(E.-in-C.O.).*
"Some Considerations Relating to the Clerical Organisation of the Engineering Dept."
20 Nov. F. W. GASKINS, A.M.I.E.E.
"Cabling of the Tyne and other Tyne Bridges."
1 Dec. J. W. HASTINGS.
"The Teleprinter and possibilities of its Development."
1930.
15 Jan. R. T. ROBINSON, A.M.I.E.E. *(E.-in-C.O.).*
"Motor Transport in the P.O. Engineering Department."
19 Feb. R. PARKER.
"The Middlesbrough Automatic Telephone System."
19 Mar. W. T. GEMMELL.
"The Heating and Ventilating of Post Office and Telephone Exchanges."

NORTH EASTERN CENTRE.

1929.
8 Oct. J. W. ATKINSON, M.I.E.E.
Chairman's Address.
12 Nov. E. S. RITTER, M.I.E.E., D.F.H. *(E.-in-C.O.).*
"Picture Telegraphy."
10 Dec R. T. ROBINSON, A.M.I.E.E. *(E.-in-C.O.).*
"Motor Transport."
1930.
14 Jan. A. MORRIS, A.R.C.Sc., M.I.E.E. *(E.-in-C.O.).*
"Telephone Cable Circuit Interference."
11 Feb. H. E. FRANCIS.
"Rural Automatic Exchanges."
11 Mar. H. MCLEAN.
"Notes on Insulating Materials."

NORTH WESTERN CENTRE.

1929.
14 Oct. W. H. LANE
"Telephone Transmission." A brief description of the standard arrangements for giving effective transmission to telephone subscribers.
12 Nov. A. MORRIS, A.R.C.Sc., M.I.E.E. *(E.-in-C.O.).*
"Telephone Cable Circuit Interference."
9 Dec. A. S. RENSHAW. *(E.-in-C.O.).*
Subject to be announced.
1930.
— Jan. Visit to Automatic Telephone Manufacturing Company's Works, Liverpool.
10 Feb. A. S. CARR (Cantab), A.M.I.E.E., and E. HOPPER, A.M.I.E.E.
"Blackpool Telephonic Repeater Station."
10 Mar. T. WOODHOUSE, A.M.I.E.E.
"Cells."

SOUTH LANCS. CENTRE.

1929.
14 Oct. W. J. MEDLYN, M.I.E.E.
Chairman's Address.
11 Nov. H. M. TURNER.
"Small Power Rectifiers."
16 Dec. *To be arranged.*
1930.
13 Jan. *To be arranged.*
11 Feb. S. S. A. WATKINS, B.Sc., A.M.I.E.E. *(Western Electric Co., Ltd.).*
"Talking Films."
(Joint meeting with the I.E.E.).
10 Mar. *To be arranged.*
7 Apl. S. JACKSON.
"Manchester Repeater Station."

NORTH WALES CENTRE.

1929.
9 Oct. R. A. WEAVER, M.I.E.E.
Chairman's Address.
14 Nov. E. S. RITTER, M.I.E.E., D.F.H. *(E.-in-C.O.).*
"Picture Telegraphy."
11 Dec. Major C. A. BLACKWELL.
"Fault Procedure."
1930.
8 Jan. Capt. N. CAVE-BROWN-CAVE.
"Sound."
12 Feb. A. MORRIS, A.R.C.Sc., M.I.E.E. *(E.-in-C.O.).*
"Telephone Cable Circuit Interference."
12 Mar. H. P. LLOYD
"Electrolysis."

SOUTH WALES CENTRE.

1929.
14 Oct. A. MORRIS, A.R.C.Sc., M.I.E.E. *(E.-in-C.O.).*
"Telephone Cable Circuit Interference."
11 Nov. P. O. SULLIVAN.
Visit to B.B.C. Station. Investigation of wireless complaints.
9 Dec. C. W. BROWN, A.M.I.E.E. *(E.-in-C.O.).*
"Automatics."
1930.
13 Jan. S. G. RICKARD.
"E.L. and Power: Administrative procedure regarding Statutory and 48 hours' Notices."
10 Feb. C. G. HEIGHTON.
"Cable Balancing and Sheath Current Tests."
10 Mar. A. C. TIMMIS, B.Sc., A.M.I.E.E.
"Carrier Current Telephony."

NORTH MIDLAND CENTRE.

1929.
30 Sept. *To be arranged.*
4 Nov. Mr. EDE.
"Fitters and their work."
2 Dec. *To be arranged.*
1930.
6 Jan. *To be arranged.*
3 Feb. Mr. COOTE.
"Some Aspects of Maintenance in Auto Exchanges."
3 Mar. Mr. WARRAND.
"Main and Local Lines: Plans and Records."

SOUTH MIDLAND CENTRE.

1929
2 Oct. J. E. TAYLOR, M.I.E.E (Chairman).
"Electro-magnetic Theories."
6 Nov. A. S. RENSHAW. *(E.-in-C.O.).*
"Some Considerations relating to the Clerical Organisation of the Engineering Department."
4 Dec. W. H. G. NAYLOR.
"Telephone Repeater Apparatus, Theory and Use."
1930.
8 Jan. W. L. TAYLOR.
"Motor Vehicles."
5 Feb. L. G. GOSH.
"Underground Works. Negotiations with Road Authorities."
5 Mar. E. S. RITTER, M.I.E.E., D.F.H. *(E.-in-C.O.).*
"Picture Telegraphy."

EASTERN CENTRE.

1929.
— Oct. Visit to the Cambridge University Labs.
5 Nov. A. MORRIS, A.R.C.Sc., M.I.E.E. *(E.-in-C.O.).*
"Telephone Cable Circuit Interference."
1930.
14 Jan. S. G. LAST.
"The Abnormal Development of Southend-on-Sea and the Transfer to Auto-External."
11 Feb. C. A. MITCHELL.
"Southend's Automatic Telephones."
18 Mar. A. C. TIMMIS, B.Sc., A.M.I.E.E. *(E.-in-C.O.).*
"Carrier Current Telephony."

SCOTLAND EAST CENTRE.

1929. } Programme not yet available.
1930. }

SCOTLAND WEST CENTRE.

1929.
7 Oct. Informal Meeting.
2 Dec. A. D. KIER.
"Local Experience on Contract Work."
1930.
20 Jan. A. MORRIS, A.R.C.Sc., M.I.E.E. *(E.-in-C.O.).*
"Telephone Cable Circuit Interference."
3 Feb. J. D. MCLEOD.
"Glasgow-Wemyss Bay Cable—Drawing-in, Balancing and Locating."
3 Mar. R. MCWHITTER, B.Sc., Dip. R.T.C.
Subject to be announced later

SOUTH WESTERN CENTRE.

1929.
8 Oct. A. MORRIS. A.R.C.Sc., M.I.E.E. *(E.-in-C.O.).*
"Telephone Cable Circuit Interference."
12 Nov. A. E. MILLARD. *(E.-in-C.O.).*
"Rural Automatic Exchanges."
10 Dec. G. E. H. BODY.
"Telephonic Repeaters."
1930.
14 Jan. A. BUCKLITSCH.
"Maintenance Work and Costs."
11 Feb. E. S. RITTER, M.I.E.E., D.F.H. *(E.-in-C.O.).*
"Picture Telegraphy."
11 Mar. *To be arranged.*

NORTH IRELAND CENTRE.

1929.
22 Oct. Chairman's Address, to be followed by exhibition of film "Voices Across the Sea."
28 Nov. R. T. ROBINSON, A.M.I.E.E. *(E.-in-C.O.).*
"Motor Transport in the Post Office Engineering Department."
1930.
14 Jan. A. H. JACQUEST, A.M.I.E.E. *(E.-in-C.O.).*
"Trunk Exchange Construction."
11 Feb. W. S. FRENCH.
"Rural Automatic Exchanges."
18 Mar. J. G. MORROW.
"Wireless"—
(*a*) "Broadcast Interferences. Their causes and remedies."
(*b*) "Brief description of Trans-Atlantic working."
14 May Visit to Messrs. Harland & Wolff's Shipbuilding Yards."

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Postmaster-General's Department,
Treasury Gardens,
Melbourne, C2,
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H. C. Brent, Esq.,
District Telegraph Engineer's Office,
Wellington, N.Z.

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Telegraphs & Telephones,
C.T.O.,
Colombo,
Ceylon.

A. J. Kellaway, Esq.,
Department of Posts and Telegraphs,
P.O. Box 366,
Pietermaritzburg,
South Africa.

STAFF CHANGES.

POST OFFICE ENGINEERING DEPARTMENT.

PROMOTIONS.

Name.	Grade.	Promoted to	Date.
Brown, Major, O.B.E.	Superintending Engineer N. Midland District.	Assistant Engineer-in-Chief.	1-9-29
Gilbert, A. B.	Assistant Superintending Engineer, Scot. East District.	Superintending Engineer, N. Midland District.	1-9-29
Cornfoot, T.	Assistant Superintending Engineer, S. East District.	Asst. Suptg. Engineer-in-Charge, N. Ireland District.	1-10-29
Fulcher, H. W.	Executive Engineer, Central Power Section, London District.	Assistant Superintending Engineer, London District.	6-6-29
Blight, W. O.	Acting Assistant Staff Engineer, Equipment, Section, E.-in-C.O.	Assistant Staff Engineer, Equipment Section, E.-in-C.O.	2-8-29
Wakefield, J. H. M.	Executive Engineer, Guildford Section, S. Midland District.	Assistant Superintending Engineer, S. East District.	1-10-29
Kingston, Major J. R., O.B.E. ...	Executive Engineer, Power Section, E.-in-C.O.	Acting Assistant Staff Engineer, Power Section, E.-in-C.O.	2-8-29
Witherby, J. C.	Assistant Engineer, Glasgow South Section, Scot. West District.	Executive Engineer, Hereford Section, S. Wales District.	1-8-29
Gilbert, D. P.	Assistant Engineer, Power Section, E.-in-C.O.	Acting Executive Engineer, Power Section, E.-in-C.O.	12-7-29
	Acting Executive Engineer.	Executive Engineer.	2-8-29
Beeton, H. C.	Assistant Engineer, South Power Section, London District.	Acting Executive Engineer, Central Power Section, London District.	2-8-29
Bignell, L.	Chief Inspector, Technical Section, S. Eastern District.	Assistant Engineer, Technical Section, S. Eastern District.	8-7-29
Bruce, R.	Chief Inspector, N. Ireland District.	Assistant Engineer, Liverpool (Intl.) Section, S. Lancs. District.	To be fixed later.
Worthy, L. F.	Chief Inspector, City (Extl.) Section, London District.	Assistant Engineer, East (Extl.), Section, London District.	8-7-29
Townsend, S. B.	Chief Inspector, Sheffield Section, N. Mid. District.	Assistant Engineer, Middlesbro' Section, N. District.	1-8-29
Hill, J. N.	Chief Inspector, Technical Section, London District.	Assistant Engineer Technical Section, London District.	17-7-29
Milton, G. P.	Chief Inpector, Telephone Section, E.-in-C.O.	Assistant Engineer, Lines Section, E.-in-C.O.	To be fixed later.
Husband, S. J.	Clerical Officer, Equipment Section, E.-in-C.O.	Chief Inspector, Equipment Section, E.-in-C.O.	To be fixed later.
Saite, G. P.	Skilled Workmen, Class I., S. Eastern District.	Inspector, S. Eastern District.	,,
Prudden, R. W.	,, ,,	,, ,,	,,
Hoad, S. E.	,, ,,	,, ,,	,,
Milne, J.	,, ,,	,, ,,	,,

TRANSFERS

Name.	Rank.	From	To	Date.
Manning, G.	Assistant Engineer	London District.	E.-in-C.O.	24-7-29
Salter, L. F.	Assistant Engineer	E.-in-C.O.	London District.	1-7-29
Wright F. V.	Assistant Engineer	S.W. District.	E.-in-C.O.	1-9-29
Gilbert, J.	Inspector	Sco.t E. District.	London District.	30-6-29
Bridges, J. T.	,,	N. E. District.	S.E. District.	6-8-29
Shaw, J. W.	,,	,,	London District.	25-8-29
Whittaker, A. W.	,,	N. W. District.	,,	1-7-29
Salt, R. S.	,,	E. District.	E.-in-C.O.	23--6-29
Britton, G. A. C. R.	,,	S. Mid. District.	,,	23--6-29
McMillan, D.	,,	London District.	,,	1-8-29
Helman, S. L.	,,	,,	,,	1-8-29
Dudley, J. C.	,,	,,	,,	1-8-29
Lewis, N. W. J.	,,	,,	,,	1-8-29

Retirements.

Name.	Rank.	Districts.	Date.
De Lattre, A. L.	Assistant Engineer-in-Chief.		31-8-29
Hardie, J.	Assistant Superintending Engineer.	Scot. West.	14-9-29
Lakey, T.	Executive Engineer.	E.	15-9-29
Davey, F. W.	,, ,,	E.-in-C.O.	31-8-29
Chambers, J. L.	Assistant Engineer.	Scot. West.	31-5-29
Beer, G. F.	,,	S. Lancs.	14-6-29
Dwyer, J. J.	,,	S. Mid.	13-7-29
Ancell, W. J.	,,	S.E.	8-6-29
Browne, F. G.	,,	N. Mid.	28-7-29
Phillips, F. J.	,,	London.	31-7-29
Teggins, A. W.	,,	S. Mid.	31-7-29
Greenfield, G.	Chief Inspector.	London.	31-7-29
Atkinson, J. S.	,, ,,	Testing Branch.	20-6-29
Roy, J. D. B.	Inspector.	Scot. East.	3-6-29
Garrett, P. J.	,,	London.	17-5-29
Aitchison, J. W.	,,	S. Lancs.	28-5-29
Bebington, A. E.	,,	London.	30-6-29
Jackson, G.	,,	Scot. W.	25-8-29

Resignations.

Name.	Rank.	District.	Date.
Willis, F. B.	Assistant Engineer.	E.-in-C.O.	30-6-29
Riley, J. H.	,,	,,	10-7-29
Hedley, D. J.	Inspector.	,,	7-7-29

Deaths.

Name.	Rank.	District.	Date.
Addis, C.	Inspector.	Oxford Radio.	4-7-29
Hollis, W. A. J.	,,	N. Wales.	24-8-29

CLERICAL ESTABLISHMENT.

Promotions.

Name.	Grade.	Promoted to.	Date.
Harrop, F. N.	Higher Clerical Officer, S. Lancs. District.	Staff Officer, S. Lancs. District.	2-7-29
Aspden, S. C.	Assisting Executive Officer, E.-in-C.O.	Executive Officer, E.-in-C.O.	15-7-29
Child, A. J.	Clerical Officer, E.-in-C.O.	Acting Executive Officer, E.-in-C.O.	15-7-29

RETIREMENTS.

Name.	Grade.	District.	Date.
Weir, A. W.	Staff Officer.	S.W.	10-6-29
Whiteside, J. G.	Higher Clerical Officer.	N. Wa.	2-7-29
Jones, E. J.	Executive Officer.	E.-in-C.O.	14-6-29

TRANSFERS.

Name.	Rank.	From	To	Date.
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