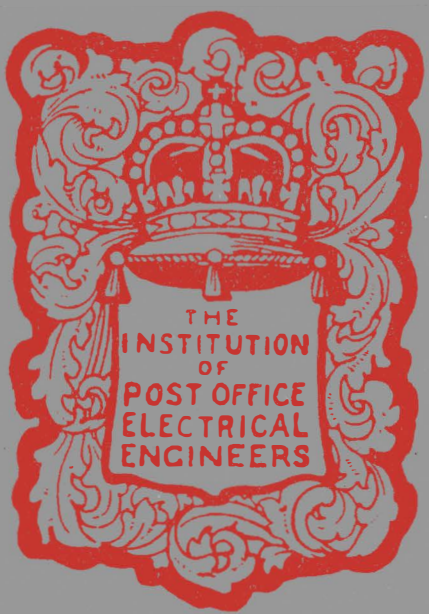
THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL



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APRIL 1926

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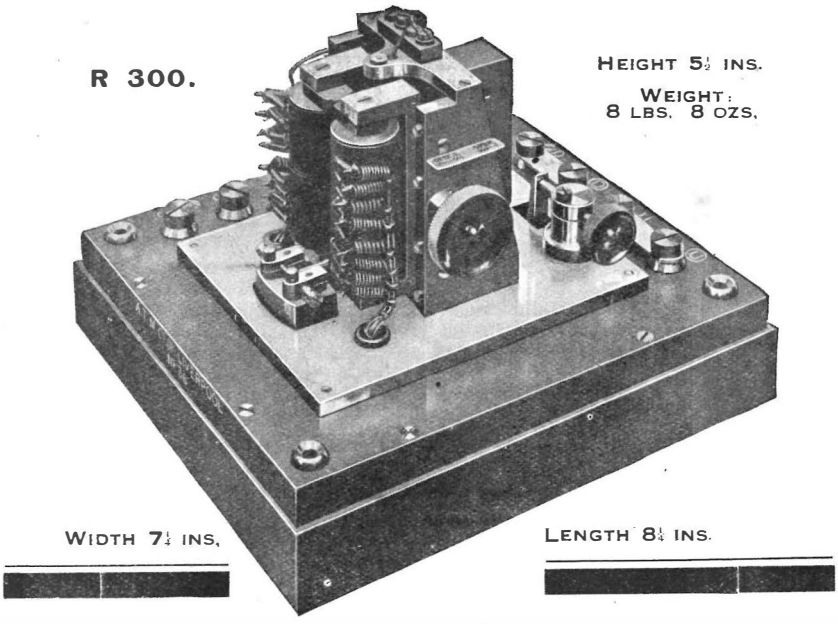

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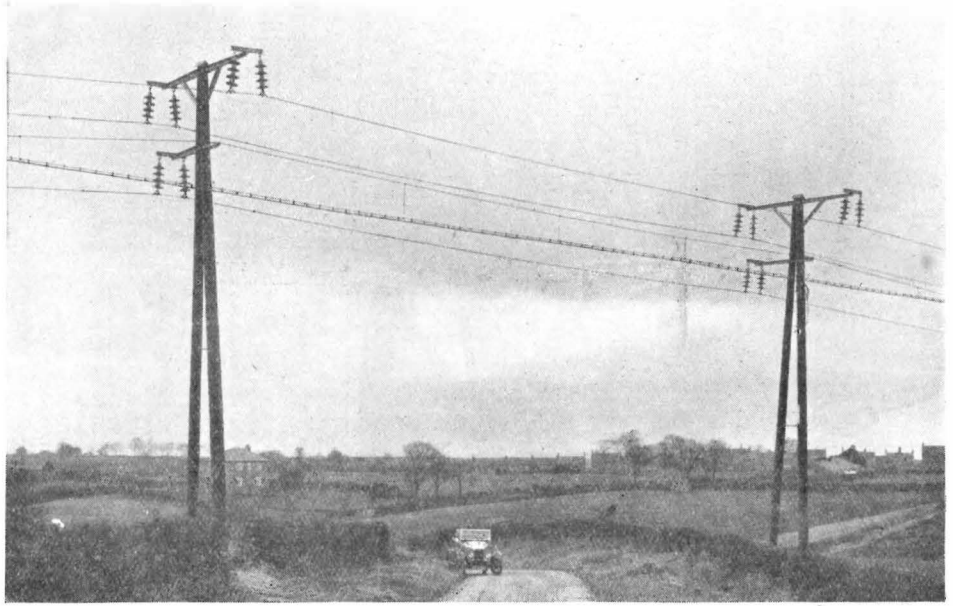
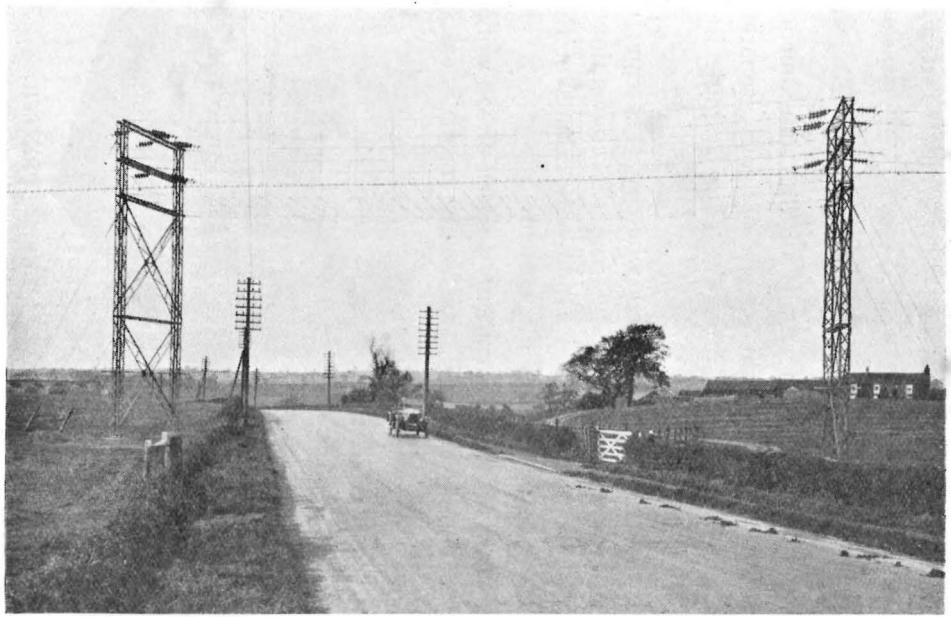


66,000-volt, 3-phase, Overhead Transmission Line, with auxiliary pilot cable suspended from earth wire, crossing a road.



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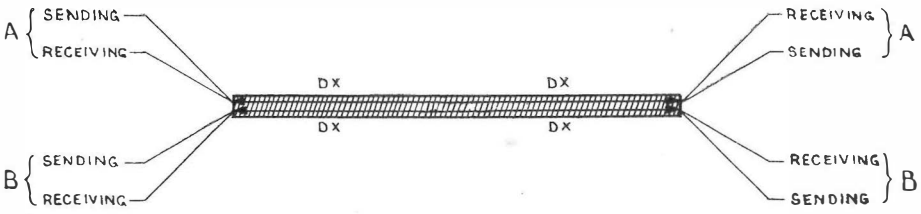

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It is the only system yet designed whereby this can be accomplished, and it differs considerably from the conventional Quadruplex arrangement hitherto used which only admits of the automatic working of one section of the system.

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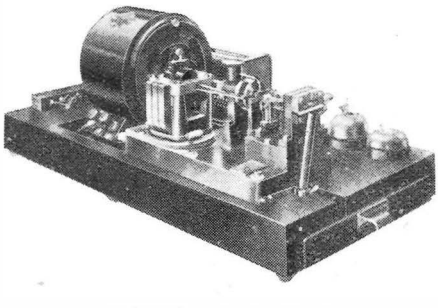

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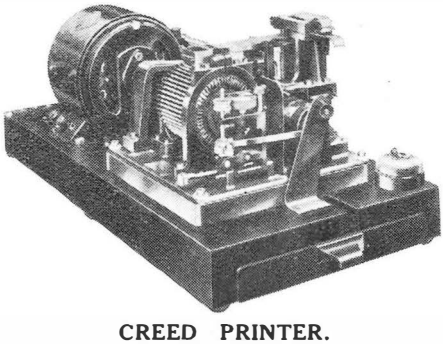

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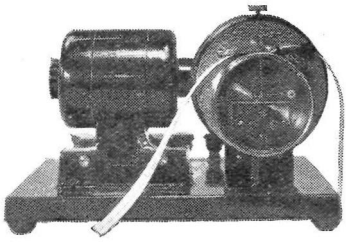

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During one of the heaviest snowstorms of this Winter the Creed Quadruplex on a line between London and Manchester maintained a speed of 220 words per minute, that is, 110 on each channel from London to Manchester, throughout the period. This achievement will more readily be appreciated when it is realised that the line—which was handling newspaper traffic—was the only one to maintain this speed, all other lines between the same points either having to work Simplex or being down altogether.

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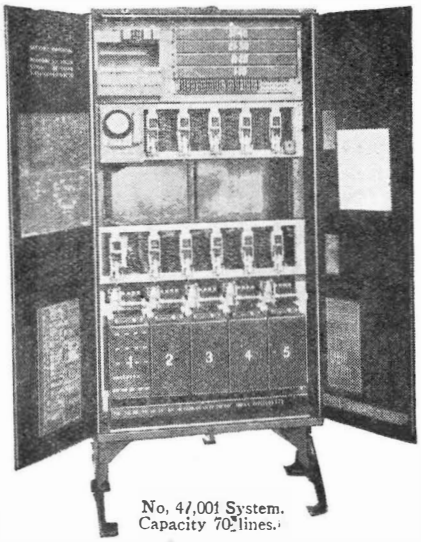

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4. High speed of operation. There is no waiting on the No. 47001 system, as the number is selected by the mechanism during the process of dialling.
5. The caller is instantly advised if the wanted line is engaged and (should he decide to hold the telephone for a minute or so) he is automatically connected as soon as the required line is free.
6. The caller is given confidence in the apparatus as he supervises the call and can hear the distant bell ringing.
7. The apparatus is simple to instal, being in standardised unit form.
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UNDERGROUND TELEGRAPH CIRCUITS WORKED FROM UNIVERSAL BATTERIES.

In the *I.P.O.E.E. Journal* for April, 1921, Messrs. R. T. King and E. J. Barnes described a Relay and Galvanometer, each with four windings, used in connection with Automatic signalling experiments. The apparatus gave Cable circuits supplied from Universal batteries the same freedom from the effects of outside interference as circuits provided with Independent batteries.

In 1923 the Telegraph Section, Engineer-in-Chief's Office, conducted experiments to compare the speeds obtainable on a loop circuit, equipped, in one case with Standard "B" Relays and Independent batteries, and in the other with Relays having four windings and Universal batteries. Practically the same duplex speeds were obtained in both circuits.

A limited supply of these new Relays and Galvanometers was then obtained. The items are described as "Relay Standard H," and "Galvanometer, double, differential." Details of the winding and resistances of the Relay are shown in Fig. 1.

In addition to its special function, for which the duplicate windings are required, it can be used as an ordinary 'B" Relay by utilising one set only of the main coils, or as a "G" Relay by bringing in the Vibration Coils.

The Galvanometer has four separate coils of 44 ohms, each shunted by 300 ohms.

For duplex working the apparatus is connected as shown in the theoretical diagram, Fig. **2.**

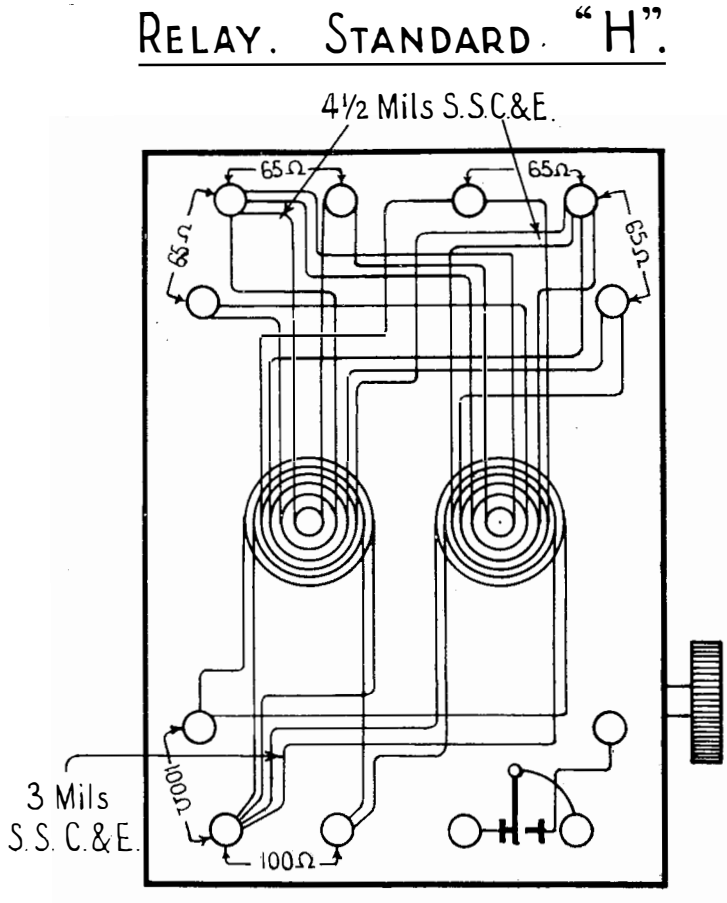


Fig. 1.

If the ' B " line link at the Test Box be disconnected, a single line can be used with a set wired for the " H " Relay. Twice the

normal resistance of the line will, however, be required in the Rheostat when balancing for duplex.

The circuit of the " B " line is arranged to be in every respect similar to the circuit of the " A " line, but the currents induced in the two circuits pass through the apparatus in such a way as to produce opposite magnetic effects. Currents arising from outside influences, *e.g.*, neighbouring cable circuits, or earth currents, therefore neutralise each other.

The " A " line only is used for the signalling current. The compensation circuit reproduces the line side conditions closer than the standard method because a Relay coil and a Lamp resistance are in circuit after the Rheostat.

The current in the compensation circuit traverses two coils of the Relay and Galvanometer, hence it is necessary to adjust the Rheostat to twice the value of the line resistance. The magnetic effects of line and compensation currents in the sending apparatus are then equal and opposite. A pamphlet, E.-in-C. No. 167, has been issued explanatory of the system.

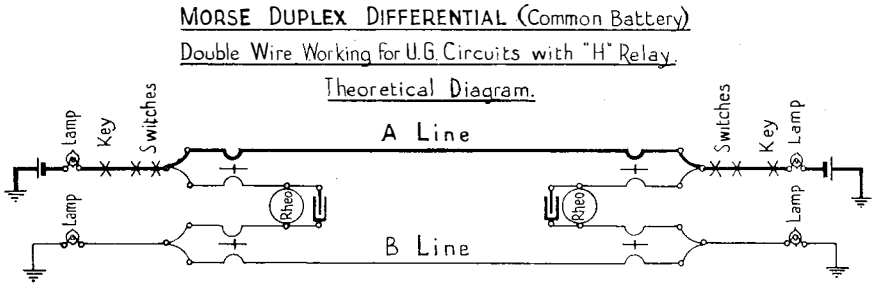


FIG. **2**.

The first circuit employing the new apparatus was installed in April, 1924, between London and Huddersfield, this circuit having previously proved unworkable with the " B " Relay and Universal batteries. Two other circuits, LE—MR, LE—LV, which were subject to serious inductive disturbance and gave much trouble when routed on adjacent pairs, are now working quite satisfactorily with " H " Relays.

A multiplex circuit has been equipped with the apparatus recently and further extensions are contemplated.

The circuits at present working are as shown :—

Circuit.	Mileage.	Conductor.	System.
TS HF	211.8 miles	40 lb. 203.7 M. 100 ,, 8.1 ,,	Morse dx.
TS YO1	219.9 ,,	40 lb.	,, ,, Adjacent Cable pairs.
TS YO2	,, ,,	,,	,, ,, Adjacent Cable pairs.
LE MR	83.9 ,,	,,	,, ,, Adjacent Cable pairs.
LE LV	120.7 ,,	40 lb. 83.9 M. 100 ,, 36.8 ,,	,, ,, Adjacent Cable pairs.
TS LV	221.3 ,,	150 lb. 122.5 M. 100 ,, 94.4 ,, 40 ,, 4.4 ,,	Baudot quadruple duplex.

The system has the following advantages:—

(*a*) The space required for loop batteries is saved and the heavy charges incurred for their maintenance avoided.

(*b*) Less power is required, the line resistance is half that of a circuit employing an independent battery.

(*c*) Faults arising from low insulation of batteries are eliminated.

(*d*) Special arrangements to deal with earth currents are unnecessary.

There are, however, three disadvantages.

(*a*) The Cable pairs cannot be used for superposing.

(*b*) Unless provided with similar apparatus, circuits in the same Cable (other than metallic loop circuits) will suffer inductive disturbance.

(*c*) The "B" line is subject to inductive disturbance from its associated "A" line. This, up to the present, has created no difficulty.

R.P.S.

WAR OFFICE PNEUMATIC TUBE CENTRE.

J. E. McGregor, A.C.G.I., A.M.I.E.E.

General. This pneumatic tube installation, which represents the latest developments in pneumatic tube practice, consists of an Exchange Centre to which surrounding offices are connected by short pneumatic street tubes, and where the messages to and from these

offices are transferred from and to trunk tubes connecting the Tube Room at the War Office with the C.T.O., thus saving the large expenditure that would be incurred if all the offices were connected through to the C.T.O. by individual tubes. A list of the offices connected is given in the Appendix.

The street tubes are connected to electrically operated rotary switches which transfer the carriers automatically between the street tubes and house tubes terminated in Flap Terminals through which the carriers are delivered or inserted.

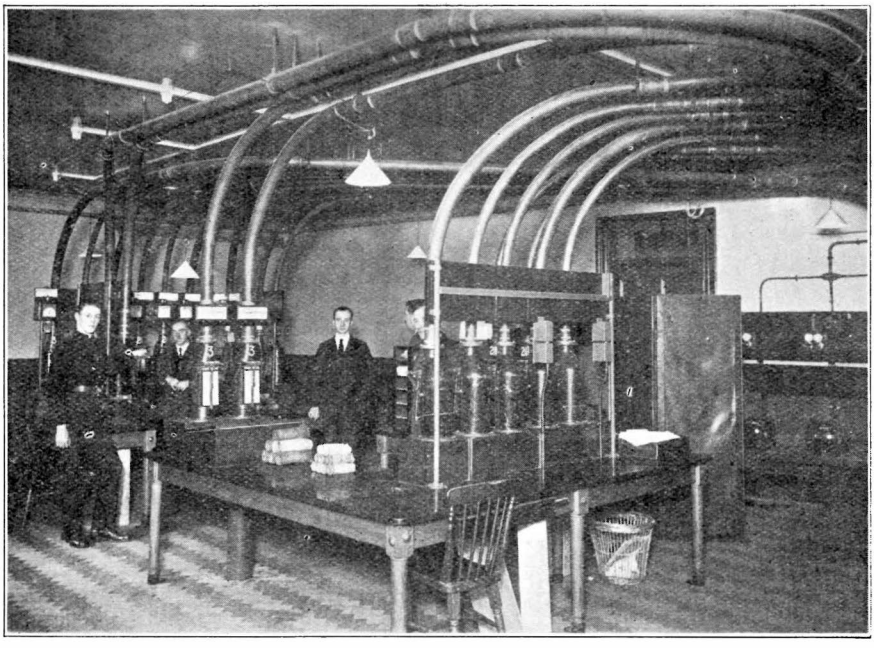


FIG. 1.—TUBE ROOM.

In the case of the trunk tubes to and from the C.T.O. no switch is required at the delivery end and the carriers are discharged automatically through the flap terminals directly into the Instrument Room at the C.T.O. and the Tube Room at the War Office respectively.

The whole of the switching and signalling arrangements are of a novel character and represent a great deal of experimental work, the result being that the tube terminals in the Exchange are located in a very compact form, all the switching arrangements for the insertion and reception of carriers into and from the street tubes being carried out automatically in a separate room, and the amount of manual work being reduced to a minimum. In addition to the

large reduction in staff, owing to the abolition of the heavy hand-operated pneumatic switches which would otherwise have been required, the automatic discharge of the carriers also means an avoidance of delay in handling the messages.

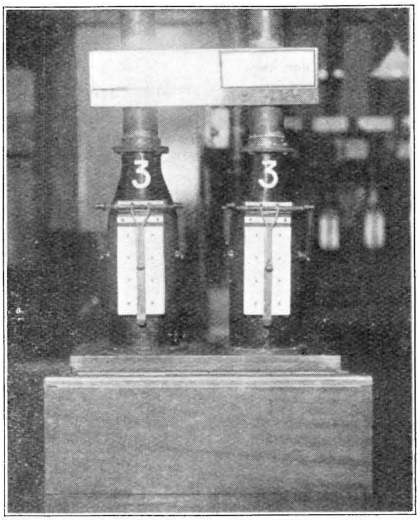


FIG. 2.—FLAP TERMINALS.

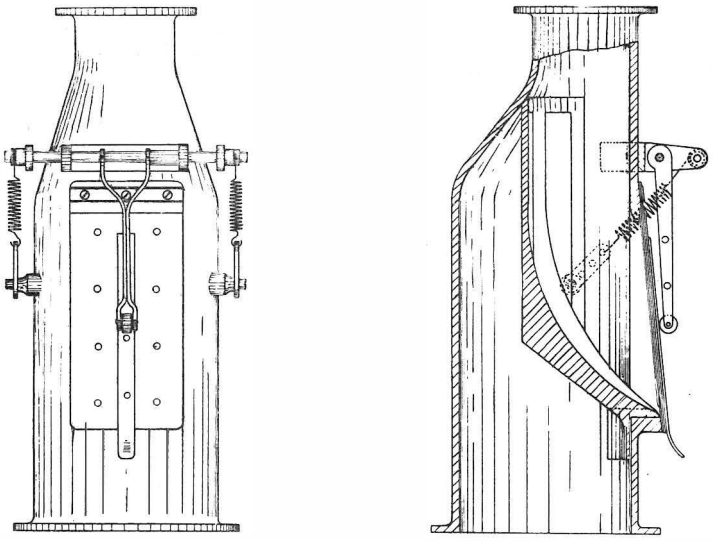


FIG. 3.—FLAP TERMINAL.

In the outlying offices connected up, the messages can be inserted direct into the street tube by the receiving officer at the counter with no more trouble than that associated with the use of

house tubes, a flap terminal again being used, and the delivery of the messages can be made direct to the instrument room (as at the C.T.O.), or to the various sending out rooms, no auxiliary house tube system being required at the various offices.

The special apparatus used has been invented and designed in the Power Section of the Engineer-in-Chief's Office and erected by the London Engineering District.

Compressor Room. The War Office Tube Centre is served by three electrically-driven air compressors of Messrs. Weir's manufacture. These are of the horizontal type and are each capable of delivering 600 cubic feet of air per minute at about

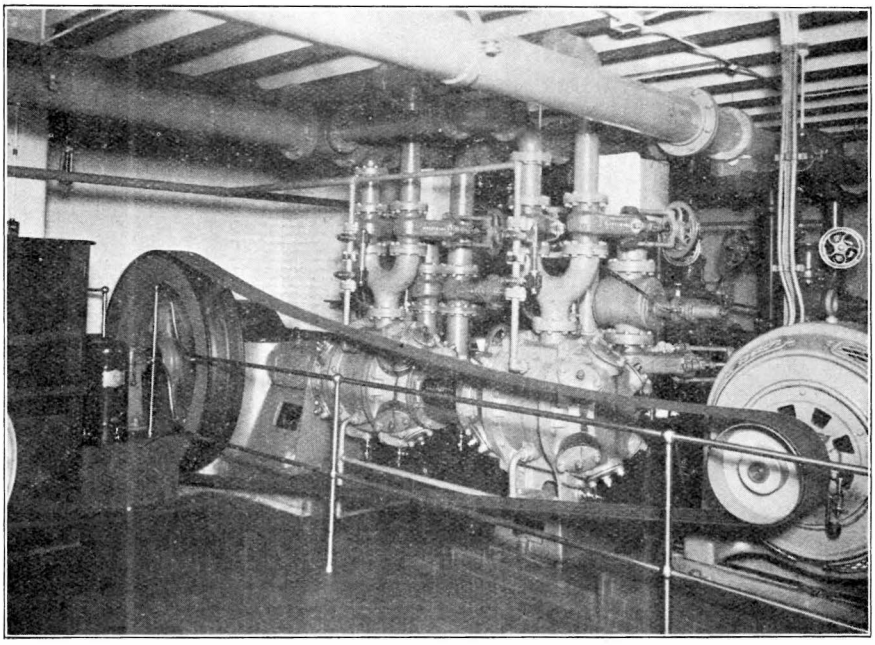


FIG. 4.—AIR COMPRESSOR.

10 lbs. per square inch pressure, or 12 to 16 inches vacuum, incoming tubes being operated by vacuum and outgoing tubes by pressure. The compressors are belt-driven from electric motors of 40 B.H.P. capacity and run at 130 r.p.m., the full motor speed being 600 r.p.m. The two trunk tubes from the C.T.O. are supplied with air under pressure from the C.T.O. Valves are provided so that any of the compressors may be used for either service, vacuum or pressure.

From the Compressor Room the air is taken to pressure and vacuum headers in the *Switch Room* which in turn are connected

through electrically controlled, pneumatically operated valves to the pneumatic tube switches.

These *Air Supply Valves,* a bank of which can be seen in the illustration (Fig. 5), are operated by auxiliary Westinghouse valves. In these a solenoid causes a piston to open or close ports connected to an auxiliary air supply. This in turn moves a piston in the main valve against a spring opening ports which connect the tubes to the main air supply. On switching off, the valve body is connected to atmosphere and the spring returns the piston to the "off" position.

In the case of tubes working both "up" and "down," a second similar valve determines whether the air supply is vacuum or pressure.

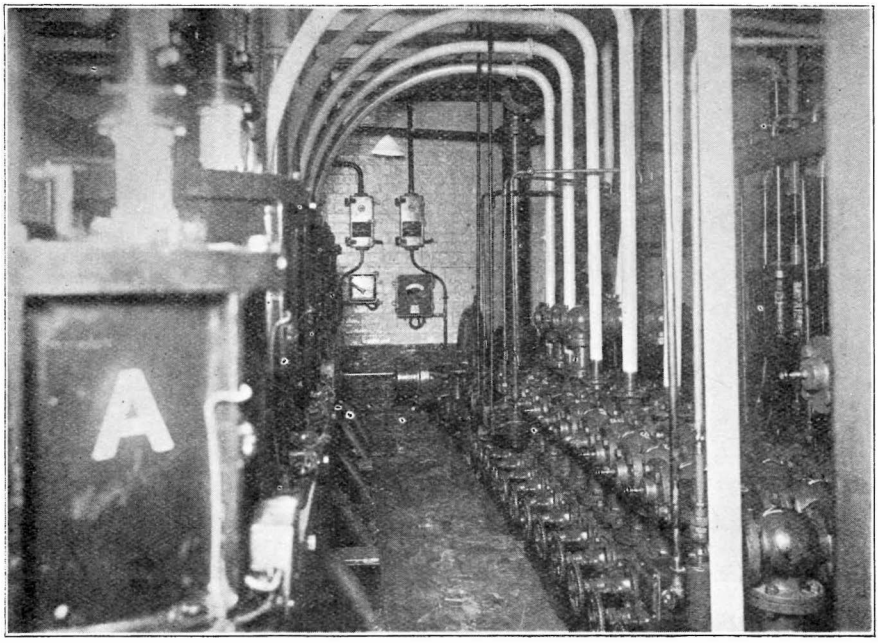


FIG. 5.—PNEUMATIC SWITCH ROOM.

In the Switch Room are located four Keith Blackman Centrifugal Blowers of 700 cu. ft. per min. capacity, two of which are used alternatively for pressure, and two for vacuum, for operating the house tubes connecting the Pneumatic Switches with the Tube Room.

The Pneumatic Switches are operated by means of magnetic clutches connected through chains and gear wheels to line shafting driven by two alternative motors of 3 H.P. capacity, a simple

throw-over clutch being provided by which either motor is connected to the shafting.

The *Pneumatic Switch* consists of a fixed open cylindrical frame with top and bottom plates having orifices to which the street and house tubes are connected and also the air supply pipes (vacuum and/or pressure).

Inside this frame is a rotating body consisting of three tubular sections welded at the top and bottom to plates similar to those on the outside frame. Packing rings are inserted round the orifices to prevent leakage of air. When receiving, the carrier, which has been inserted in the street tube at the "out" office through a flap terminal, passes from the street tube into one of the tubular compartments of the switch, where it is held by a grid covering the

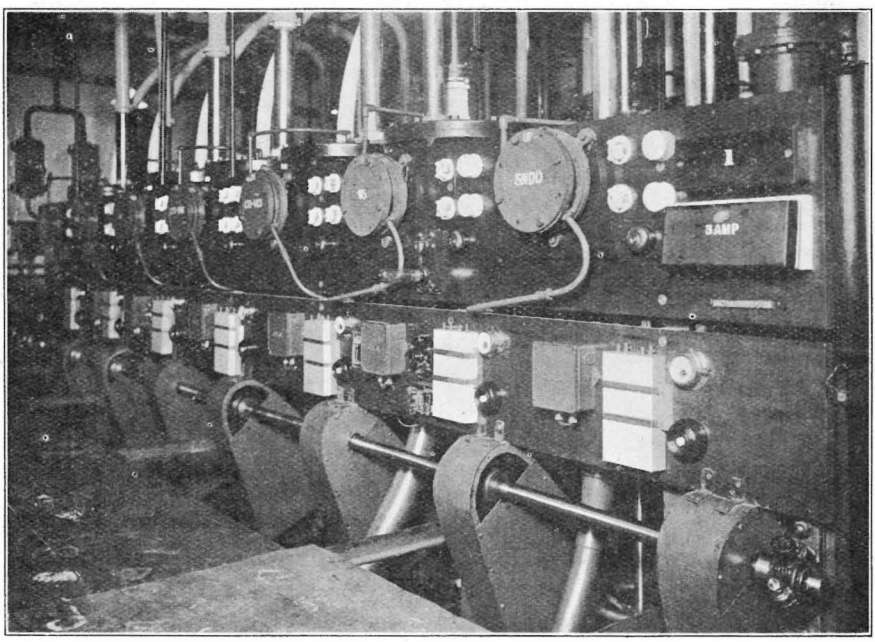


FIG. 6.—PNEUMATIC SWITCH ROOM. CONTROL BOARD.

vacuum supply pipe. As the carrier rests against the grid it interrupts the flow of air, causing a considerable difference of pressure before and behind the carrier.

Small pipes are led from above and below the switch, transmitting these pressures to a *Differential Indicator*.

The *Differential Indicator* consists of a cast iron case divided into two compartments by a rubber diaphragm stiffened by aluminium discs proportioned to the pressures used. The move-

ment of the diaphragm is transmitted by an axial pin to a pair of contacts, thus completing or opening an electrical circuit. The diaphragm is biassed by a spring against the difference of pressure due to the normal flow of air through the switch, and contact is only made when the difference of pressure is increased owing to the presence of the carrier in the switch. As soon as this contact is made, it completes a circuit through auxiliary plunger contacts on the switch and the magnetic clutch is energised and couples the switch to the shafting by a pinion and crown wheel.

When the switch leaves its normal position the differential indicator ceases to function and a retaining contact is provided to

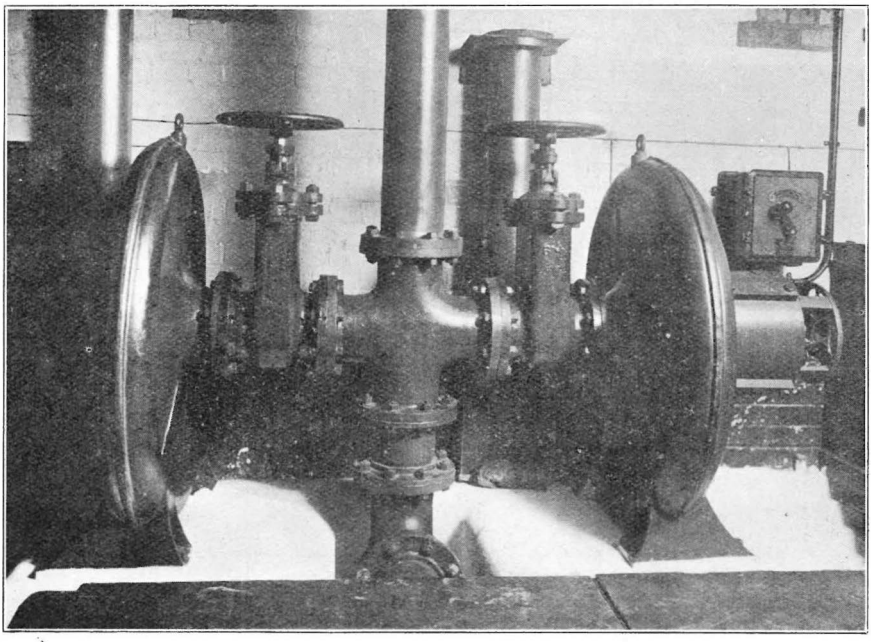


FIG. 7.—CENTRIFUGAL BLOWERS.

maintain the electrical circuit. When the switch has made one-third of a revolution the carrier is brought into position to be blown into the house tube by the low pressure air from the centrifugal blowers, and the retaining contact is opened by means of a ramp fixed on the rim of the rotating part, leaving the switch ready to receive another carrier.

The switches are fitted with friction band brakes to minimise any variation in torque required by the various switches and to ensure stoppage at the correct points. A condenser is inserted to reduce sparking at the contacts.

The carrier passes through the house tube and is blown through the flap terminal in the Tube Room.

For sending from the War Office Centre the process is reversed, the carrier being drawn by vacuum from the flap terminal to the switch, which rotates and delivers the carrier to the street tube, whence it is discharged at the distant office through a flap terminal.

Where there is likelihood of the carriers being discharged at excessive velocity a bye-pass is fitted near the end of the tube releasing the pressure behind the carrier to atmosphere.

Signal and Air Control Circuits. The signal circuits are arranged, not only to give the ordinary block instrument indica-

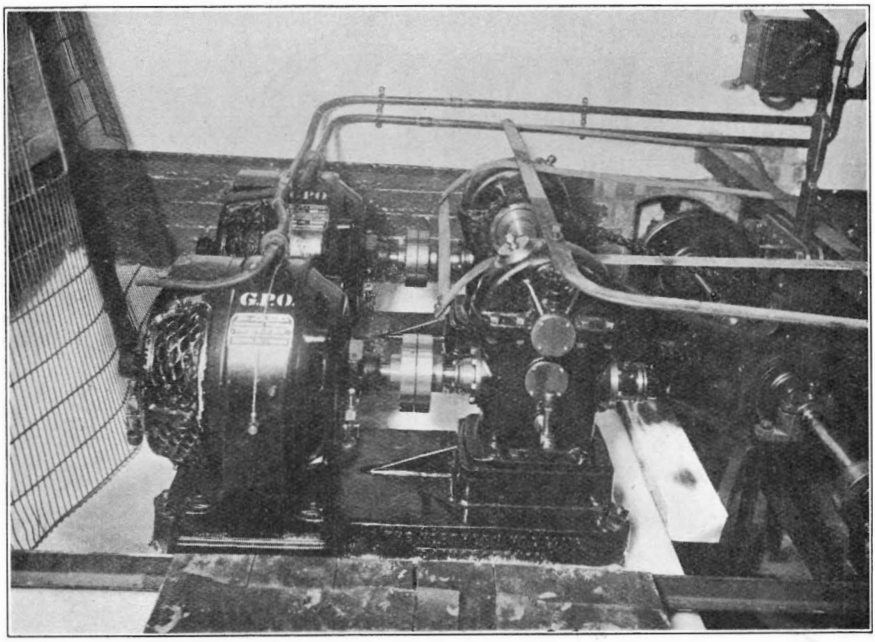


FIG. 8.—DRIVING MOTORS.

tions, but also to operate the air supply valves for the shorter tubes through which a considerable amount of air would otherwise be wasted when not in use, as the far end is open to atmosphere.

In the case of long tubes this waste is greatly reduced owing to the frictional effect of the tube on the air, and it is only at rare intervals that there is no carrier in the tube. In these tubes the time interval between the carriers would be too great if only one carrier were allowed to travel at a time and Signallers are placed to indicate the passage of a carrier at a certain distance from the sending point, after which another carrier may be inserted. Up

till now, dependence has been placed on a timing control for loading long tubes, which is not satisfactory, as it does not prevent carrier after carrier being inserted if a carrier has stopped and so causing the tube to become jammed. With a definite space interval at the start and an open end trouble from this cause will not arise.

On the trunk tubes to the C.T.O. this corresponds to a time interval of 10 to 15 seconds between the despatch of the carriers, which is ample, as there can be no delay in discharging the carrier from the tube, this being unrestricted by the flap terminal, which is not dependent on the attention of a tube attendant.

The Signaller used is a *Differential Indicator Signaller* similar to the differential indicator used for operating the switches, but of

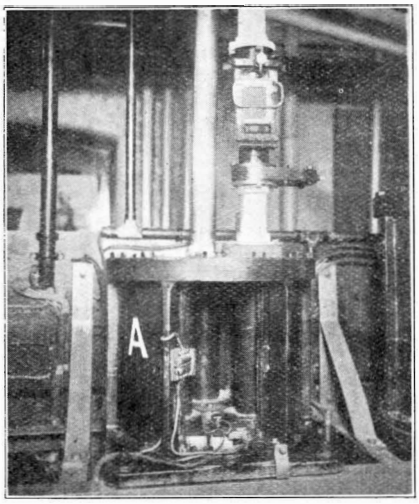


FIG. 9.—PNEUMATIC SWITCH.

a more sensitive type and with a greater range of adjustment with an external setting. The pressure pipes actuating the signaller are connected to the street tube at two points about 24 feet apart and the difference of pressure caused by a carrier traversing this section causes a contact to be made.

The tubes are automatically blocked when sending from the War Office by means of a relay in the retaining contact circuit of the Pneumatic Switches.

On shorter tubes, when arranged for receiving, the line is blocked by means of a press button at the distant station, and the same signal operates a Teleswitch which causes the air supply valve to open. The Teleswitch is a form of relay with contacts suitable for 200 volts, which are closed with the first current

impulse, opened with the next, closed with the third and so on. When the carrier arrives in the Pneumatic Switch a relay is operated which clears the block signal and operates the Teleswitch again, cutting off the air.

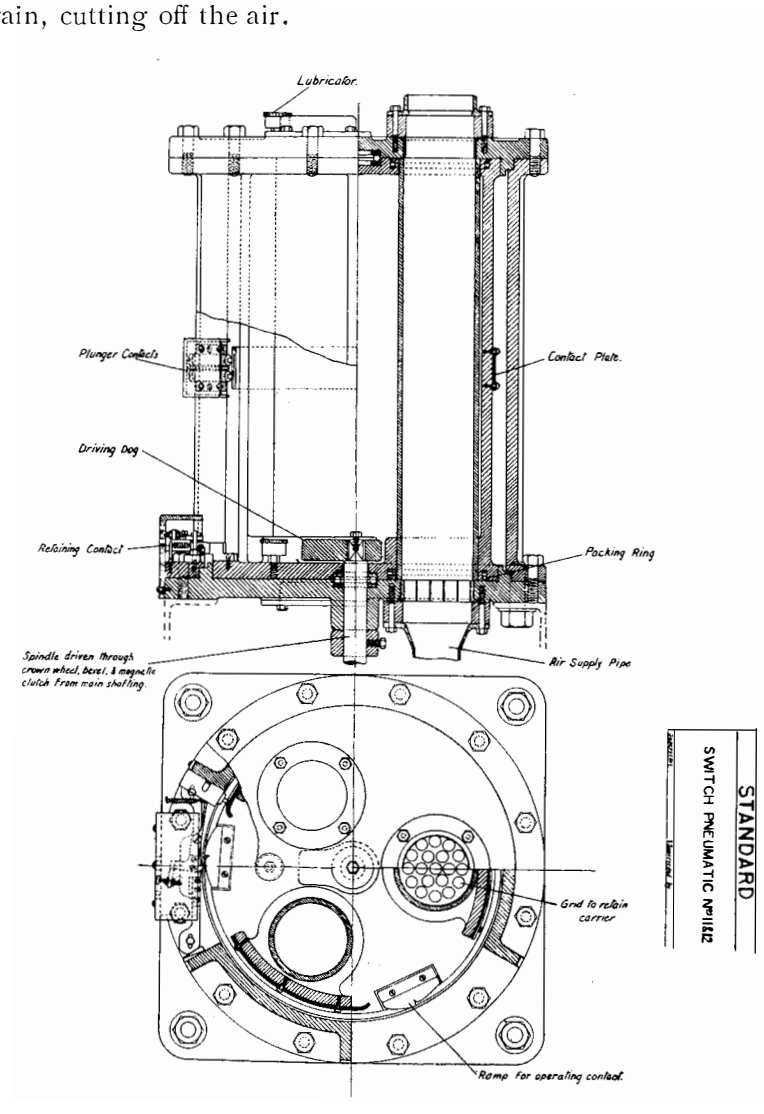


FIG. **10**.—PNEUMATIC SWITCH.

For sending on these tubes a similar arrangement was installed, but was not found to be quite satisfactory as no indication was given to the tube attendant that the air supply had actually been switched on. (In the case of a carrier being sent from an out office to the War Office it would not leave the attendant's hand

until the vacuum was on the tube.) On these tubes therefore a modified form of starting switch has been installed; the handle is first pressed in, sending the block signal, and then the arm is brought over to the " on " position, when the air valve is switched on and the arm held over by a retaining electro magnet.

When the carrier arrives at the distant office the attendant depresses his push button, clearing the block signal and releasing the switch arm, which is returned to the off position by a spring, cutting off the air supply.

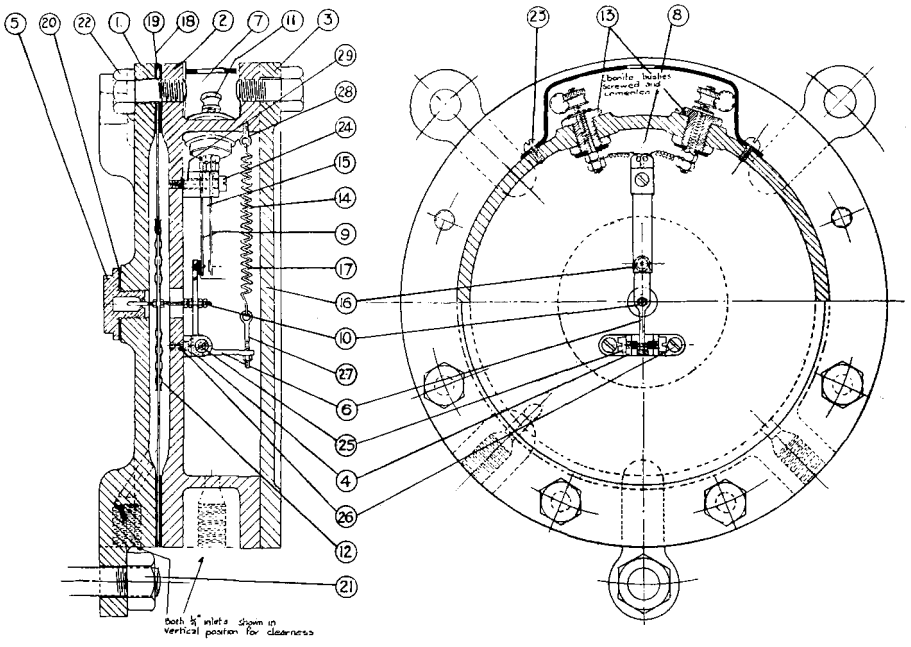


FIG. 11.—DIFFERENTIAL INDICATOR.

On tubes arranged for two-way working the signalling is automatic, but the control of the air supply is by hand. Automatic control of this by a further modification of the switch used when sending on short tubes, combined with the use of a Teleswitch for receiving, has been devised, but the wiring becomes very complicated and it is found that the arrangement used works well in practice.

The current for the signal circuits is supplied from rotary DC/DC converters (double-wound generators) at the War Office, power leads being run to the outlying offices, replacing the batteries shown in the illustration. The air supply valves and

magnetic clutches are connected to the public electricity supply mains.

Costs. The cost of the whole scheme, including laying certain tubes for newspapers from the C.T.O. (which are not served by

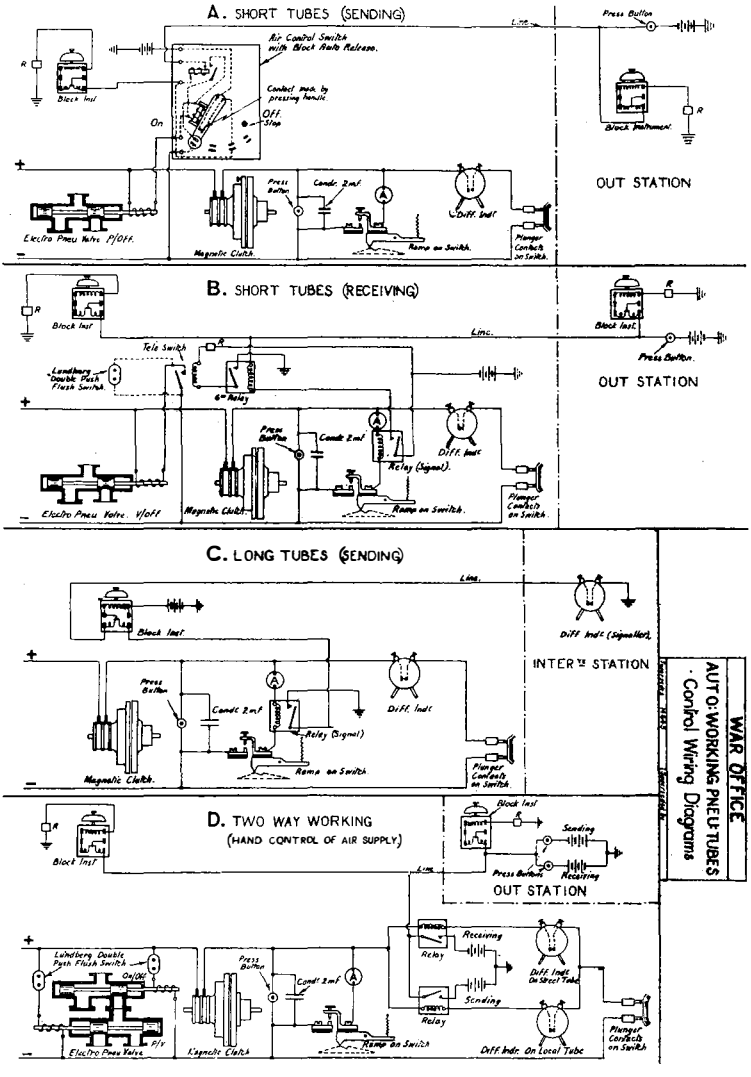


FIG. 12.—CONTROL DIAGRAM.

the War Office Centre but which were laid at the same time), the automatic switching apparatus, and all incidental charges, was in the neighbourhood of £60,000, and it may perhaps be of interest to know how such a large expenditure can be justified.

In the first place, the introduction of tubes admits of the abolition of transmission of telegrams by wire and the saving on this account alone, amounting to some thousands of pounds per annum, having regard to the number of offices served by the tubes, was calculated to justify the expenditure, while the introduction of automatic working results in a further considerable saving.

There are, however, other considerations. Although an individual telegram cannot perhaps be sent more quickly by tube than by wire, a number of messages can be conveyed in one carrier and the acceleration in transmission becomes very marked when large numbers of telegrams are handed in at one time, or where lengthy telegrams, or telegrams containing code or cypher, are required to be forwarded.

The provision of tubes for newspapers in the same trench as the trunk tubes afforded a means of supplying the facilities at a lower charge than would have been the case if it had been necessary to open the ground for the purpose, and at the same time the revenue from these tubes allows for a certain margin of profit and can therefore be regarded partly as a set-off against the interest charges on the initial outlay.

APPENDIX.

LIST OF OFFICES CONNECTED TO THE WAR OFFICE CENTRE.

Office.	Direction of working.	Diameter of Tube.	Remarks.
C.T.O.	*Via* Embankment	3″	The routes are used alternatively, one tube each way being sufficient to carry the traffic owing to the use of the intermediate signaller.
	Up	3″	
	Down		
	Via W. Strand	3″	
	Up	3″	
	Down		
Parliament St. B.O.	Up & Down	$2\frac{1}{4}$″	
Foreign Office	Up & Down	$2\frac{1}{4}$″	
Victoria Street and S.W.D.O.	Up	$2\frac{1}{4}$″	
	Down	$2\frac{1}{4}$″	
Admiralty	Up	3″	
	Down	3″	
Houses of Parliament	Up	3″	This tube is to be connected through to the C.T.O. at night time.
*W. Strand B.O.	Up	3″	
	Down	3″	
St. James St. B.O.	Up	$2\frac{1}{4}$″	
Charles Street	Up	$2\frac{1}{4}$″	
*Charing Cross Station	Up & Down	$2\frac{1}{4}$″	

* Not connected at time of writing.

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 31ST DEC., 1925.

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.
474,323	619	4,181	54,885	461	London	22,944	54,482	1,619,737	48,178
57,406	1,900	20,164	57,421	1,601	S. East	3,803	21,615	100,178	13,400
60,906	4,496	26,248	46,013	1,848	S. West	13,749	5,746	94,010	29,199
47,762	8,480	31,238	42,088	5,124	Eastern	12,860	26,687	56,477	45,699
80,108	8,521	41,715	52,442	3,118	N. Mid.	10,687	37,387	140,487	79,328
58,269	4,894	26,415	57,694	4,181	S. Mid.	12,099	16,168	112,592	84,950
51,876	5,087	28,697	45,527	1,895	S. Wales	5,229	19,262	85,457	67,082
84,728	8,118	24,291	43,619	5,244	N. Wales	12,087	34,272	161,885	48,264
130,937	1,652	17,142	45,812	2,954	S. Lancs.	12,696	68,280	347,712	31,931
78,365	6,322	30,118	41,922	2,641	N. East	8,205	31,223	175,319	24,933
52,700	3,645	23,969	36,429	2,485	N. West	8,358	30,412	103,646	32,892
40,064	2,465	15,535	24,049	2,140	North	3,383	8,738	71,651	47,585
18,392	4,833	6,074	11,837	197	Ireland N.	140	213	29,167	2
54,545	5,495	21,974	33,167	1,177	Scot. East	1,943	7,951	98,728	38,200
75,262	7,466	23,357	40,054	819	Scot. West	12,107	21,998	188,999	23,383
1,365,643	73,993	341,118	632,959	35,885	Totals.	149,290	384,434	3,386,045	615,026
1,334,917	74,332	337,558	624,507	36,055	Figures on 30th Sept., 1925.	150,189	359,235	3,292,280	572,197

AUTOMATIC EXCHANGE DEVELOPMENT.

PRESS BUTTON TYPE DIALLING EQUIPMENT FOR A POSITIONS.

By J. HEDLEY, M.I.E.E.

IN connection with the introduction of automatic exchange working in large multi-office networks, it generally happens that subscribers on certain nearby manual exchanges have a large community of interest with the subscribers on the automatic exchange.

Calls from the Museum manual exchange subscribers to the Holborn automatic exchange subscribers will be a particular case when the director system commences to operate in London. The present standard method of handling this class of traffic for the London system will be by means of order wire working from the manual exchange to a Cordless B. operator in the automatic exchange.

An experimental trial equipment will be installed in the Museum manual exchange, whereby the A operators at that exchange will be in a position to complete calls for subscribers on the Holborn automatic exchange without the aid of a B operator at the latter point and without increasing the value of the call to the Museum A operator.

The scheme proposed is as follows:—

1. Existing A position cord circuits and operators' telephone circuit unaltered.
2. Each position will be equipped with a sender lamp and strip of 10 keys of the press button type, similar to those being provided on Cordless B. positions; the key strip and lamp will be associated automatically with

common exchange sending equipment during the setting up of a call only.

3. Each position will be equipped with 4 or 5 jacks outgoing to the automatic exchange. These jacks will be individual to each position, and replace the regular outgoing junction multiple jacks, their location on each position to be such that the operators' reach is the shortest possible. The jacks will be associated with a common group of exchange sending equipment during the setting up of a call and also with a common group of junctions outgoing to the distant automatic exchange after the sending equipment has established connection.
4. The sender circuit as developed for Cordless B position working remains unaltered.

The circuit conditions are shown in the figure. It will be seen that each jack referred to in (3) is associated with a homing rotary line switch, the banks of which have access to a graded group of junctions to the automatic exchange and also to a second homing rotary line switch having access to a graded group of senders for accepting storing and transmitting the number set up by the A operator.

This scheme enables each position to have access to a common group of junctions and also a common group of senders.

The operating of a call will be as follows:—

1. A operator inserts answering plug, throws speaking key, and obtains calls from subscriber for, say, Holborn 2534.
2. A operator inserts calling plug into jack (individual to her position) labelled Holborn.
3. A operator repeats Holborn 2534 to calling subscriber and upon receipt of steady glow on position sender lamp, will set up on position key strip 2534;
4. Position sender lamp will flash during period of sending out impulses to Holborn Exchange, after which sender lamp will darken and standard supervisory signals will now be received on A operator's cord circuit.

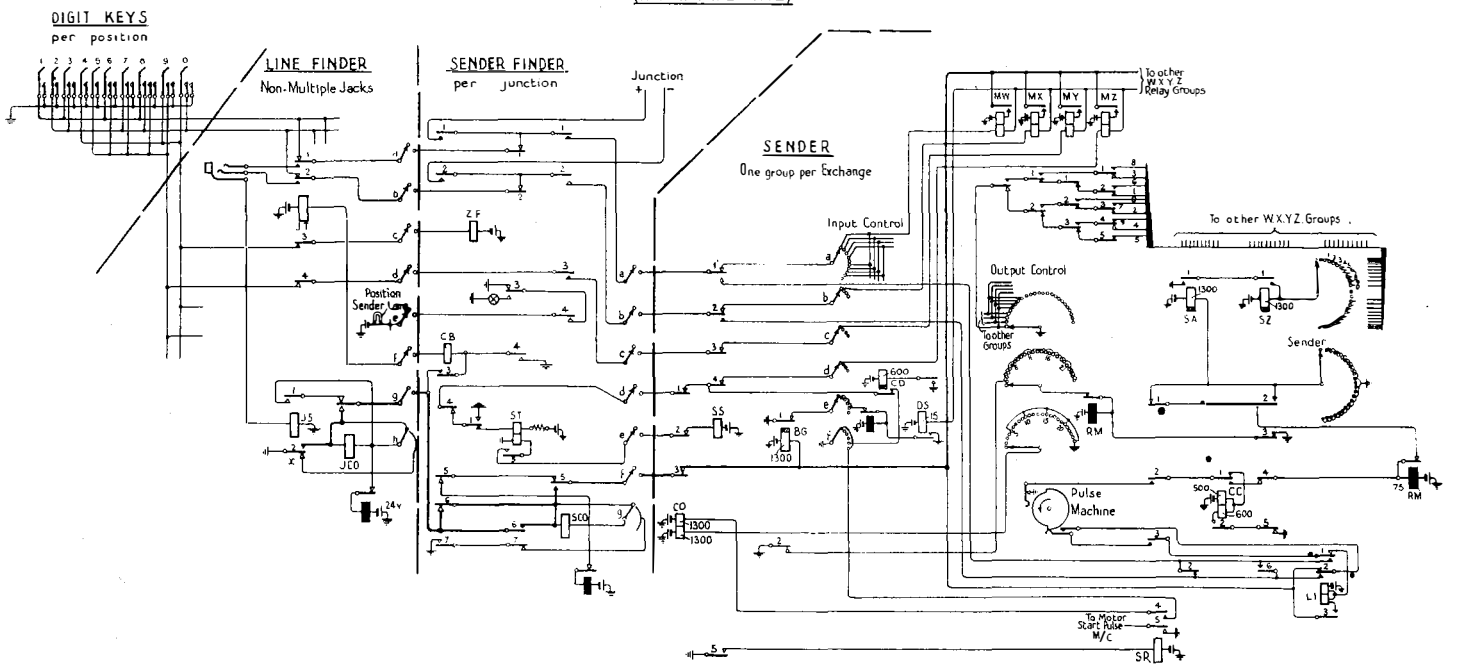
With individual jacks to Holborn on each position, the A operator will be able without testing for an idle jack to insert the calling plug into a vacant jack labelled Holborn, as soon as she hears the exchange name Holborn passed by the calling subscriber, *i.e.*, operation (2) will be an overlapping operation between (1) and (3).

The circuit operations are as follows:—

1. Operator inserts calling plug into jack, Relay JS energises and joins earth to home contact of wiper

MANUAL EXCHANGES. DIALLING-IN TO AUTOMATIC EXCHANGES.

AUTOMATIC LINE FINDER AND KEY SENDING EQUIPMENT (EXPERIMENTAL)



"*h*," to operate jack rotary line switch, which rotates to find idle junction.

2. When idle junction found, JCO operates and places earth on wiper "*g*," which is extended *via* normal contacts 6 of relay CB to home contact of wiper "*g*" to operate sender rotary line switch, which rotates to find idle sender.
3. When idle sender found SCO operates and is held *via* normal contact 6 of CB, wiper "*g*," operated contacts of JCO and JS; operated contact 5 of SCO extends earth *via* wiper "*f*" to engage sender, operation of SCO also extends digit key circuit, through to sender.
4. Position sender lamp glows *via* wiper "*e*" operated contact 4 of SCO and normal contact 3 of ST.
5. Operator sets up number on digit keys, after which relay ST operates, *via* its own contact 1, contact 4 of CB, wiper "*d*" contact 1 of CO, operated contacts of CD and earth on sender input control switch. ST locks in series with SS of sender. Position sender lamp now flashes from contact 3 of ST.
6. Relays JT and CB operate in series *via* contact 4 of ST and lock *via* contact 3 of CB wiper "*g*," contacts JCO and JS, *i.e.*, relays JT and CB are maintained in an operated condition until plug withdrawn by operator. Relay JT disconnects digit keys from the circuit. Relay CB extends the junction to the sender and leaves the operation of SCO dependent upon ST.
7. When digits sent out from sender, CO operates, disconnecting SS, which releases ST, thereby disconnecting position sender lamp and de-energising SCO, thus causing sending rotary line switch to return home and joining junction line through to jack for standard supervisory conditions to be obtained on A operator's Cord Circuit.

The advantages of direct dialling by an A operator are:—

1. B operator eliminated, reducing possibility of error due to wrong numbers, after call received from subscriber.
2. Fatigue of A operator reduced, due to short reach with calling plugs.
3. Operating simplified, as after number set up, call proceeds automatically.
4. Better service, as 4 figure number can be set up within two seconds after repeating to calling subscriber.
5. Better service, as errors confined to one operator only.
6. Fewer A operators required, as call value reduced.

LEEDS TELEPHONE AREA.

OPENING OF NEW AUTOMATIC EXCHANGES.

H. W. Dipple, A.M.I.E.E.

The opening of the new automatic exchanges at Chapeltown, Headingley, Roundhay, and Stanningley, on 7th November, 1925, represents a further stage in the conversion of the Leeds area to Automatic working. The scheme was planned by the Post Office in 1913, but owing to war-time difficulties it was not until 18th

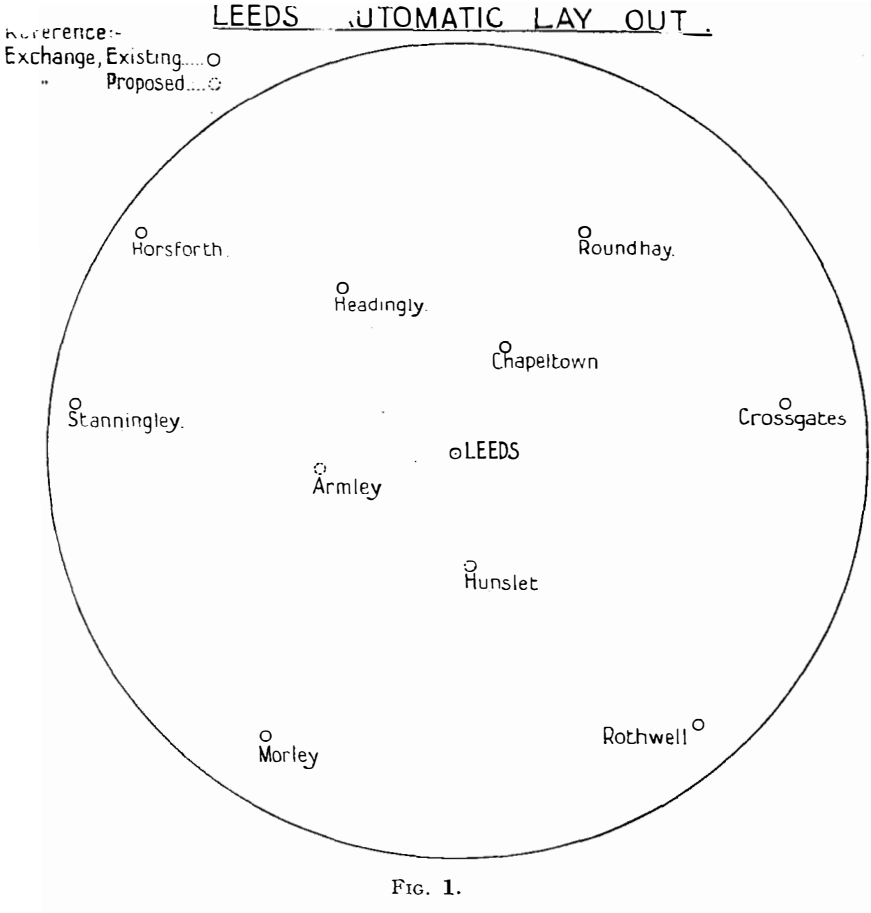


Fig. 1.

May, 1918, that the Leeds Automatic Exchange, representing the first stage of the scheme, was brought into use. The many post-war difficulties have had their effect in delaying the second stage of the scheme until the end of last year.

Fig. 1 shows the existing and projected exchanges within the 5 mile radius from Leeds. A satellite exchange will be opened at

Armley in 1927 to serve subscribers at present connected to Leeds Exchange.

About 1933 it will be economical to open a Satellite to serve the district around Hunslet, which is at present served from Leeds.

The small Exchanges at Crossgates, Horsforth, Morley, and Rothwell will continue to work as Manual Exchanges for several years.

With the Automatic Exchanges now in use, however, approximately 80% of the subscribers in the Leeds area are receiving automatic service.

The present and ultimate equipments of the Leeds Exchange and the four sub-exchanges are :—

	Present.	*Ultimate.*
Leeds	9600 lines ...	14000 lines.
Chapeltown ...	1300 ,, ...	2100 ,,
Headingley ...	1500 ,, ...	2400 ,,
Roundhay	1200 ,, ...	2000 ,,
Stanningley ...	800 ,, ...	1500 ,,

An extension of the equipment at Stanningley is in hand which will bring the present equipment up to 1000 lines. Five figure numbers are in use throughout the area, the scheme of numbering at present being as follows :—

Leeds	20000-29599
Chapeltown	41000-42299
Headingley	51000-52499
Roundhay	61000-62199
Stanningley	71000-71999

The range of numbers 38000-39299 has been allotted to Armley new Exchange, and 34000-35599 has been reserved for the projected Exchange at Hunslet.

The equipment at each of the new exchanges is standard Strowger appartus manufactured by the Automatic Telephone Manufacturing Company, of Liverpool.

Fig. **2** shows the Preselector side of the Line Switch Units at Roundhay.

Fig. **3** shows the Final Selector side of the Line Switch Units at Headingley.

Fig. **4** is a general view of the Chapeltown Exchange showing the Line Switch Units and the Switching Selector Repeater Board.

Fig. **5** shows in the left foreground the Outgoing Junction Preselectors at Stanningley exchange. At the rear are the Switching Selector Board and the 3rd Selector Board.

All exchange equipments are housed in buildings specially designed by the Office of Works for the purposes of automatic telephone exchanges. To meet the developments that are taking place in the residential portion of Leeds, rearrangements of the boundaries of the territory served by several of the sub-exchanges were necessary. These rearrangements tended to complicate the general scheme of transfer, and in view of this it was decided the transfer should be effected at twelve o'clock midnight, when it was expected the traffic would be very light. The scheme of transfer included the following :—

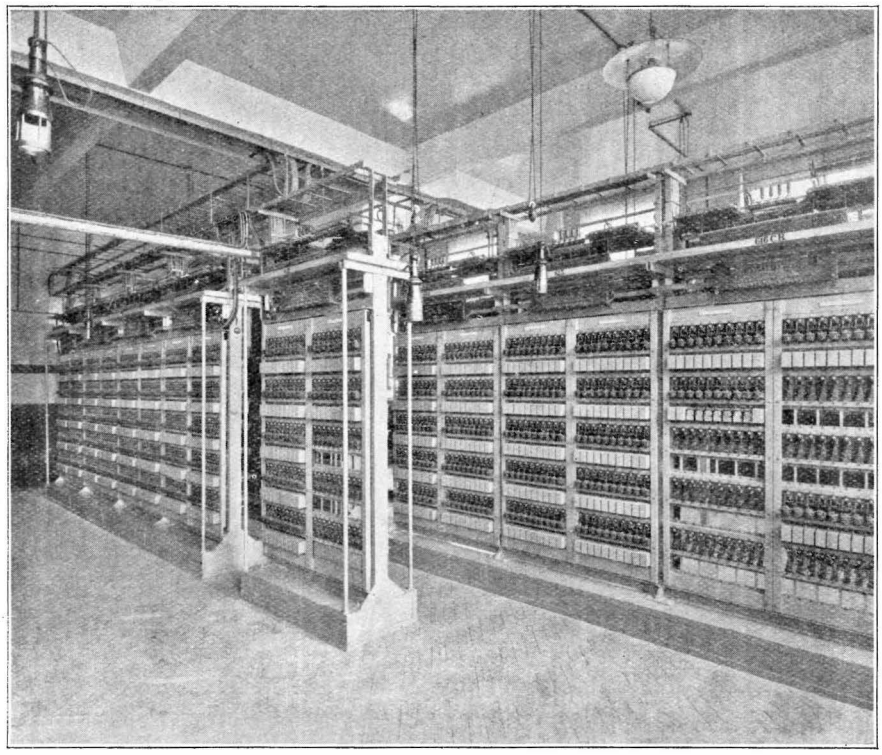


FIG. 2.—ROUNDHAY—LEEDS EXCHANGE. ROTARY LINE-SWITCH UNITS.

(*a*) Conversion of 3,602 subscribers and 553 Junctions to automatic working.

(*b*) Transfer of 147 subscribers from Leeds Exchange to Headingley.

(*c*) Transfer of 21 subscribers from Leeds Exchange to Chapeltown.

(*d*) Transfer of 227 subscribers from Roundhay Exchange to Chapeltown.

(*e*) Transfer of 133 subscribers from Chapeltown Exchange to Roundhay.

(*f*) Rearrangement of circuits at the Leeds Manual Exchange.

(*g*) Rearrangement of Junction circuits at the Leeds Automatic Exchange.

The conversion of the 4 sub-exchanges together with the rearrangements at Leeds Automatic and Manual Exchanges, represent in effect six separate transfers carried out simultaneously. The work required careful organisation and testing out, and the

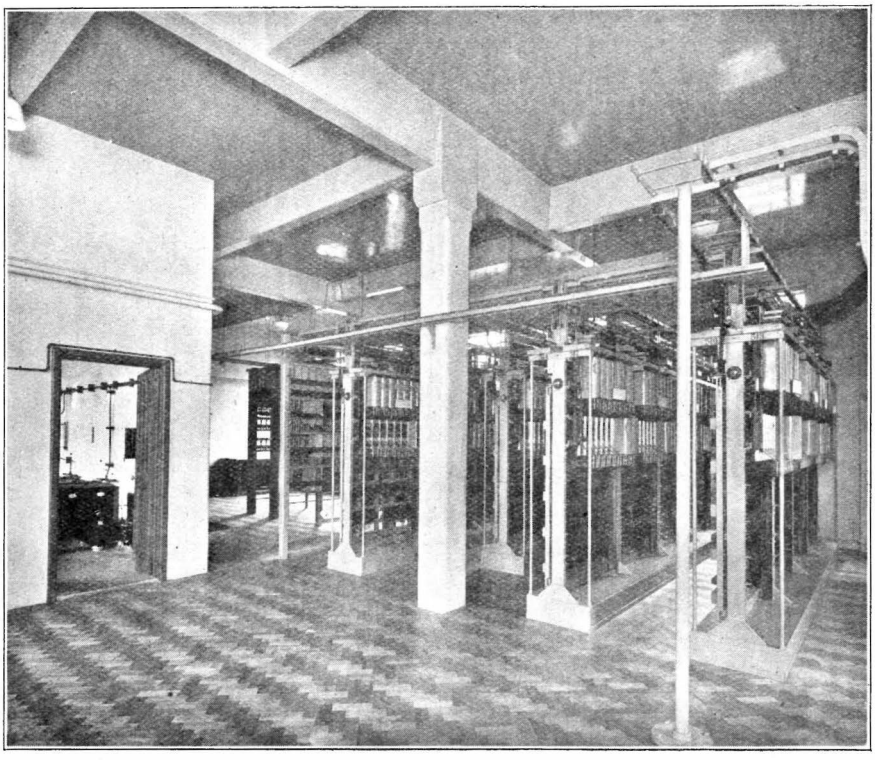


FIG. 3.—HEADINGLEY—LEEDS EXCHANGE. GENERAL VIEW.

smoothness with which the transfer was effected and the comparatively few faults experienced, reflects great credit on the local engineering force at Leeds.

As was anticipated, the traffic at midnight was negligible, and this enabled the "permanent loops" due to receivers off, external line faults, etc., to be quickly detected and plugged out at the M.D.F. Up to the time of the transfer the weather had been very bad, with high winds and rain for thirty hours. In spite of this,

however, the number if lines so plugged was only 114, representing 3.1% of the subscribers' lines transferred. In view of the bad weather conditions this may be regarded as very satisfactory.

Each of the exchanges is a satellite on Leeds exchange, and a feature of the switching scheme is the use for the first time in this country of Switching Selector Repeaters.

A Switching Selector Repeater combines the function of an Outgoing Repeater for calls to other Automatic exchanges, with that of a Selector for calls to subscribers on the same exchange. When a subscriber on the Satellite dials a number within the range

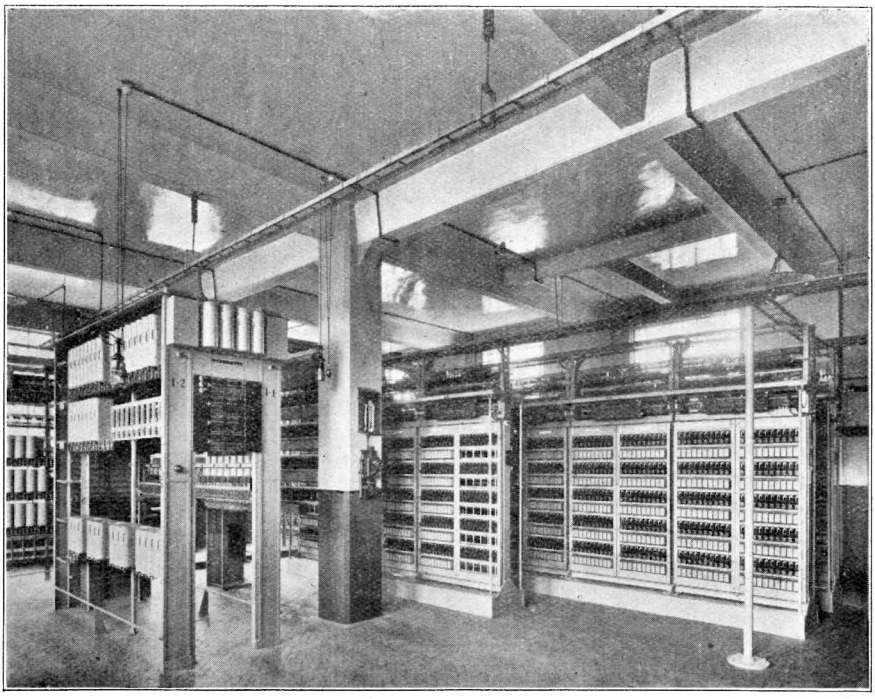


FIG. 4.—CHAPELTOWN—LEEDS EXCHANGE. GENERAL VIEW.

of numbers allotted to that satellite, *i.e.*, a local call, the apparatus acts as a Selector Switch, the Repeater equipment being switched out of circuit. When a number other than a local number is dialled, the apparatus acts as a Transmission Bridge and Impulse Repeater.

With each Selector Repeater is associated a Junction Preselector, which tests for and connects an outoing junction to the Selector Repeater. On all originating calls, therefore, a calling

subscriber on lifting the receiver is connected to a Selector Repeater, and also to a 1st Selector at Leeds Exchange. When dialling takes place the Switching Selector Repeater and the 1st Selector operate simultaneously until the digits which determine whether a call is local or not have been dialled. On local calls, when " switching " takes place the 1st Selector at Leeds is released and the junction and 1st Selector become available to other calling

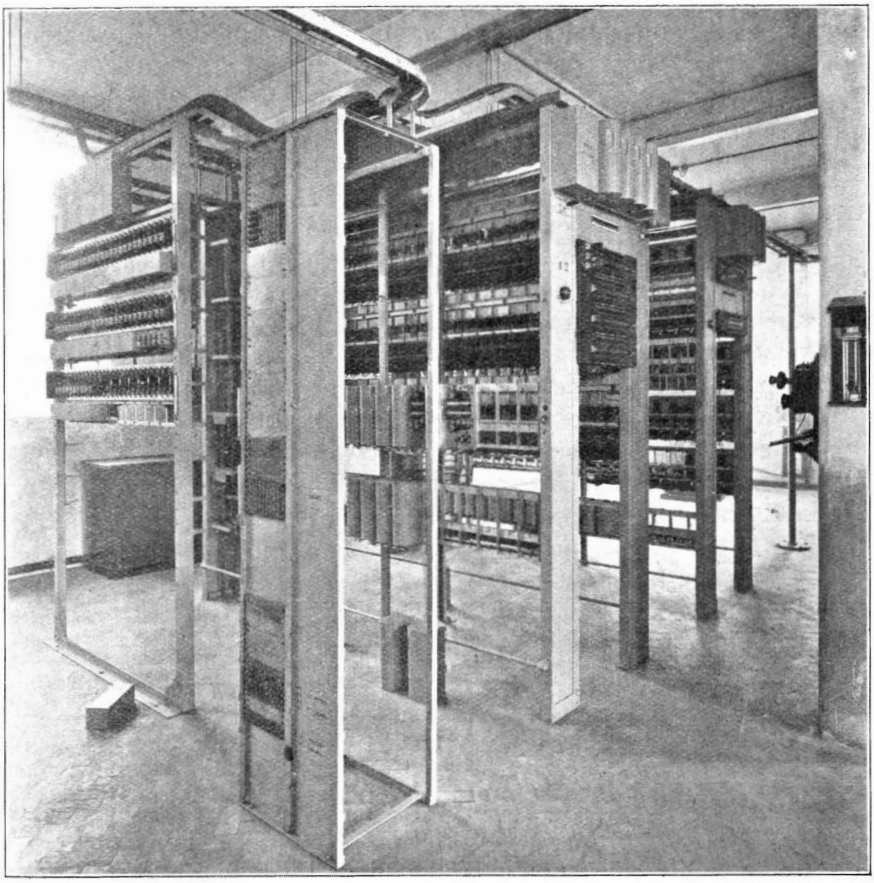


FIG. 5.—STANINGLEY—LEEDS EXCHANGE. OUTGOING SECONDARY LINE-SWITCH RACK AND SELECTOR TRUNK BOARDS.

subscribers. " Switching " may take place on the 1st, 2nd, or 3rd digit according to the numbering scheme, but in the case of the Leeds Satellites the first digit determine whether the call is local or not. A " Digit Absorbing " feature is incorporated in the Switching Selectors to enable them to be used both as 1st and 2nd Selectors on local calls. This special feature consists of a

circuit arrangement which operates the Release magnet and restores the switch to normal after the first digit has been dialled. Assuming the case of a local call, when the initial digit is dialled the wipers of the Selector Repeater are raised to the corresponding level, and are then rotated to the first contact of the level. The Release magnet circuit then operates and the wipers are returned to normal. When the second digit is dialled the Switch functions as a 2nd Selector in the normal manner, and after the wipers have selected a free trunk to the next rank of switches, the Repeater portion of the apparatus is switched out, and the outgoing junction to Leeds Exchange is released. The remaining digits of the number operate the local switches, *i.e.*, the 3rd and Final Selectors. A separate group of circuits is provided for short trunk traffic, so that when 0 is dialled the call is routed direct from level 0 of the Selector Repeaters to the Manual Board. This arrangement makes for economy in external plant, as it is necessary to provide circuits of high grade transmission only for the circuits direct to the Manual Board. The use of level 0 of the Selector Repeaters for direct Manual Board circuits precludes the use of the digit 0 at the second digit in subscribers' numbers, as will be seen from the numbering scheme for the Satellite Exchanges. Fig. **6.** Figs. A to F indicate various methods of routing calls from a Satellite Exchange equipped with Selector Repeaters.

Figs. A and B show the routing of calls *via* 1st Selectors at the Main Exchange, the apparatus acting as a Repeater.

Fig. C shows the routing of calls over direct 0 level junctions. The apparatus functions as a Selector Switch, a special Outgoing Junction Repeater being provided.

Fig. D may be used in 4 figure systems where the number of lines on the Satellite exceeds 1000. The apparatus functions as a 1st Selector.

Fig. E is used on 5 figure systems where the number of lines on the Satellite exceeds 1000. The apparatus functions both as a 1st and 2nd Selector.

Fig. F is used on 5 figure systems where the number of lines on the Satellite does not exceed 900 and where direct 0 level junctions to the Manual Board are provided. The apparatus functions as a 1st, 2nd and 3rd Selector.

Each switching Selector is provided with two "Private" wipers and two contacts on each private level of the bank contacts, these being known as the P1 and P2 wipers and contacts respectively. On levels used for local calls, and the "0" level when direct Junctions to the Manual Board are provided, the contact banks of the Switching Selectors have the +, −, and P2 contacts multipled together. On other levels the contacts are left

SWITCHING SELECTOR REPEATERS

A. T. M. Co's System.

Schematic Diagram of various methods of Routing Calls

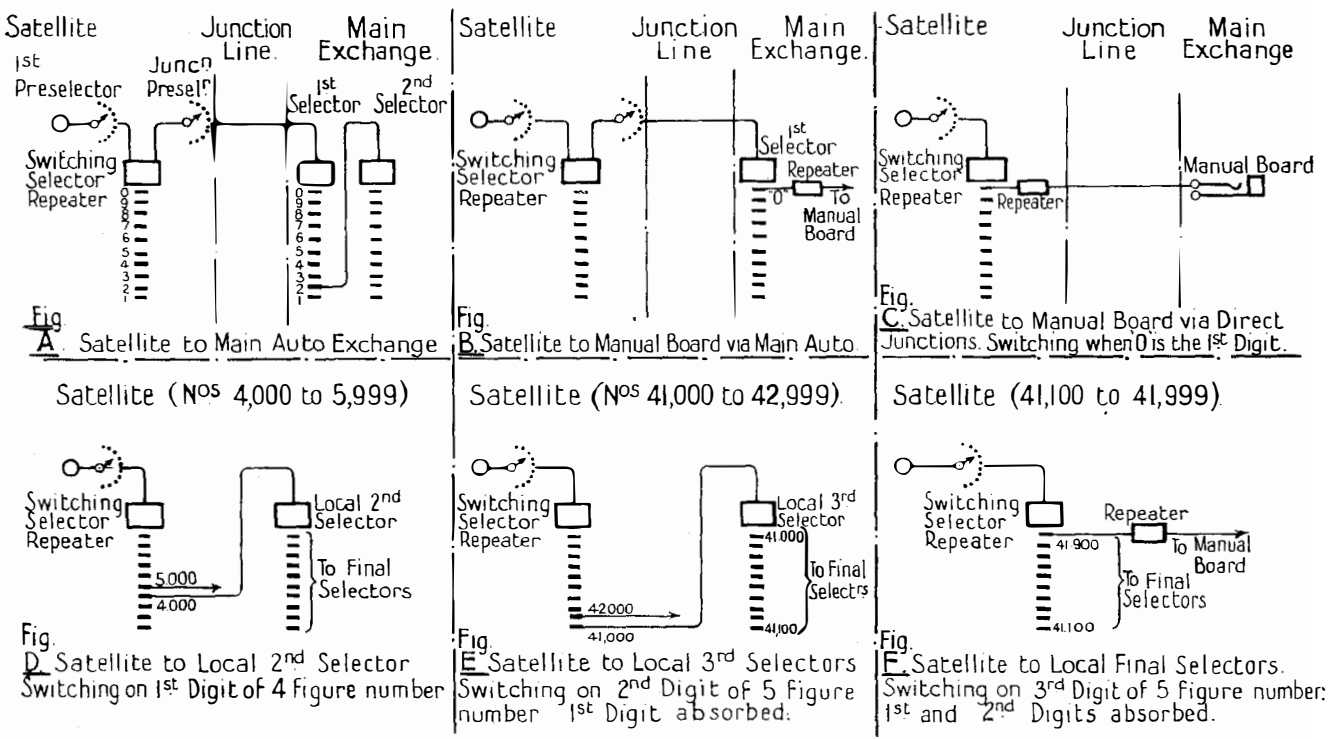


FIG. 6.

unwired, except that the first P1 contact of the level corresponding to the first digit of the local numbers is earthed *via* the Switching Selector Repeater circuit.

Fig. 7 shows a typical bank wiring scheme for a Satellite numbered 41000—42999. When the initial digit 4 is dialled, the wipers are raised to the fourth level and are then rotated to the first contact. The earth on the P1 contact completes the release magnet circuit and the wipers are returned to normal. When the second digits, 1 or 2 are dialled, the switch functions as a 2nd Selector in the normal manner. For calls to other exchanges, the wipers are lifted to the level corresponding to the initial digit, and

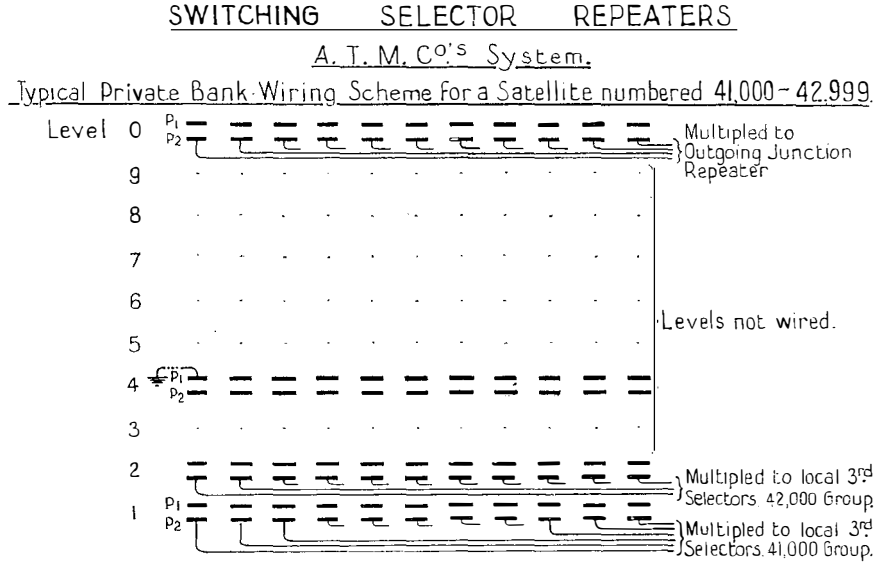


FIG. 7.

remain at that level until the release takes place at the termination of the calls, the apparatus acting as a repeater only, for the remaining digits of the number.

CIRCUIT DESCRIPTION OF CALL TO MAIN AUTO EXCHANGE. FIG. 8.

Selector Repeater. The operation of the subscribers' Line Switch when the receiver is lifted extends the calling line to the Selector Repeater, and the A relay is operated *via* the subscribers' loop.

The A relay operates to—

(1) Prepare a loop to energise the A relay of the 1st Selector at the Main Exchange.

(2) Operate relay B of the Selector Repeater.

Relay B operates to—

(1) Complete Release trunk circuit *via* normal contacts of K to earth.

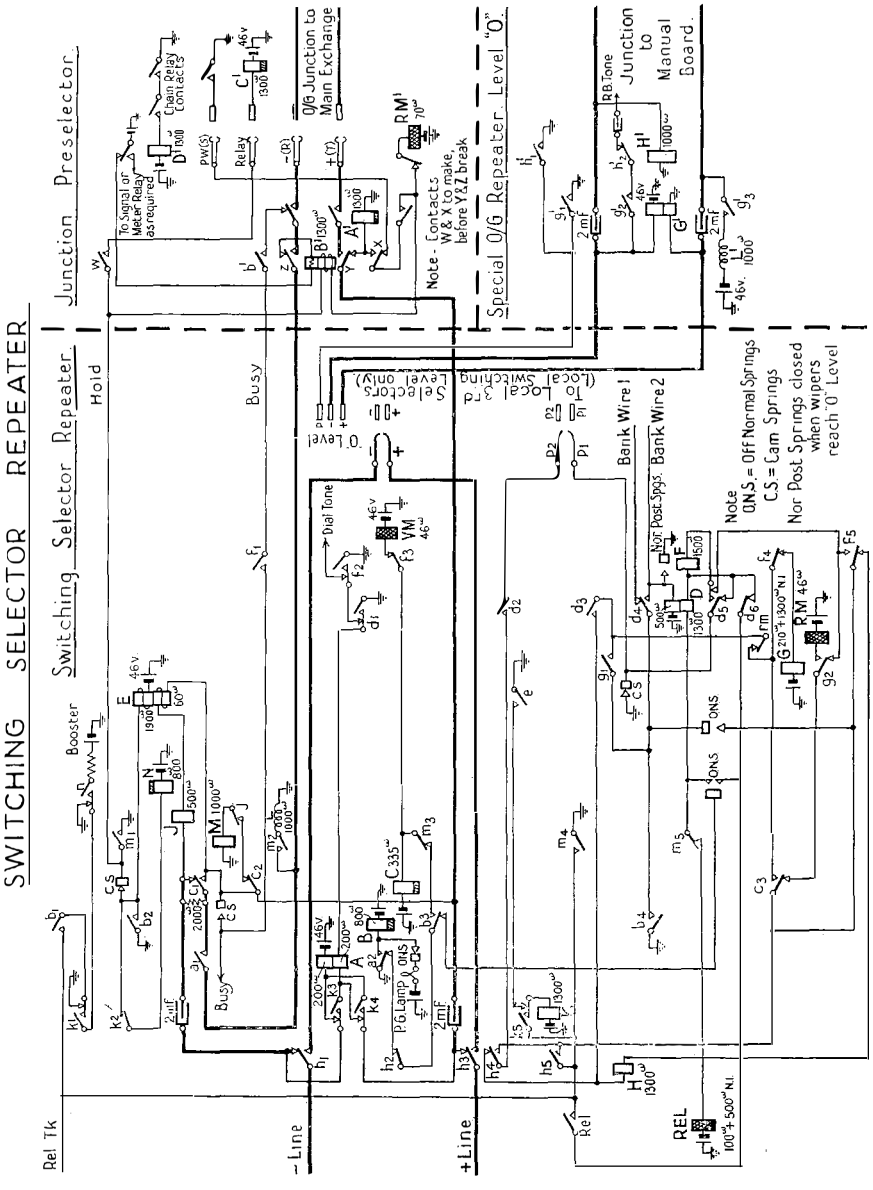


FIG. 8.

(2) Earth the Bank Wire No. 1 *via* normal contacts of D.

(3) Earth "Hold" wire of Junction Preselector *via* normal contacts of cam springs.

(4) Complete the 1900 ohm polarising winding of relay E, which does not operate on this winding alone.
(5) Prepare the circuit of the vertical magnet.
(6) Operate relay N to prepare the metering circuit.

Junction Preselector. The A1 relay of the Junction Preselector operates by battery from normal contacts of D, 300 ohm non-inductive winding of B1, – line, operated contacts of A of the Selector Repeater, normal contacts of C, winding of J, 60 ohm winding of E, + line, winding of A1 to earth. Relay A1 completes a circuit for the Rotary magnet through normal contacts of B1 to PW wiper. Should the Preselector be standing on a busy junction, earth on the PW contact will short-circuit the 1300 ohm winding of B1, and will step the Preselector round in search of a free junction. When a free junction is reached, the PW circuit will be "open" and relay B1 will operate by battery through Rotary magnet to earth at Hold wire.

The operation of Relay B1 of the Junction Preselector—
(1) Switches the + and – lines through.
(2) Complete a circuit *via* the Hold wire for relay C1, which operates and earths the PW circuit, thus making the junction busy.
(3) Completes a circuit for relay A1 which is now held operated by battery through Rotary magnet, operated contacts of A1 and operated contacts of relay B1.

The Rotary magnet will not operate in circuit with the windings of relays A1 and B1 in parallel.

The calling subscriber is now extended over a junction to a 1st Selector in the Main Exchange, which is held operated by the loop circuit in the Selector Repeater previously described, and which will operate in synchronism with the Selector Repeater until after the first digit is dialled. Relay E of the Selector Repeater does not operate at this stage as the current through the 60 ohm winding opposes that in the 1900 ohm winding.

Impulses Received. When the first digit is dialled, relay A of the Selector Repeater falls back at the first break of the dial springs, and a circuit is completed for the vertical magnet through normal contacts of relays F and M, operated contacts of B, normal contacts of H, to earth at A. Relay C also operates in parallel with the vertical magnet and remains operated during the train of impulses. The vertical magnet operates each time the A relay falls back, and lifts the wipers to the level corresponding to the digit dialled.

The C relay operated to—
(1) Prepare the circuit of relay G.

(2) Disconnect relay M from the + line.

(3) Open the circuit through relay J and the 60 ohm winding of E, and substitute a direct loop to the 1st Selector at the Main Exchange. A 2000 ohm non-inductive resistance is bridged across the – line contacts of C to prevent the Selector Switch ahead being given a false impulse during the operation of C.

At the first vertical step of the Selector Repeater, the off-normal springs operate to—

(1) Complete the circuit of relay G, which operates through normal contacts of F, operated contacts of C, off-normal springs, to earth at operated contacts of B.

(2) Prepare the Release magnet circuit.

(3) Short-circuit the 1300 ohm winding of D.

Relay G operates and locks up *via* normal contacts of F, normal contacts of Rotary magnet, operated contacts of G, operated contacts of B to earth, in order to prepare the circuit for the first rotary step.

At the completion of the dialling of the first digit, relay A remains held by the subscribers' loop and opens the circuit of relay C which releases and

(1) Restores the circuit through relay J and the 60 ohm winding of E to the switch ahead, which remains held through the windings of these relays.

(2) Operates the Rotary magnet *via* operated contacts of G, normal contacts of C, off-normal springs, to earth at operated contacts of B.

Rotary Motion. The Rotary magnet operates and

(1) Steps the wipers on the first bank contact.

(2) Opens the circuit of relay G which releases.

The release of relay G

(1) Opens the Rotary magnet circuit, thus allowing the wipers to remain on the first contact of the level dialled.

(2) Operates relay F by battery through release magnet normal contacts of M, off-normal contacts, normal contacts of D, winding of F, normal contacts of D and G, normal contacts of C, off-normal contacts, to earth at operated contacts of B. The release magnet does not operate in series with F.

The operation of F breaks the circuit of relay G and also the vertical magnet, thus preventing any further impulsing on the Selector Repeater.

Any further impulses to complete the required number will be repeated by relay A to the selectors at the Main Exchange.

Metering a Call. When the called subscriber answers, the current flow over the junction through the 60 ohm winding of E will be reversed, and as the two windings now assist each other, relay E will operate to

(1) Complete the circuit to operate relay K, which then locks to earth at release trunk.

The operation of relay K—

(1) Completes the booster battery circuit *via* operated contacts of N, operated contacts of K and B, to release trunk and subscribers' meter.
(2) Open the circuit of N, which releases slowly.
(3) Reverses the current to the calling subscriber.

Relay N being slow to release, holds its contacts long enough for one metering impulse to be given to the subscriber's meter, and when finally released connects earth to the release trunk.

Release. When the called subscriber restores the receiver, relay A is released to

(1) Open the loop across the junction line, thus releasing the switches at the Main Exchange.
(2) Release relay B.
(3) Prepare circuit of release magnet.

Relay B restores and completes release magnet circuit, which now operates by a circuit through normal contacts of M, off-normal springs, normal contacts of B, H and A.

The operation of the release magnet returns the switch to normal and maintains earth on the release trunk *via* the off-normal springs until the switch has actually returned to its normal position.

The release of the Selector Repeater removes earth from the "Hold" wire of the Junction Preselector, thus releasing the A1, B1, and C1 relays of that switch. Relays A1 and C1 release slowly and maintain a circuit for the rotary magnet *via* the normal contacts of B1 for a sufficient length of time to allow the switch to rotate to the next free junction. This is done, so that should the first junction selected be faulty, the calling party on making another call would not be connected to the same junction.

All Outgoing Junctions Busy. If, when a call is made, all the outgoing junctions are busy, the calling subscriber will receive the busy tone after dialling the first digit.

The C1 relay of each Junction Preselector when operated prepares a portion of a circuit to operate relay D1, and when all C1 relays in the group are operated, relay D1 operates to disconnect battery from the 300 ohm non-inductive winding of the B1 relays, thus preventing the operation of the A1 relays. When a call is

originated, therefore, the B1 relay will be operated immediately the "Hold" wire is earthed at the Selector Repeater.

When the first digit has been dialled, relay F of the Selector Repeater operates as previously described, and completes the busy tone circuit. Busy tone is now given to a calling subscriber *via* operated contacts of relays F and B1, normal contacts of A1, operated contacts of B1, to negative line.

Circuit Description of a Local Call.

Call to a Local Number—1st Digit Dialled. The circuit operation of the Selector Repeater is as previously described up to the stage when the vertical impulses cease and the switch rotates to the first bank contact of the level corresponding to the digit dialled.

Assuming that the first digit of the local number is 4, the first P1 contact of level 4 will be connected to earth *via* bank wire No. 1, normal contacts of relay D, to earth at operated contacts of B. When the wipers reach the P1 contact, a circuit is completed for the release magnet *via* normal contacts of M, off-normal contacts, normal contacts of D, wiper P1, bank contact P1, bank wire No. 1, upper normal contacts of D, to earth at operated contacts of B. Relay D will not operate at this stage as the 1300 ohm winding is short-circuited through the off-normal contacts. Relay F is also short-circuited by the earth at the P1 contact. The release magnet operates to release the switch and to provide a locking circuit for itself *via* the off-normal contacts to earth at the release trunk to ensure that release takes place and also to operate relay D by its 1300 ohm winding.

When the shaft returns to normal, the off-normal contacts are broken, and

(1) Removes short-circuit from 1300 ohm winding of D.
(2) Disconects earth *via* P1 wiper from release magnet.

Relay D now operates in series with the release magnet to

(1) Lock up through its 500 ohm winding to earth at operated contacts of relay B.
(2) Open the circuit of its 1300 ohm winding.
(3) Disconnect earth from bank wire No. 1 and private wiper P1.
(4) Prepare a short-circuit on relay H.
(5) Disconnect Dialling Tone from subscriber's line.

Second Digit Dialled. When the second digit is dialled, the operation is as previously described except that immediately the switch steps off normal and relay G operates, the short-circuit on

relay H is completed *via* off-normal springs, operated contacts of relays D and G, and normal contacts of relay F.

When the impulses cease, relay C releases and operates the rotary magnet as previously described.

Rotary Motion. If the first trunk is engaged, the P2 contact will be earthed. Relay G after releasing when its circuit has been opened by the rotary magnet interrupter springs, will operate again *via* the earth on P2 contact. The earth on P2 also maintains the short-circuit on relay H, in order that it shall not operate until a free trunk is found. The wipers are thus stepped round until a free trunk is found or until they pass off the 10th contact.

All Trunks Busy. The wiper shaft at the 11th rotary step operates the cam springs, which

(1) Opens the "Hold" trunk to the Junction Preselector, releases the junction and consequently the 1st Selector at the Main Exchange.
(2) Places busy tone on the line to the calling subscriber.
(3) Operates relay F by battery through release magnet, 1300 ohm winding of relay D, winding of F, operated contacts of D, to earth at cam springs.

Relay F operates to open the circuit of relay H and thus prevent release of the Selector until the calling subscriber restores receiver.

Free Trunk Found. If a free trunk is found, relay G on restoring after its circuit has been opened by the rotary magnet interrupter springs, removes the short-circuit from relay H, which operates in series with relay G *via* normal contacts of F, rotary interrupter springs, operated contacts of D, winding of H off-normal springs, to earth at operated contacts of B. Relay G does not operate in series with H.

The operation of relay H—

(1) Extends the calling line to the next rank of switches.
(2) Extends the release trunk to private wiper P2 *via* operated contacts of D.
(3) Opens the circuit of relays A and B, which release and open the circuit to the Junction Preselector and to the 1st Selector at the Main Exchange.

Remaining Digits. The remaining digits operate the switches ahead in the normal manner. Operation of the calling subscriber's meter is effected by the final selector.

Calling Subscriber Clears. When the calling subscriber restores the receiver, the release of the relays in the Final Selector removes earth from the release trunk, thus releasing relay H. The

release of H completes the circuit for the release magnet, and release then takes place in the usual manner.

Calls to Manual Board Direct from Selector Repeater. The operation of the Selector Repeater when 0 is dialled as the initial digit, is as described for local calls except that when the wipers reach the tenth level the "Normal Post" springs operate to complete a circuit for the 500 ohm winding of relay D. Relay D operates to

(1) Disconnect dialling tone.
(2) Allow relay H to operate in series with relay G, and thus extend the subscriber's loop and the release trunk to the Special Outgoing Repeater.

Relay G1 of the Special Repeater operates *via* the calling subscriber's loop, and

(1) Earths release trunk.
(2) Connects audible ringing signal to calling subscriber.
(3) Completes circuit of Retard Coil L1 of Repeater *via* B line of junction to line relay at Manual Exchange.

Operator Answers. When the answering plug is inserted in the answering jack, battery from the ring side of the plug passes over the A line of the junction to operate the H1 relay of the Repeater. Standard supervision is given to the operator by the calling subscriber, but it will be seen that so long as the answering plug is in the jack, relay H1 is held operated to maintain earth on release trunk and prevent the subscriber from releasing the connection. The operator thus controls the connection.

Calls to Manual Board via Main Auto Exchange. The Selector Repeater is designed to give similar control when calls are made *via* the 1st Selector at the Main Exchange. When, say 91, is dialled, the 1st Selector at Leeds extends the line through a Special Repeater to the Manual Board.

The loop *via* relay J and the 60 ohm winding of E in the Selector Repeater, completes a circuit for the line relay in the Special Repeater at the Main Exchange and the calling lamp lights. When the operator inserts the answering plug, the Special Repeater connects battery to both the + and − line of the junction. The effect of this is to de-energise relay J of the Selector Repeater. The release of relay J completes a circuit for relay M, which operates by battery over the + line.

The operation of relay M—

(1) Earths the release trunk.
(2) Earths "Hold" trunk to Junction Preselector.
(3) Connects retard L to the − line.
(4) Breaks release magnet circuit.

Standard supervision is given to the operator, and the subscriber cannot release the connection until the answering plug is withdrawn and relay M released.

The equipments were manufactured and installed by the Automatic Telephone Manufacturing Co., Liverpool, to whom we are indebted for the photographs illustrating the article.

TIME SAVING TESTERS.

FOR AUTOMATIC EXCHANGES.

By W. PRICKETT AND H. S. SMITH.
(Engineer-in-Chief's Office).

AUTOMATIC exchange plant, installed for the Department by contractors, is subjected before acceptance to a series of tests. In the April 1925 issue of this Journal, a brief survey of these necessary preliminary tests was made and a promise was given that they would later be described in greater detail. The present article is the first of a series intended to fulfil that promise.

Formerly the tests were made by the ordinary manual method. But this was slow and not so reliable as it might be and in 1923, when it came into competition with the new method of automatic testing, it was definitely relegated to second place. During the installation of the L.C.C. P.A.B.X., in the County Hall, Westminster, which was the first of the series of exchanges installed for the Department to be equipped with the now standard rotary type of line switch, the testing was begun by the old manual method, but the opportunity was taken of trying out an automatic tester (described later in the article) and of comparing the result. As an Irishman might say, there was no comparison. The automatic method at once took and still keeps the lead, although the manual method is still used for tests for which automatic methods have not yet been devised.

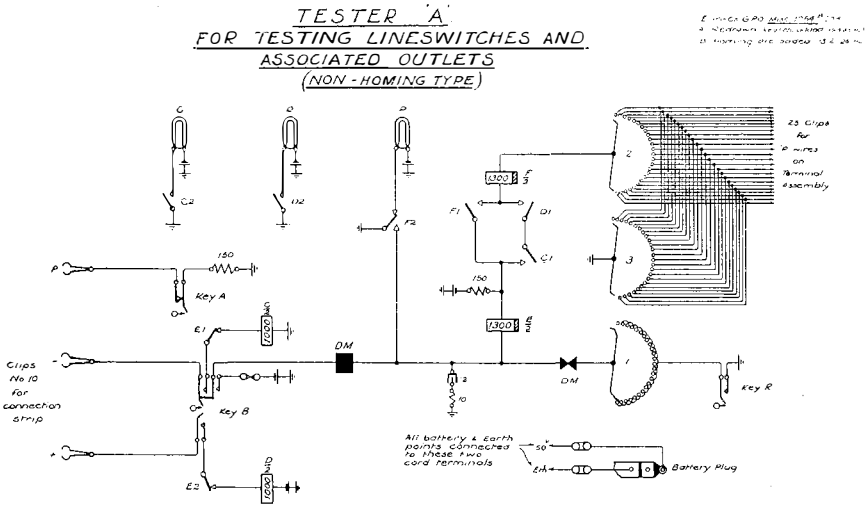
Tester " A," used on this occasion has now only an historical interest, but it is worth describing in some detail as an introduction to the later and improved apparatus, the underlying principles of both being similar.

Arrangements have been made for each of the sets of apparatus required for the tests to be permanently associated on suitable mountings, and enclosed in a protective case, the whole being known as a " tester " and being supplied complete to the exchange concerned.

TESTER "A."

For Testing Line Switches (non-homing type) and Associated Outlets.

Line switches, in common with all other automatic switches, should be closely watched for satisfactory mechanical operation.



In addition, it is required to verify that:

(1) The cut-off relay ("BCO") operates when the "busy" condition is applied to the "P" wire of the circuit on the subscribers' multiple;

(2) An originating call causes the line switch to hunt for and seize the first available disengaged outlet;

(3) When the latter has been found the subscriber's line is extended to a first group selector and the multiple made "busy" against incoming calls.

Tester "A," the circuit of which is shown in the sketch, is operated as follows:—

The wipers of all the line switches to be tested are set to contacts No. 1. The tester is connected to the switch under test by means of the three clips "−," "+" and "P," which are attached to the appropriate tags on the unit I.D.F. jumper strip. In cases, however, where the jumpers are in position and provided that the lines on a unit are all in the same group the connection may be made *via* the wipers of the test final selector, which is stepped round by hand to each of the 100 lines on the unit as required.

There are, in addition, twenty-five clips for making contact with the " P " wires of the outlets from the bank. These are numbered from " 1 " to " 25 " and are connected accordingly, on the outlet terminal assembly.

The battery plug is inserted in the unit power jack and the test may then be commenced.

At this stage, no keys are thrown and it will be seen from the diagram, therefore, that earth through 150 ohms is connected *via* key A normal to the P wire. This should operate the BCO relay. To prove that the calling conditions have thus been removed, key B is now thrown, connecting relays C and D to the – and + lines. Should either of these relays operate, the corresponding lamp will glow to indicate the existence of a fault.

If no lamp glows, key R is operated to set the tester preselector to its starting position. The circuit is from Earth *via* R operated, homing arc, DM contacts normal, driving magnet DM, key B operated to battery. The driving magnet will operate, breaking its own circuit each time until the preselector wipers reach contacts 1.

Key A is now operated, thus releasing the BCO relay and restoring the calling conditions to the – and + lines.

A circuit is now complete from battery, *via* line relay, – line, key B operated, E1 normal, and relay C to earth. This should cause the calling relay of the line switch to operate. As the wipers of the latter, however, are resting on disengaged contacts, no rotation should take place and the subscriber's circuit should be extended to the first outlet, on which the selector should be seized. The operation of tester relay C should then be maintained *via* the – line and one coil of the selector relay A to battery.

Relay D in the tester, the battery on which would cause it to operate in the first place *via* E2 normal, key B operated, + line to earth at the line switch, should now remain operated *via* the + line and the other coil of the selector relay A to earth.

If the selector concerned accepts the call correctly, it will now return earth *via* the P wire to maintain the operation of the BCO relay. This earth completes a circuit from battery *via* 150 ohm spool, C1 operated, D1 operated, relay F, and wiper 2 of tester preselector, contact 1 and P clip 1.

Relay F, operating, locks *via* its own contact F1 to battery and applies earth at F2 operated to battery *via* key B operated and the driving magnet. The latter operates, but the wipers do not move forward. Relay E is also operated from battery *via* 150 ohm spool.

The operation of relay E disconnects relays C and D, which release at E1 and E2 operated, and so removes the calling con-

ditions from the selector relay A. The latter, releasing, should in turn cause relay B to release and remove the earth from the P wire. On the removal of this earth, the locking circuit of relay F is broken, and this relay releases, but as it is slow releasing time is allowed for the BCO relay to restore the line switch calling conditions in readiness for the next test, before the earth is removed at F2 normal from the driving magnet. The latter now steps forward and prepares the circuit of F at wiper 2 for testing the P wire of the second outlet, and also places a busy earth on the P wire of the first outlet *via* wiper 3 and contact 2, in order to ensure that the line switch will be tested for rotation over an engaged outlet. As the reader will no doubt be aware, the wipers of the non-homing type line switch normally remain on the contact last used.

When relay F released, the earth was also removed from relay E which is also slow to release. In due course then, relay E releases and restores the calling circuit to relays C and D at E1 and E2 normal.

The sequence of operations is now repeated, but as outlet 1 is busy, the line switch, operating, should step forward to outlet 2 and seize the selector connected thereon.

When outlet 2 has successfully been tested, it is busied in turn and the test proceeds on outlet 3 and so on until all outlets have been tested.

As each line switch is equipped with a double set of wipers it is necessary to make two sets of tests on the outlets. The line switch, therefore, should be stepped on to contact 1 again when it comes to rest on contact 25, and the tester should be allowed to proceed until the requisite fifty tests have been completed, when keys A and B should be released and the −, + and P clips rmoved to the next subscriber's line switch.

Each time an outlet is seized during the progress of the tests, the " PG " lamp of the associated selector will glow for a short period. A convenient means is thus available for checking the order in which the selectors are engaged, against the switch designation shown on the outlet chart. In addition, a rough test is afforded for contacts between adjacent − or + lines, as a fault of this nature will cause the simultaneous operation of more than one switch.

The circuit of the tester is arranged so that faults of various kinds cause the sequence of operations to be suspended. Observation of the lamps provided will afford some indication as to the portion of the circuit affected, and to some extent the nature of the fault, although the requirements are merely that its existence shall be indicated.

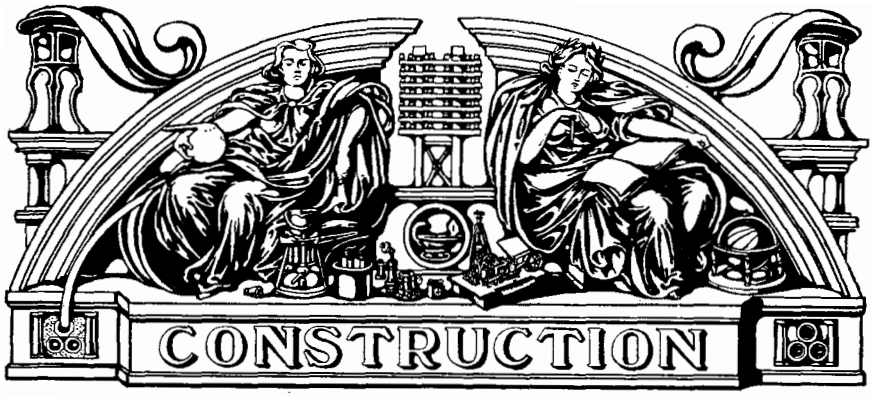
The appended schedule gives a brief indication of some of the conditions which are found when wiring faults are present. Other faults, such as apparatus defects, may also be detected, either by observation of the switches or by the tester.

A comparison of results reveals that the tests on a unit of 100 line switches, which formerly occupied two men for four hours, can now be carried out by one man in one hour. In addition, the reduction of the human factor minimises errors and reduces fatigue.

Other testers will be described in further articles of the series.

SCHEDULE OF FAULT INDICATIONS.

Nature of Fault.	Location.	Wire.	Keys operated.	Lamps		Tester Preselector stops on Contact.
				Glowing.	Not Glowing.	
Dis.	Line switch	−	A B	D P	C	1
		+	A B	C P	D	1
		P	B	Tester proceeds without operation of Key A.		
	Outlet	−	A B	D P	C	Line switch also chatters. Connected to Faulty Outlet.
		+	A B	C P	D	
		P	A B	C D P	—	
Contact	Line switch	− & +	B	—	C D P	1
		− & P	B	D P	C	1
		+ & P	B	D P	C	1
	Outlet	− & +	A B	P	C D	Connected to Faulty Outlet.
		− & P	A B	D	C P	
		+ & P	A B	—	C D P	
Reversal	Line switch	− & +	A B	P	C D	1
		− & P	B	D P	C	1
		+ & P	B	C	D P	Test proceeds without Key A being operated.
	Outlet	− & +	A B	P CD flash		Line switch chatters. Connected to Faulty Outlet.
		− & P	A B	P		
		+ & P	A B	—	C D P	
Earth	Line switch	−	A B	D	C P	1
		+	B	C D P	—	1
		P	A B	P	C D	1
	Outlet	−	A B	—	C D P	Connected to Faulty Outlet.
		+	A B	C D P	—	
		P	A B	—	C D P	



GUILDHALL EXCHANGE TUNNEL.

It would be hard to find a site in London more difficult to reach with underground conduits than that in Wood Street, E.C., on which the Guildhall Exchange will stand. Wood Street is in the centre of that warren of narrow thoroughfares which has existed since the Roman occupation. The Romans must have used it when they built old London Wall. By the 13th century it had acquired some importance and is clearly shown on old maps which purport to show what London was like in those days. It is still so narrow that it is doubtful if its general outline has changed during the past seven centuries.

In this area, however, one must not judge the importance of a street by its width. It is in Wood Street that many of the great "soft goods" merchants of London have their headquarters, for it is the centre of what is irreverently termed the "Rag" trade. Why people in a similar line of business should huddle close together is a social phenomenon that has never been satisfactorily explained; there seem to be as many reasons why they should repel as attract each other, but, whatever the explanation, the fact that such congregation does take place is demonstrated before one's eyes. They get as close together as possible, and there is so small a space to hold them all that in order to make the most of what room there is the buildings have to go skywards. The buildings are all substantial and well built, and have an air of commercial solidity that apart from the famous names that appear on them would create confidence.

During the daytime Wood Street is choked with traffic. To have laid ducts by surface excavation, had that course been open to us, would have completely blocked the street. There were,

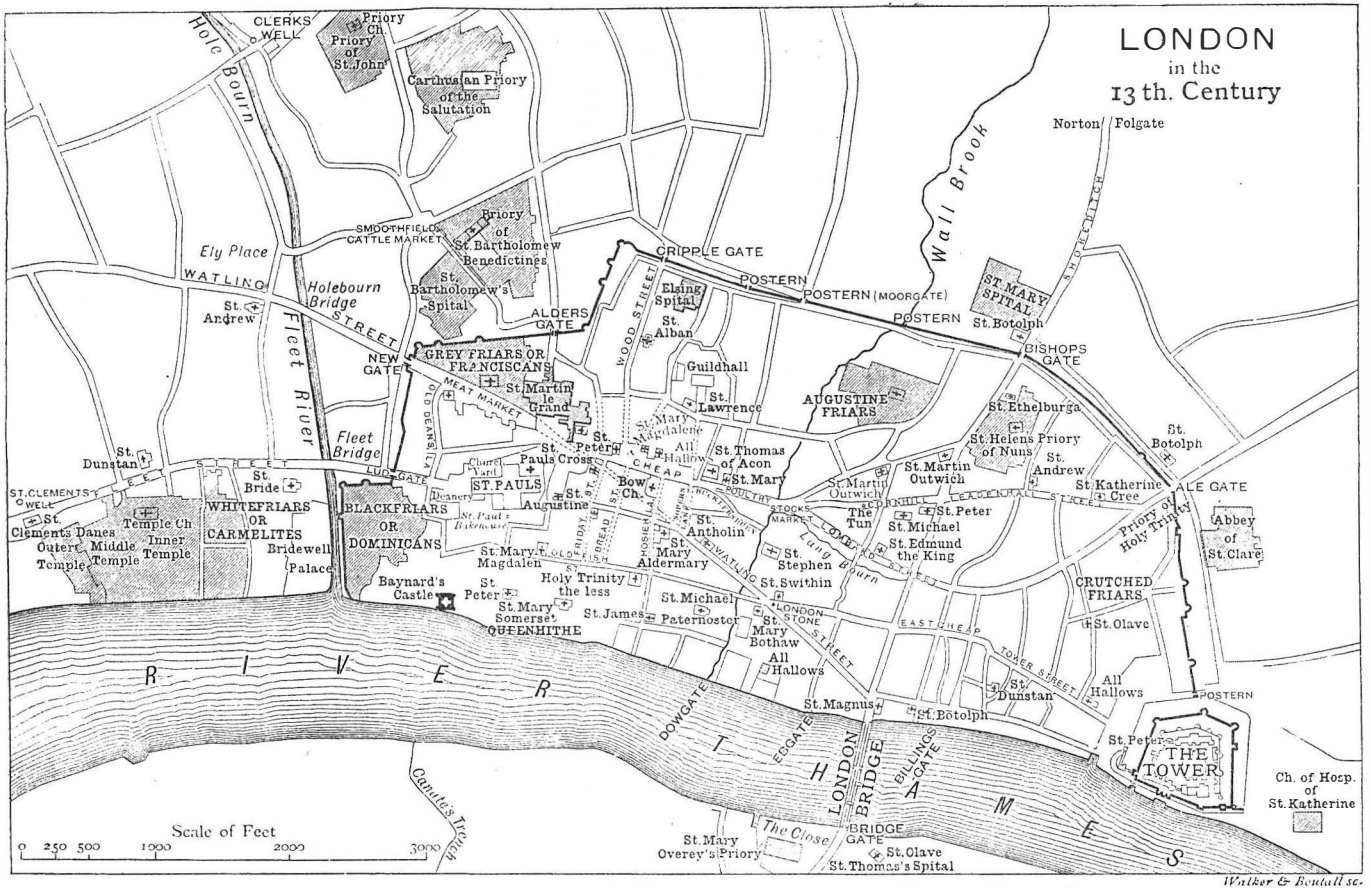


FIG. 1.—MAP OF LONDON FROM GREEN'S "SHORT HISTORY OF THE ENGLISH PEOPLE."

however, other reasons which prevented that method being seriously considered. The mains of many public utility undertakings are already under the street and occupy all the available space to a considerable depth. Still deeper, at approximately 14 ft. from the surface, is a large sewer six feet in diameter; there was therefore not sufficient space for the conduits except by going below the sewer. Under the sewer at a depth of rather more than 20 ft. there is a stratum of wet sand and ballast. In some places this waterlogged ground is as much as 9 ft. in thickness before the famous blue clay of London is reached. The difficulties would

FIG. 2.—WOOD STREET, CHEAPSIDE.

have been greatly increased if we had gone through this wet ground, and a route through the solid blue clay was clearly the one to adopt.

If there had been none of these difficulties the conditions laid down by the City authorities would still have made it necessary to construct a tunnel. One of the stipulations was that we were not to open up either Wood Street or London Wall. The exchange site was, therefore, the only place on which an opening

could be made. Through an excavation at this spot practically the whole of the tunnelling operations were carried out.

Both Wood Street and London Wall are in the area known to the Fire Brigade authorities as the Danger Zone, and if there had been no other reason this alone would have been sufficient to have caused the City Corporation to refuse to allow the streets to be obstructed.

The development figures required provision for at least 60 cables to be made along Wood Street and 48 cables along London

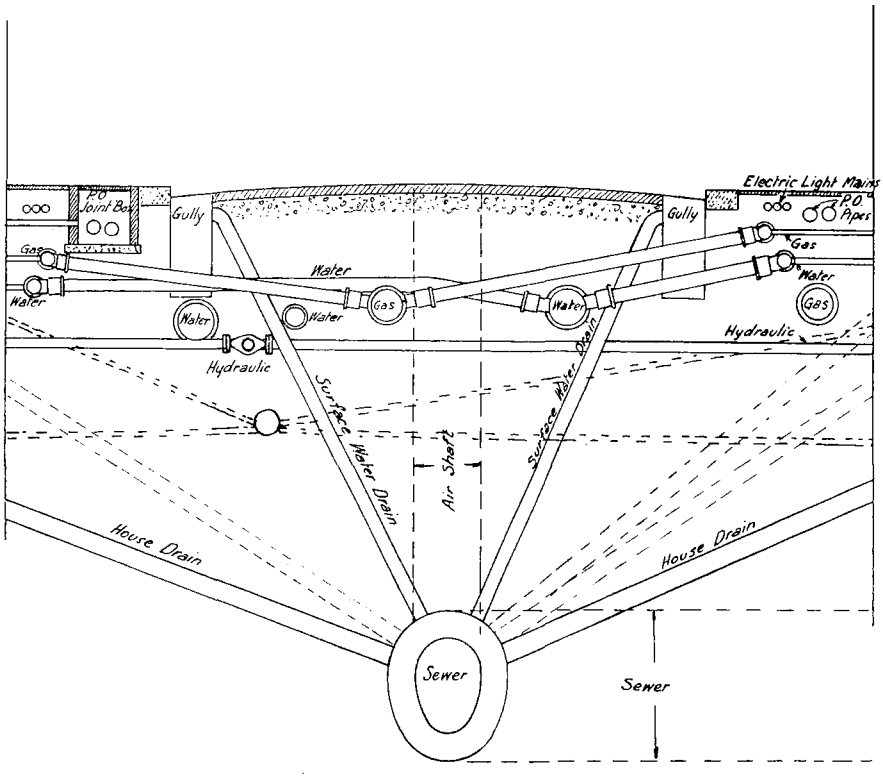


FIG. 3.—SECTION SHOWING PLANT UNDER WOOD STREET TO SEWER LEVEL.

Wall. Three ways of meeting these requirements were considered. The first was to construct a tunnel and fill it with octagonal ducts; the second, to build a brick subway and support the cables on bearers; and the third, to construct a tunnel built of cast iron sections like a miniature tube railway.

For what now appear to be quite obvious reasons the first and second proposals were soon ruled out. The first method, under the conditions which have previously been mentioned, would have involved the excavation of the whole of the tunnel, before the ducts

could have been laid. A brickwork tunnel could have been carried along as the excavations were being done but only at great inconvenience. Further, it would have involved an enormous amount of timbering to hold up the excavation. The City Authorities require all supporting timbers to be drawn after the permanent work is done, and the ground filled in solid. Further, a brick tunnel could only have been built at an expenditure much greater than that actually incurred. Apart from that vital consideration a brick tunnel can rarely be made completely watertight.

Fig. 4.—Boring in Progress.

Before a decision to provide a cast iron tunnel was finally reached many knotty points had to be settled. First of all it had to be agreed that we had the necessary statutory powers to construct a tunnel. When that was out of the way the conditions governing the construction of tunnels were reviewed. It was obvious that work of this kind, to be carried out at a considerable depth, in narrow streets, the width of which made it necessary to

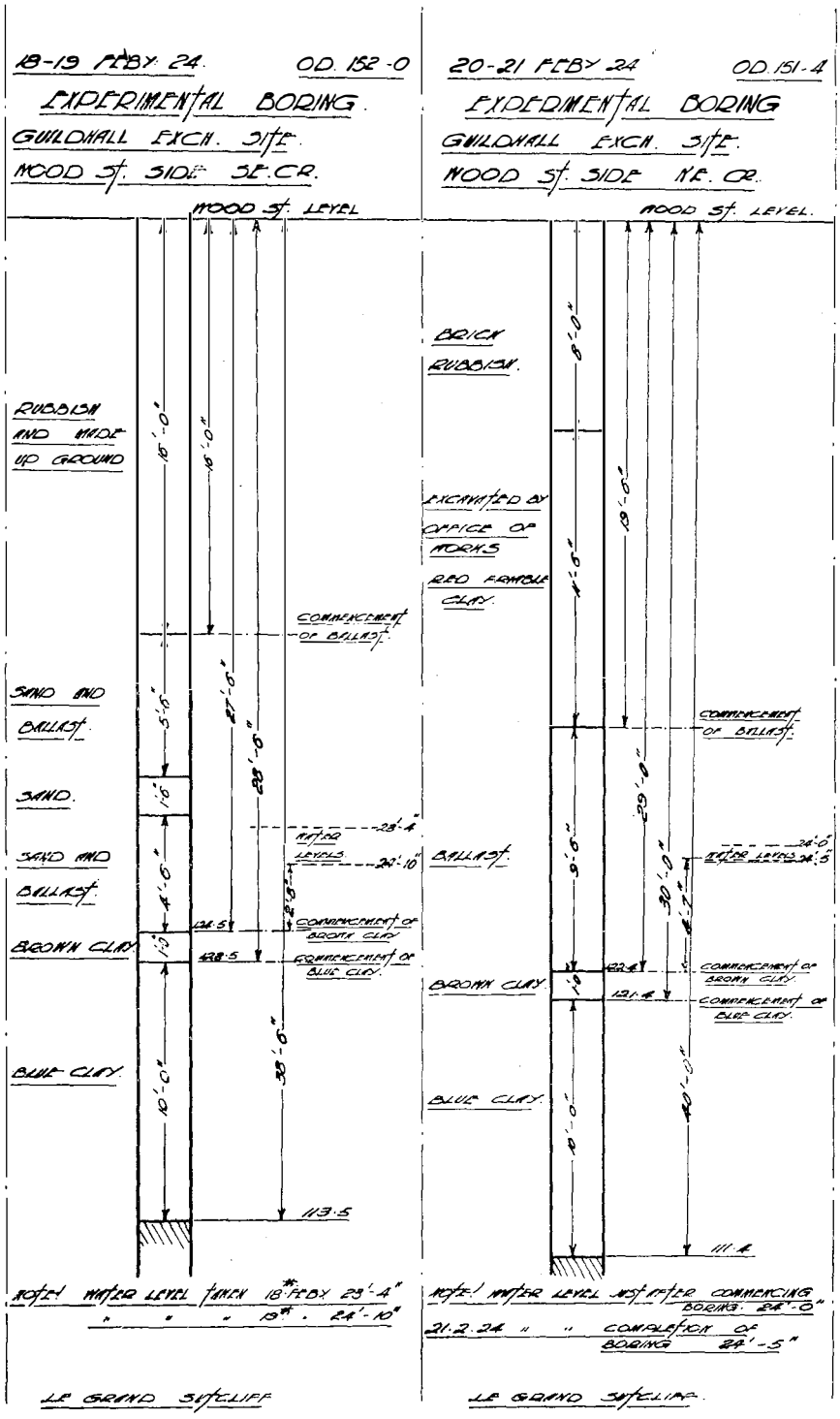


FIG. 5.—RESULTS OF BORINGS AND INDICATING WATER LEVELS.

follow a course nearly vertically below the foundations of important buildings, could only be done if the usual engineering practice in such circumstances were followed. Long tunnels in city areas are never undertaken except under the supervision of a Consulting Engineer, and the Department was fortunate in being able to obtain the services of Mr. Harley H. Dalrymple Hay, M.I.C.E., who had already been engaged in that capacity on the Post Office Tube Railway (London).

In order that the Consulting Engineer should know the condition of soil which would be met with, the Department placed contracts with two well known firms of well sinkers to make borings through the subsoil to a depth of at least ten feet into the

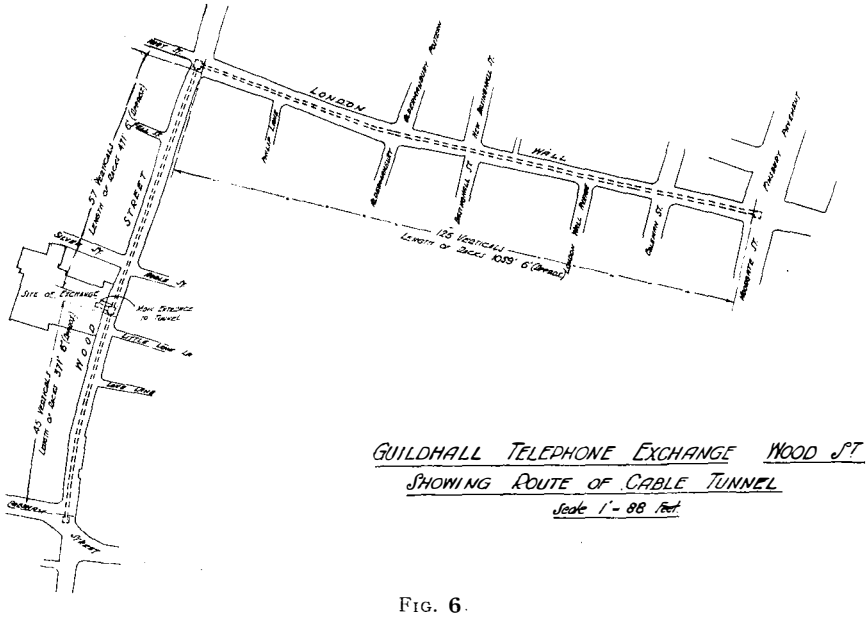


FIG. 6.

London clay. This work was carried out by Messrs. Le Grand Sutcliffe & Gell, of London, and Messrs. C. Isler & Co., of London and Birmingham.

From what has already been said about the traffic conditions and underground services it will be clear that boring to ascertain soil conditions could only be done during week-ends, and after a small excavation had been made to a greater depth than that of the supply services. It will be seen from the drawing that these openings were made at regular intervals along the route to a depth of rather more than 40 ft. From the information thus obtained the line of the tunnel was fixed. The conditions were then ripe for the preparation of the specification by the Consulting Engineer who,

of course, looked to the Department to supply all information as to its requirements.

It would overburden this short account if full details were given of the dimensions of all parts of the tube. The following particulars may, however, be not without interest. Those who desire fuller details will be able to get them from the illustrations. The main section has an internal diameter of six feet, and extends from the junction of Wood Street and Gresham Street to London Wall and thence to Moorgate, a total distance of 654 yards.

Shafts 4′ 5″ in diameter giving access to the tunnel have been provided from the floors of carriageway manholes already in use

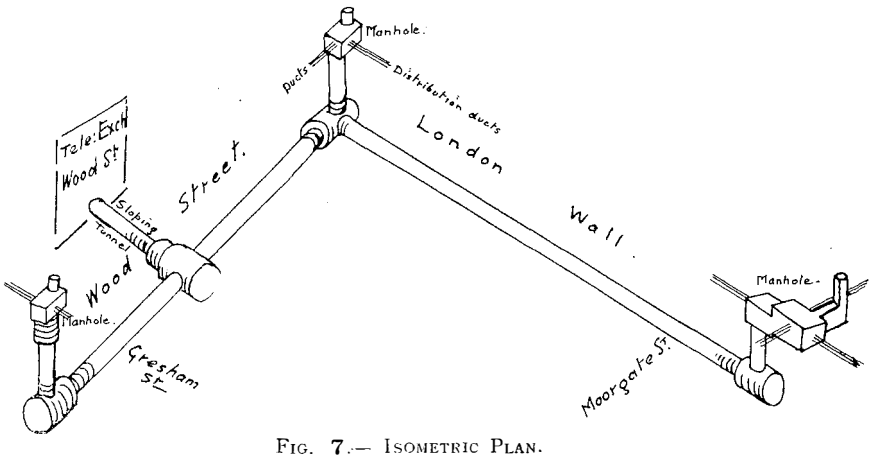


FIG. 7.— ISOMETRIC PLAN.

on the distribution ducts at Gresham Street, at the junction of Wood Street and London Wall, and at Moorgate. The depth from the street levels of these shafts is about 42 ft. to the centre of the 6 ft. tunnel.

The connection to the Exchange basement is made through a sloping subway 8 ft. in diameter and 48 feet long. This subway is constructed at an angle of 30° and concrete steps have been built in it so that access is readily obtained.

The whole of the excavation work except that involved in the construction of the sloping subway was done in free air. For the sloping subway, which passed through the water-bearing ground, it was necessary to provide an air-lock and work in compressed air to keep back the water.

It has already been mentioned that the three shafts enter the floors of existing manholes. This simple statement conveys no idea of the difficulties which the Department's staff met with before this could be arranged. It was necessary to enlarge each of the manholes to provide the space required by the large open-

ings from the shafts. Sewers and large mains had to be diverted to allow of a straight drop down the shaft. The City authorities allowed this work to be done at their convenience and did not press the conditions they had laid down because we were working on existing plant. At Moorgate the traffic conditions at the time were so heavy that the work was held up for more than three months before it could proceed. It will be seen from the route plan that these manholes are in each case at street junctions where

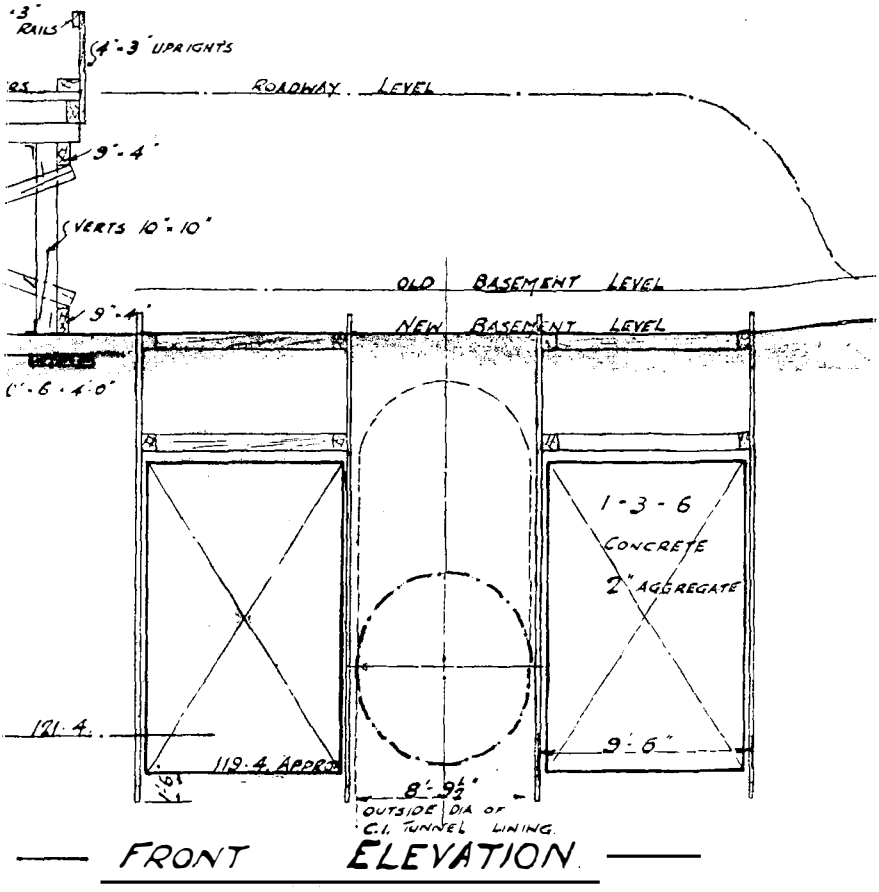


FIG. 8.—SHOWING POSITION OF TUNNEL.

there is more carriageway space than is to be found in either Wood Street or London Wall.

The sloping subway which serves the building made it necessary for the Office of Works to take precautions to ensure that their foundations would not be weakened. The position of the subway was so arranged that it came between two of the main columns of the building. These columns had in consequence to

be put at a greater depth than any others on the site, and this put their bases into waterlogged ground. It was, therefore, decided to build the columns inside a framework of steel interlocking piles.

The piles used were 24′ 6″ long and were driven in 20 ft. and reached a depth of approximately 40 ft. The site enclosed by them was 20 ft. by 9 ft. 6 in. The only water that had to be dealt with was that trapped in the space enclosed by the piles. After the ground had been excavated inside the piles the whole space was filled with a good quality concrete.

The clearance between the piles and the subway is only about four inches, and the whole space around and above the subway to the top of the piling will be filled with concrete.

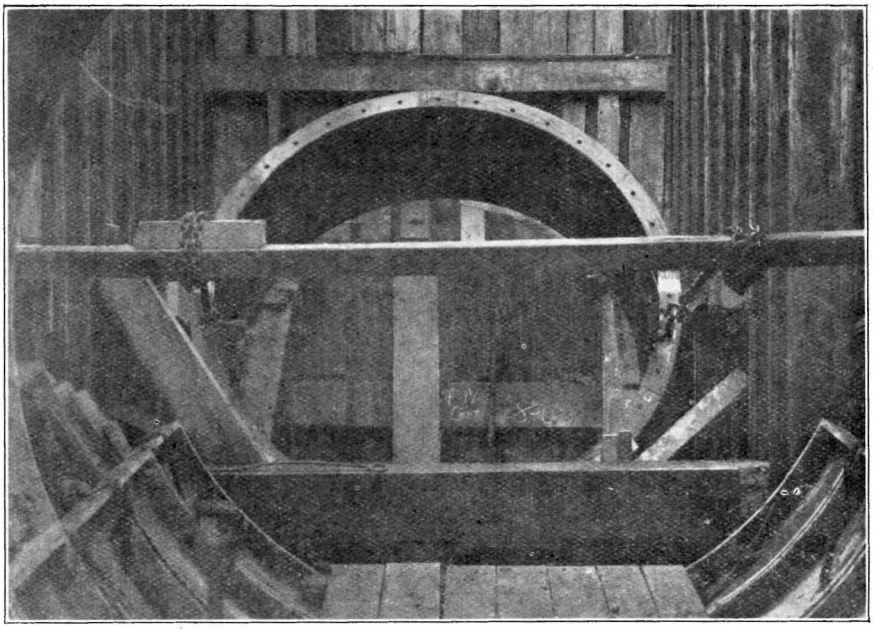


FIG. 9.—FIRST RINGS IN POSITION.

The water difficulty which caused the piling to be done was, of course, present during the making of the subway, as previously stated, and made it necessary to carry out this portion of the work under compressed air. The use of compressed air makes work through water-bearing ground much simpler and quicker than it would be without air. Every foot in height of water exerts a pressure of .434 lbs. per square inch and therefore, if air, which is under a pressure above normal corresponding to the head of water acting upon the tunnel, is introduced, the flow of water is held back from the excavation and the work is carried out in practically

the same way as in dry ground. The air pressure introduced is sufficient to hold back the water at the bottom of the tunnel. In the subway the air pressure was about 5 lbs. per square inch.

The air pressure is made available by means of an air lock.

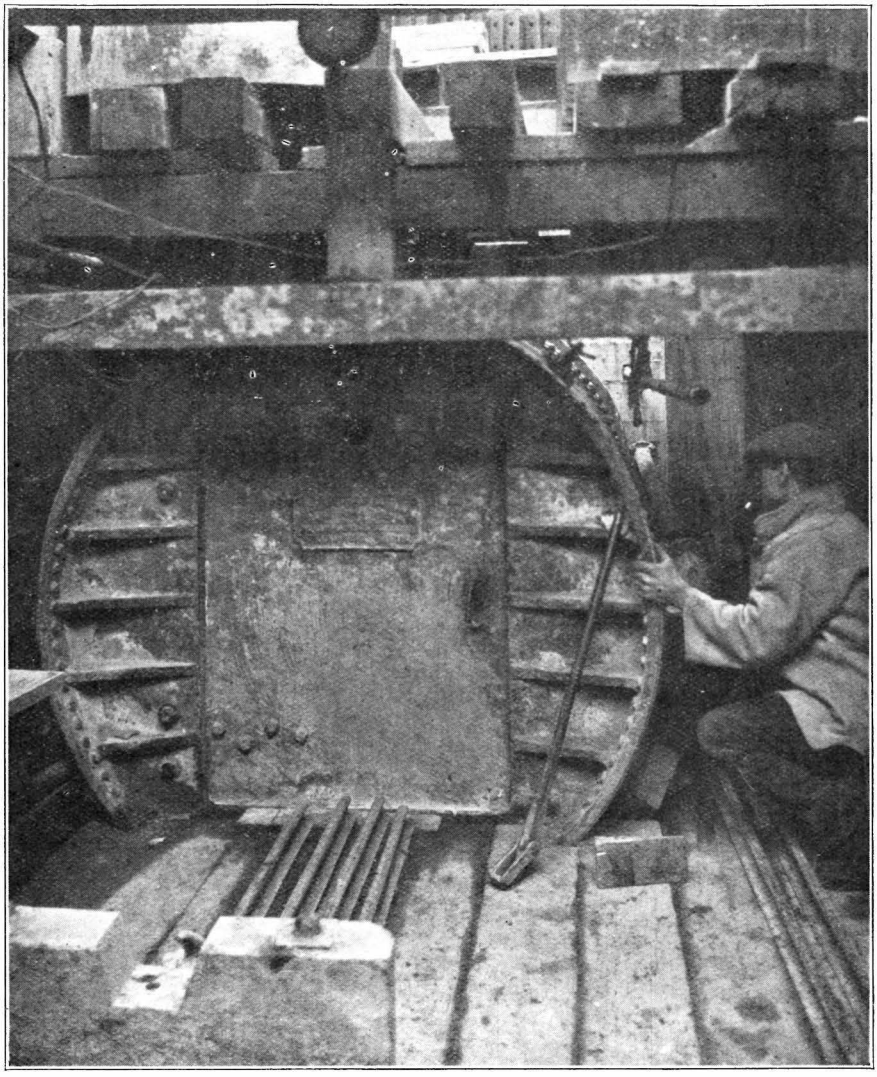


FIG. 10.—AIR LOCK ENTRANCE.

Its appearance will be better understood from the photograph than by a lengthy description. Access to the air lock is through the door shown. This door is forced to, and is quite air-tight when the pressure is on.

The sensation of being under air pressure above the normal is not altogether pleasant. When the pressure is first applied it sets up a throbbing in the head. The best way to counteract this increase of pressure is to pinch the nose tightly and force air into the nostrils and air passages, so as to counteract the increased external pressure on the diaphragms of the ears. The normal speaking voice is of little use; it is necessary to shout in order to be heard.

FIG. 11.—LOOKING UP SLOPING TUNNEL.

It has already been stated that the main tunnel is 6 ft. in diameter. The cables to be carried in it will reach the exchange from two directions and this made it necessary to increase the size of the exchange subway to 8 ft. diameter. The junction of the subway with the main tunnel is made by increasing the diameter of the subway section by steps up to 14 ft., and the

largest section forms suitable space for manipulating the cables. This is shown in the photograph taken from the foot of the subway.

The excavation of the tunnel proceeded without a hitch from the beginning to the end of the work. Owing to the small diameter of the tunnel only two diggers could work on the face at

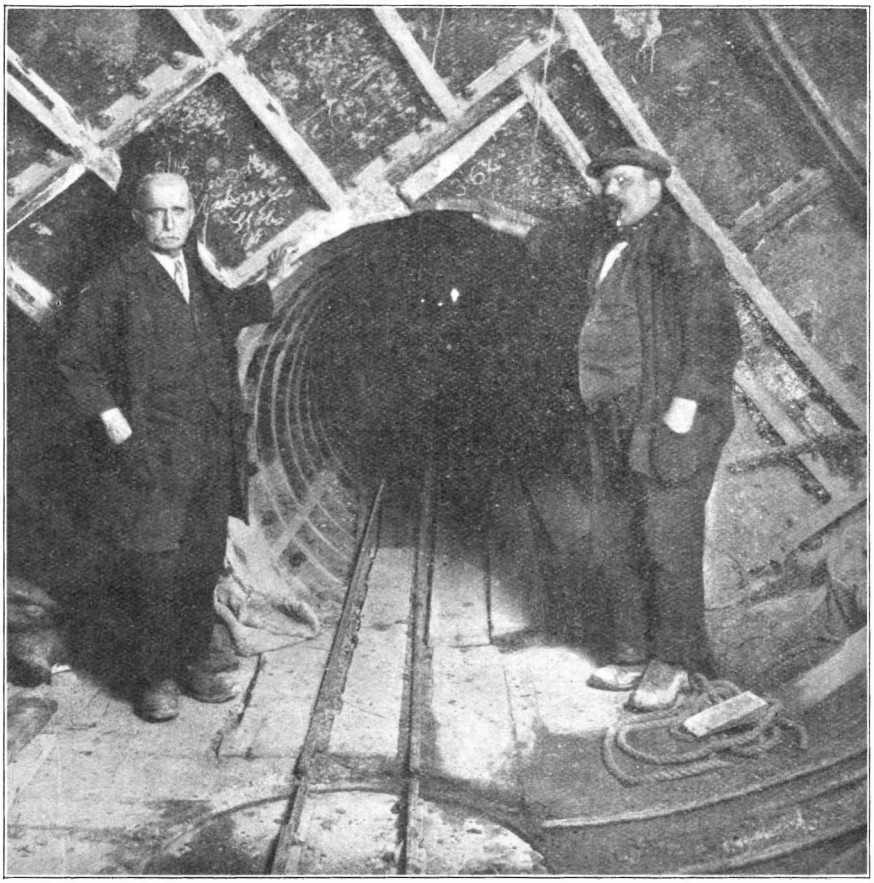


FIG. 12.—VIEW FROM FOOT OF SUBWAY.
(On the left Mr. Steve Morgan, P.O. Inspector of Works.)

a time. As the clay was removed it was filled into trucks and hauled by electric motor to the exit. At this point it was lifted by a crane fixed on an overhead staging, and dropped into carts underneath. Six complete cast iron sections were put in each day, the men working double shifts of eight hours.

Each section measured 1′ 8″ long, and was inserted immediately the excavation to take it had been made. There is a hole

1″ in diameter in each casting through which a Portland cement grouting was forced at a pressure of 60 lbs. per square inch.

The blue clay is an easily worked substance. The tunnel is at least 10 feet below the surface of the clay, which at this depth was found to be dry and tough. Occasionally the excavators came across a substance known as clay stone. This is very much harder than the clay usually met with, but is believed to consist only of clay which has been subjected to exceptional pressure.

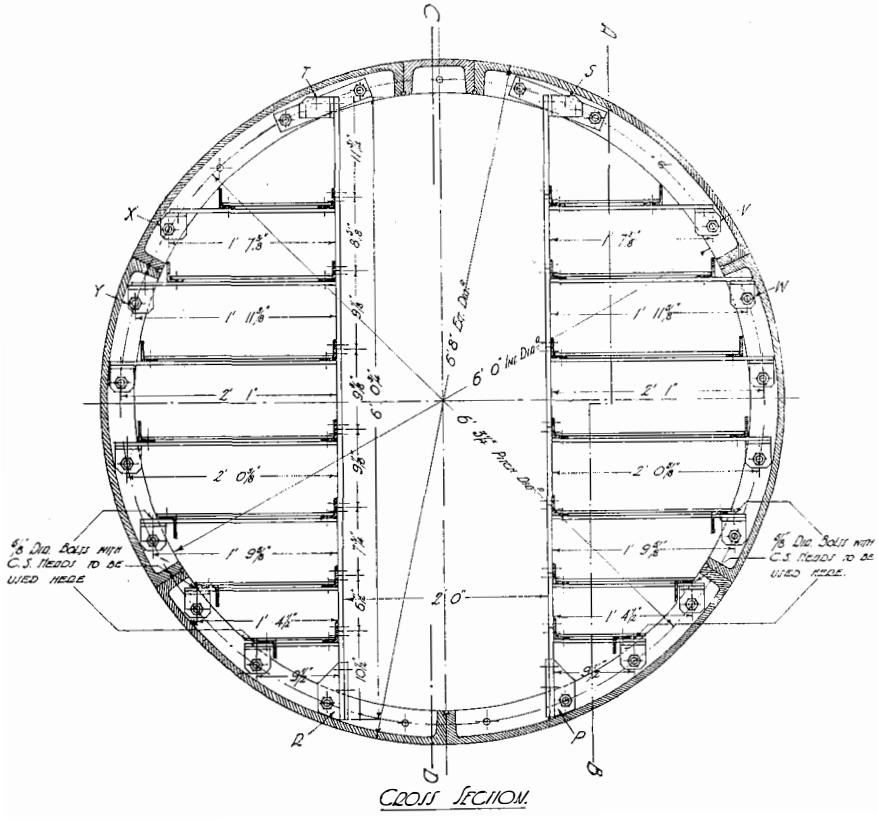


FIG. 13.—SECTION SHOWING CABLE BEARERS.

The contractors were Messrs. Mowlem & Co., who also carried out the Post Office Tube Railway (London).

The tunnel will provide space for about 80 cables on bearers. Should it be found necessary at a later date a considerable increase in this number could be obtained by dispensing with some of the bearers.

The bearers are being supplied under a separate contract, and when completed will have the appearance shown in the diagram.

It will be seen that the verticals are bolted together so that sections can readily be removed in order that the cables can be placed on the racks.

The tunnel will be fitted throughout with electric light. Arrangements are also being made for ventilating fans to be fitted. Electrically heated melting pots for plumber's metal will also be used.

In order to avoid gas accumulations which might leak into the tunnel from ducts led into the surface manholes, 2″ iron pipes will be led from points as high up the walls of these manholes as it is possible to get them, to the surface of the street at the building line.

It remains to be seen how far this form of construction will be necessary in the future. The increasing demand for telephone service in London, and the conditions under the streets due to the presence of other undertaker's plant make the provision of duct work difficult, apart from inconvenience which surface openings cause to traffic, so that it is not improbable that more work of this kind will be required.

I have to thank Mr. O. P. Moller for the assistance he has given me with the illustrations for this article, and also Mr. H. C. Stone for the details which show the congested condition of the subsoil in Wood Street. The drawing which shows the cable bearers in the tunnel was prepared by the London Engineering District.

H.B.

THE POST OFFICE WIRELESS SERVICES.

THE completion of the high-power station at Rugby, with its many novel features largely due to the resource and initiative of Post Office engineers, and its success as a telegraph and telephone transmitting station have received generous notice in the press of the day, and have called attention to the important and increasing wireless services conducted by the Post Office by means of its point-to-point and coast stations. A short account of the stations and the organisation by which these services are operated will be of interest to readers of the Journal.

The point-to-point stations are under the control of the Engineer-in-Chief for all purposes. The coast stations are controlled by the Inspector of Wireless Telegraphy, and his staff of Wireless Overseers and operators perform day-to-day maintenance work in addition to operating, although the major maintenance of these stations is in the hands of the Superintending Engineers of the Districts in which the stations are situated. The Engineering Department took over the point-to-point stations from the Inspector of Wireless Telegraphy on 1st April, 1925. This change was brought about by the rapid increase in the size, power and complexity of the stations intended for long distance working, with the consequent necessity for the employment of trained engineering staff. The general adoption of the land line control method of operating such stations, by which the staff of telegraphists is concentrated at the Central Office in London, also contributed to the change of policy, as the point-to-point stations have in fact become relay stations at which the retention of operating telegraphists is unnecessary. A map showing the location of the Post Office Stations is given on page 59.

The stations transferred to the Engineering Department under the new arrangements are as follows :—

Leafield, with Banbury Receiving Station, collectively known as "Oxford Radio."
Northolt.
Stonehaven.
Devizes.
Radio Relay Station, London.
Caister.

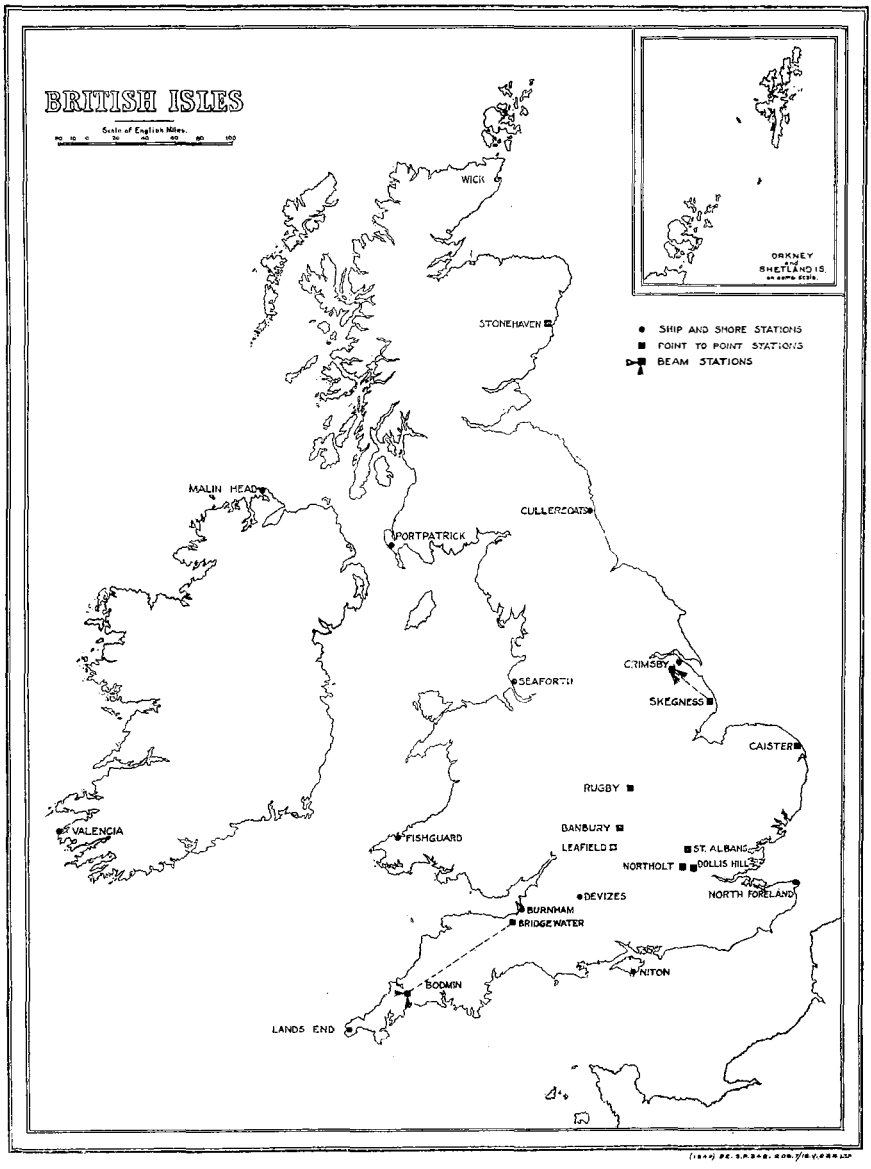


FIG. 1.—LOCATION OF P.O. WIRELESS STATIONS.

Cairo, the sister station of Leafield, remains under the Inspector of Wireless Telegraphy and is manned by his staff, including some engineering officers seconded for service at the station.

Leafield and Banbury ("Oxford Radio") form one group under the charge of an Executive Engineer, with the necessary staff of Shift Officers, arc attendants, turbine drivers, etc. Banbury is still staffed by overseers and operators seconded from the commercial side, who are mainly employed in the reception of inward Cairo traffic. The necessity for retaining Banbury as a receiving station arises from the unsuitability of the Radio Relay Station in London for the reception of long distance and difficult signals, owing to local interference from power plant in the neighbourhood. A new receiving station for all services is in course of construction at St. Albans, and it is anticipated that this station will be able to relay Cairo's signals to the Central Radio Office, as is already done in the case of Continental Services.

Leafield and its complementary station, Cairo, were the first and only stations of the Imperial Wireless "Chain" to be completed. The necessity for the chain disappeared as the range of the high-power stations, of which Rugby is the latest example, increased, until it became world wide. They were originally designed in 1913 as 300 K.W. spark installations, with crystal reception, and it is interesting to speculate upon the probable measure of success which they would have attained under these conditions. The installations were commenced but the outbreak of war interrupted operations, and the subsequent development of other methods rendered it necessary to reconsider the design of the stations. In 1919 it was decided to proceed with the installation of 250 K.W. Elwell-Poulson Arc transmitters, and Leafield and Cairo were erected by the Post Office Engineering Department and completed in 1921 and 1922 respectively.

Leafield is situated on a plateau 600 ft. above sea level, approximately 20 miles N.W. of Oxford. No power supply being available, a complete steam generating plant was installed. Two Babcock & Willcox water tube boilers, each capable of evaporating 10,000 lbs. per hour and fitted with superheaters, provide the steam required. The prime movers consist of two 250 kilowatt Allens de Laval type steam turbines, each coupled to two 500 volts D.C. generators in series, thus giving the 1000 volt D.C. supply required for the arc generators. Two 60 K.W. turbo generators, of the same type, supply the power necessary for auxiliary purposes at a pressure of 220 volts D.C.

The water supply for the Station is obtained from a well situated in the valley some two miles distant, at which a pumping

station has been erected. A reservoir to contain 50,000 gallons was built at the top of the wireless site, and also a cooling pond, measuring 200 ft. × 200 ft., to hold 1,000,000 gallons of water for the condenser circulating system.

The arc generators are designed for an input of 250 K.W. and are each capable of delivering a current to the aerial of 250 amperes at a frequency of 24.3 kilocycles, corresponding to a wave-length of 12,350 metres. In order to eliminate harmonics and mush, emitted by the arcs, a coupled circuit has recently been installed. The four condensers used in the primary circuit, each of which have a capacity of .025 μ.f., are constructed of aluminium plates supported in steel tanks. The dielectric used is oil.

Typical readings of the coupled arc circuit are given in the following table:—

D.C. Supply to Arc.		Primary Circuit.	Aerial Circuit.	Wave-length.
Volts.	Amps.	Amps.	Amps.	Metres.
660	320	225	230	12,350

The keying is carried out by means of a Creed pneumatic key having eight pairs of contacts, which short-circuit coils coupled to an inductance fitted in the primary circuit, thus causing marking and spacing waves to be emitted, the difference in wave-length between the marking and spacing waves being 40 metres. The keys are capable of a speed of 80 words per minute.

The aerial, which is of the inverted L type, is supported by ten tubular steel masts, each 305 ft. in height. It is constructed with 7/19 phosphor bronze wire and is approximately 1000 yards long by 200 yards wide.

Leafield is utilised for commercial purposes to Cairo and Prague and for a press service to Halifax, Nova Scotia. The Halifax and Prague traffic is dealt with at about 40 words per minute as a rule, and the Cairo work usually at from 18 to 25 words per minute.

Until recently the British Official Press, the Long Distance Ships commercial service and the Marconi Company's and Radio Communication Company's press services to ships were transmitted by Leafield, but the desirability of a world wide range for these items has led to their being transferred to Rugby.

The day range of Leafield and Cairo is 2,500 miles, but the night range is very much greater, and during tests made last year Leafield was received at strength 8 (strong signals) in the China Seas.

Northolt Radio Station is situated 11 miles W.N.W. of London and was put into commission in August, 1921, using two 25 K.W. Elwell Poulsen Arc transmitters. A 30 K.W. Valve transmitter was installed in 1925 and the two transmitters are

now in simultaneous use daily. The power supply is obtained from the Uxbridge Power Supply Company at 6,000 volts, 3-phase, 50 cycles per second, and is transformed down to 415 volts for use on the Station. Motor generators giving 650 volts and 110 volts D.C. are provided for the main and auxiliary power supplies.

The valve transmitting set is equipped with a valve rectifying unit consisting of 6 2½ K.W. Silica Valves. These are fed from a 3-phase transformer, three-phase full wave rectification being employed. This rectified supply is fed to the oscillating unit, which consists of 3 water-cooled 10 K.W. metal valves.

To ensure constant frequency and wave-length a system was developed and first used practically at Northolt in which a valve-sustained tuning fork working at audible frequency provides the control for the main oscillators. A harmonic of this frequency is selected for amplification.

Keying is carried out by the simultaneous interruption of the grid circuits in the second stage of the tuning fork, and also in the grid circuits of intermediate valve and oscillating valves. The key used for breaking the last two connections is a Creed pneumatic, double contact type. The break in the tuning fork stage is effected by means of a small auxiliary key.

Typical readings of the valve set are given below:—

D.C. Input.			Intermediate Aerial.		Frequency.	W.L.
Volts.	Amps.	K.W.	Circuit Amps.	Current.		
7,700	3·7	28.5	33	70	43200	6940

The two 25 K.W. arc transmitters are designed for an input of 40 K.W., and are connected to the aerial through a coupled circuit in order to eliminate undesirable emissions.

Typical readings for the arc sets are as follows:—

D.C. Supply to Arc.		Intermediate Circuit.	Aerial Circuit.	Frequency.	Wave-length.
Volts.	Amps.	Amps.	Amps.		
460	63	46	38	72070	4160

Keying is carried out by means of a single contact Creed pneumatic key which short-circuits a small portion of the inductance in the primary circuit, thus emitting marking and spacing waves, the difference between these two wave-lengths being 80 metres.

The aerials are supported from three wooden lattice masts, each 446 ft. high, arranged in the form of an equilateral triangle, and one 300 ft. tubular steel mast.

The Northolt Valve transmitter is used mainly for European broadcast press services, but, in addition, it maintains commercial

services with Buda Pest and Belgrade. The arc transmitter is allocated wholly to Italian traffic, working in conjunction with Milan. The press, which is received at a large number of stations on the Continent, is forwarded at hand speed but the commercial work is dealt with at speeds up to 50 words per minute.

Stonehaven was originally designed and completed in 1916 as a two transmitter station, with 30 K.W. and 5 K.W. spark installations, to serve the dual purpose of coast working with ships and for emergency communication with Aberdeen in the event of a total breakdown of the land lines connecting that city with the South. The development of continuous wave transmission led to the addition of two 25 K.W. arc sets and later to the conversion of the 30 K.W. spark set into a valve transmitting installation of similar power. The latter task was undertaken by the Post Office Engineering Department after enquiries had shown that satisfactory tenders from outside firms were not forthcoming for a valve installation of this size. A large amount of pioneer work was done in connection with this alteration, with a result which more than fulfilled expectations, as the aerial power was doubled as compared with the arc with a smaller expenditure of electrical energy.

A public supply not being available, generating plant consisting of two 75 B.H.P. Gardner oil engines direct-coupled to 40 K.W. 220 volt, Crompton generators is installed, together with a storage battery of 120 cells of 1070 A.H. capacity. The high tension D.C. supply is derived from Crompton Motor-Alternators, the output on the generator side being 30 K.W. at 1000 volts, 350 cycles. This supply is transformed, rectified and smoothed for delivery to the transmitting valves at 12,000 volts. Rectification is effected by means of two sets of three two-electrode valves, V.T. No. 21, in parallel. The transmitting valves, V.T. No. 19, eight in number, are connected in parallel and are each capable of dissipating 800 watts from the anode. Current for the valve filaments is obtained from 5 K.W. motor-alternators through a step-down transformer, the supply being 16 amps. at 16.5 volts. Separate secondary windings are provided on the transformer for the rectifying and oscillating valves. The wavelength is 4600 metres.

Keying is effected by means of a two-contact Creed pneumatic key, the method of keying being that of breaking the grid leak and transformer primary circuits simultaneously. An air blast is provided to prevent arcing at the contacts.

The main services conducted *viu* Stonehaven are those to Warsaw and Hapsal (Esthonia); certain Continental press services are also dealt with. The station is used during breakdowns of

cable and land lines for emergency services between London and Aberdeen and to Berlin and Iceland. Although the Aberdeen requirement was one of the reasons for the selection of Stonehaven as a site it should be noted that this function has seldom been brought into operation.

The continental traffic is handled at speeds up to 60 words per minute and the station is a very efficient one, in spite of the serious drawback of its being controlled by a land line nearly 500 miles in length with three repeaters in circuit, and containing long sections of overground line.

Devizes Relay Station, which is controlled from the Burnham Receiving Station, deals with C.W. ship traffic and has a guaranteed range of 1500 miles. It is situated 4½ miles from Devizes and in the absence of a local power supply is equipped with prime movers. Its equipment consists of two 30 H.P. Robey Engines driving 15 K.W. D.C. generators, which are used for operating the transmitters and charging the 450 A.H. battery.

The transmitting equipment consists of two 6 K.W. valve transmitters working on 2100 and 2400 metres respectively. The transmitters, including their running machines, are remote controlled from Burnham, two transmissions being carried on simultaneously.

The first transmitter was installed in 1920 by the Marconi Company and the second was designed and installed by the Department in 1925. The second transmitter is separately excited by means of the Tuning Fork Control System and contains one novel feature. Owing to the relatively high frequency of transmission a double multiplication of frequency is made in the Tuning Fork Unit. The wave generated at the fork frequency (2000 cycles) is distorted to enlarge the harmonics and the 9th harmonic is picked out, filtered and amplified. This 18,000 cycle wave is then distorted and, by selecting and amplifying the 7th or 8th harmonic, frequencies of 126,000 and 144,000 cycles are obtainable, corresponding to wave-lengths of 2380 and 2080 metres respectively.

The aerial systems are suspended from three 300 ft. masts arranged in a straight line and under working conditions currents up to 15 amperes are obtained on each set.

Caister is a 1½ K.W. Valve Station, which is retained for emergency communication with Holland during cable breakdowns.

Rugby and the short wave Beam Stations now in course of erection will be dealt with in future articles. The Beam Station at Bodmin, Cornwall, with its receiving station at Bridgwater, Somerset, is intended for communication with South Africa and

Canada. A second group of stations, Grimsby and Skegness (receiving), are to be utilised for working to India and Australia. Similar stations are being erected in the Dominions named. The guaranteed periods of effective transmission per day by these stations, of comparatively low power, is Canada 18 hours, South Africa 11 hours, India 12 hours and Australia 7 hours.

The Coast Stations were taken over from the Marconi Co. and Lloyds Corporation in 1909: the stations taken over were:—Caister, North Foreland, Niton, Lizard, Seaforth, Holyhead, Malin Head and Crookhaven. The Cullercoats Station was taken over from the Poulsen Company in 1912. All these stations were remodelled or replaced by other stations, and equipped with rotary disc discharge transmitting plant in the years 1913-14. After the war, stations at Wick, Grimsby and Port Patrick were taken over from the Admiralty. The stations at present comprising the coast stations are:—Wick, Cullercoats, Grimsby, North Foreland, Niton, Lands End, Fishguard, Seaforth, Port Patrick, Malin Head and Valencia: the two Irish stations, Malin Head and Valencia, although still under the control of the British Post Office, are manned and maintained by the Irish Free State on behalf of the British Government. The Coast Stations have been further improved from time to time to bring them into line with the latest practice: in 1920 valve receivers replaced crystal receivers at all stations. The power of the coast stations varies from $1\frac{1}{2}$ to 5 Kilo-watts.

Direction finding equipment has been installed in the Niton and Cullercoats stations for giving bearings to ships. This service is of great utility and facilities are to be extended by making similar provision at other coast stations, either in their present positions, or on fresh sites more favourable to direction finding requirements.

The Lands End station has been equipped with direction finding equipment, but this is used only to assist ordinary reception in the face of jamming: the site is not suitable for a direction finding service to ships.

The near future will see the complete remodelling of the Coast Stations: valve transmitters are to be installed and these will be arranged for tonic train transmission, the equivalent of spark transmission with valve equipment. This provision will minimise interference to other services, inherent to the spark system, and will provide immediately for continuous wave transmission if and when it is adopted generally for ship working. The trend of development is that spark working shall be ultimately eliminated.

Experimental short wave (non directive) $1\frac{1}{2}$ K.W. stations have been erected at Dollis Hill, the Post Office Experimental

Station near London, and at Leafield. During the past nine months, Dollis Hill has dealt with traffic for Cairo and Halifax, Nova Scotia, from late afternoon onwards into the night very efficiently. The Leafield short-wave set has just been completed and also promises well. It is the intention to instal short-wave transmitters at Rugby and Devizes in the near future. These sets will be used in substitution for or in addition to the main transmitters when conditions are favourable for short-wave transmission.

The Central Radio Office and the Radio Relay Station are dealt with in another article in this issue. Both these offices are in the Central Telegraph Office building in London. The whole of the wireless point-to-point traffic is dealt with in these offices, with the exception of inward Cairo traffic as previously mentioned, outward by land line control of the various stations, and inward by reception in the R.R.S. and relaying to the C.R.O.

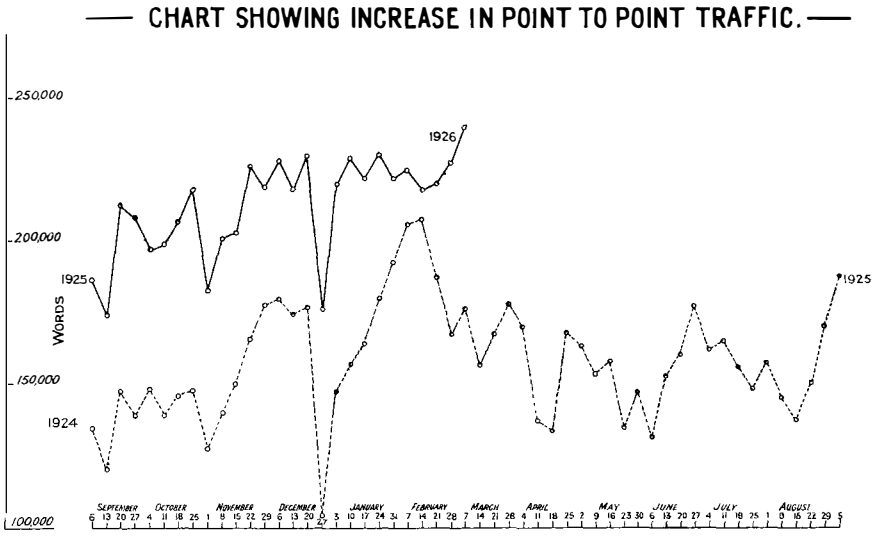


FIG. 2.—GRAPH SHOWING POINT-TO-POINT WIRELESS TRAFFIC.

A graph showing the traffic dealt with by the point-to-point stations since the beginning of September, 1924, and indicating the increase during the past six months, as compared with the corresponding period of the previous 12 months, is appended.

E.H.S.

THE CENTRAL RADIO OFFICE.

By A. IRWIN.

"On the 26th January a duplex wireless service was opened between London and Berlin for a period of three hours daily. . . . . The following shows the traffic passed to and from London on the 25th February and is a fair example of the normal working:—

	Messages.	Words.
Received from Berlin	120	2142
Sent to Berlin	85	1373
Total	205	3515

The above is an extract from the April, 1921, issue of this Journal and records what was really the beginning of the point-to-point radio services now controlled from the C.T.O. This service was carried on in a small room on the 4th Floor of G.P.O. West. The Stonehaven radio transmitter controlled by landline from this room was used as the transmitting station on the British side, while Germany utilised its station at Königswursterhausen.

In 1922 an additional service was opened between London and Rome, the Northolt arc transmitter being used for this purpose and controlled from the same room. This room was now being used to its fullest capacity and it became apparent that to develop these services and also to allow for future extensions additional accommodation would have to be provided.

In September, 1922, therefore, these two services were transferred to a larger room which had been built on the roof of the same building. Here better accommodation was available for the existing services and provision made for additional apparatus. Improved leading-in facilities for the increasing number of aerials required was also provided.

During the whole of this period the radio services had to be carried on under two very serious handicaps. In the first place the isolating of these services from cable services dealing with similar traffic, gave rise to difficulty in keeping both services supplied with traffic and, at the same time, equalising the delay.

Secondly, and from the technical side more important, the receiving conditions leave very much to be desired. Owing to the proximity of the aerials and the radio receiving apparatus to the C.T.O. and other sources of electrical disturbance common to large towns, comparatively strong signals only can be received and high speed recording cannot be undertaken to the same extent as would be possible under more ideal conditions of reception.

In addition, owing to the location of the receiving station in a crowded area, no advantage can be taken of any system of directional reception, which experience has shown to be of considerable assistance in the elimination of unwanted and disturbing signals.

The Post Office, therefore, decided that the reception of radio signals should be transferred to a position free from the disturbing factors mentioned above and a Radio Relay Station is now in course of erection near St. Albans, Hertfordshire. As the name implies, this station will be used only for the reception and relaying of the radio signals into the C.T.O., all operating being performed at the latter office.

In order to gain experience under relaying conditions, both from the technical and operating points of view, and also to provide space in the radio room on the roof for additional receivers, it was decided to proceed with the installation of a Central Radio Office in the C.T.O. itself, in close proximity to the Cable Room where similar traffic is dealt with.

The Central Radio Office was opened in February, 1925, and it is the main object of this article to describe in detail the arrangement of this room.

Since the opening of the C.R.O. all table space in the radio room on the roof, previously occupied by landline control apparatus used in connection with the transmitting stations, has been fitted with additional radio receivers. This room has now become *pro tem* the Radio Relay Station, which in the course of a few months will be transferred to St. Albans. This station contains ten receiving sets of various ranges and capable of reception on any wave-length between 20 and 20,000 metres.

The Central Radio Office is situated on the second floor of G.P.O. West, and occupies a floor space of approximately 1400 sq. feet. In order to minimise to the fullest extent the noises in this room, it has been completely screened from other portions of the telegraph gallery. For similar reasons all noisy apparatus, such as Gell perforators and Creed type-printing machines, are fitted outside this room.

Transmitter Control Sets.

As previously mentioned all operating, both as regards transmission and reception, is carried out in the C.R.O. In connection with the former, six control sets have been provided. These are ordinary D.C. Duplex sets which, in conjunction with the necessary landlines, directly control the radio transmitters situated in various parts of the country. Each set is fitted with a Wheatstone transmitter.

It may here be explained that transmission is invariably carried out by Wheatstone transmitter, irrespective of the speed required. In this connection, the type of transmitter ordinarily used for high speed working on landline circuits, has been found unsuitable for radio working owing to its variation of speed when running on the lower limits.

A type of motor-driven transmitter, specially adapted for speeds between 15 and 150 w.p.m., is now being tried and promises to be free from the disability possessed by the standard type of transmitter.

FIG. 1.—CENTRAL RADIO OFFICE, G.P.O. WEST.

CHECK SETS.

A small receiving aerial erected on the roof of the building is connected to three receiving sets fitted on the back table in the C.R.O. These sets are capable of being tuned to the various transmitting stations in use and supply loud speaker signals at the control positions. A complete check on transmission, both as regards the landline and the radio transmitting apparatus, is therefore provided. (See Fig. **4**).

TELEPHONE RECEIVING POINTS.

There are 17 positions situated in various parts of the room to which aural signals, at hand speed, relayed from the R.R.S., can

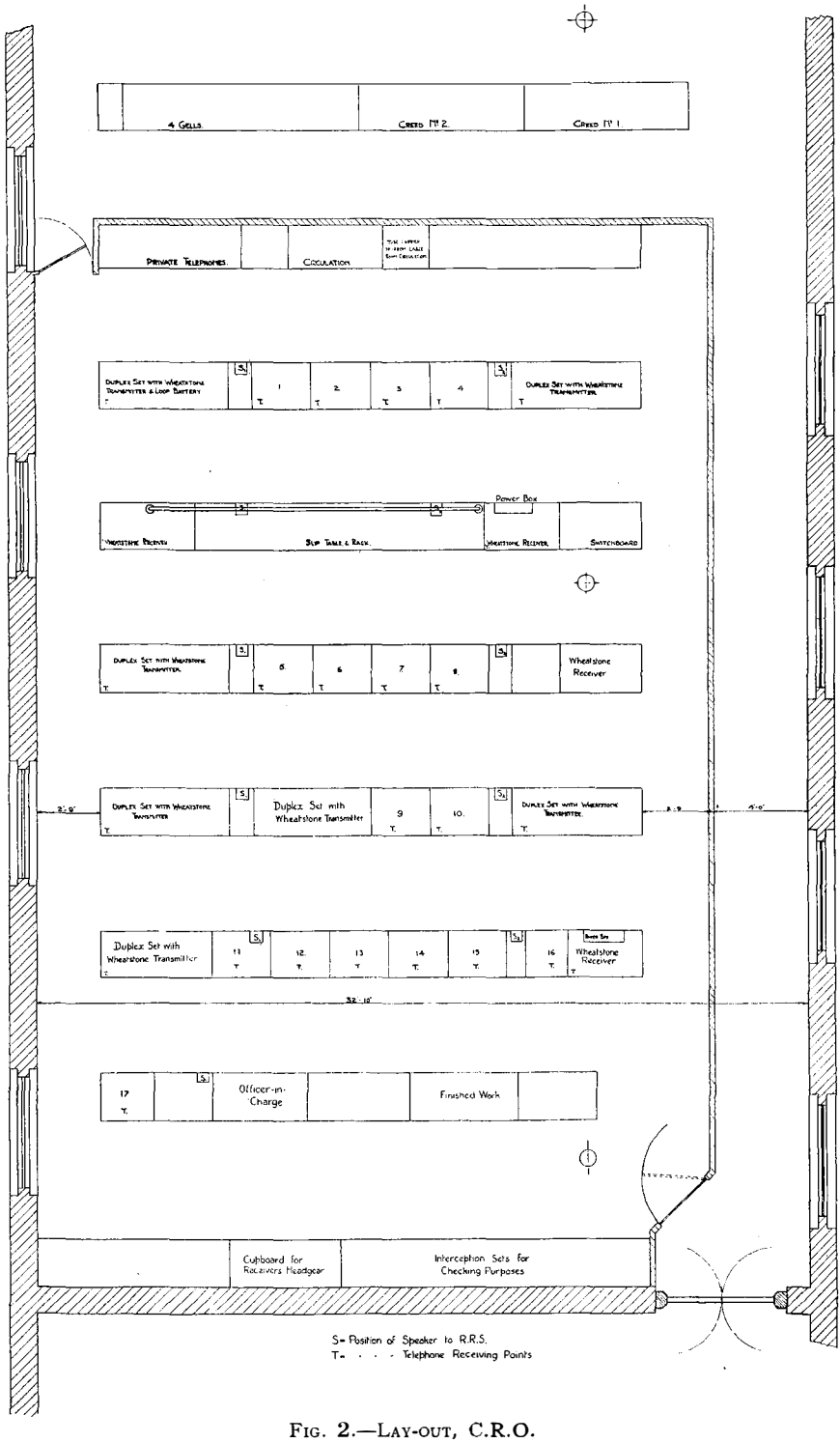


FIG. 2.—LAY-OUT, C.R.O.

be led. These positions are fitted with three jacks joined in parallel, thus allowing for three pairs of headgear receivers being connected to the same line.

Where traffic is heavy but strength of signal or atmospheric conditions will not permit high speed reception, transmission is often carried on at fast hand speed and without the usual pause between messages. In these circumstances two operators are employed, each operator receiving alternately. Under such adverse conditions the transmitter is thereby used to the best advantage.

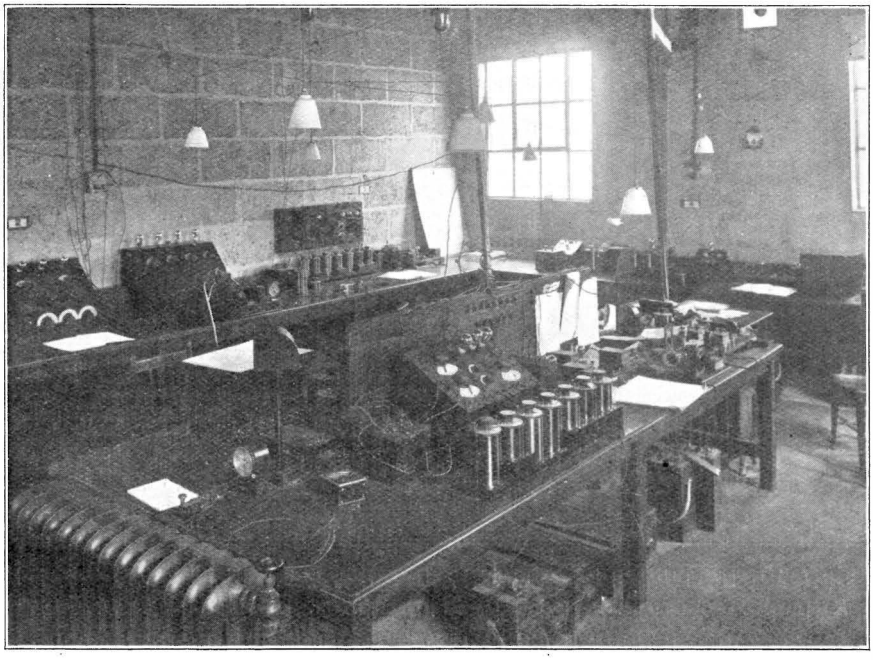


FIG. 3.—RADIO RELAY STATION, G.P.O. WEST.

The third receiver connection enables the Officer-in-Charge to examine the signals being received and thus deal with any complaints which may arise.

WHEATSTONE RECEIVING POINTS.

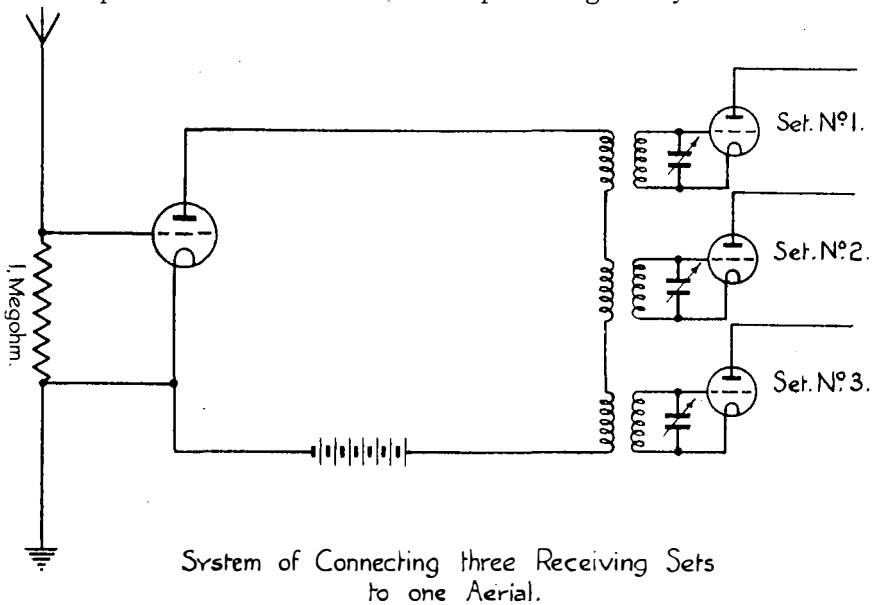
In spite of the adverse conditions before mentioned, improvements in the radio receiving and recording apparatus designed by the Post Office has enabled a considerable amount of high speed reception to be carried out. The actual recording of radio signals is done in the R.R.S. and relayed in the ordinary way over lines to the C.R.O.

Four Wheatstone receiving sets adapted for Creed working are provided in the C.R.O. The aural signals being recorded are also led to this position. The operator can thus receive aurally any remark concerning the work which may occasionally be transmitted by hand.

This combination also permits an operator who may be receiving aural signals to refer to the slip, should confirmation of the whole or part of a message be desired.

Local Speaker Sets.

Two local speaker (Sounder) sets are provided between the R.R.S. and the C.R.O. In the case of the latter room these sets are duplicated on each desk, thus providing ready access to a



System of Connecting three Receiving Sets to one Aerial.

Fig. 4.

speaker for an operator in any part of the room. To avoid unnecessary noise from this source, each set is fitted with a switch for cutting such set out of circuit when not required.

With the exception of the speaker sets, which are directly connected to their relative sets in the R.R.S., connections from all the above described sets are led to the switchboard in the room. To this switchboard are also connected all lines from the R.R.S., junctions to TS Provincial Test for extending to the C.R.O. the necessary land lines from transmitting stations, and also means for connecting the relays of the Wheatstone Receiver sets to the Creed printing apparatus outside the room.

It can be seen therefore that this arrangement provides for complete interchangeability, and allows for the grouping of services where, as in the " fork " system, one transmitting point controls several reception services.

Fig. 5 is a skeleton diagram showing the arrangement adopted for the relaying of the received signals from the R.R.S. to the C.R.O. Ten pairs of wires are led from the R.R.S. to the testing point in the basement of the G.P.O. West. They are led into this position instead of being taken direct to the C.R.O. in consideration of the temporary nature of the present R.R.S. arrangement; this arrangement allowing for the permanent connections between St. Albans and the C.R.O. being made with the minimum disturbance to the services.

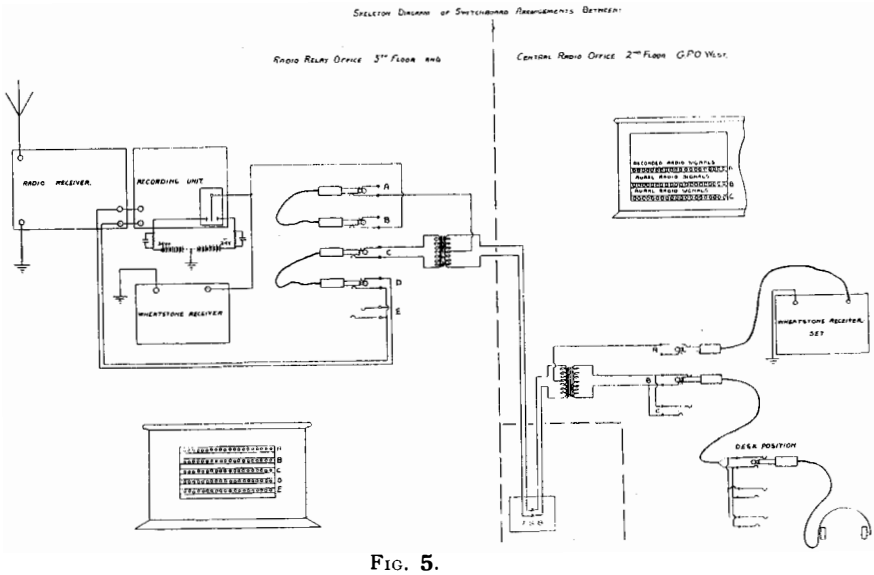


FIG. 5.

From the testing point in the basement twenty pairs of wires are taken to the switchboard in the C.R.O. Ten of these pairs are joined to the ten pairs coming from the R.R.S. The remaining ten pairs are at present spare and can therefore be utilised during the transfer of the services to St. Albans without in any way interfering with the connections to the present Relay Station.

When the lay-out of the C.R.O. was considered it was anticipated that adequate space had been provided to meet requirements for some time to come, but so rapid has been the development in this direction that with the opening of the Beam Stations now being erected for communicating with the Dominions a further considerable encroachment into the adjoining gallery of the C.T.O. will be necessary.

TRANSATLANTIC TELEPHONY.

By Major A. G. Lee, M.C., B.Sc., M.I.E.E.

It is more than a coincidence that the jubilee of Graham Bell's invention of the Telephone has been celebrated by the achievement of two-way conversation across the Atlantic.

This historic event took place from the Rugby Wireless Sation at 4.0 a.m. on February 7th, 1926. The line from the receiving station at Wroughton, near Swindon, had been extended to Rugby so that the Engineers who were concerned with the experiment could talk from that point. Conversation was opened promptly at the prearranged time and proceeded without interruption till late in the evening.

The next step was to consolidate the work which had been done; lines were tested and frequency characteristics improved and a special hybrid coil bălance arranged. An invitation was then sent to representatives of the London Press to witness a demonstration on March 7th, when it was intended, if conditions were favourable, to put each one through to his opposite number in New York, where a similar gathering of journalists had been arranged.

Mr. Shaughnessy filled in the preliminary part of the demonstration with a talk indicating how the radio and line circuits were made up and he showed lantern slides of the salient features of the installations at Rugby and Wroughton.

The first Press representative went into the Telephone Cabinet at 1.30 p.m. and conversed with Miss Mabel Abbott, of the "World," New York. The hour in New York was, of course, 8.30 a.m., and this enterprising lady journalist was the only one of the American reporters present on time, but she carried on a lively conversation with several press representatives on this side until her laggard male confreres arrived.

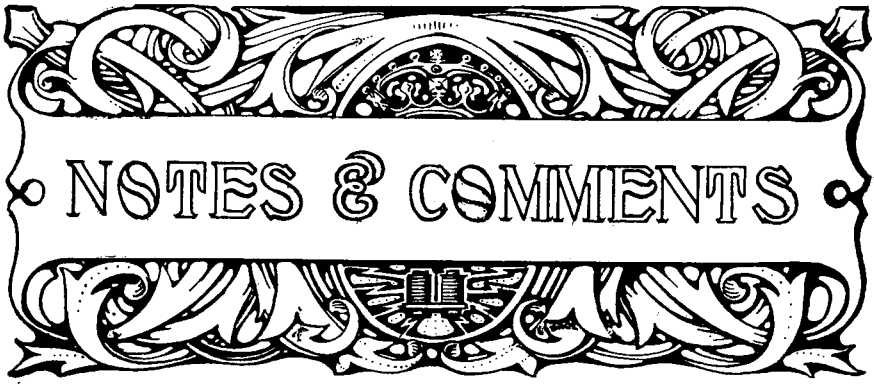
The conversations were continued all the afternoon and were as clear and as easy as those obtained on an ordinary trunk line in this country. Speaking technically, the conversation was a 10 standard mile talk.

The outstanding feature of this demonstration was that it was possible to arrange beforehand for a gathering of people in London to talk to a similar body in New York. The success attending the demonstration came as a complete surprise to the journalists present, who showed a tendency to be somewhat too enthusiastic about the possibilities of an immediate commercial telephone service to America.

Two separate frequencies were used, one of 57 kilocycles for the

transmission from Rocky Point to Wroughton and 52 kilocycles for the transmission from Rugby to Houlton, Maine. The system used is that known as single side band with suppressed carrier, which was first developed by the American Telephone and Telegraph Coy. for use in wired wireless. The modulating equipment at Rugby was manufactured by that Company, while the power amplifier for the telephony was supplied by the Western Electric Coy. The output circuits and aerial and the receiver at Wroughton were constructed by the Post Office.

The American Telephone and Telegraph Coy. are to be congratulated on the successful culmination of a long continued research on the possibilities of long distance wireless telephony, and the Western Electric Coy. and the British Post Office are also fortunate in having been associated with them in this great enterprise.



NOTES AND COMMENTS.

"HISTORY," says Voltaire, "is a fable which men have agreed upon." Not so long ago history was presented in the schools as a sort of vast panorama across which passed in their seasons the magnificent and romantic figures of the great ones of the earth. They were the men that "made history," the men who moulded the destinies of peoples, who founded empires and controlled absolutely the lives of the millions who toiled and fought and died with but scant reward and who were treated as so many pawns to be sacrificed for the opening-up of the game for the higher pieces to manœuvre. We suppose we must agree upon ancient and mediæval history as being something of that nature; that there was actually an age of chivalry extending back to the time of the Round Table and the quest for the Holy Grail; that what really mattered for generations was the fight for supremacy between the House that sported the red rose and the one that favoured the white. It was not until the beginning of last century that public opinion, swelling up from below, began to make itself felt seriously in the affairs of state, although for several generations the yeomen of England had raised their heads—very high in Cromwell's time. Even in military matters the soldiers of the line had gained recognition; at Waterloo, even as at Ypres, the victory was won, not by brilliant leadership but by the men of the county battalions sticking it dourly and not running away.

The invention of the steam engine and the growth of industrialism brought entirely new factors into political operation. The introduction of new processes of manufacture to cheapen production, the discovery of new sources of raw material and fresh markets for the output, and the opening of new means of com-

munication became the historical points most worthy of record. The wars of last century were due rather to financial than, as formerly, to dynastic reasons, in spite of the fact that commerce and finance had become internationalised. However, now that the tumult and shouting of the last great war have died down and the spirit of Locarno is abroad it is the bounden duty of the peoples of Europe to see that business between the nations should be made a means of facilitating peaceful development and not a cause of war. Most people are convinced that commercial intercourse begets better relations, and the more the races get to know each other the more appreciative they become and the less likely they are to start shooting. In this connection the growth of what may be called international telephony is very significant and is bound to have its effects on the future. We believe that Mr. Gill built here even better than he knew. The conferences have been conducted in the best of good feeling and the friendly rivalries over units, methods and systems are all to the good and will tend to bring the best in the associated countries to the advantage of all. The British representatives have been fortunate in their chief; he brought to the gatherings a sense of efficiency and fairness and combined with it a feeling of bonhomie and friendliness which charmed the continental delegates. The Telegraph Conference at Paris contributed a good deal in the same direction, and here again the British delegation owes much to the ability and suavity of Mr. John Lee.

These events form landmarks in the progress towards the closer union of European states, and it is only fair that we should chronicle the Department's share in working towards that end. The telegraph line has long been regarded as a pioneer arm reaching out from civilisation to the dark places of the earth, and the same may be said, with modifications, with regard to the extension of the trans-continental telephone system. One cannot conceive anything but good arising from the extension of communications, but lest our successors in the future meet with difficulties and troubles at present unforeseen let us here produce the following anecdote which carries its own moral. "Once upon a time a telegraph company built an aerial line across the desert separating two trading centres. The surveying staff did their work so well that the route was followed ever afterwards by the caravans. In the fulness of time well-defined tracks became outlined along both sides of the pole route. One day a traveller came along and in his haste he collided with one of the poles. A letter to the 'Times' followed, in which he pointed out the iniquity and crass stupidity of the telegraph administration in running their unsightly poles right down the centre of the road!"

Captain Carter writes to point out that in his article on the Ingersoll Rand Equipment, which appeared in our last issue, the figures shown on page 366 should be numbered across the page (5), (4), (3). Fig. **6** shows the 156H tool in operation, not the 158.

The Relay Automatic Telephone Coy. has completed a P.A.B.X. with a capacity for 6 A and B Feeds and 40 lines for the B.B.C. Station at Broad Street, Birmingham. The Exchange Battery drives the Ringing Machine, which also provides the standard tones, dialling tone, ringing tone, busy back tone and number unobtainable tone. A one-position manual board fitted with 4 exchange and 2 tie lines and 7 cord circuits is installed alongside the auto. racks in the same room.

The contract for the new Fontainebleau exchange, which we mentioned in last issue as having been placed with the Relay Coy., covers an equipment for 3,000 lines and not 300 as stated in error.

We learn that Mr. F. Morley Ward, M.I.E.E., who until recently was General Manager (and previously Chief Engineer) of the Relay Automatic Telephone Co., Ltd., has now taken up a position in Spain with the International Telephone and Telegraph Corporation.

Mr. Ward will be well known to our readers; he was transferred from the N.T. Co., and in 1913 resigned from the Department to join the Marconi Co., who had acquired world wide patents for the Betulander (Electro Mechanical) Auto. Telephone System. Improvements in this system subsequently led to Betulander's invention of the Relay System and Mr. Ward, as the Co.'s Chief Engineer, was responsible for developing this system to meet British requirements.

The Journal has lost a very good friend and one of its best workers in the person of Mr. J. W. Gladwell, of the Messengers Lobby, E.-in-C.O., who unfortunately met with a fatal accident while cycling to the office one morning in February. Mr. Gladwell was our direct agent for many years at headquarters and also kept the general stock. He was most methodical in his methods and enthusiastic in his efforts to further the interests of the magazine. An old soldier, who had been quartered for years in India, Mr. Gladwell joined up for the period of the great war and served in the R.E. Postal Section in France. He came back matured in judgment, full of wise saws, and maintained our stock

like a real "quarter bloke." Mr. Gladwell leaves a widow and large family to whom our fullest sympathy is extended.

Mr. J. E. Taylor, S.E., Reading, read an interesting and original paper on "The Propagation of Electric Waves" on Wednesday, the 17th February, before a large audience at the Society of Arts. An animated discussion followed; in reply, Mr. Taylor suggested that the contents of the paper should be allowed to sink in before final judgment is passed.

A summary of Telegraph and Telephone progress during the last two years appeared in the January issue of the *I.E.E. Journal*. We recommend it to our readers, as it gives valuable information on the problems and scope of the work carried out by the Engineering Department of the P.O.

HEADQUARTERS NOTES.

EXCHANGE DEVELOPMENT.

The following works have been completed:—

Exchange.	Type.	No. of Lines.
Gosport	Auto.	600
Hayling Island	,,	200
Shrewsbury	,,	870
Aberdare	Manual.	360
Abertillery	,,	140
Bognor	,,	760
Brighouse	,,	440
Colchester	,,	210 additional
Cowes	,,	1700
Grangewood	,,	1520
Hoylake	,,	320
Huddersfield Extension ...	,,	720
Oswestry	,,	600
Pinner	,,	380
Redditch	,,	320
Rossendale Extension ...	,,	460
Todmorden	,,	300
Woking Extension ...	,,	380
Bank of S. Africa ...	P.A.B.X.	100
Barrow Hepburn & Gale...	,,	70
Bilsland Bros.	,,	40
Birkenhead Corporation ...	,,	100
Bradford Newspaper Co....	,,	60
B.B.C. Birmingham ...	,,	30
British Mannesman Tube Co.	,,	40
Cooper's Store, Liverpool.	,,	20
J. Hall & Sons	,,	30
Jarrett Rainsford ...	,,	40
Liverpool Courier Extn....	,,	20
Manchester Corporation ...	,,	30

Exchange.	Type.	No. of Lines.
The Observer Ltd. ...	P.A.B.X.	30
Prices Candle Co. ...	,,	70
Sharpe & Sons	,,	30
Shell-Mex, Brixton ...	,,	30
Shell-Mex, Cardiff ...	,,	30
Taylors Drug Co. ...	,,	40
Tyldesley U.D. Council...	,,	20
United Water Softeners ...	,,	30
Vulcan Foundry	,,	40
Willis Faber Extension ...	,,	30

Orders have been placed for the following new Exchanges:—

Exchange.	Type.	No. of Lines.
Armley	Auto.	700
Basford	,,	1380
Keighley	,,	1300
Leicester	,,	8604
Nottingham	,,	7130
Sandal	,,	250
Syston	,,	130
Wakefield	,,	941
Western	,,	6800
Western Park	,,	205
Wigston	,,	250
Dartford	Manual.	560
Letchworth	,,	640
Manchester Relief ...	,,	5800
Newcastle Relief	,,	2600
Ashton-under-Lyme Infirmary	P.A.B.X.	30
Auto Strop Co.	,,	30
Bain & Son	,,	30
Birmingham Chamber of Commerce	,,	40
Birmingham Corporation...	,,	30
Blake & Co.	,,	40
Bradford Royal Infirmary	,,	40
Bristol Docks	,,	60
Collins & Co.	,,	20
Eastbourne Corporation ...	,,	50
Failsworth Co-op ...	,,	50
Hawkes & Son	,,	50
Kendal Milne Co. ...	,,	100
Lambeth Council ...	,,	50
Manifoldia Ltd.	,,	30
New Hudson Ltd. ...	,,	30
Newton Chambers & Co...	,,	100
North West Road Car Co.	,,	30
Perfecta Tube Co.... ...	,,	30
Robinson Bros.	,,	30
Spillers & Bakers ...	,,	40
Stewart Thompson & Co.	,,	40
United Water Softeners...	,,	30
Valor Co.	,,	30
Watney Coombe Reid ...	,,	130
Weston-super-Mare Council	,,	30
Wilson Wright Davies ...	,,	30
Yardley & Co.	,,	50

Orders have been placed for extensions to existing equipments as follows:—

Exchange.	Type.	No. of Lines.
Grimsby	Auto.	940
Marton	,,	100
Portsmouth	,,	—
Sketty	,,	170
Birmingham (East) ...	Manual.	380
Douglas (Glasgow) ...	,,	1820
Jesmond	,,	1240
Leeds Trunk	,,	—
Mansfield	,,	220
Mill Hill	,,	160
Paddington	,,	1000
Park	,,	2540
Romford	,,	320
Sydenham	,,	1580
Wimbledon	,,	1400
Willis Faber & Co. ...	P.A.B.X.	30

The installation of Leeds Telephone Repeater Station is well in hand, while work is also proceeding at Edinburgh, Jedburgh, Newcastle, Catterick, Birmingham, Gloucester and Newport stations. An installation of 2-wire repeaters is being fitted at Southampton Repeater Station to provide for extending the London—Southampton cable to Bournemouth. Engineering arrangements have been carried out at Aldeburgh for a night service circuit between London and Berlin.

Traffic Metering in Automatic Exchanges.

In manual exchanges, such traffic records as cannot be taken by means of the subscribers' meters can usually be obtained without undue difficulty by the operating staff.

With the introduction of automatic working, by which the majority of the calls are effected at the exchanges without human agency, these means are not available and special methods have to be adopted. The traffic records required in automatic exchanges may be divided into four main classes:—

1. Records of the effective calls originated by subscribers. These have, of course, been taken from the inception of automatic telephony in this country, as they are the basis of subscribers' accounts. They are mentioned here for completeness, and also because they may be used to supplement other records.

2. Records of the number of calls which fail to mature on account of insufficiency of switching plant. This is a measure of the service given to the public from the traffic point of view, *i.e.*, it is a measure of the quality of the product which the Telephone Department sells.

3. Records of the amount of traffic carried by the component parts of the exchange. This information is required to assist in design when an extension of the exchange is being planned.

4. Records of the total traffic carried by the exchange. These records are usually taken only quarterly and are required for general statistical purposes.

As regards the last three classes of records, a considerable number of records have been taken by actual observation at the switches. This method is tedious and is liable to cause interference with efficient maintenance. It has been considered desirable, therefore, to devise automatic means of taking these records, and although the final details of the various schemes have not been settled, enough has been done to enable complete metering schemes to be included in all the London exchanges and all future provincial ones.

LONDON ENGINEERING DISTRICT NOTES.

Mileage Statistics.

During the three months ended 31st December, 1925, the following changes have occurred:—

Telegraphs.—Nett decrease in Open Wire of 16 miles and a nett increase in Underground of 225 miles.

Telephones (Exchange).—Nett decrease in Open Wire (including Aerial Cable) of 258 miles and a nett increase in Underground of 30,278 miles.

Telephones (Trunks).—Nett decrease in Open Wire of 6 miles and nett increase in Underground of 2,258 miles.

Pole Line.—Nett increase of 82 miles, bringing the total to date to 5,272 miles.

Pipe Line.—Nett increase of 116 miles, the total to date being 6,385 miles.

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

Telegraphs	24,393
Telephones (Exchange)	1,675,409
Telephones (Trunk)	59,918
Spares	48,638

External Construction.

During the quarter ended December 25th, 1925, 11,451 exchange lines, 7,273 internal extensions and 1,109 external exten-

sions were provided. In the same period 4,376 exchange lines, 3,015 internal extensions and 659 external extensions were recovered, making nett increases of 7,075 exchange lines, 4,258 internal extensions and 450 external extensions.

Internal Construction.

New Exchanges.—A new C.B.S. No. 2 Exchange equipment was brought into use at Upminster on January 14th. New exchanges are in course of construction at Primrose Hill (C.B.1, 4500 lines), Rodney—Walworth (C.B.1, 3700 lines), Waterloo—Hop Relief (C.B. 10A, 900 lines), and Kelvin—Western Relief (C.B. 10, 700 lines). The two first named Exchanges are being installed by the B.L.M. Ericsson Manufacturing Company and the General Electric Company respectively. The work in connection with Waterloo and Kelvin is being carried out by the District staff.

C.C.I.—The work at several of the manual Exchanges in the District at which C.C.I. equipment is to be introduced has been commenced.

Exchange Batteries.—Experiments have recently been carried out in the building up of batteries which have for their connections a lug and short bus-bar instead of the usual bus-bar which connects up positive plates in one cell to the negative plates in another cell. The new scheme is one which will enable cells to be rapidly erected, and will permit of sections which become faulty in existing cells to be replaced readily. The plates are standardized and at present about five various capacities are being dealt with. The lugs are merely bolted together, and no lead burning is necessary. The batteries dealt with in London up to the present are Paddington, Lee Green, Putney and Gerrard, and, so far as can be seen, the new arrangements, which have been designed by the Engineer-in-Chief, Telephone Section, will result in simplification and efficiency with economy. Lead-lined wood boxes are employed.

Wireless Induction.—An unusual fault which occurred recently affected the wireless aerials concentrated on G.P.O. West. Heavy induction was observed, and, from the frequency of the interruptions, the trouble was apparently due to a Baudot set. As, however, there are about 70 sets in use, neither the particular set nor the actual cause could be traced for some time. It was found necessary to start each Baudot separately, on a Sunday, when the trouble was finally traced to sparking at the contacts of a newly-devised receiver, which was in experimental use. Morse could be read by telephone while the induction existed, but mechanical reception was interfered with.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

ADMISSION of Post Office Candidates to the Institution of Electrical Engineers (approved by Membership Committee, 1923, and confirmed at meeting of 20th January, 1926).

Official Rank.	*Eligible for*
Staff Engineers	Full membership without examination.
Superintending Engineers ...	
Assistant Staff Engineers ...	
Assistant Suptdg. Engineers	
Executive Engineers ...	
*Assistant Engineers:	
(1) Recruited by open competition, or	After 5 years' service: Full membership without examination.
(2) Possessing exemption qualification	Otherwise: Associate membership without examination.
(3) Not recruited by open examination nor possessing exemption qualification	Associate membership after passing Part 2 of examination.
*Chief Inspectors and *Inspectors:	
(1) Possessing exemption qualification	Associate membership without examination.
(2) Not possessing exemption qualification	Associate membership after passing Part 2 of examination.

* Subject to 2 years' substantive service as Inspector, Chief Inspector or Assistant Engineer.

The foregoing defines "eligibility" only and has to be taken in conjunction with the byelaws of The Institution of Electrical Engineers.

LOCAL CENTRE NOTES.

NORTHERN CENTRE.

On the 2nd December last a party of members visited the Ropeworks of Messrs. Hood, Haggis & Co., at Willington

Quay-on-Tyne. The visit was very enjoyable and was rendered interesting and instructive by the courteous guidance and explanations of the Works Manager and his Assistant, to whom our members are very much indebted. The refreshments provided by the firm after the tour of inspection were much appreciated.

On the 20th January, 1926, Mr. C. Robinson, B.A., A.M.I.E.E., of the Engineer-in-Chief's Office, delivered a very instructive lecture, illustrated by lantern slides, on the subject of "Telephonic Repeaters and their Maintenance," before a well attended meeting. The points raised in the brisk discussion which followed the lecture were dealt with by the lecturer in an expert manner and the meeting in according a vote of thanks to Mr. Robinson voiced its appreciation in no uncertain manner.

On the 17th February, Mr. F. W. Longmore read a paper on "The Elements of Telephone Machine Switching." The paper dealt with the first principles of Automatic Telephony and was recognised by the meeting as a simple and useful introduction to the further study of automatics. A pleasing feature of the discussion which followed the reading of the paper was the increased participation of the junior members. A vote of thanks to Mr. Longmore was carried with hearty applause.

The Institute of Public Administration has extended an invitation to the members of this Centre to attend a Lantern Lecture to be given in the Mining Institute, Newcastle-on-Tyne, on Wednesday, the 24th February, at 7 p.m. The subject is "The P.O. Engineering Department and its Work," and the lecturer our respected chairman, Mr. J. R. M. Elliott, M.I.E.E.

It is with mingled feelings that we have to record the transfer of Mr. Charles Whillis, M.I.E.E., from the Technical Section, Superintending Engineer's Office, Newcastle-on-Tyne, to the Construction Section, Engineer-in-Chief's Office, on the occasion of his promotion to the rank of Assistant Staff Engineer. Pleasure in his promotion is tinged with regret at the loss of a man of outstanding personality and character coupled with a human understanding and sympathy with his fellow men.

Mr. Whillis's departure took place at short notice and precluded the possibility of arranging an entertainment at which to bid him goodbye, but a large number of members of the staff of the Northern District Engineering Department met in the Superintending Engineer's Office on the 9th March for the latter purpose and at the same time presented him with a Bureau of Chippendale period as a token of their good will and for remembrance.

The Chair was taken by Mr. J. R. M. Elliott, M.I.E.E., Superintending Engineer of the Northern District, who paid eloquent tribute to Mr. Whillis's ability as an Engineer and those personal

gifts which had endeared him to all those with whom he came in contact. Messrs. Baldwin, Andrews, Motyer and Cook expressed the congratulations of the staff. Mr. Baldwin called attention to the fact that Mr. Whillis was the second officer from the Northern District who, within the last 3 months, was called to take up an important position on the Headquarter's staff.

In accepting the gift, Mr. Whillis paid generous tribute to the assistance which he had received from all branches and referred particularly to the good relations and friendly spirit which had always existed between the various sections of the Northern Engineering District, a spirit which appeared to permeate those who came into the District as well as those who had grown up in it.

H.R.J.D.

SCOTLAND WEST CENTRE.

At the third meeting of the current Session, held on 7th December, 1925, in the Royal Technical College, Mr. J. Hardie introduced our new Chairman, Mr. R. Aitken.

The lecturer for the day was Mr. J. D. McLeod, the subject being "Main Cables: Loading, Testing and Transmission." The paper gave a brief explanation of the tests made on Loading Coil Sections of Main Loaded Cables and the result of these tests in order to meet the conditions aimed at in balancing.

The paper went on to describe the further tests made on groups of Loading Coil Sections when circuits are loaded for phantom working, in order to reduce the cross-talk between "phantom" and "side" as well as between "side" and "side" circuits. The acceptable values in each of the tests—insulation, conductor resistance, capacity unbalance, and cross-talk—were explained, and a brief summary was also given of the tests made on the completed cable to prove that the inductance added to the cable by the loading coils is up to specification and that the cross-talk is not unduly increased by the joining up of the loading coils; also that the standard of transmission aimed at by loading is attained.

The meeting arranged for 1st February had to be abandoned as one of the lecturers, owing to unforeseen circumstances, found it impossible to deliver his lecture.

NORTH EASTERN CENTRE.

The membership of the Leeds Branch has now passed the century mark and the Session just terminated has been most successful.

Lectures have been given on:—

"Telephone Exchange Accommodation."
"Manufacture and Testing of Earthenware Conduit."
"From Youth-in-Training to Engineer."
"Cable Faults—Causes and Remedies."
"Recruitment and Promotion of Staff."
"Slide Wire Bridge Testing."

Five of the six lectures were illustrated by lantern slides and the general opinion is that illustrated lectures are the most interesting and helpful. As will be readily understood from the titles quoted above, the field has been a varied one, many difficult ditches and hedges have been negotiated and at times it has been necessary for the M.F.H. to call the "hounds off," otherwise in their thirst for knowledge the hunt would have gone far into the night.

What is the Institution doing? Well, in this District it can with truth be said: (1) The Institution is bringing gentlemen together whose only other connection is "on paper," and as a result of the meeting in the flesh a better understanding amongst men is the result. (2) The Institution is giving to each member a synopsis of other work outside his own, thus placing him in a better position to more thoroughly understand the comprehensive work the Department is engaged upon. (3) The Institution is giving confidence, inasmuch as it affords an opportunity for men to speak in public on a subject on which they have specialised knowledge. (4) The Institution brings before each member the latest development in any phase of its work, so that all its members are kept interested and in touch with the progress of the "Science of Communications," which is so rapid as to make it impossible for any one member to be a specialist in all its branches.

The Staff is now recognising the real value of the Institution and the attendances and discussions are most satisfactory.

SOUTH MIDLAND CENTRE.

There was an attendance of 54 at the first meeting of 1926, held on the 26th January. Mr. V. Smith read his essay, "New ways of doing old jobs," which gained the first prize at the first essay competition for workmen held at the end of 1923.

Mr. Smith explained at the outset that his paper was written before he had gained experience as a supervisor.

His first suggestions for improving efficiency were in the wiring of tag blocks and in wiring apparatus when tees were necessary. With the aid of admirable sketches, a new method of wiring tag blocks at the top of 120 line C.B.S. lamp signalling switchboards was clearly explained. An arrangement for running several lead

cables branching off to different points was set out and a simple device for ensuring that the screw of a rack and the hole in a switchboard are in alignment was described.

Mr. Smith next dealt with a method of fitting rows of ceiling brackets and after mentioning the difficulties attending the use of rawl plugs, described a jig the introduction of which he claimed would overcome most of them.

There was no lack of questions. A paper full of practical suggestions was assailed with a stream of practical questions, to which the lecturer replied. Messrs. Campbell, Atkins, Bolton, Gravill, Dwyer, Harris and the Chairman joined in the discussion, and Mr. Smith realised that a feature of the history of inventions —the simultaneous discovery of a new idea—also applied to some of the results of his own enterprise.

Each speaker congratulated the lecturer and more than one of them emphasized the utility of papers of this type. The Chairman closed the meeting with a cordial expression of the thanks of the hearers.

Eighty-two members and visitors severely taxed the accommodation in the Physics' Lecture Room at the University College, Reading, on the occasion of the 56th meeting, held on March 3rd.

It had been arranged for Mr. J. S. Brown to read a paper entitled "The Training of Staff for, and Maintenance of, Automatic Telephone Exchanges," but owing to the numerous and insistent requests for a lecture on the principles of "Automatics" before his retirement at the end of March, Mr. Brown kindly undertook to take as read the paper on "Training, etc.," copies of which had been circulated, and proceed to answer questions thereon. That portion of the paper which dealt with training commenced with an account of the tuition at Portsmouth in 1914 and details of the 27 months' course were given. The six training duties scheduled at the present time for Portsmouth and Southampton were described.

The method of recruitment and the qualifications required of young applicants for training were detailed. Mr. Brown dealt with the maintenance of automatic apparatus under four headings —cleanliness, arrangement, organisation and routine—and very valuable information was imparted under each of the quartette.

The questions asked by Messrs. Atkins, Moody, Beaumont and the Chairman received adequate replies.

At this stage Mr. Halton eulogized Mr. Brown's work for the Institution and referred to the large number of helpful papers he had prepared.

Mr. J. S. Brown then commenced on the subject of "The Principles of Automatics."

A strong plea was made at the outset for members to study

automatic telephony which, the lecturer emphasized, was undoubtedly the system of the future. A very amusing account followed of the impressions gained by a journalist possessed of an unusually vivid descriptive powers on a visit to the Torquay Exchange.

The lecture, delivered in an easy unhesitating style, was given without notes and was illustrated by diagrams, sketches and a skeleton set. Reference was made to the early arrangement invented by Strowger and the kernel of all step by step system—a cylinder surrounding an axis capable of vertical and horizontal motions—was carefully explained. The refinements required for two, three, four or more digits were touched upon, and the introduction of Keith line switches and preselectors and later rotary line switches were explained. The use of rotary switches in key impulse senders and the storing of impulses was demonstrated by using a bank of preselectors.

The use of the transmission bridge and the principles of the register were ilustrated and the necessity proved for the eleventh point on the private banks. The problem of faults was investigated.

Replies were given to the questions put by Messrs. Halton and Beaumont, and Mr. Atkins thanked the lecturer for a three months' course received in an hour, which sentiment was echoed by other listeners.

In the absence of the Chairman, who had to leave the meeting at the close of the lecture, the Vice-Chairman thanked Mr. Brown on behalf of the large audience and expressed the hope that he would continue to give his valuable papers after the termination of his official duties for the Department.

The members present, by loud and prolonged applause, upheld this valedictory expression of the Vice-Chairman.

A.W.L.

RETIREMENT OF MR. T. E. P. STRETCHE.

On the occasion of his retirement from the service, Mr. T. E. P. Stretche, Superintending Engineer of the North Western District, was entertained by the members of his staff and other friends and colleagues in the service at a Smoking Concert held in the Victoria Hotel, Preston, on the evening of 3rd March, when he was presented with a William IV. silver tea and coffee service. Mr. J. S. Terras, Assistant Superintending Engineer, presided over a large company and among many others present were Mrs. Stretche with other ladies, and Messrs. T. B. Johnson (Superintending Engineer, N.E. District), W. J. Medlyn (Superintending Engineer,

S.Lancs. District), V. R. Kenny and A. E. Stocker (Assistant Surveyors, N.W. District), J. T. Whitelaw (Telephone District Manager, Manchester), S. O. Allen (Telephone District Manager, Blackburn), R. T. Vity (Postmaster of Preston), J. Curran (Postmaster of Southport), T. J. Collins (Postmaster of Wigan), F. W. Best (Executive Engineer, Rochdale), S. Upton (Executive Engineer, Blackburn), W. J. Rolfe (Executive Engineer, Preston Technical Section), J. T. Bramwell (Executive Engineer, Lancaster), and Mr. R. A. Jones (Staff Officer, Preston).

After the National Anthem had been sung, the Chairman read apologies for absence and expressions of good wishes from Colonel T. F. Purves, O.B.E. (Engineer-in-Chief), Messrs. A. L. DeLattre, J. Sinnott, O.B.E., and E. H. Shaughnessy, O.B.E. (Assistant Engineers-in-Chief), Mr. Randall Bell (Surveyor, N.W. District) and several other gentlemen, including a very delightful letter from Mr. J. W. Sullivan, late Assistant Superintending Engineer in the N.W. District.

Mr. Terras in making the presentation, after mentioning that Colonel Purves was greatly disappointed at not being able to come himself to Preston to make it, referred to Mr. Stretche's ability as an administrator and to the feeling of confidence, respect and affection which his staff entertained towards him. He remarked that outstanding qualities in Mr. Stretche's work in the N.W. District had been his regard for the position and prestige of the Engineering Department in its relation with other branches of the Public Service and with the outside world, his concern for seeing that engineering officers in the various towns had adequate and suitable office accommodation, his skill in conducting negotiations for the Department and particularly his constant endeavour to treat all members of his large staff with the most scrupulous fairness. After observing that Mr. Stretche was going away in vigorous middle-age with the capacity for getting much enjoyment out of existence for many years to come in his new home in Shropshire and that the good wishes of the staff extended equally to Mrs. Stretche, Mr. Terras made the presentation in a scene of much enthusiasm, the health of Mr. and Mrs. Stretche being drunk with musical honours.

Mr. F. W. Best, in paying a special tribute on behalf of the engineering officers in the District, referred to Mr. Stretche's high reputation as a chief who looked after the interests of his staff and to his charm and goodheartedness.

Mr. R. A. Jones paid a similar tribute on behalf of the clerical staff in the District: he made reference to Mr. Stretche's high conception of the dignity of the Civil Service and to the way in which he had upheld its best traditions.

Mr. Stretche, in responding, said words really failed him to

express adequately the feelings of Mrs. Stretche and himself on receiving so handsome a present and such a demonstration of affection from the members of his staff and his other old friends in the service. He thanked the staff of all ranks for the splendid service they had rendered to the Department through himself and said that no man could have been surrounded by a more loyal or conscientious staff. He ended by expressing his warmest wishes for the future success of every member of the staff and extending a hearty invitation to everyone to visit Mrs. Stretche and himself after they had settled down at Church Stretton with the single proviso that they did not all arrive on the same day!

Mr. S. Upton in a humorous speech proposed the health of the guests, and this was responded to by Mr. T. B. Johnson—a very old friend of Mr. Stretche, who gave some amusing reminiscences of their early days together in the service—and by Mr. R. V. Kenny, Mr. R. T. Vity, Mr. J. T. Whitelaw and Mr. S. O. Allen.

During the evening a capital musical programme, arranged by Mr. C. H. H. Bott, was carried through, the gentlemen taking part, who were all members of the staff, being Messrs. T. H. Tootell (flautist), C. G. Holland, J. Kelly, F. H. Lee, G. S. Powney, V. G. Dean, D. Barratt, W. Crookes, T. L. Abberley, H. S. Turner and R. B. Austin (vocalists), A. W. Field (monologue) and H. Horrocks and W. Nelson (humorous songs).

During the evening, Miss C. A. Roberts, senior typist in the Superintending Engineer's Office, presented Mrs. Stretche with a bouquet of pink carnations.

Mr. R. H. Ellis (with Mr. R. B. Austin as deputy) very carefully discharged the duties of honorary secretary and treasurer in connection with all the arrangements.

THOMAS EDWARD PRICE STRETCHE.

WITH the retirement of Mr. Stretche there passes from the service one of the best known and most popular men in the Engineering Department.

Entering the service at Gloucester in the autumn of 1880, about six years later Mr. Stretche joined the staff of the late Mr. A. W. Heaviside, I.S.O., then Superintending Engineer at Newcastle-on-Tyne. Some idea can be formed of the vast change which has taken place in the scope of the work since those days when one learns that the entire staff in the Superintending Engineer's Office at Newcastle consisted of five clerks. In other provincial Districts it was only four. As is well known, the Post Office had a telephone exchange system in Northumberland and Durham in very early days, and the experience which Mr. Stretche gained there relieving engineers was to prove valuable to him at

the Telephone Trunk Transfer in 1896, and later in connection with the telephoning of London by the Post Office, also still later when the National Telephone Company's system was taken over in 1912. Service at Newcastle was succeeded by short periods on the staff of the Supjerintending Engineer (Mr. Jenkin) at Cambridge, in the office of the Engineer-in-Chief and at Mount

THOMAS EDWARD PRICE STRETCHE.

Pleasant Factory in London. In 1893 Mr. Stretche became an Engineer, 2nd Class, in the Scotland West District, first under Mr. Ashton and afterwards under Mr. Stewart. Seven years' service in Glasgow was followed by a transfer to London in May, 1900, as 1st Class Engineer, and early in 1904 Mr. Stretche was

offered the post of Assistant Director of the Egyptian Government Telegraphs by Mr. (later Sir) John Cameron Lamb, but this was declined for domestic reasons. Very shortly afterwards Mr. Stretche was appointed Technical Officer on the Engineer-in-Chief's staff and had the responsible task of organizing the newly-formed Contracts Section. About this period there was great activity in laying underground lines for the more important telegraph routes, such as to Scotland and the West of England, also the telephoning of London, and it fell to Mr. Stretche's lot as head of the Contracts Section to have through his hands the work of preparing specifications, inviting tenders and placing contracts for these works, also arranging details with the various local authorities regarding re-instatement. Further advancement came in 1907 when he succeeded the present Engineer-in-Chief as Assistant Superintending Engineer in the old Southern District, which was then in charge of the Royal Engineers (K Company), and on the Royal Engineers' departure to Dublin was Assistant Superintending Engineer in the South Eastern District under Mr. Moir. In 1911 Mr. Stretche was appointed the first Superintending Engineer of the newly formed North Western District with headquarters at Preston. Offices for the latter had to be found, and also new offices for Sectional Engineers at Rochdale, Preston, Blackburn, Lancaster and extended accommodation at Carlisle, tenancies for which were negotiated by Mr. Stretche personally and proved to be a great improvement on the accommodation usually provided for Superintending Engineers' and Sectional Engineers' Staff elsewhere.

The clerical staff for the new District, which was drawn from all parts of the country, started work temporarily at Manchester, pending occupation of the Preston premises, the removal actually taking place on December 27th, 1911, a sorry date for a removal.

The fourteen years spent in the North Western District have been a busy period, the work carried out including the opening of 3 automatic and 14 C.B. Exchanges and the laying of a complete network of main cables between the principal towns.

Fond of open-air life, Mr. Stretche has played cricket for Gloucester, Northumberland and the West of Scotland: he played football also in Gloucester and when in Newcastle was Secretary of the Northern Rugby Football Club. In later years he has played golf and when in form is a strong man off the tee.

Mr. Stretche took a lively interest in the old Volunteer Forces, serving in the Gloucester Artillery and later, in Scotland, first in the Lanark Artillery and afterwards in the Highland Light Infantry. He has also been a member of the Senior Constitutional Club in London for over twenty-five years. Mr. Stretche is interested in Freemasonry, being at present Worshipful Master of

Lodge No. 314 and Scribe E of the Royal Arch Chapter. As all his friends know, Mr. Stretche is an authority on the subject of old furniture and old buildings and he is finding scope for indulging this excellent hobby in devoting the early days of his retirement to renovating and panelling out the Old Manor House of All Stretton, Church Stretton, Shropshire, where in the country of his forbears he has decided to make his home and where he has told us Mrs. Stretche and he will always be glad to welcome old friends.

In 1915 Mr. Stretche offered his services in a military capacity, but before this could be arranged he met with a serious motor accident whilst arranging for a tapping of German wireless in West Cumberland, sustaining a fractured arm and other injuries which incapacitated him for some time. He acted as Military Representative and later National Service Representative on the Recruiting Tribunal, for which he received the thanks of Lord Derby, then Secretary for War, Sir Auckland Geddes, Minister for National Service, the G.O.C. Western Command, etc., etc. He also commanded a Company and acted as Adjutant of the National Reserve.

Mr. Stretche was a distinct personality in the Engineering Department. Blessed by nature with a fine presence, with a habit of crisp and outspoken comment on men and things and with a great fund of humour, he was indeed well fitted to uphold the best traditions of the service. Few men could so quickly grasp the essentials of a case or argue it more convincingly. To those under him he was a fair and considerate chief, whose popularity with his staff was universal.

BOOK REVIEWS.

"Practical Electrician's Pocket Book. 1926." By H. T. Crewe. Cloth, pp. 585. Rentell, 3*s*. net.

The twenty-eighth edition of this well-known pocket book has been subjected to a very thorough revision. The bulk of the matter dealing with elementary principles has been entirely re-written, whilst new chapters on Power Factor Correction, Fault Localisation on Underground Cables, and Automatic Protective Gear have been added. We consider that it should appeal to a still wider circle of engineers and students than heretofore.

"Radio Year Book. 1926." Sir Isaac Pitman & Sons, Ltd. Pp. 182. 1*s*. 6*d*. net.

This is the fourth year of this interesting book. It deals largely with broadcasting matter, giving photographs and information concerning many of the B.B.C. staff at the different

stations, and of notable contributors to the success of the B.B.C. undertaking. A full list of broadcasting stations, including those in Australia, Canada and America, with their respective Call-signs and Wave-lengths is provided, and an excellent photograph among others of the 2LO masts on the roof of Selfridges.

"Insulated Electric Cables: Vol. I.—Materials and Design." By C. J. Beaver. London, Ernest Benn, Ltd. Pp. 264. 36*s*. net.

The author in his preface states that his object in writing this book has been firstly to supplement, balance, and focus the existing knowledge of the subject in order to guide and conserve the efforts of future workers, and secondly to promote among cable-users a wider knowledge of the properties of cables and a better appreciation of the reasons which govern the various types of construction and which determine the most suitable types for given duties. The present volume deals with Materials and Design, while a second volume is in preparation on the subject of Manufacture and Installation. As might be anticipated from its title the book deals with the subject more particularly from the Power Cable aspect, but much of the subject matter on materials is applicable to Telegraph and Telephone Cables.

After a short introductory chapter the author tackles the subject of Materials, dividing it under three headings, viz.: Conducting materials, insulating materials and, thirdly, protective and preservative materials. The subject is handled in a very thorough manner. The sources of supply, the characteristics both good and bad which render particular materials suitable or unsuitable in particular cases and the manufacturing processes through which these materials have to pass before emerging as finished products are minutely described.

One of the difficulties which the cable manufacturer has had to contend with is that in many cases he was compelled to purchase the components of his finished product in a comparatively late stage of manufacture and as a result he had in the past little or no control over the properties of these components, which in many cases are common articles of commerce such as cambric, paper, rubber and wax. Trouble from this cause has induced cable manufacturers to gradually extend their operations towards the source of their raw materials so that at the present time the majority of cable works include wire drawing and rubber mills, while some of the larger concerns go so far as to own controlled interests in rubber plantations, paper factories and lead and copper mines.

In dealing with materials the largest section is naturally devoted to insulating materials. At the present time the cable

user has the choice of roughly four types of dielectric, viz., rubber, paper, bitumen and varnished cambric, and of these the two first mentioned are by far the most generally used; the rubber being particularly suited for indoor low tension work, while paper has advantages for outdoor and general high tension work. Rubber, owing to its being attacked by ozone, is not to be recommended for use in situations where it cannot be protected from the effects of corona.

In the second portion of the book dealing with design a short preliminary chapter is devoted to the mechanical principles of design wherein among other points dealt with are notes on the behaviour of cables under tensile stress and the precautions necessary for the avoidance of twist.

A chapter then follows on the subject of conductors, wherein the properties of stranded conductors, their flexibility and make-up for various purposes are discussed. The forms and disposition of conductors, the advantages and disadvantages of shaped conductors and the grouping of conductors in special assemblies are among other things dealt with in this chapter.

Then follow two chapters on dielectrics, the first on composition design and the second on properties and limitations of dielectrics.

In regard to the choice of insulating papers all comparisons made by the author, whether bearing on electrical properties or on chemical properties, between papers of the pecto and ligno cellulose types, give results which are in favour of the former.

In dealing with the "mechanism" of breakdown of paper cables the author has established, as the result of experimental investigation, that the paper and impregnating materials usually employed are decomposed by simple destructive distillation at comparatively low temperatures with production of water. The moisture so produced is condensed on the interior of the lead sheath or absorbed by the contiguous paper forming an electrical weak path which will heat up and produce more water.

Much useful experimental work has been carried out by the author on rubber and the effects of different fillers and accelerators. As regards accelerators the author's experience, taking into account manufacturing and economic factors, is in favour of paranitrosodimethylaniline without the use of any inorganic accelerator. Vulcanised rubber, containing organic accelerators such as paranitrosodimethylaniline, have as good electrical properties and superior ageing properties compared with rubbers containing litharge and other inorganic accelerators.

The penultimate chapter in this interesting and comprehensive book is devoted factors in voltage rating. These are dealt with under the headings of potential gradient, grading and stress distortion.

A short chapter on sheaths completes the work to which a name and subject index is provided.

A book on cables might easily be dry and uninteresting, the

present work, however, is quite the opposite. It is written in an easily readable style, which conveys the maximum of information in the minimum of space and this is evidently due to the fact that the writer knows his subject perfectly from beginning to end. There are many other works on cables, but this book will be regarded as a standard work on the subject for many years to come. The printing and general get-up are worthy of the contents.

A. J. GILL.

STAFF CHANGES.

POST OFFICE ENGINEERING DEPARTMENT.

PROMOTIONS.

Name.	Grade.	Promoted to.	Date.
Shackleton, J. M. ...	Asst. Supt. Engineer, London District.	Superintending Engineer, N. West District.	11-3-26
Best, F. W.	Executive Engineer, N. West District.	Asst. Superintending Engineer, N. Wales District.	To be fixed later.
Whillis, C.	Executive Engineer, N. District.	Asst. Staff Engineer, E.-in-C. Office.	11-3-26
Bannister, G. W. ...	Assistant Engineer. S. West District.	Executive Engineer. S. West District.	17-1-26
McCormack, W. ...	Assistant Engineer, N. West District.	Executive Engineer, S. Lancs. District.	7-2-26
Lockhart, J.	Assistant Engineer, Scot. West District.	Executive Engineer, Rochdale Section, N. West District.	To be fixed later.
Tebbits. J. E.	Assistant Engineer, N. Wales District.	Executive Engineer, Hanley Section, N. Wales District.	23-2-26
Lakey, E. A.	Assistant Engineer, E.-in-C. Office.	Executive Engineer, Telegraph Section, E.-in-C. Office.	23-2-26
Finlayson, W. J. ...	Assistant Engineer, N. West District.	Executive Engineer, Lancaster Section, N. West District.	To be fixed later.
Sharpley, A. J. ...	Assistant Engineer, E.-in-C. Office.	Executive Engineer, St. Albans Section, East District.	do.
McMullen, J. F. ...	Assistant Engineer, S. Wales District.	Executive Engineer, Southampton Section, S. Mid. Disrtict.	do.
Gibbon, A. O. ...	Assistant Engineer, E.-in-C. Office.	Executive Engineer, Telegraph Section, E.-in-C. Office.	3-4-26
Kirkwood, D. ...	Chief Inspector, S. Lancs. District.	Assistant Engineer, S. West District.	10-1-26
Kay, C. P.	Chief Inspector, N. District.	Assistant Engineer, Northern District.	24-12-25
Riley, J. H.	Chief Inspector, E-in-C. Office.	Assistant Engineer, E.-in-C. Office.	20-12-25
Snell, W. S.	Chief Inspector, Power District.	Assistant Engineer, E.-in-C. Office.	8-2-26
Willis, F. B.	Chief Inspector, E-in-C. Office.	Assistant Engineer, E.-in-C. Office.	To be fixed later.
Leech, W. H.	Third Officer, H.M.T.S. " Alert."	Second Officer, H.M.T.S. Alert.	1-11-25

PROMOTIONS—(continued).

Name.	Grade.	Promoted to.	Date.
Milton, G. P. ...	Inspector, London District.	Chief Inspector, E.-in-C. Office.	To be fixed later.
Gray, W. H. D. ...	Inspector, N. Wales District.	Chief Inspector, N. Wales District.	5-11-25
Davey, H. B. ...	Inspector, S. Lancs. District.	Chief Inspector, N. Wales District.	18-10-25
Monk, A. J.	Inspector, Testing Branch.	Chief Inspector, Testing Branch.	10-9-25
Wilmot, C. J.... ...	Inspector, S. Mid. District.	Chief Inspector, E.-in-C. Office.	To be fixed later.
West, A. S.	Inspector, E-in-C. Office.	Chief Inspector, E.-in-C. Office.	4-10-25
MacQueen, J. J. ...	Shift Officer, Oxford Radio.	Inspector, Oxford Radio.	13-1-26
Johnson, W. S. ...	,,	,,	5-1-26
Chislett, G. F. S. ...	Skilled Workman, Class I., S. Wales District.	Inspector, S. Wales District.	11-1-26
Clark, S. J.	,,	,,	18-1-26
Thatcher, E. J. ...	,,	,,	18-1-26
Taylor, G.	Skilled Workman, Class I., Scot. East District.	Inspector, Scot. East District.	7-12-25
Choldcroft, E. W. ...	Skilled Workman, Class I., Eastern Disrtict.	Inspector, Eastern District.	21-12-25
Leggatt, J.	,,	,,	19-7-25
Ragless, A.	,,	,,	25-11-25
Hamilton, H. ...	Skilled Workman, Class I. N. Ireland District.	Inspector, N. Ireland District.	22-9-25
Thompson, C.	Skilled Workman, Class I., S. Midland District.	Inspector, S. Mid. District.	18-10-25
Court, A. F.	,,	,,	10-12-25
Clatworthy, F. H. ...	Skilled Workman, Class I., Testing Branch.	Inspector, Testing Branch.	10-9-25
Mason, F. C.	Skilled Workman, Class I., N. Wales District.	Inspector, N. Wales District.	1-9-25
Ballard, W.	,,	,,	21-10-25
Kendall, H.	,,	,,	26-9-25
Blofield, J.	,,	,,	5-11-25
Connacher, A. ...	Skilled Workman, Class I., Scot. West District.	Inspector, Scot. West District.	1-7-25
Dodds, E.	Skilled Workman, Class I., Northern District.	Inspector, N. District.	1-1-26
Freestone, A. G. ...	Skilled Workman, Class I., E.-in-C. Office.	Inspector, E.-in-C. Office.	29-11-25
Matthews, W.	Skilled Workman, Class I., S. West District.	Inspector, S. West District.	To be fixed later.
McIver, T. G.... ...	Skiller Workman, Class I., Scot. West District.	Inspector, Scot. West District.	10-10-25
Dawson, A.	S.C. & T., Sheffield.	Repeater Officer, Class II., N. Wales District.	14-9-25

STAFF CHANGES.

APPOINTMENTS.

Name.	Grade.	Appointed.	Date.
Stretch, W.	Probationary Assistant Engineer,	E.-in-C. Office.	29-12-25
Owen, J. McA. ...	,,	,,	29-12-25
Jones, F.	,,	,,	1-1-26
Wylie, T. O. K. ...	,,	,,	23-12-25
Hodge, G. W. ...	,,	,,	29-12-25
Chapman, F. B. ...	,,	,,	22-12-25
Procter, W. S. ...	,,	,,	29-12-25
Morrish, H. E. ..	,,	London District.	29-12-25
Beach, W. R.	,,	E.-in-C. Office.	1-2-26
Straw, J. G.	,,	Testing Branch.	25-1-26
Tyson, W. R. ..	,,	E.-in-C. Office.	10-1-26
Jones, H. C.	,,	,,	8-1-26
Williams, H.	,,	,,	25-1-26
Tufnail, M. E. ..	,,	,,	12-1-26
Baines, J.	,,	Testing Branch.	31-1-26
Hollinghurst, F. ...	,,	E.-in-C. Office.	1-1-26
Edwards, J. J. ...	,,	Testing Branch.	18-1-26
Cox, H. E.	,,	E.-in-C. Office.	12-1-26
Morrill, A. E. ...	,,	Testing Branch.	1-2-26
Wright, F. V. ...	,,	,,	12-1-26
Cooper, M. C. ...	,,	E.-in-C. Office.	10-1-26
Reading, J.	,,	,,	31-12-25
Palmer, R. W. ...	,,	,,	12-1-26
Swift, R. E.	,,	,,	9-2-26
Hudson, A.	,,	,,	9-2-26

TRANSFERS.

Name	Grade.	Transferred.		Date.
		From	To.	
Cowie, J.	Executive Engineer.	S. Lancs. District.	London District.	31-1-26
Bramwell, J. T.	Executive Engineer,	Lancaster Section, N. W. District.	Northern District.	To be fixed later.
McLeod, J. ...	Chief Inspector.	S. Wales District.	Northern District.	1-2-26
Atkinson, J. W. ...	Assistant Staff Engineer.	E.-in.C. Office.	London District.	11-3-26

RETIREMENTS.

Name	Grade.	District.	Date.
Stretche, T. E. P. ...	Superintending Engr.	North Western.	10-3-26
Masaroon, R. G. ...	Asst. Superintending Engineer.	N. Wales District.	26-1-26
Newlands, T. H. ...	Executive Engineer.	E.-in-C. Office.	31-1-26
Waters, E. W. ...	Assistant Engineer.	London.	9-2-26
Brown, J. S.	Executive Engineer.	South Midland.	31-3-26
Whitehead, J.	Executive Engineer.	Eastern.	31-3-26
Harding, W. D. ...	Chief Inspector.	S. Wales.	25-12-25
Radcliffe, H. H. D. ...	Inspector.	Scotland West.	24-11-25

DEATHS.

Name.	Grade.	District.	Date.
Shepherd, G. M. B. ...	Executive Engineer.	E.-in-C. Office.	24-1-26
Giffen, A. E.	,,	North Wales.	3-2-26
Braine, P. S.	Inspector.	London.	16-11-25
Loughborough, A. R....	,,	,,	28-11-25
Holmes, J. W. ...	,,	N.E.	13-12-25

CLERICAL ESTABLISHMENT.

APPOINTMENTS AS CLERICAL OFFICER.

Name.	District.	Date.
Strain, W. J.	North Eastern.	17-1-26
Reid, R.	Scotland East.	17-1-26
Stanes, H. G.	London.	14-1-26
McConnell, J. F.	South Eastern.	12-12-25

RETIREMENTS.

Name	Grade.	District.	Date.
Roberts, G.	Clerical Officer.	S. Lancs.	31-12-25
Lima, F. A.	,,	,,	31-12-25
Nance, L. M.	,,	London.	31-10-25

COMMUNICATIONS.

All Remittances and Communications should be addressed to the MANAGING EDITOR, P.O.E.E. JOURNAL, Engineer-in-Chief's Office, Alder House, London, E.C.1.

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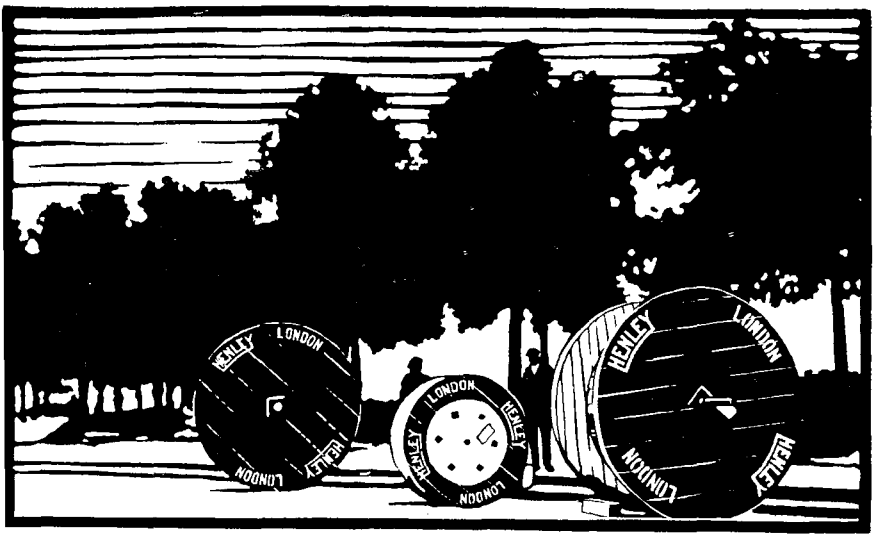

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