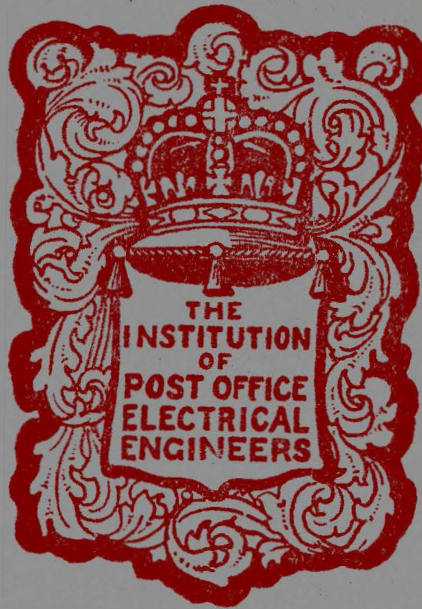


# THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL



**Vol. 18  
PART 2**

**JULY  
1925**

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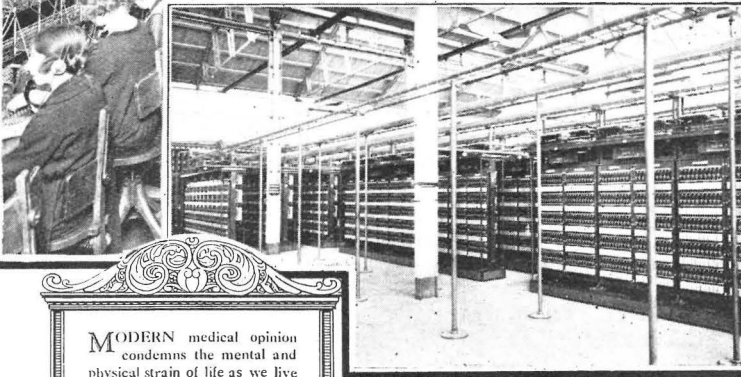
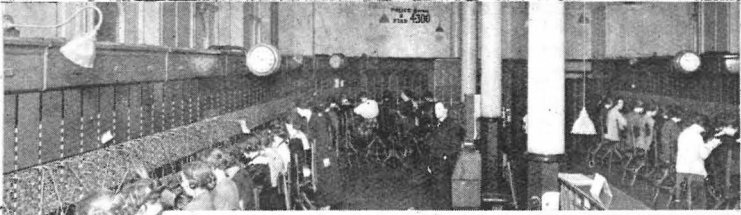
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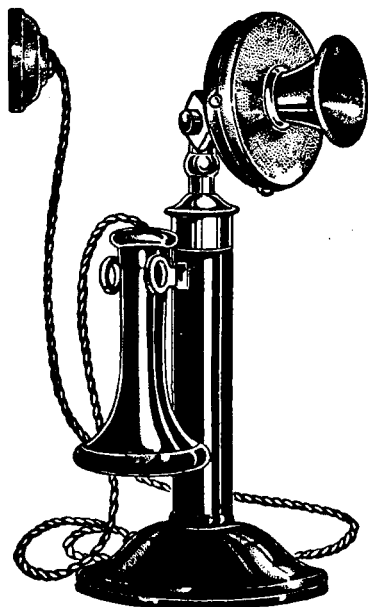
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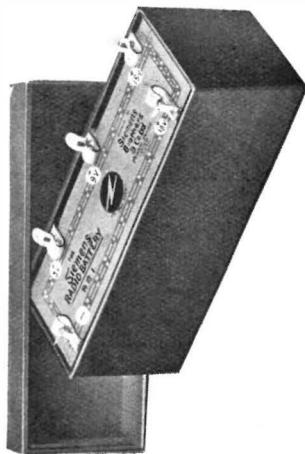
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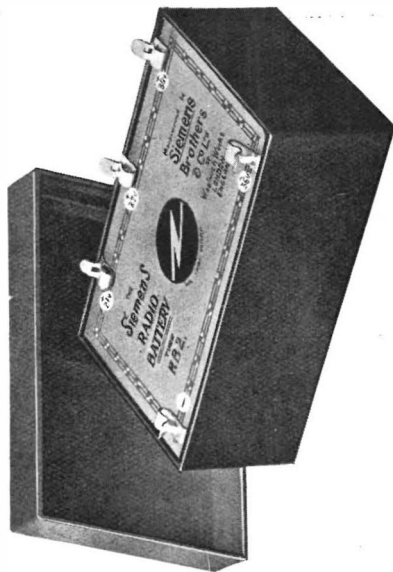
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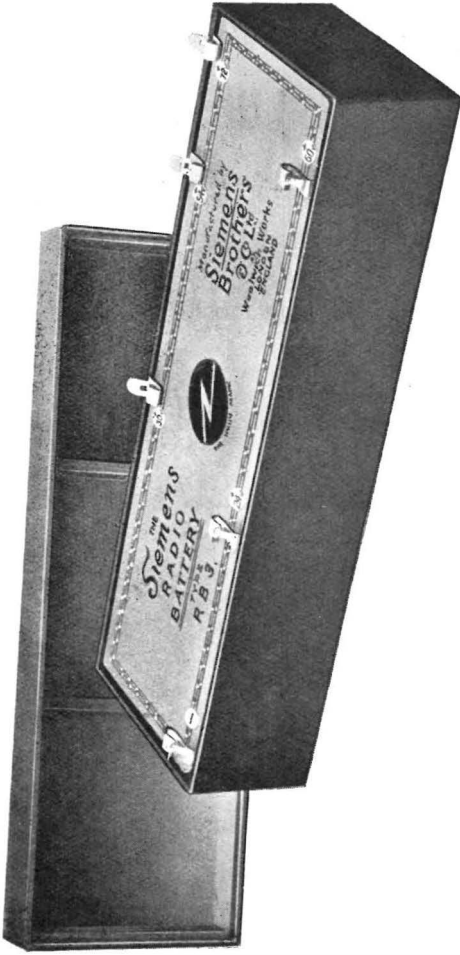
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The author of this work has been intimately associated with the telephone service of this country for the past thirty years, and during that period has had wide experience of telephone engineering work in the provinces and in the metropolis, under the administration of both the National Telephone Company and the Post Office.

For many years he has collected information, illustrations, and other material relative to telephony of considerable interest, much of which is included in this book, which the publishers now place before the public with confidence that it will fill a long-felt want in telephone literature.

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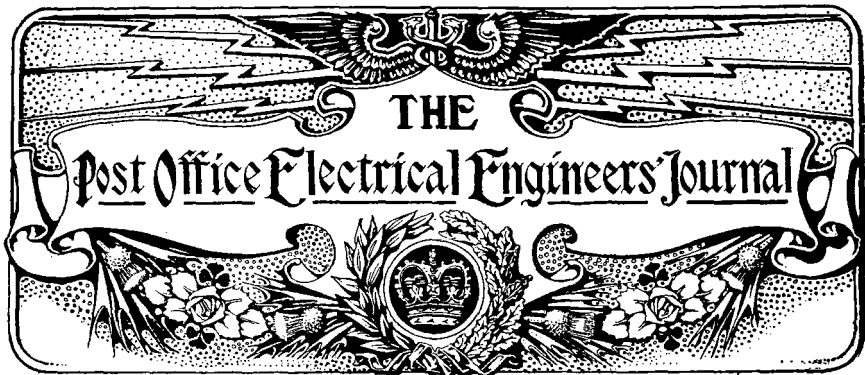
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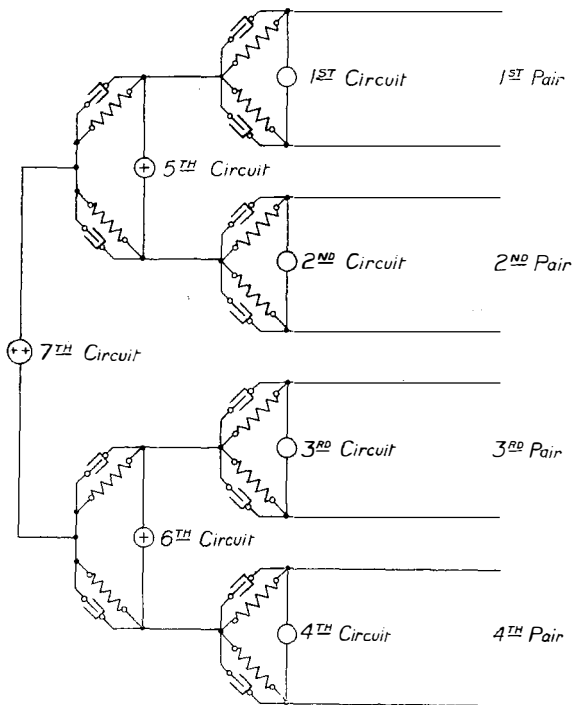
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## TELEGRAPH SUPERPOSING ON UNDERGROUND CABLES.

A. C. BOOTH.

IT may not be a matter of general knowledge to our readers that for the past two or three years additional underground telegraph circuits, urgently required for the Transatlantic cables,



SUPERPOSING : LONDON-PENZANCE.

## TELEGRAPH SUPERPOSING ON UNDERGROUND CABLES.

have been obtained between London and Penzance by superposition on the physical loops of the cable. The arrangement is shown diagrammatically in the accompanying diagram.

The fifth and sixth circuits are referred to as "plus" circuits and are indicated by the usual plus sign, while the seventh circuit is referred to as a "double plus" circuit and is indicated accordingly. By this arrangement seven loop circuits, all workable duplex, are obtained from eight wires. As the length of the cable is approximately 300 miles, the value of the arrangement is appreciable.

Each wire is of 100-lb. copper conductor, so that each physical circuit is a metallic loop of 100-lb. copper; each plus circuit is a metallic loop of 200-lb. copper and the double plus circuit is a metallic loop of 400-lb. copper.

The superposing apparatus consists of plain resistance coils,  $5000 + 5000$  ohms, shunted by condensers having a value of  $10 + 10$  microfarads across the physical loops, while that across the plus circuits is  $5000 + 5000$  ohms, shunted by condensers of  $20 + 20$  microfarads.





## ENGINEER-IN-CHIEF'S AUTOMATIC TELEPHONE TRAINING SCHOOL & CIRCUIT LABORATORY.

By B. O. ANSON, M.I.E.E.

THE decision to adopt step-by-step automatic telephone switching equipment as standard in Great Britain and to purchase plant from a number of different contractors, made it necessary for the Post Office to control conditions so as to work towards an ultimate standardisation of circuits, and perhaps also to some measure of standardisation in mechanical details. An Equipment Committee, under Mr. M. Ramsay, Staff Engineer, was set up to deal with the problems involved, and it was soon found that even apparently small differences in manufacture militated against the standardisation of circuits. It became necessary therefore to place the apparatus of the different manufacturers under test and also their circuit proposals.

At the same time it was realised that the standardisation of step-by-step automatic telephony necessitated the introduction of a definite and comprehensive scheme of training for the staff.

To set up a Circuit Laboratory for the testing of contractors' circuit proposals and of sample apparatus called for an extensive model equipment in order that the actual tests might be confined simply to the apparatus and circuits submitted. Similarly an extensive model plant would be needed for the training of staff. It was decided, therefore, to combine these requirements and instal a single model plant to fulfil the two purposes.

Fig. 1 shows the lay-out of the apparatus racks in the Demonstration Room of the School and Circuit Laboratory in King Edward Building. The equipment comprises the following:—



ENGINEER-IN-CHIEF'S AUTOMATIC TELEPHONE TRAINING SCHOOL.

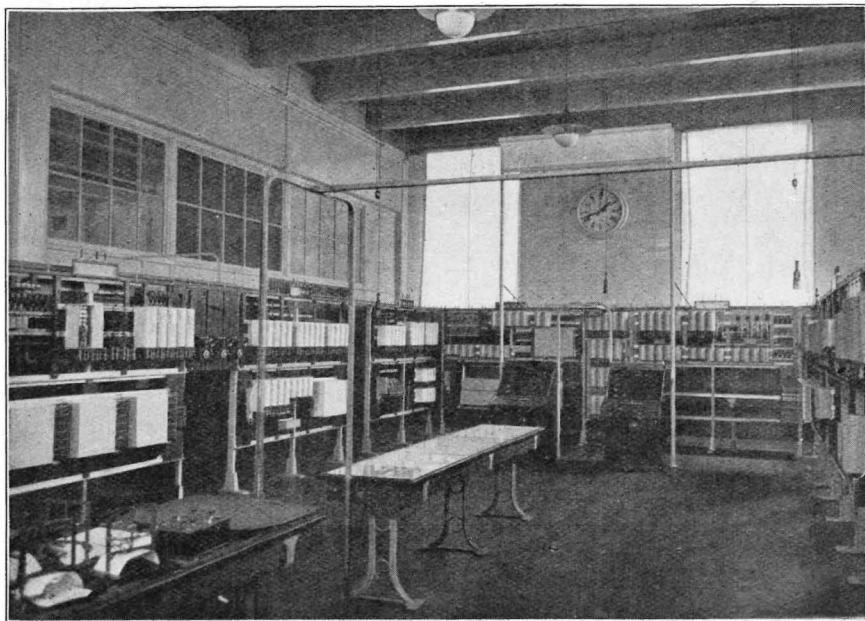


FIG. 2.—DEMONSTRATION ROOM, LOOKING WEST.

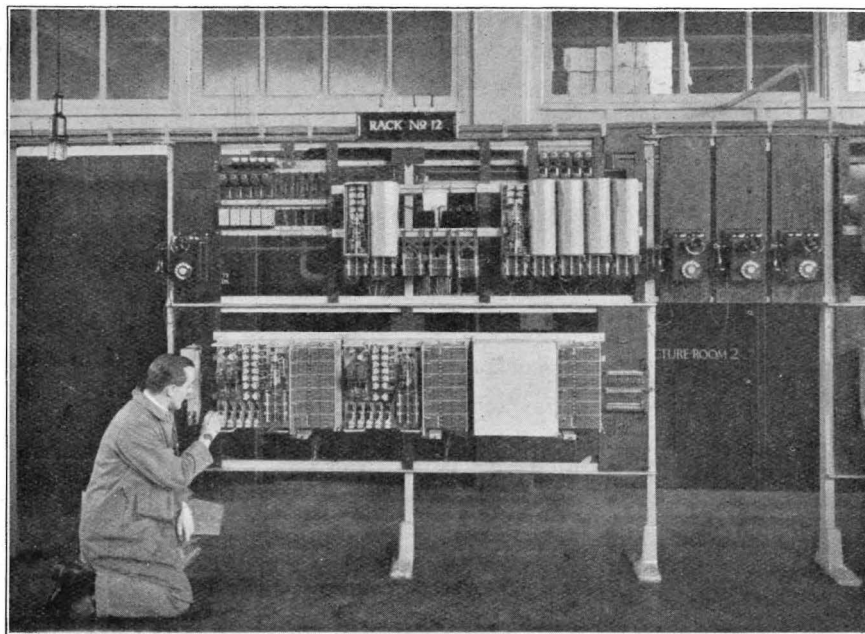


FIG. 3.—TYPICAL RACK, SHOWING 1ST CODE SELECTOR,  
A DIGIT SELECTORS AND DIRECTORS.

ENGINEER-IN-CHIEF'S AUTOMATIC TELEPHONE TRAINING SCHOOL.

- (a) Three racks representing a "director" automatic exchange "North."
- (b) Three similar racks for another exchange "South."
- (c) A Cordless "B" Position with all accessory apparatus working on "North."
- (d) A semi-mechanical tandem cordless "B" position with accessory apparatus.
- (e) A Satellite exchange working on "South."
- (f) A rack representing standard provincial apparatus and circuits (non-director).
- (g) A Composite "A" Position equipped with the various types of dialling-in cord circuits and trunks incoming and outgoing from automatic equipment.
- (h) One rack having samples of dialling-in and dialling-out of repeaters.
- (i) One rack representing Messrs. Siemens' No. 16 equipment.
- (j) One Call Indicator position with accessory apparatus.

The racks in the Demonstration Room are all cabled to an intermediate distribution frame at the east end of the room, and the trunking scheme is arranged by cross-connections in the jumper field that carry the circuits through a break jack panel. It is possible, therefore, to intercept any of the circuits for Laboratory purposes and to facilitate this work the Circuit Laboratory is placed at the east end of the Demonstration Room.

Fig. 2 gives a general view of the west end of the Demonstration Room. The tables along the centre are utilised for adjustment work, but also serve as study tables, being equipped with glass tops so that a standard set of diagrams can be placed beneath the glass. The diagrams are changed to suit the current courses. The cordless "B" positions can be seen in this figure.

Fig. 3 shows a typical rack with some of the apparatus covers removed for inspection.

Fig. 4 shows the call indicator "B" position and its accessory apparatus on rack No. 5. The call indicator system adopted by the British Post Office is designed to give traffic distribution to the "B" operators and thereby permit of the closing down of positions during slack periods. This feature is illustrated in the model by the provision of a second call indicator display in the multiple panel, thus avoiding the need for installing more than one model position. This figure also gives a view of the composite "A" position.

Fig. 5 shows a group of students undergoing adjustment tuition.

Fig. 6 shows a group of students in the Study Room.



ENGINEER-IN-CHIEF'S AUTOMATIC TELEPHONE TRAINING SCHOOL.

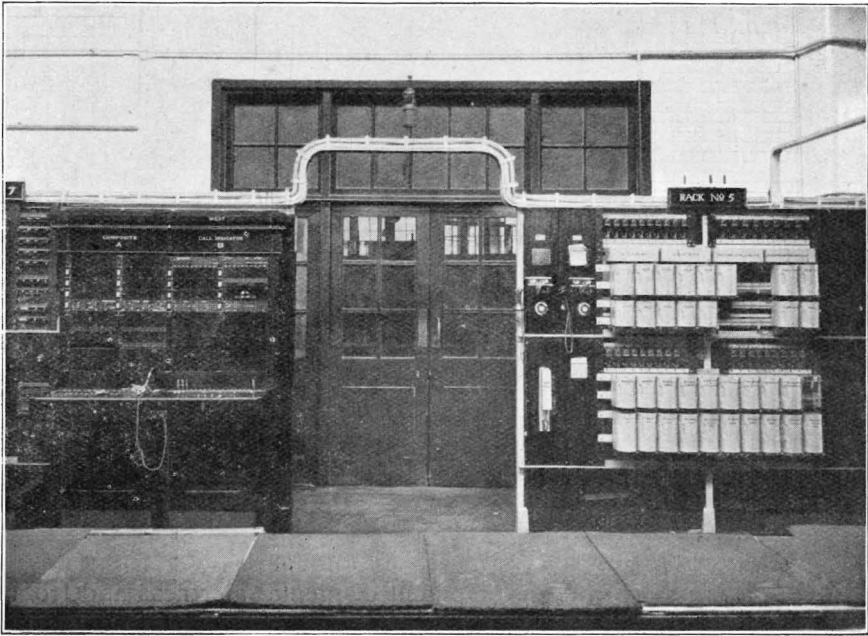


FIG. 4.—CALL INDICATOR POSITION AND ACCESSARY APPARATUS.



FIG. 5.—STUDENTS BEING TRAINED IN ADJUSTMENTS.

Fig. 7 shows a Lecture in progress. There are two Lecture Rooms, in one of which Lantern Equipment is available. In Fig. 7 near the door will be seen a small working model for the use of the Lecturer. It is frequently necessary whilst lecturing to illustrate a point by reference to working apparatus and the small model shown has been designed to illustrate a large variety of facilities. In connection with the daily lectures given at the Training School, arrangements are made for the demonstration of working apparatus in the Lecture Rooms. Directors, coders, senders and other types of equipment are brought into the room and electrically connected to the working equipment of the Demonstration Room. Sample apparatus boards also are demonstrated in the Lecture Room; these consist of apparatus mounted on boards painted black with prominent white lines connecting the apparatus in the front but actual wires at the back. By placing the correct electrical conditions on these boards certain features can be illustrated with more effect than by the drawing of sketches on a blackboard.

In connection with the study work of students, considerable attention is paid to the development of mental alertness and from time to time simple test papers are set. These afford a useful indication to the Instructors as to the effectiveness of their work, and as the setting of the test papers is done without the stiff and serious conditions of an examination, it has the effect of placing the students at their ease and encouraging them to answer the papers naturally. Another rather useful and interesting innovation is the distribution to the students of circuit diagrams known to contain errors. The students are requested to discover the errors and state what effect such errors would have on the actual working of the circuit. The theoretical and practical training afforded at the School is supplemented by the copious distribution of diagrams and descriptive letter press. These, together with the students' Note Books, remain their personal property.

As regards the practical training of the maintenance staff, samples of every piece of apparatus and type of relay are handed to each student, who dis-assembles, re-assembles and places on the apparatus the standard adjustment. The apparatus is repeatedly re-adjusted until the Instructor is satisfied that the student is a capable maintenance man as regards that particular item. The students are passed through a definite routine, which includes a course of fault localisation, and at the end of the course an assessment of their progress is made. The courses vary from five weeks to 12 weeks in duration and it is planned to train and give lectures to 650 people per annum.

The work in the Circuit Laboratory consists in the carrying out of expert tests on apparatus and circuits submitted by the

ENGINEER-IN-CHIEF'S AUTOMATIC TELEPHONE TRAINING SCHOOL.



FIG. 6.—STUDENTS IN STUDY ROOM.

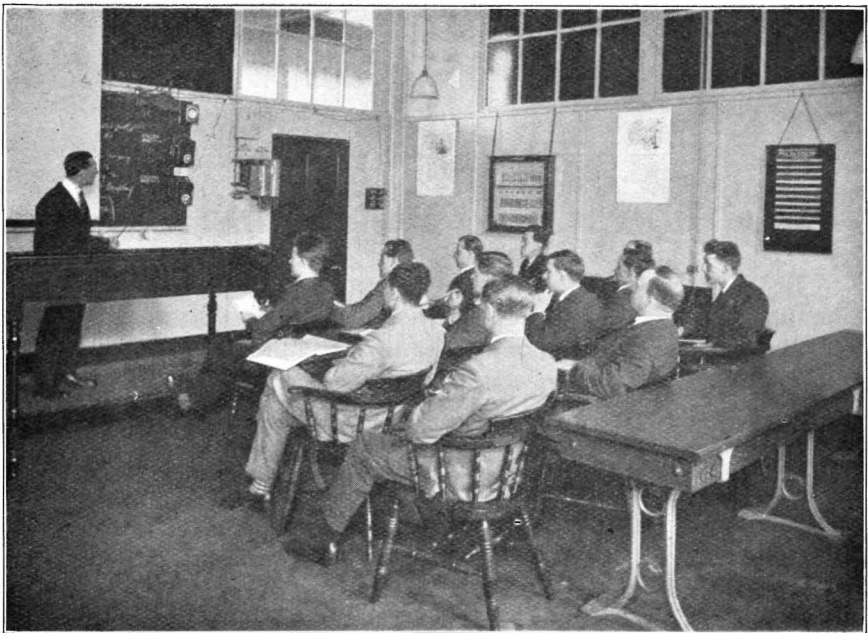


FIG. 7.—LECTURE IN PROGRESS.

## A MONSTER TELEPHONE BATTERY.

different contractors. Although the bulk of the work performed in this department is done in conjunction with the London Equipment Committee, tests are also carried out in connection with the circuits designed by other Sections of the Engineer-in-Chief's Office, and the Circuit Laboratory is now an established part of the Engineer-in-Chief's circuit design work.

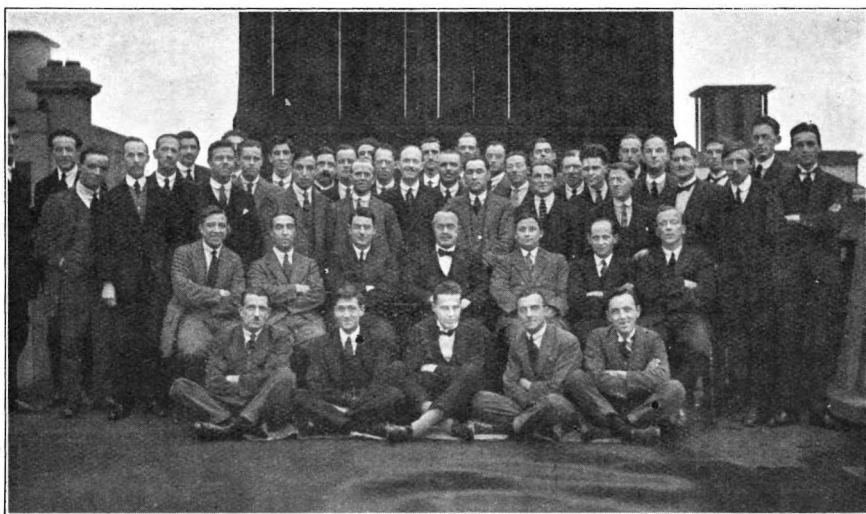


FIG. 8.—STAFF OF SCHOOL AND CIRCUIT LABORATORY WITH A GROUP OF STUDENTS.

Fig. 8 shows the staff of the School and Circuit Laboratory with a group of students.

---

## A MONSTER TELEPHONE BATTERY.

IN connection with the Automatic Telephoning of Greater London, now in progress, there are being supplied by the Chloride Electrical Storage Company, Ltd., of Clifton Junction, near Manchester, four storage batteries of record size and capacity so far as Telephone Service is concerned.

There are four batteries in all, two of which will supply the current for operating the Holborn Mechanical Tandem Exchange, and the others that for working the Automatic Equipment in the Holborn Exchange proper. Both installations are in progress, the responsible contractors and manufacturers of the Strowger equipment being the Automatic Telephone Manufacturing Company, Liverpool.

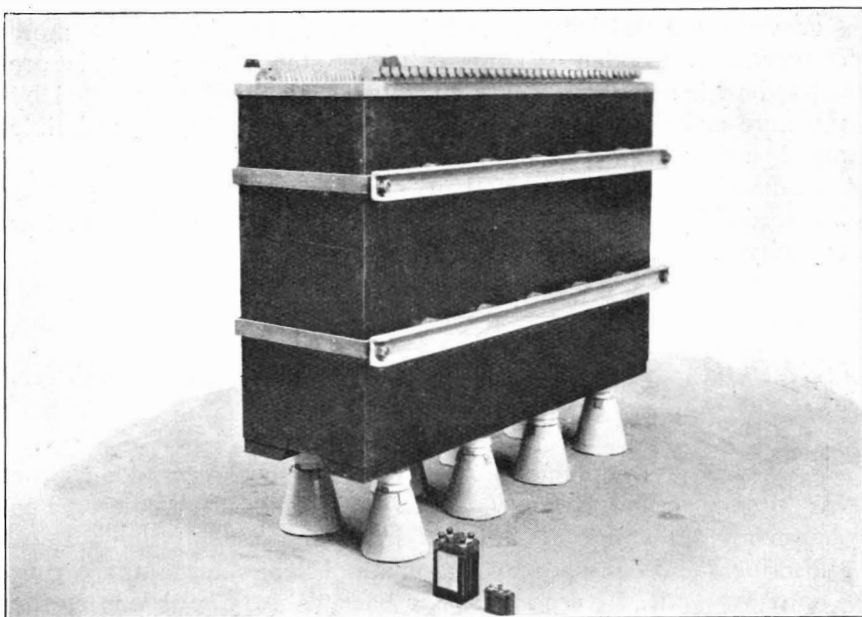
In point of actual dimensions of individual cells those consti-

## A MONSTER TELEPHONE BATTERY

tuting the above batteries will be the largest yet installed in this country for telephone services.

The overall dimensions of each cell are: length, 5ft. 8ins.; width, 1ft. 8ins.; overall height, 5ft. There are 35 positive plates and the total weight per cell, including electrolyte, is 4,600 lbs., or over two tons. Overall plate dimensions are: height, 29ins.; width, 14ins.

The containers are of wood, lined with lead, and the positive and negative plates are separated by glass tube separators, all plates of common sign being burned to heavy lead connecting bars fitted with suitable terminal cups at the ends of each battery to which the main copper bus bars will be attached.



ONE OF THE CELLS FOR THE HOLBORN EXCHANGE BATTERIES.

The positive plates are of pure lead, "Plante" type, and the negatives of box type.

The cell capacities are 8,400 A.h., discharging in 5 hours to 1.85 volts per cell, and 9,870 A.h. discharging in 9 hours to 1.83 volts per cell.

Taking into account the very small currents required to actuate individual telephone transmitters, these huge current values appear disproportionate, especially to readers familiar with the old magneto telephone system, in which a couple of Leclanche elements, or dry cells, located at the subscriber's premises, furnished all the necessary current for effective telephoning under that system.

## NEWPORT STROWGER AUTOMATIC TELEPHONE AREA EXTENDED.

It has to be borne in mind, however, that the ingenious electro-mechanism of the Automatic Telephone System which is being introduced into the service of Greater London telephone subscribers calls for the expenditure of electrical energy to actuate it, and although individual switches do not make any heavy demand upon the source of supply, the aggregate consumption when some thousands of people are telephoning or dialling simultaneously is fairly heavy, quite apart from the current flowing out over the lines to the subscribers' premises to energise their microphones during actual conversation.

The four batteries each comprise 25 special J.F.L.W. 35 cells answering to the above description, and a special feature, apart from their abnormal dimensions and capacities, is the use of stoneware pedestal supports, eight per cell, in place of the more conventional wooden stillage. These stoneware pedestals are capped with smaller oil-type insulators, which are unaffected by moisture or acid, the combination being practically indestructible and insuring high insulation and immunity from leakage.

Some idea of the size of these monster telephone storage cells is afforded by the illustration, which also depicts two familiar low capacity wireless batteries in the foreground.

---

## NEWPORT STROWGER AUTOMATIC TELEPHONE AREA EXTENDED.

AUTOMATIC Telephone facilities have just been extended by the Post Office in the Newport (Mon.) area of South Wales. The Automatic Exchange at Newport itself now serving some 2,400 subscribers and equipped by Automatic Telephone Manufacturing Company, Ltd., Liverpool, as far back as 1915, was one of the earliest Strowger exchanges to be put into service in this country.

The original installation was completed soon after the outbreak of war and before the disorganisation caused by the subsequent demand for men and munitions held up the further development of the system.

The success of the original Newport installation has created the inevitable demand for equal facilities in outlying districts, and this is now being met by the opening of two new Strowger exchanges at Risca and Cwmbran respectively. These are satellite exchanges of Newport and will operate in conjunction with the Strowger equipment at the main exchange.

Risca is a town on the River Ebbw, 6½ miles N.W. of Newport. It has a population of 16,745. It is the centre of tinplate works, chemical works, and collieries.

## NEWPORT STROWGER AUTOMATIC TELEPHONE AREA EXTENDED.

Cwmbran, also an industrial centre with ironworks and collieries, is a village  $6\frac{3}{4}$  miles from Newport.

Both installations are of the Rotary P.B.X. type, comprising single units, that at Risca being equipped with 57 subscribers and 3 coin-box lines, whilst the Cwmbran unit boasts 76 subscribers and 4 coin-box lines respectively.

Although the system is 4-digit in both cases the local line Switch Units are only equipped with Rotary Line Switches, Final Selectors and Repeaters, the 1st and 2nd Group Selectors being located at Newport Main Exchange. Thus in making a local call in either Risca or Cwmbran the route will be *via* the local Rotary Line Switch and Repeater to Newport, where, after passing through the 1st and 2nd Group Selectors and Main Exchange Repeater, it will be diverted back to the local Final Selector and there completed.

Subscribers' meters of the Booster battery type are provided, the calling subscriber's meter being operated only when the called subscriber answers. Ineffective calls are neither metered nor charged against the subscriber.

The coin-box lines have access to two special Repeaters in each exchange and the junctions from these Repeaters terminate on the Manual board at Newport, where an operator is in attendance to obtain the required number.

Risca has 6 outgoing and 11 incoming junctions, whilst Cwmbran is equipped with 8 outgoing and 12 incoming junctions. These are in addition to the two outgoing coin-box junctions previously referred to.

Following standard Strowger practice, the rotary line switches are mounted on two gates which may be swung outwards from the centre, allowing access to all the switchboard cabling. They are divided into four sections, each of 25 switches.

Above the line switches is mounted a power-connecting panel with alarm fuses, through which the current is fed to the switches. Over this again is a terminal assembly, where the outgoing primary trunks from the line switches are connected to the trunks to Repeaters. The incoming trunks and final selector connections are also made at this point. Four tag blocks above the terminal assembly serve as terminals for the lines to line switches, and mounted between them is a supervisory lamp strip for signalling faults.

On the Final Selector side of the two units are shelves, each with a capacity for 8 switches. The present equipment at Risca is 11 Final Selectors and 1 Test and offering Final Selector, whilst Cwmbran has 12 Final Selectors and 1 Test and offering Final Selector.

On the other shelves are mounted the Regular and Coin-box

## THE L.M. ERICSSON AUTOMATIC TELEPHONE SYSTEM.

Repeaters, together with the Howler Circuit Relay Group. To the left of each shelf is a fuse panel controlling the current supply to individual switches.

The banks of all Final Selectors are multiplied together, thus allowing any Final Selector access to any line terminating on the banks.

Mounting plates above the Final Selectors carry miscellaneous relays and equipment.

The Strowger Automatic Telephone Exchange equipment for these typical small outlying exchanges is extremely compact, despite which it gives immediate access without error or delay to any other subscriber in the Newport area or *via* "Trunks" to any part of the Kingdom.

The completion of these Newport satellite exchanges marks another step in the progressive programme of Post Office automatic telephone development by which areas surrounding a central main Exchange will eventually enjoy the advantages of a full automatic service.

As in the case of the original Newport installation, the Strowger equipment for Risca and Cwmbran exchanges has been manufactured and installed for the Post Office by Automatic Telephone Manufacturing Co., Ltd., Liverpool.

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## THE L.M. ERICSSON AUTOMATIC TELEPHONE SYSTEM.

THE following is a description of the Automatic Telephone System of the Swedish L.M. Ericsson, of Stockholm, designed to meet the needs of modern telephonic communication, with its involved requirements and often dense concentrations.

This system is of the power-driven type, employing connecting switches of 500 lines capacity; associated wiper sequence-switches mounted on bases which also carry the trunk relays; trunk register finders or alternatively register trunk finders, of sequence switch pattern; and register sets, which temporarily come into service for projecting a call.

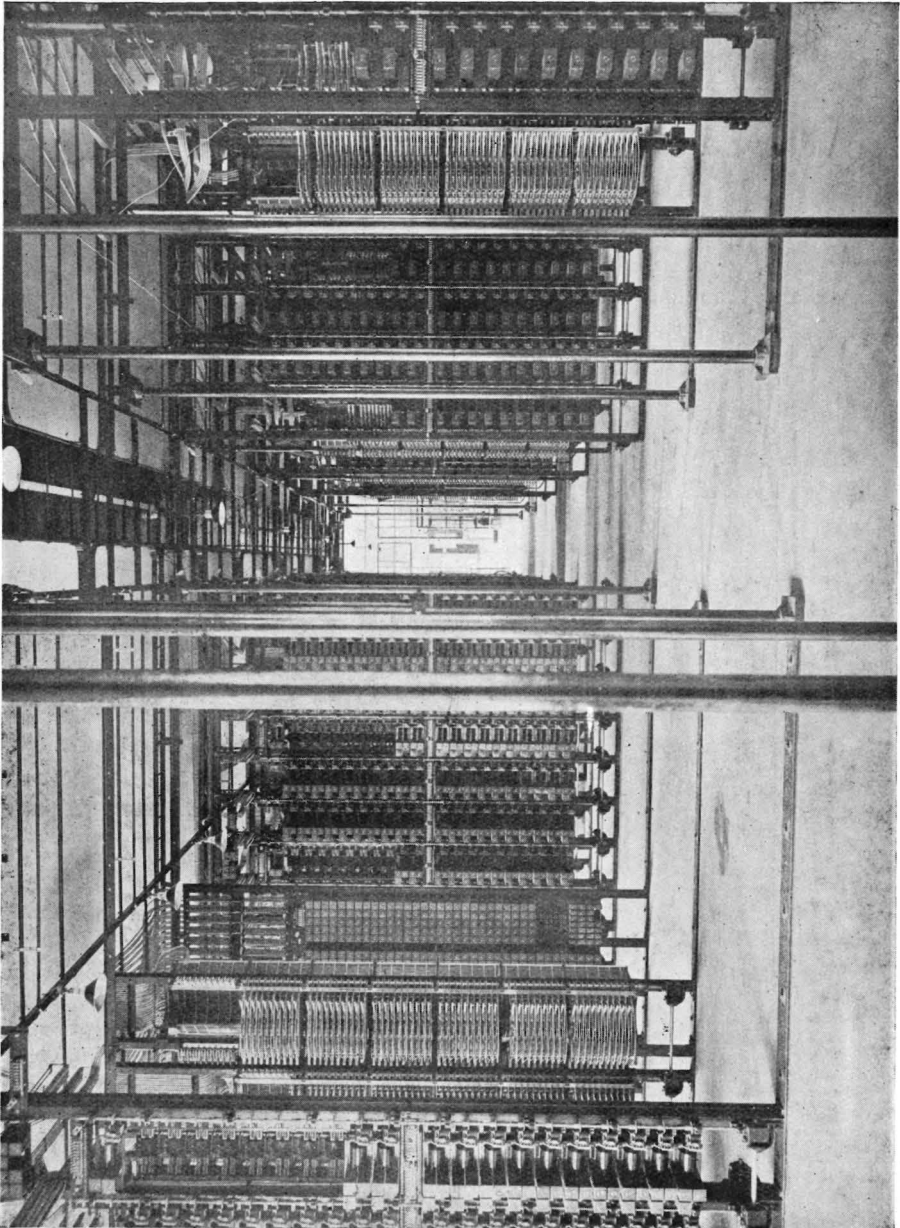
All the three mentioned unit types, which together with relays may be said to constitute the system, are shaft driven and made readily demountable.

A salient feature is the arrangement of the multiple, which consists of bare wires arranged in vertical frames for twenty lines, twenty-five such frames being mounted radially in a rack, the whole of a height that all switches requiring access to the group



THE L.M. ERICSSON AUTOMATIC TELEPHONE SYSTEM.

of five hundred lines thus formed can embrace any required line upon its same stretch of bare wire multiple.



A VIEW OF AN L.M. ERICSSON INSTALLATION.

These multiple racks are of identical construction for all stages, *i.e.*, line finders, group selectors and connectors, so consequently all connecting switches are of similar design, varying only in minor detail.

## THE L.M. ERICSSON AUTOMATIC TELEPHONE SYSTEM.

To economise in height these switches are of dish formation operating in a horizontal plane, with a double movement of rotary and radial motion, the rotary movement first locating the required one of the twenty-five frames and the radial movement causing the brush carrier to travel along the multiple wires of this frame to a maximum depth of twenty lines.

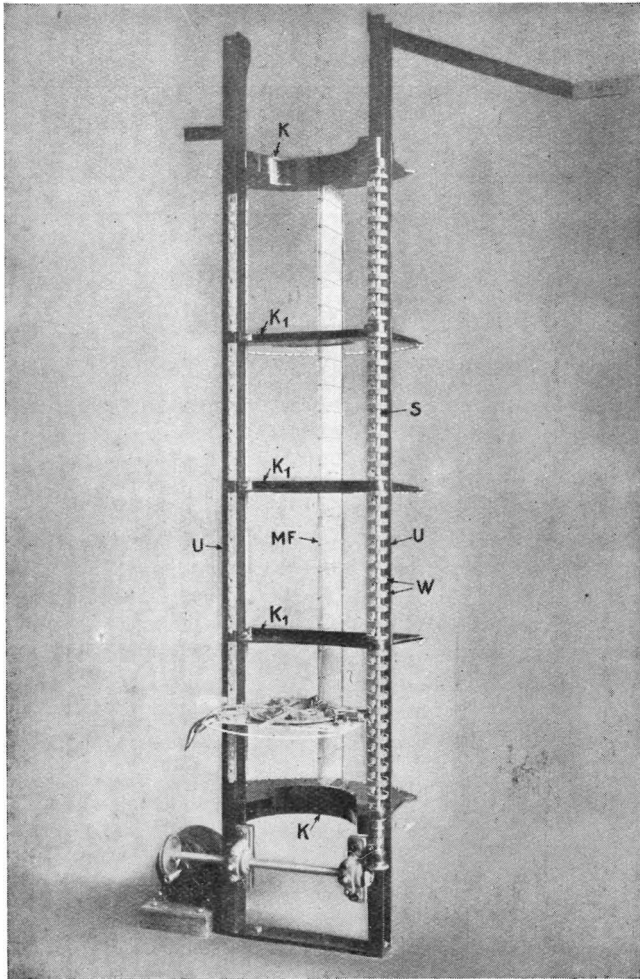


FIG. 1.—SELECTOR RACK FOR 40 SELECTORS.

### I.—DESCRIPTION OF THE SWITCHING APPARATUS.

#### A. *The Selectors.*

The selectors are mounted in racks accommodating 40, 50, 60 or 70 selectors. Fig. 1 shows a rack for 40 selectors. Such a

THE L.M. ERICSSON AUTOMATIC TELEPHONE SYSTEM.

rack consists of two vertical channel irons connected both at the top and bottom by means of the brackets K. Additional brackets  $K_1$  are inserted for each group of 10 selectors.

On the insides of the channel irons are fastened metal strips with horizontal notches into which the selectors are slipped and locked in place.

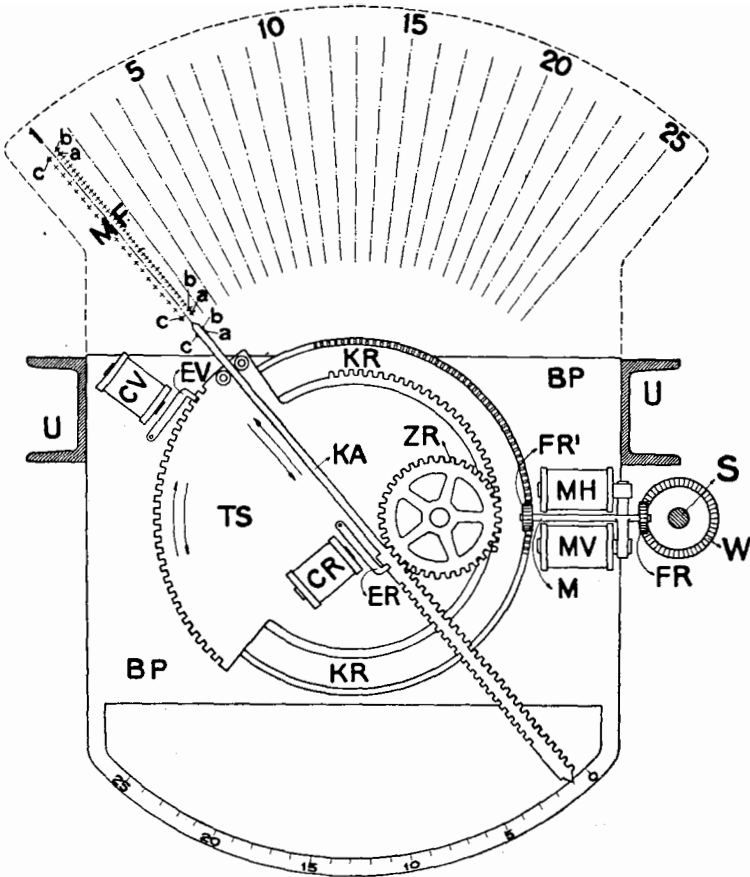


FIG. 2.—A 500 LINE SELECTOR PLAN.

Down the right side of the rack is the driving shaft, mounted in ball-bearings and furnished with double toothed drivers, W, one for each selector.

The multiple consists of 25 multiple frames MF (Fig. 1 shows such a frame in position) placed radially in relation to the selector's centre of rotation, as shown in Fig. 2. Each multiple frame is composed of vertical bare wires for 20 lines, held by strips of insulating material.

Fig. 2 shows in outline a selector rack with one selector as seen

from above. A connector is shown in Fig. 3. The main components are :—

Base plate	...	...	...	...	BP
Magnet coupling	...	...	...	...	MH - MV
Rim gear wheel	...	...	...	...	KR
Rotary disc	...	...	...	...	TS
Locking magnet for the same	...	...	...	...	CV
Contact arm	...	...	...	...	KA
Locking magnet for the same	...	...	...	...	CR

The magnet coupling, mounted directly on the base, has two magnet coils MH and MV. The shaft M, carrying the toothed wheels FR and FR<sub>1</sub>, is run through the armature, which is common to both coils. The armature can be attracted by either the coil MH, giving it an upward movement, or the coil MV, giving it a downward movement. These movements cause the toothed wheel to be brought against either the upper or the lower driver W, thereby giving the shaft M a rotary movement in either the one or the other direction.

The function of the rim KR is to convey the movement from the wheel FR<sub>1</sub> to the rotary disc and the contact arm. The teeth on its outer edge gear into the wheel FR<sub>1</sub> and those on its inner edge gear into the wheel ZR, which is pivoted on the rotary disc TS, and whose function is to convey movement to the contact arm. The rear part of the contact arm is formed into a rack geared to the wheel ZR (ZR consists actually of two wheels, pivoted on the same shaft, the under one being geared to the rim KR and the upper one to the rack on the contact arm).

Moveably mounted on the rotary disc TS is the contact arm KA, the front part of which is covered by an insulating sleeve of rectangular section, carrying the three selector contact springs, *a*, *b*, and *c*. The contact arm has two different movements, namely, a rotary movement, in which it follows the turning of the disc around its axis, and a radial movement, by which it moves into or out of a multiple frame.

The movements of a selector are controlled by means of the two locking or centering magnets CV and CR.

The magnet CV controls the rotary movement of a selector, its armature being shaped to a dog EV, which fits into notches on the rotary disc, thereby locking it. The notches are spaced so as to exactly conform to the position of the contact arm in relation to the multiple frames. In Fig. 2, for example, the contact arm is centred exactly opposite frame number 1.

The magnet CR controls the radial movement by means of its armature, which forms the dog ER, whose function it is to centre and lock the contact arm. This it accomplishes by striking into

notches on the contact arm, corresponding to the positions of the 20 lines of a multiple frame.

The magnets MH and MV are furnished with the necessary current through contacts located on the locking magnet armatures, when these latter are attracted. The two following cases can then occur :—

1. If the locking magnet CV is actuated, the selector is released for rotation and the rotary disc, together with the contact arm, will start turning. This movement continues until the circuit through CV is broken and the dog engages a notch, thus locking the rotary disc, the current supply to the magnet coupling being simultaneously cut off. A left- or right-handed rotary movement is obtained depending on which of the magnet coupling coils MH or MV is energised.

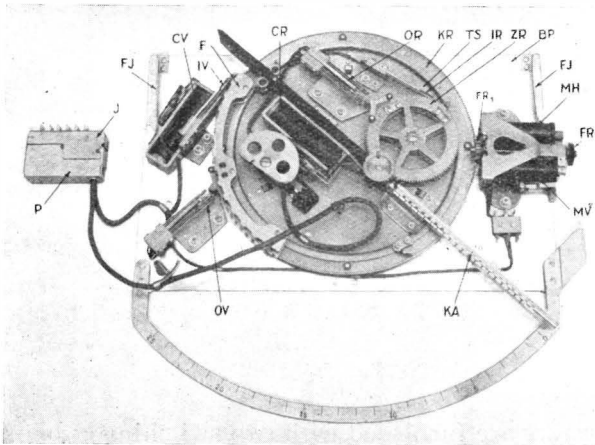


FIG. 3.—A CONNECTOR.

2. If the locking magnet CR is actuated the contact arm is released for radial movement. This movement continues until the circuit through CR is broken and the dog engages a notch on the contact arm, thus locking the same, the supply of current to the magnet coupling being simultaneously cut off. The contact arm is either thrust into or withdrawn from a multiple frame, depending on which one of the magnet coupling coils MH or MV is energised.

As has already been mentioned, the three different types of selectors used in this system, *i.e.*, line finders, group selectors, and connectors, are mainly of the same construction. The details in which they differ are as follows :—

Each line finder is provided with a special test spring, mounted on the rotary disc (does not occur in Fig. 3, which shows a connector), by means of which that multiple frame is found, in which an incoming call is located. The vertical front bars of the multiple frames in the line finder racks are, for this purpose, used as test bars, with which this test spring comes into contact during the line finder's rotary movement.

Group selectors and connectors have always a definite starting position for the rotary movement. They are provided with a cam plate F, mounted on the rotary disc, which alternately closes and opens a group of switching springs IV, thus sending impulses back to the register.

The connectors are further provided with a switching group, IR, for the sending of impulses to the register when the contact arm is moving into a multiple frame. This switching group is actuated by means of a cam wheel, mounted under the toothed wheel ZR on the same shaft.

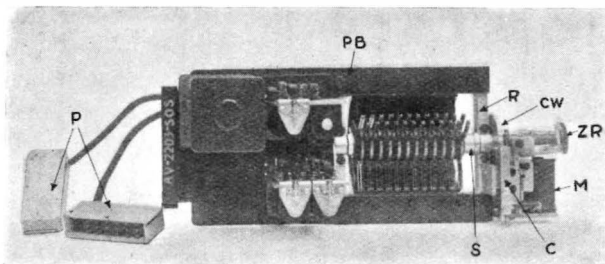


FIG. 4.—SEQUENCE SWITCH.

All selectors are furnished with two switching groups, OV and OR, mechanically actuated in the extreme positions, one of their functions being to reverse the movements. OV reverses the rotary movement and OR the radial movement.

The connecting of a selector's wiring to the trunk lines is accomplished by means of an 18-point plug P, fitting into a corresponding jack J, mounted on the rack.

After being pushed into place in the rack, the selector is firmly locked in position by means of the two springs FJ.

#### B. The Sequence Switches.

Each selector is furnished with a sequence switch and relays, the appearance of which is shown in Fig. 4. The contact bank consists of circular segments (the length of the arc being  $\frac{1}{3}$  of a full circle) in which metal contacts are embedded. Each segment has two rows of metal contacts, and a maximum number of 13 segments can be screwed upon a frame R, which, in turn, is screwed

to a second framework PB. This framework PB acts also as a support for the trunk relays.

As a sequence switch of this type has 12 positions and 13 rows of double contacts, it follows that  $12 \times 13 = 156$  different contact combinations are possible, but additional combinations can be obtained by making the bank contacts of different widths, so as to extend over more than one contact position.

The sequence switches are power driven in the same manner as the selectors. M is the magnet coupling, with the toothed wheel ZR pivoted on its armature. The attracting of this armature causes ZR to engage a driving wheel mounted on the common driving shaft, the rotary movement being transmitted to the shaft S and the wiper arms.

Each sequence switch is furnished with an electrically controlled centering device, consisting of a cam wheel, CW, and the switching group C. Its function is to control the movements of the wiper arms by keeping the circuit closed through the centering spring until the wiper arms have reached the exact desired position.

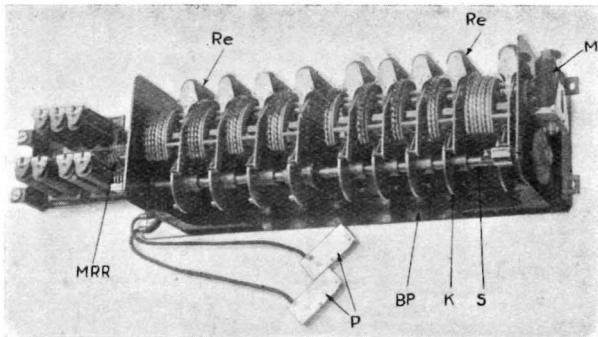


FIG. 5.—COMPLETE REGISTER SET FOR A 10,000 LINE SYSTEM.

Sequence switches are connected to the trunk lines by exactly the same methods as selectors, *i.e.*, by means of plugs P to jacks, which are mounted on the racks.

The sequence switches are mounted on both sides of the rack, each side or panel accommodating 20 switches, with their fuses and alarm devices.

### C. The Register Sets.

A register set is shown in Fig. 5, the more important components being:—

The Base	...	...	...	...	...	BP
The Register Units	...	...	...	...	...	Re

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The Restoring Mechanism, consisting of:—

A Magnet Coupling	...	...	...	M
A Shaft S with discs	...	...	...	K
A Sequence Switch	...	...	...	MRR

The relays with which a register set is equipped are mounted on the base BP, as shown at extreme left in Fig. 5.

A register unit—shown in Fig. 6—is a step-by-step selector. The bank of contacts consists of circular segments of insulation (extending over slightly more than half a circle) in which the metal contacts are secured. The wiper arms are mounted on the shaft S, which also carries the ratchet wheel SW and the restoring arm RA. A register unit has 27 contact positions, *i.e.*, the starting position 0, 25 positions from 1 to 25, and one extra position, 26.

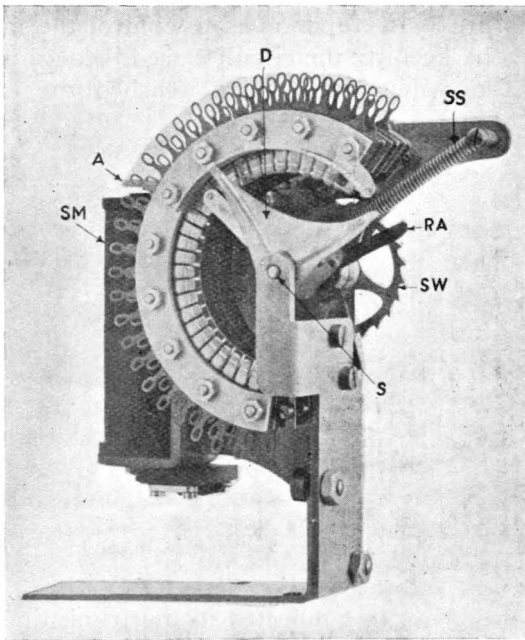


FIG. 6.—REGISTER UNIT.

The ratchet device of the register unit consists of a magnet coil SM and its armature A. The armature actuates an escapement lever (not visible in the illustration) which, in turn, acts as a releasing mechanism for the ratchet wheel SW.

One end of the coil-spring SS is fastened to the frame and the other encircles the shaft S.

This spring tends to rotate the shaft and wiper arms, which movement, however, is counteracted by the escapement lever,



which engages the ratchet wheel SW. Should the magnet coil SM be energised its armature will be attracted and the lever will release the wheel, allowing the wipers to advance one step. A renewed breaking of the current will readjust the lever, allowing the wipers to advance one more step. The wipers are thus advanced two steps for each full impulse (*i.e.*, one closing and one breaking of the circuit).

D is an indicator, which shows the position occupied by the wipers.

The register units forming part of a register set are mounted on the base BP (Fig. 5).

The shaft S with the discs K is made to rotate when the restoring magnet coupling is brought to engage the vertical driver shaft. The discs K are provided with studs which operate the restoring arms RA of the register units, thus restoring the wiper arms to the starting position, o.

Register sets are also removable in the same way as selectors and sequence switches, *i.e.*, by means of plugs fitting into jacks mounted on the racks.

The register sets are mounted on either one- or two-sided racks, with 10 to 12 sets to each panel.

#### D. The Relays.

The relays used in an automatic exchange are of an improved type, eliminating all internal connections, all switching group and coil connections being carried out to soldering tabs. The advantage of being able to remove and replace coils and switching groups is hereby gained. The relay armatures have been redesigned so as to make them more sensitive and quick-acting. Special pains have been taken to obtain a correctly balanced pressure for the contact points.

## II.—THE BUILDING UP OF THE SYSTEM.

A.—The extending of calls to the group selectors, in the Ericsson automatic system, is accomplished by means of line finders. The Subscribers' lines are brought together in groups of 500. Every such group is connected to the multiple in a line finder rack. The number of line finders necessary for 500 lines depends on the traffic (*i.e.*, number and average duration of calls during the busy hour) and usually varies between 20 and 50.

B.—Each line finder is associated with a group selector, as shown in Fig. 7, LF signifying a line finder and GS a group selector. Should 40 line finders be required, the corresponding group selector rack will also contain 40 group selectors. Trunks

lead from the multiple frames in the group selector rack to the connectors or to further group selectors.



FIG. 7.—LINE FINDER AND GROUP SELECTOR.

If the full capacity of the twenty-five multiple frames for a group selector rack is utilised for trunks to connectors, a capacity of  $25 \times 500 = 12,500$  lines is obtained. For practical reasons, however, it is not customary to use more than the first 20 frames for this purpose, the remaining 5 (21 to 25) being used for special lines.

A capacity of  $20 \times 50 = 10,000$  lines is thus reached by the use of only one group selector, as shown in Fig. 8.

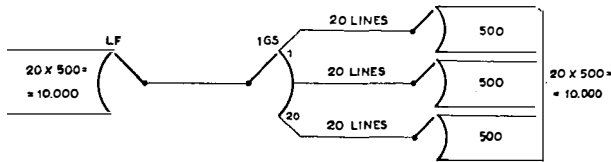


FIG. 8.—SCHEMATIC DIAGRAM FOR A 10,000 LINE SYSTEM.

The group selectors in a 10,000 line plant direct the connecting in of the desired 500-group by means of the rotary movement, while the radial movement is utilised to search out a disengaged connector.

C.—The connector makes the final connection to the desired number. The group of 20 which contains the desired number is sought out by means of the selectors' rotary movement, and the final connection is accomplished by means of the radial movement.

A connector multiple contains 500 lines, similar to the line finder multiple. Each group of 500 lines, therefore, has its connector rack, containing a certain number of connectors, their number depending on the intensity of traffic.

Fig. 9 shows the method of numbering the multiple frames in a group selector rack for a 10,000-line plant, while Fig. 10 shows how connector multiples are numbered.

Each group of 1,000 occupies 2 frames in the group selector multiple, the first containing the 5 lower hundreds—from 0 to 4, and the second containing the 5 higher hundreds, from 5 to 9.

D.—The capacity can be increased to  $25 \times 20 \times 500 = 250,000$  by adding one more group selector, as shown in Fig. 11.

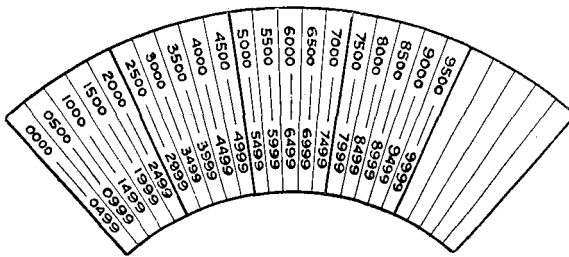


FIG. 9.—NUMBERING OF MULTIPLE IN A GROUP SELECTOR RACK.

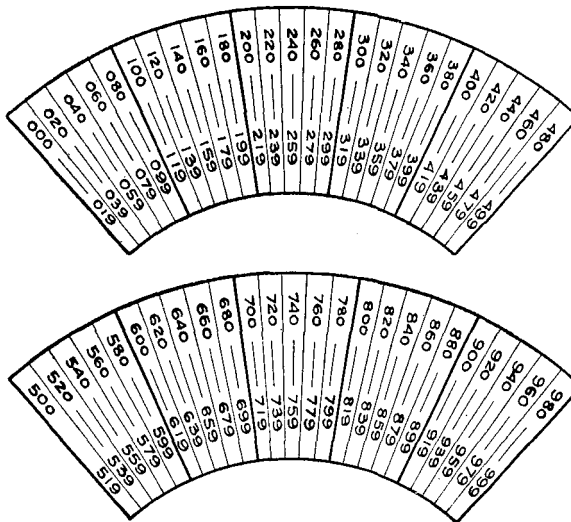


FIG. 10.—NUMBERING OF MULTIPLE IN A CONNECTOR RACK.

Trunks are carried from the first group selectors 1 GS to 25 ten thousands groups. These trunks end in second group selectors 2 GS, the multiples of which are trunked to the connectors C of the respective 500 hundreds groups.

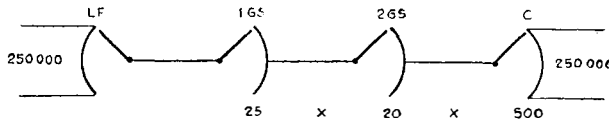


FIG. 11.—SCHEMATIC DIAGRAM FOR A 250,000 LINE SYSTEM.

E.—Another system, in which either one or two group selectors are used to complete the connections, is applicable to plants of from 10,000 to 60,000 lines. A schematic diagram of this system, for a plant of 30,000 lines, is shown in Fig. 12.

The 30,000 lines are grouped in 3 ten thousands. The traffic between subscribers whose numbers are within the same ten

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thousands group is handled by one group selector 1 GS, since the multiple frames of the first group selector rack contain trunk lines to the 20 five hundreds corresponding to their own 10,000 group. Trunk lines from the multiple frames 21 to 25 proceed to the second group selector 2 GS, the multiples of which are in turn trunked to connectors.

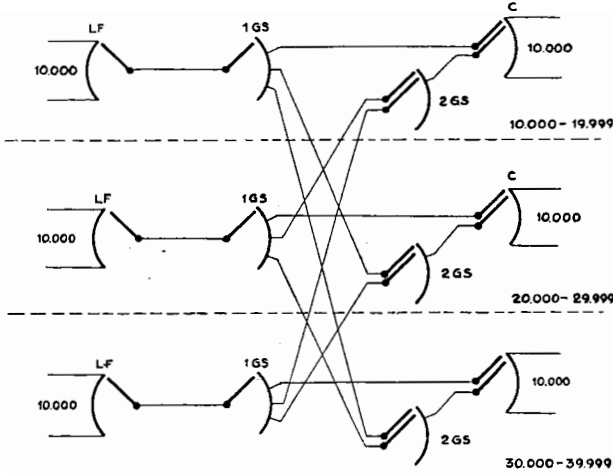


FIG. 12.—SCHEMATIC DIAGRAM FOR A 30,000 LINE SYSTEM.

Thus, a capacity of  $10,000 + (5 \times 10,000) = 60,000$  is reached by this system when all the multiple frames of the first group selectors are utilised.

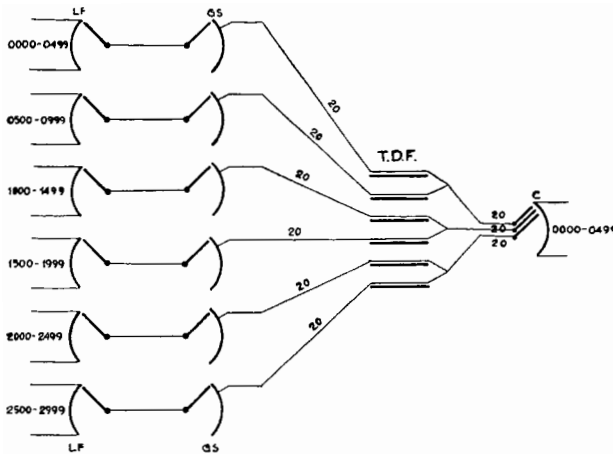


FIG. 13.—CONNECTION OF GROUP SELECTORS TO T.D.F.

F.—The connecting in parallel of the group selectors' multiples, and the connecting of the cables to the connectors is

done in a traffic distributing frame. These frames are composed of two vertical angle irons furnished with tab strips to which the cable wires coming from the group selectors' multiple frames are connected and coupled in parallel so as to obtain an even distribution of connectors in relation to the amount of traffic. An example is illustrated in Fig. 13. LF and GS are line finder and group selector racks for 6 five hundreds groups. Trunking to the traffic distributing frame is shown from the first multiple frame only, corresponding to the five hundreds group 0000 to 0499. Thus a 20-line cable is led from frame No. 1 in each group selector frame to the T.D.F. Suppose that traffic conditions necessitate the use of 60 connectors for 500 lines; the distribution can then be arranged as shown in Fig. 13, for example, by parallel coupling the multiples in pairs, each pair with 20 trunk lines to the connector rack in question.

#### G. Connecting of the Register Sets.

When a line finder is connected to a subscribers line, a register set must also be connected for the purpose of directing the movements of the group selectors and connectors. Consequently, the register is placed between the line finder and group selector, as shown in Fig. 14.

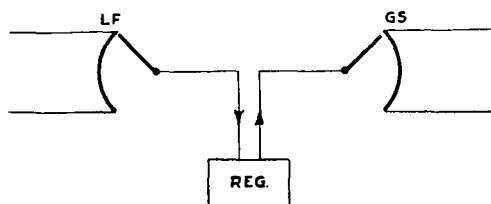


FIG. 14.—SCHEMATIC DIAGRAM FOR LINE FINDER, SELECTOR AND REGISTER.

In view of the fact that a register set is engaged only as long as it takes the subscriber to dial the desired number and for the group selectors and connectors to move to their respective positions, while line finders, group selectors, and connectors, on the contrary, are engaged as long as the conversation lasts, it is easily understood that it would be highly uneconomical to provide a register set for each individual line finder, especially as they are comparatively expensive and bulky devices. For this reason, only a certain number are allotted to each group of line finders, the number being determined by traffic conditions. Special selectors are used for connecting the register sets to the line finders. Two different principles can here be applied, clearly illustrated in Figs. 15 and 16.

In Fig. 15 the connecting is accomplished by means of so-called register trunk finders. Each register set is furnished with a register trunk finder (the construction of which corresponds to that of a sequence switch) accommodating 35 lines.

In this case, therefore, the line finders will form groups of 35. To each such group is allotted a certain number of register sets (6 to 9, depending on the traffic). A call entering such a group sets all the register trunk finders RS belonging to disengaged register sets in motion, and the one that first finds the calling line finder LF is connected.

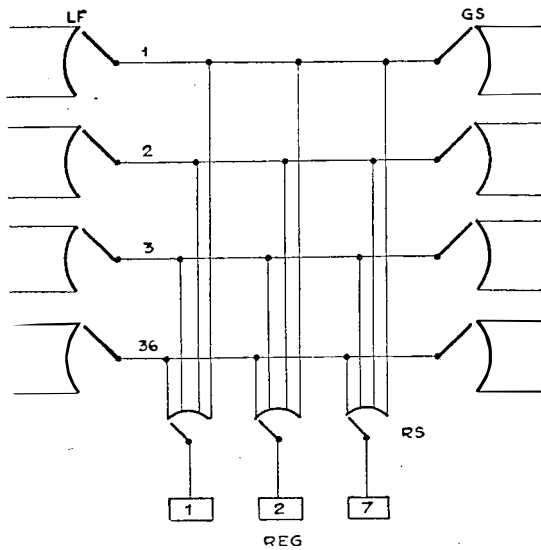


FIG. 15.—SCHEMATIC DIAGRAM FOR TRUNK REGISTER FINDERS.

In Fig. 16 the register sets are connected by means of trunk register finders RV, of which one is allotted to each line finder LF. The contact banks of these finders—consisting of 20 contact positions—are coupled in parallel and connected to 20 register sets. The number of line finders LF which can be connected to a group of 20 register sets depends on traffic conditions. (One group of 20 sets can, as a rule, be connected to the line finders for 3 or 4 five hundred groups).

### III.—FUNCTIONING OF REGISTER SET.

The mechanical construction of a register set has already been described under II—C. When considering its functions, a register set may be divided in two parts, namely, the registering part, which receives and “registers” the numbers dialled from the subscriber’s telephone (or, in the case of a semi-automatic

exchange, the numbers called from the operator's keyboard), and the controlling part, which directs the proper setting of the group selectors and connectors.

The schematic diagram of a register set for a plant with subscribers' numbers of four digits (0000 to 9999) is shown in Fig. 17.

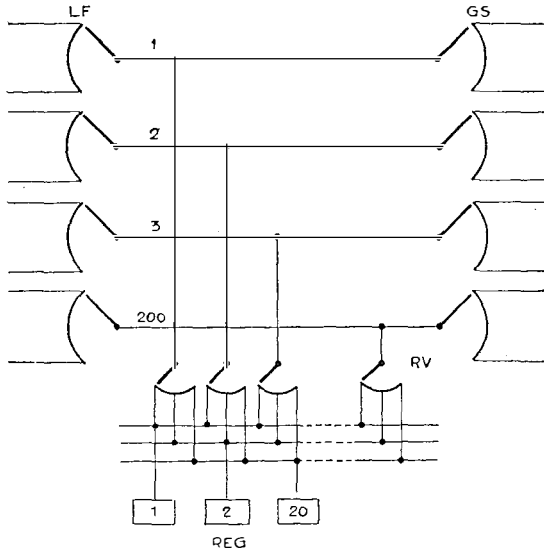


FIG. 16.—SCHEMATIC CIRCUIT FOR REGISTER TRUNK FINDERS.

*A. Registering Part of the Register Set.*

That portion of the register set which registers the numbers consists of:—

*The Impulse Relay R<sub>1</sub>.*

The main function of this relay is to receive the impulses which are sent out by means of the subscriber's dial D. Simultaneously with the connecting of a register set to a subscriber's line, a circuit from earth over the subscriber's line and telephone, and through the impulse relay R<sub>1</sub>, to battery, is closed, resulting in the actuation of the relay R<sub>1</sub>. The dialling of a digit creates a train of circuit breaks or impulses, causing the relay R<sub>1</sub> to be released as many times as the circuit has been interrupted in the dial. (The number of circuit breaks corresponds in this case to the dialled digit. The figure 1 will cause the circuit to be interrupted once, the figure 2 twice, etc., and the figure 0, lastly, will cause the circuit to be interrupted 10 times).

*The Restoring Relay R<sub>2</sub>.*

The function of relay R<sub>2</sub> is to restore the register to normal after a connection is completed. This relay is constructed so as

to be slow-releasing only. It is attracted through the contact (a) in the relay  $R_1$  at the same moment that the register is connected to a subscriber's line, and retains this position until the connection is completed. Owing to its slow releasing, relay  $R_2$  remains attracted during the impulsing of relay  $R_1$ .

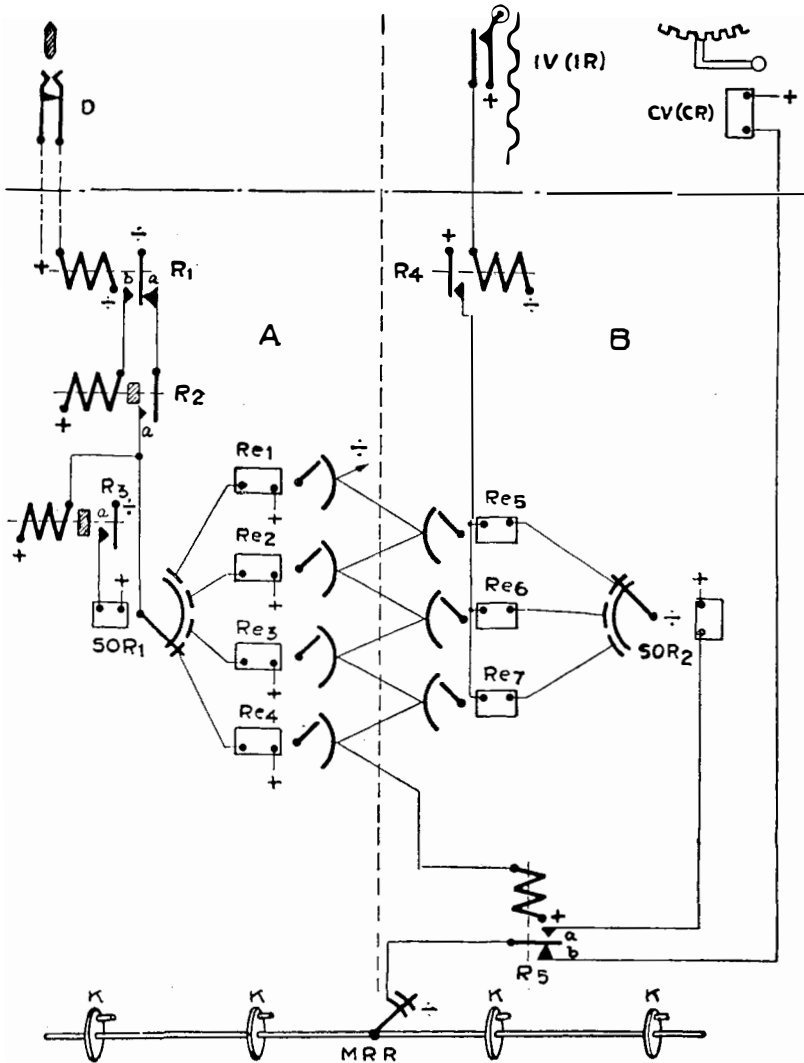


FIG. 17.—SCHEMATIC DIAGRAM OF REGISTER.

*The Controlling Relay  $R_3$ .*

The relay  $R_3$  controls the movements of the control switch  $SOR_1$ . It is a slow acting relay similar in design to  $R_2$ , and is, for this reason, attracted once for each train of impulses sent, that is, once for each figure dialled.



*The Control Switch  $SOR_1$ .*

This apparatus is similar in construction to a register unit, described under II—C, and its function is the successive connecting in of the units  $Re_1$  to  $Re_4$ . Its magnet is energized over a contact in the controlling relay  $R_3$ .

*The Registering Units  $Re_1$  to  $Re_4$ .*

The object of these units is to register the dialled numbers. They are successively connected in by the controlling switch and take the positions which correspond to the dialled numbers.

$Re_1$  is in circuit when the thousands digit is dialled.

$Re_2$  is in circuit when the hundreds digit is dialled.

$Re_3$  is in circuit when the tens digit is dialled.

$Re_4$  is in circuit when the units digit is dialled.

*B. Controlling Part of the Register Set.*

This part of the register set is composed of—

*The Revertive Impulse Relay  $R_4$ .*

The function of this relay is to receive the impulses sent out by the group selectors during their rotary movement and by the connectors during their rotary and radial movements, and repeat them to the controlling units  $Re_5$  to  $Re_7$ . These impulses are generated over the impulse contact IV (IR), and correspond in number to the number of steps which the selector and connector movements have advanced.

*The Stop Relay  $Re_5$ .*

The relay  $R_5$  cuts off the starting current to the group selectors and the connectors and serves also to close the circuit to the magnet of the control switch  $SOR_2$ .

*The Control Switch  $SOR_2$ .*

The function of this control switch is to successively connect in the controlling units  $Re_5$  to  $Re_7$ .

*The Controlling Units  $Re_5$  to  $Re_7$ .*

The controlling unit  $Re_5$  is set by the rotary movement of the group selector.

The controlling unit  $Re_6$  is set by the rotary movement of the connector.

The controlling unit  $Re_7$  is set by the radial movement of the connector.

These controlling units, which receive their impulses from the revertive impulse relay  $R_4$ , exactly follow the selector movements,

for example, when the rotary movement of a group selector has advanced 11 steps, the controlling unit  $Re_5$  has also been advanced 11 steps, etc.

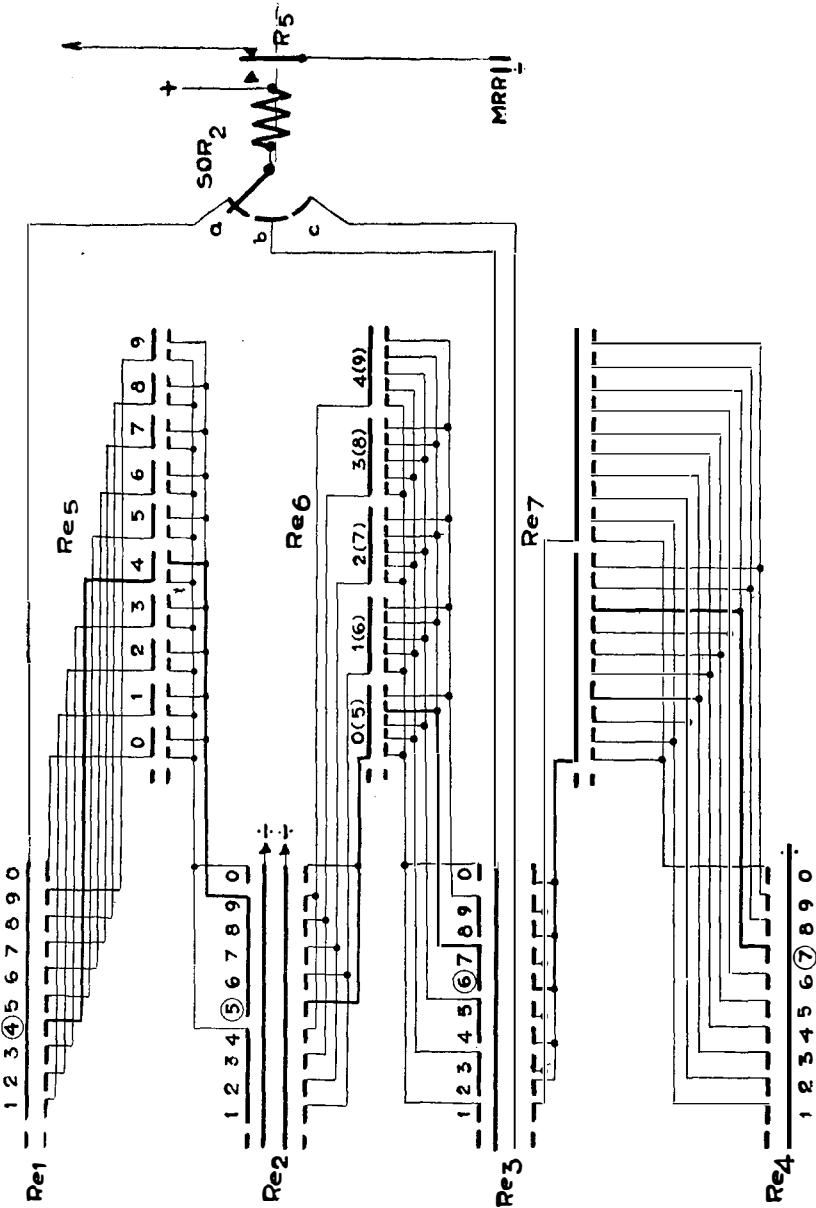


FIG. 18.—CONNECTIONS BETWEEN STORING AND CONTROLLING REGISTER UNITS.

The restoring mechanism with discs K has a sequence switch MRR connected to its shaft, one of whose functions is to connect in the battery for starting the group selectors and connectors.

The setting of the group selectors and connectors is accomplished by means of so-called revertive impulse control. When a sufficient number of digits has been dialled and registered by the registering units  $Re_1$  to  $Re_4$  (the two first digits for a four-digit numbering system), the sequence switch MRR is reset so that battery is connected in for starting the group selector. The centering magnet for rotary motion CV is energized (over a special relay, which for the sake of simplicity, is omitted in Fig. 17), whereby its armature releases the rotary disc and simultaneously closes the circuit to the magnet coupling. Impulses are sent out to the register, while the group selector is rotating, whereby the controlling unit  $Re_5$  is properly set. When the selector movement has advanced a number of steps corresponding to the first two figures in the dialled number (the thousands and hundreds figures), a circuit is closed over the registering units  $Re_1$ — $Re_5$ — $Re_2$  through the relay  $R_5$ , which hereby attracts its armature and breaks the selector-starting current at the contact in  $R_5$ .

The principle of setting for the connectors is the same as for the group selectors. The setting of a group selector, as has already been mentioned, is determined by the first two digits of a four figure number, the first digit determining the thousands group, while the second digit determines whether the switching shall be directed to a five hundreds group of a low or high hundreds figure. This principle of setting is also made evident by the numbering of the group selector multiples as shown in Fig. 9.

The rotary setting of a connector is determined by the hundreds and tens figures (see Fig. 10). It may here be noted, that the low hundreds figures 0, 1, 2, 3 and 4 are equivalent to the high hundreds figures 5, 6, 7, 8 and 9.

The radial setting of a connector, lastly, is determined by the tens and units figures.

#### IV.—CONNECTING A CALLING TO A CALLED SUBSCRIBER.

The process of establishing a speaking circuit between two subscribers is shortly as follows:—

- A. The call is connected to an idle line finder.
- B. The call is connected through the line finder and a register selector (or register finder) to a disengaged register set.
- C. The number called is registered within the register set.
- D. The group selector is set to its rotary position.
- E. The contact arm of the group selector enters the multiple, hunting an idle connector.
- F. The connector is set to its rotary position.
- G. The connector is set radially.

- H. The register set is restored to normal after having completed its function.
- I. The connector is testing to see whether the desired number is free.
- K. A ringing current is sent out to the called number.
- L. The called subscriber answers, thereby breaking the ringing circuit.
- M. The selectors are restored to normal when the call is cleared, the call being recorded on the calling subscriber's service meter.

DESCRIPTION OF CIRCUITS.

Fig. 19 depicts how a line finder seeks out a calling subscriber.

- A. Section I. Subscriber's connector multiple.
- ,, II. Line and cut-off relay and meter circuit.
- ,, III. Group relay for the 20 lines in a multiple frame.
- ,, IV. Subscriber's line-finder multiple.
- ,, V. Starting distributor.
- ,, VI. Line finder.
- ,, VII. Sequence switch.
- ,, VIII. Relevant circuit on group selector.

When a subscriber calls, the line relay LR actuating, causes

- (1) The actuation of group relay LGR.
- (2) The connecting of the cut-off relay BR to the line-finder multiple "c" wire.
- (3) The "d" or front bar of the frame to receive a potential.

Relay LGR connects with the starting distributor, common to 500 lines and relays SSR<sub>1</sub> and SSR<sub>3</sub> actuating, cause

- (1) The starting distributor to rotate by energizing the clutch magnet S.
- (2) The starting distributor arresting relay SSR<sub>2</sub> to be connected through resistance r<sub>1</sub> in parallel to all line finders which are hunting, it being gauged that ten or so such resistances in parallel will actuate relay SSR<sub>2</sub>.
- (3) Actuate relays RS<sub>3</sub> of those line finders which happen to be coupled in over the starting distributor contacts.

A relay RS<sub>3</sub> actuating, causes the sequence switch clutch magnet SOS to actuate, carrying its wipers to the second position, when

- (1) The "d" wiper is connected in through the test relay RS<sub>1</sub> back to the starting distributor.
- (2) A circuit actuates the centering relay for rotary motion of the line finder, which causes one of the clutch

magnets, in this case MVS, to rotate the line finder, springs OVS causing a reversal at an extremity.

When the calling frame is found relay  $RS_1$  stops the rotary movement; releases LGR by draining its holding current, which stops the starting distributor (providing this LGR relay was the only one actuated) and also steps the sequence switch SOS to its third position.

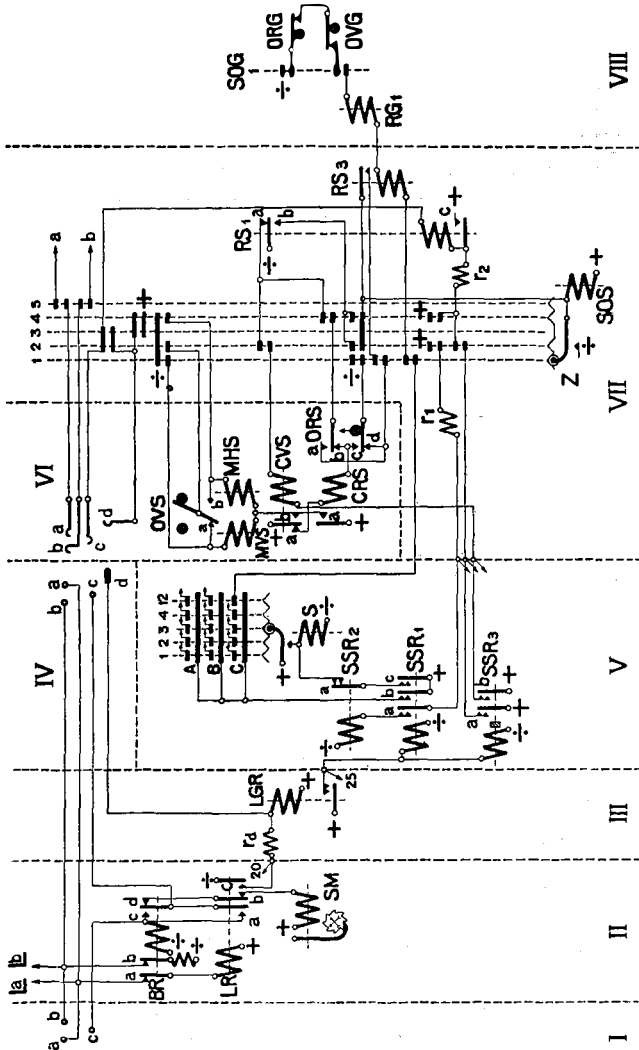


FIG. 19.—DIAGRAM OF LINE RELAY, STARTING DISTRIBUTOR AND LINE FINDER.

The sequence switch SOS does not rest on its third position, its centering cam having a blind tooth, which carries it to its fourth position.

In its fourth position it causes

- (1) The test relay  $RS_1$  to be transferred from the "d" wiper to the "c" wiper, the "d" wiper being earthed to prevent more than one line finder searching radially.
- (2) A circuit to actuate the radial centering magnet  $CRS$ , which causes the clutch magnet  $MHS$  to move the brush carrier radially along the calling frame.

When the calling line is found, relay  $RS_1$  again actuates, when simultaneously

- (1) The cut-off relay of the calling line is actuated in series with it.
- (2) This line tests engaged to other calls; the "c" wire having now too low a potential to actuate other test relays  $RS_1$  which are marginally adjusted with the resistance  $r_2$  normally in series.

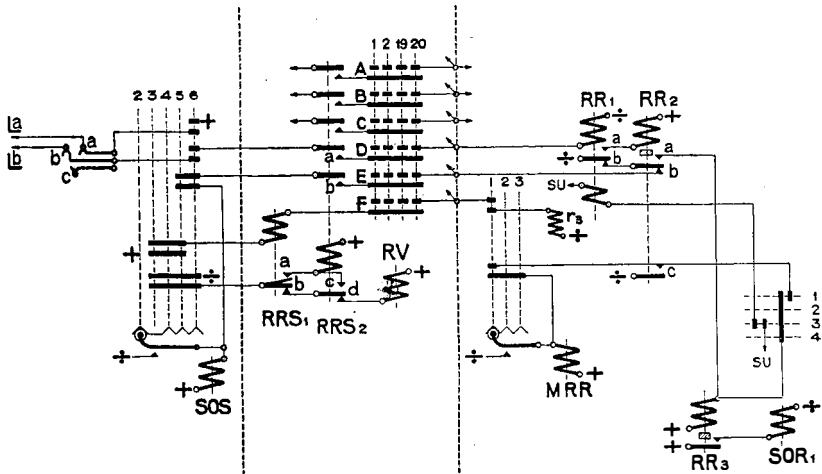


FIG. 20.—CONNECTING OF SUBSCRIBER'S LINE TO A DISENGAGED REGISTER.

- (3) The centering magnet releases, locking the brush carrier on this line and at the same time releasing the magnet clutch  $MHS$ .
- (4) The sequence switch moves to its fifth position.

The calling line has now been connected to the line finder.

### B. The Call is Connected to an Idle Register.

It will be assumed that the connection of the registers is accomplished in accordance with the principle of trunk register finders as shown in Fig. 16.

Fig. 20 shows in skeleton the method whereby the register is connected to the line finder and consequently the calling subscriber.

When the sequence switch (shown on the left) reached its third position, the clutch magnet RV of the register finder caused its wipers to search.

When an idle register is found, the finder is stopped by  $RRS_1$  which actuates through the normal position of  $MRR_1$  on the register, when  $RRS_2$  couples through the necessary connections.

As previously explained, the sequence switch is moved to its fifth position in the process of connecting the line finder to the calling line, so, when the register is also connected in, a circuit through the normals of relays  $RR_1$  and  $RR_2$  moves the sequence switch to its sixth position.

The immediate effect is that the impulsing relay of the register  $RR_1$  is actuated over the subscriber's loop, breaking this circuit to SOS before it can step to its seventh position.

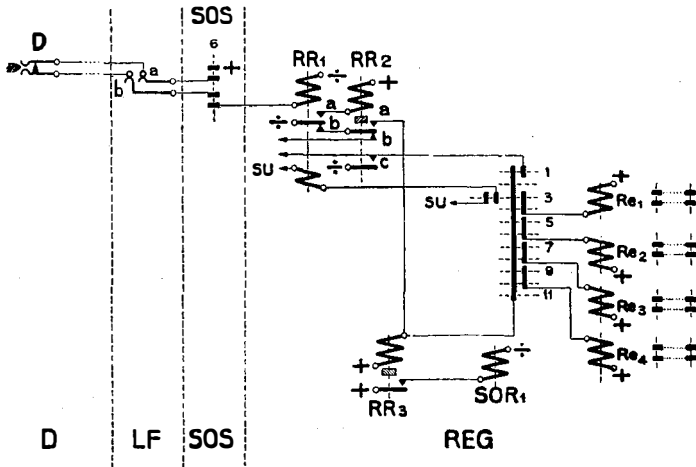


FIG. 21.—SETTING OF REGISTER BY MEANS OF THE CALLING DIAL.

At the same time it will be observed that  $RRS_1$  is released, allowing  $RRS_2$  to retain over its alternative circuit, but  $RR_1$  by actuating the retaining relay  $RR_2$  will cause the side switch  $MRR$  to step from the normal position and hold the register busy, by reason of resistance  $r_3$  being disconnected.

A circuit through the normal of switch  $SOR_1$  will actuate relay  $RR_3$ , which in turn will actuate  $SOR_1$  and step its wipers to the second position.

Now  $RR_3$  has no circuit so, when it releases,  $SOR_1$  steps to its third position, causing a dial tone SU to be induced over the relay  $RR_1$  to the subscriber's instrument.

( $SOR_1$  and all impulse responding switches on the registers step two positions for a complete impulse, resting the wipers on even numbers whilst actuated and advancing one step when released).

*C. Storing the Number in the Register.*

Fig. 21 shows the apparatus involved in storing the call in the register, D being the subscriber's dial, LF the line finder in position, SOS position 6 of its sequence switch and REG the register.

When the tone is heard, the subscriber is at liberty to dial and the result of the first train of impulses must be impressed upon switch  $Re_1$ , the second on  $Re_2$ , etc., the four such switch wipers assuming positions in conformity with the dialled number.

$RR_1$  responds to impulses.

$RR_2$  remains actuated throughout the call.

$RR_3$  actuates each time  $RR_1$  first releases and will retain until a digit train is completed.

When a digit is dialled, the circuit over the back contact of  $RR_1$ , the front contact of  $RR_2$  will actuate  $RR_3$ , stepping the  $SOR_1$  wipers from an odd to an even position without interfering with the parallel circuit through its contact bank to the storing  $Re$  switch in circuit.

Consequently whilst  $RR_3$  retains, the  $Re$  switch will respond to the train, but the delay between digits, allowing  $RR_3$  to release, will couple in the next  $Re$  switch for a further digit.

*D. The Switching Process for the Setting of the Group Selector to its Rotary Position.*

Fig. 22 shows

REG The register apparatus involved in the reception of the back impulses.

RV The  $a$ ,  $b$  and  $c$  connections through the trunk register finder.

SOS Position 6 of the line finder sequence switch.

SOG The group selector sequence switch.

GS The rotating details of the group selector.

It is necessary that the first two digits be recorded in the register before the group selector be set. Then the  $SOR_1$  switch will have reached position 7—8, and consequently the side switch MRR will be stepped to its third position.

Relay  $GR_2$  will actuate, moving the group selector sequence switch to the second position,  $GR_2$  retaining over its own contacts.

In this position the rotary centering magnet CVG is actuated, causing the clutch magnet MHG to rotate the group selector from its normal position. Each frame position passed will send back a make alternating with a break, to  $RR_7$  of the register, which will cause  $Re_s$  switch to impulse, advancing a step for each new location of the group selector until its wipers rest on contacts



conforming to the setting of the first two storing switches  $R_{e_1}$  and  $R_{e_2}$ .

In this position relay  $RR_8$  is actuated, breaking the circuit to  $RG_2$  which, by releasing, stops the group selector at the required multiple frame and also steps its sequence switch to the third position.

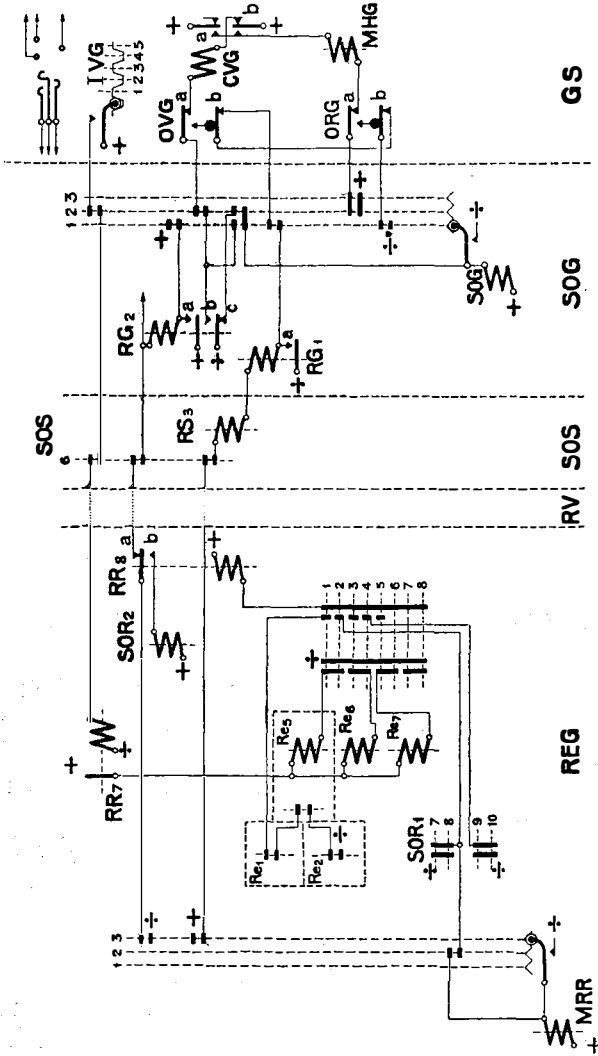


FIG. 22.—SETTING OF GROUP SELECTOR BY MEANS OF THE REGISTER.

Now the magnet  $SOR_2$  of the sequence switch for successively coupling in the back impulse switches  $R_e$ , will step its wipers to the second position and remain there if the next number dialled has not been received to move  $SOR_1$  from position 7—8.

Providing the third digit is recorded,  $SOR_2$  on its release, steps its wipers to position 3, coupling in switch  $R_{e_6}$ .

*E. The Group Selector seeks for an Idle Connector.*

The group selector has now selected the five hundreds frame in which the wanted number lies, and Fig. 23 shows the process of finding an idle connector in this frame.

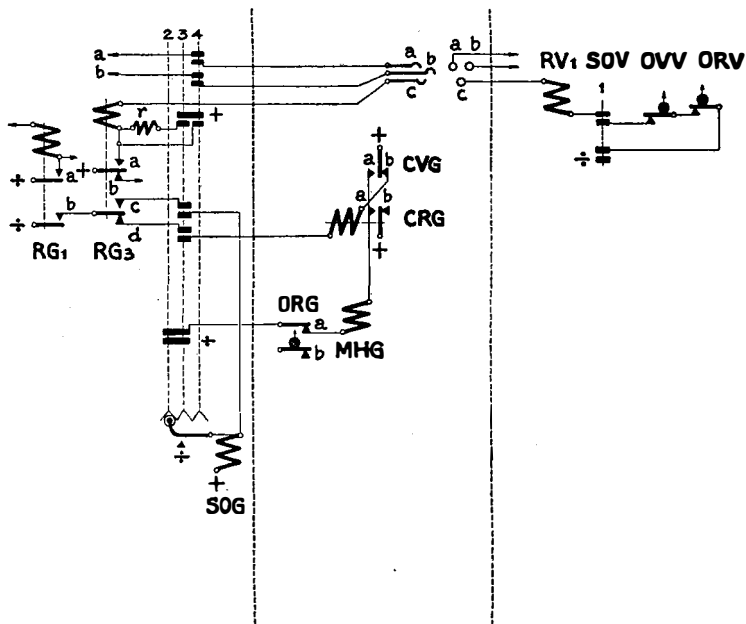


FIG. 23.--THE GROUP SELECTOR SEEKS AN IDLE CONNECTOR.

Relay  $RG_1$  operated when the group sequence switch was in its first position (Fig. 22) and has since retained over its own contacts so, SOG now being in position 3 a circuit operates the radial centering magnet CRG which, in turn operates MHG, the clutch magnet for outward radial movement.

This causes the brush carrier to travel down the frame, the "C" wiper progressively contacting with the connector test wires.

A connector to test free, must have its sequence switch SOV in its first position and the rotary springs OVV and radial springs ORV at normal, and when such a connector is found, test relay  $RG_3$  actuates, both stopping the radial movement and connecting the *a* and *b* wires through, by moving SOG to its fourth position.

*F. The Setting of the Connector to its Rotary Position.*

This process is identical to the rotary setting of the group selector, and when accomplished the  $SOR_2$  switch in the register advances to or awaits the connecting in of  $Re_7$ , depending upon whether the last digit has been stored.

*G. The Connector is set Radially.*

This is accomplished in the same manner as the rotary setting.

*H. Restoring the Register.*

With the radial setting of the connector the register has completed its function and can be released for further calls.

After the reception of the last series of back impulses,  $SOR_2$  switch steps from the  $Re_7$  switch on contacts 5 and 6 (Fig. 22) to 7 and 8 (Fig. 24) causing the line finder sequence switch SOS to step to position 7.

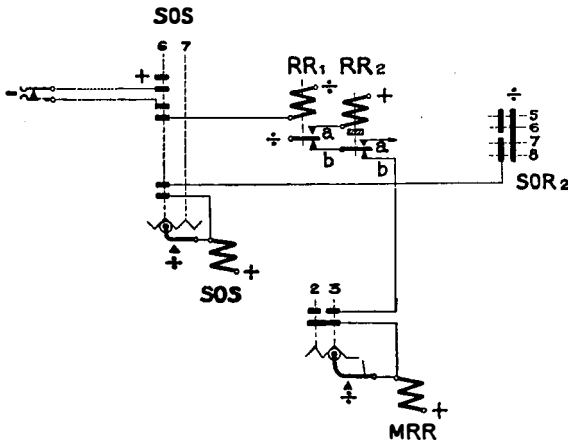


FIG. 24.—RESTORING THE REGISTER.

Relay  $RR_1$  is disconnected from the subscribers' loop and its release, along with that of  $RR_2$  will actuate the side switch MRR which, by clutching the driving shaft, will cause a cam shaft to rotate and thus reload all register switches to normal.

*I. The Connector Testing to ascertain if the Called Number is engaged.*

Fig. 25 shows the connector in conjunction with the line and cut-off relay of the called number. After the process of setting the connector, its sequence switch SOV rests in its sixth position, but, whilst passing its fifth position, the test relay  $RV_3$  was connected to the cut-off relay BR of the called number. (Relay  $RV_1$  is actuated from another source).

Should this line be free  $RV_3$  will actuate, carrying SOV to its seventh position, but should it be engaged  $RR_3$  will not actuate owing to insufficient current.

In this case SOV will remain in its sixth position, and by projecting a busy tone SU, induced over the feeding coils  $RV_5$ , advise the caller that the line is engaged.

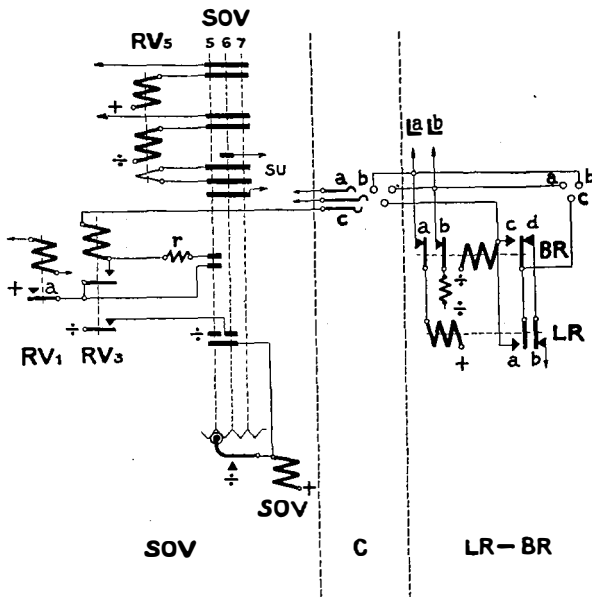


FIG. 25.—THE CONNECTOR IS TESTING THE CALLED NUMBER.

*K. A Ringing Signal is sent out to the Called Number.*

When the sequence switch SOV (Fig. 26) has attained its seventh position, it will travel to its tenth position by reason of the blind teeth on the centering wheel, in the meantime sending out a preliminary or instantaneous ringing to the called number.

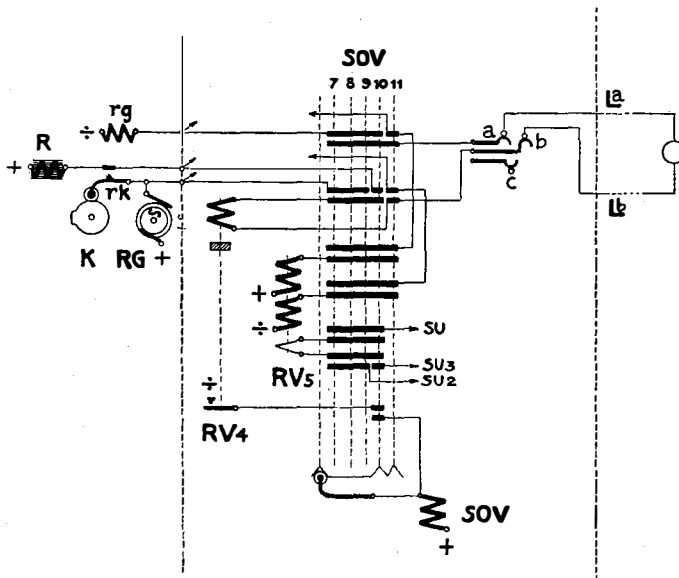


FIG. 26.—A RINGING SIGNAL IS SENT OUT TO THE CALLED NUMBER.

The tenth position causes periodic ringing, which will continue until the ringing trip relay  $RV_4$  is actuated by the number answering, or alternately until the call is abandoned.

First an instantaneous tone  $SU_2$  and then a periodic  $SU_3$  advises the caller that ringing is in progress.

The actuation of the ringing trip relay  $RV_4$  steps  $SOV$  to its eleventh position and the manner of stepping the line finder sequence switch  $SOS$  (Fig. 27) left at its seventh position to its ninth position is as follows:—

Relay  $RR_5$ , by actuating, short-circuits the test relay  $RG_3$  of the group selector, which on release, causes  $RS_3$  of the line finder also to release, when the  $SOS$  magnet moves its wipers from the seventh over the eighth (circuit not shown) to the ninth position.

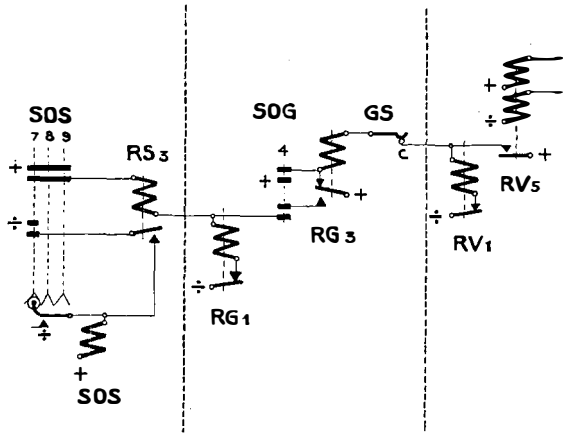


FIG. 27.—SETTING OF THE LINE FINDER'S SEQUENCE SWITCH TO SPEAKING POSITION.

When this is accomplished the speaking circuit in Fig. 28 is established, the various sections showing—

- A The calling subscriber.
- BRA Cut-off relay.
- LF Line finder.
- SOS Its sequence switch and relays.
- SOG Group selector sequence switch and relays.
- GS Group selector.
- SOV Connector sequence switch and relays.
- C Connector.
- BRB Called subscriber's cut-off relay.
- B Called subscriber.

*L. Restoring the Selectors and Sequence Switches to normal.*

In this case clearing is not effected until both subscribers hang

up their receivers, but individual clearing can be substituted at will.

The speaking or feeding relays  $RS_2$  and  $RV_5$  (Fig. 28) must both release before the apparatus can be restored to normal, the release of  $RV_1$  then starting this operation.

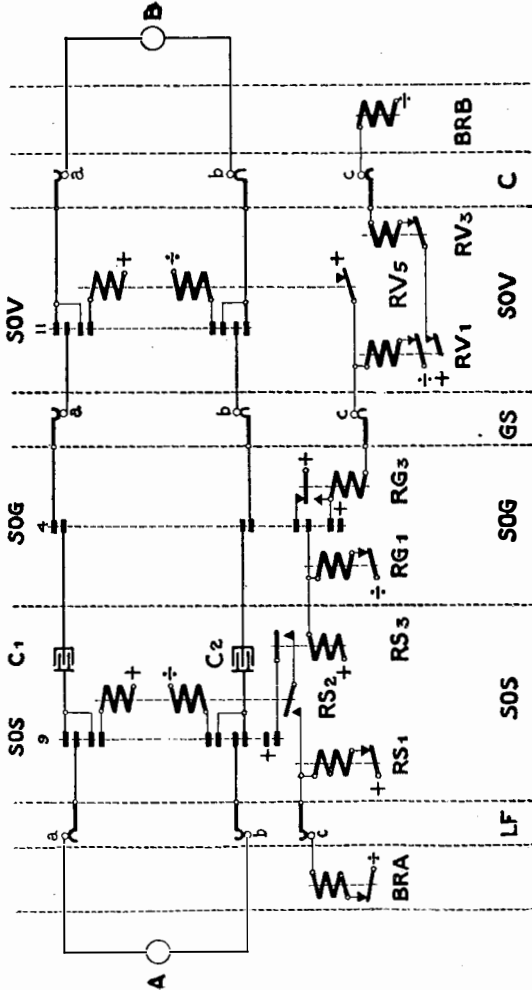


FIG. 28.—SPEAKING AND HOLDING CIRCUITS.

When  $RV_5$  releases, the short circuit on  $RG_3$  is removed and by its re-actuation,  $RS_3$  of the line finder will also re-actuate over a similar circuit on  $RG_3$ . When  $RS_2$  releases,  $RS_1$  will be short-circuited and its release will cause the sequence switch  $SOS$  to step from its ninth position over its tenth, eleventh and twelfth to normal again.

In the normal position the line finder brush carrier is withdrawn from the frame.

THE L.M. ERICSSON AUTOMATIC TELEPHONE SYSTEM.

The series coupling of  $RS_3$  to  $RG_1$  is discontinued after the tenth position of  $SOS$ , so the release of  $RG_1$  will then cause the group selector  $SOG$  to be reset to normal and in like manner the connector  $SOV$  will be restored.

*M. The Call is registered on the Subscriber's Meter.*

When the sequence switch of the line-finder passes its tenth position the cut-off relay  $BRA$  is released and over the eleventh and twelfth positions the circuit in Fig. 29 operates the meter.

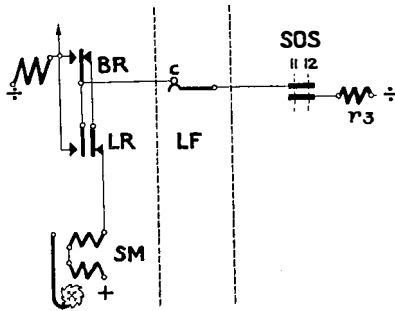


FIG. 29.--REGISTERING A CALL ON A SUBSCRIBER'S METER.

Ineffective calls, where no answer has been received or the call abandoned, the restoring of the line finder is effected from the eighth position of its sequence switch and consequently when this switch later passes its metering positions the brush carrier is already withdrawn from the multiple.

In this manner provision is also made for non-registered calls to toll operators, trouble and information desks, etc.

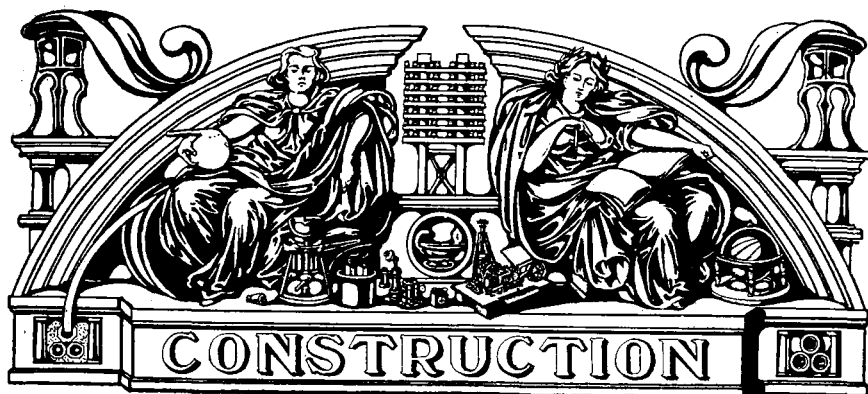
G.G.

## 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 MARCH, 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.
444,018	617	4,159	57,149	503	London	22,228	47,885	1,515,027	49,412
52,570	1,920	19,412	52,871	1,714	S. East	3,793	19,417	83,049	15,441
55,778	4,372	24,915	42,512	1,684	S. West	13,262	3,964	83,451	27,005
43,479	8,365	30,370	38,732	5,459	Eastern	13,725	21,472	44,524	46,521
75,250	8,553	41,184	50,085	3,339	N. Mid.	17,355	30,529	126,978	78,679
52,623	4,784	25,574	53,540	4,487	S. Mid.	10,607	14,028	103,485	82,781
49,518	5,037	27,900	43,873	1,941	S. Wales	5,194	14,134	77,788	31,416
78,755	8,565	23,526	40,491	4,885	N. Wales	11,813	28,807	140,204	45,155
123,777	2,986	16,837	46,708	3,296	S. Lancs.	12,364	58,481	322,817	38,932
74,318	6,344	29,166	42,014	2,724	N. East	8,070	25,960	153,628	21,002
49,126	3,870	23,785	38,068	2,094	N. West	8,504	27,594	91,685	23,430
38,692	2,526	15,233	23,613	2,117	North	2,755	8,368	60,263	25,199
17,564	4,785	5,894	11,335	234	Ireland N.	139	84	28,478	73
51,299	5,603	20,942	32,443	1,249	Scot. East	1,588	5,995	88,912	11,667
73,958	7,514	22,580	38,770	985	Scot. West	12,386	20,007	181,267	26,814
1,280,725	75,841	331,447	612,204	36,711	Totals.	143,783	326,725	3,101,556	523,527
1,249,748	76,347	327,419	606,427	37,139	Figures on 31st Dec., 1924.	141,380	308,191	3,019,720	461,448





## THE ROMFORD TO SOUTHEND-ON-SEA LOADED AERIAL CABLE.

(54 PAIR/40 LB., PAPER CORE, LEAD SHEATHED).\*

By A. W. GARDNER, A.M.I.E.E.

THIS aerial cable line is the first of its type, of any considerable length, erected in this Country. It is constructed on a method similar to that adopted in America over long distances, but with some adaptations suitable for this particular work and for coil-loading in manholes. Briefly, it consists of a lead-covered paper-core cable erected on a specially constructed pole route, the cable being suspended on a stranded steel wire by means of steel rings in place of the usual suspenders and the stranded steel wire being strained to such a tension that there is a very small dip. The poles are spaced at 40 yards. The cable, in approximately 400-yard lengths, was drawn through the rings quite easily—in fact, much more so than in the case of a cable drawn into a duct.

A few words upon the position which led up to the decision to erect this type of plant. In 1922 estimates were prepared and authorised for an underground cable along the then proposed new arterial road to Southend, but it was found later that the road would not be completed before the middle of 1924, and also that there would be great risk of dislocation of a duct line, due to possible subsidence of sections of the new road, which in several long sections is made up on embankments formed by the filling in of valleys and hollows. The need for additional trunk lines to

\* Abstract of Paper read before the Institution of Post Office Electrical Engineers, Eastern Centre.

THE ROMFORD TO SOUTHEND-ON-SEA LOADED AERIAL CABLE.

Southend, however, was urgent and it was decided, therefore, to erect an aerial cable line.

In the case of cuttings, the poles are erected at, or near, the foot of the batter or slope: in the case of embankments, the poles are placed at the foot of the embankment. This causes the line to undulate in some parts, as some of the embankments are 30 to 35 feet high.

At Rayleigh a deep cutting through a hill was made, extending for some 900 yards with a high and very gradual batter, very liable to slide and, in fact, numerous slides occurred during the work and have continued since: in this section, therefore, the line was erected over the hill on the top of the cutting and as far from the edge of the slope as possible.

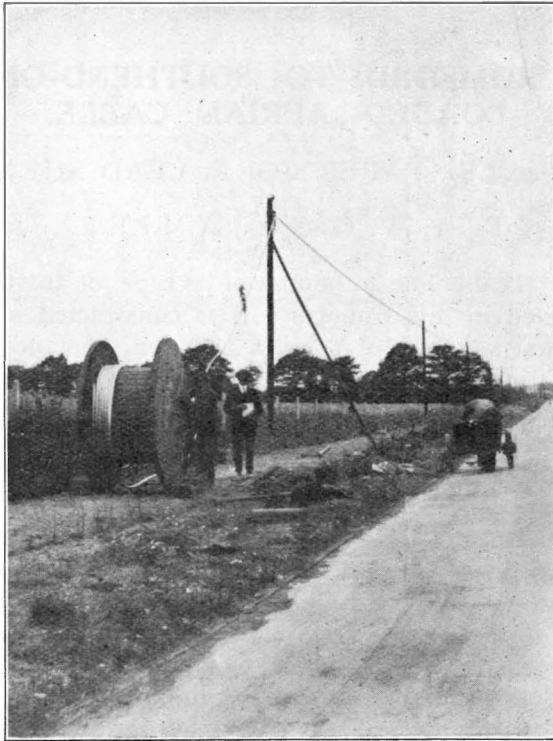


FIG. 1.—CABLING: DRAWING THROUGH CABLE RINGS.

The spans are 40 yards and the poles are 28' medium and 30', stout, in the proportion of approximately 3 to 1: if required, the line will carry a second cable similar to that already erected.

Special attention was given to staying, according to the principles in general use for open lines, and the requirements were calculated by the stay slide rule but using the breaking strength

THE ROMFORD TO SOUTHEND-ON-SEA LOADED AERIAL CABLE.

of the suspension strand wire (13,000 lbs.) in place of the breaking strength of line wires.

In cases where the "pull on the pole" is more than 50 feet, stays are fitted in prolongation of the line on each side of the angle, in addition to a stay bisecting the angle. At railway crossings the poles are back-stayed against the crossing span and also side-stayed.

Side stays are erected every quarter-mile and line stays every half-mile—that is, at half-mile intervals, the poles are stayed in four directions.

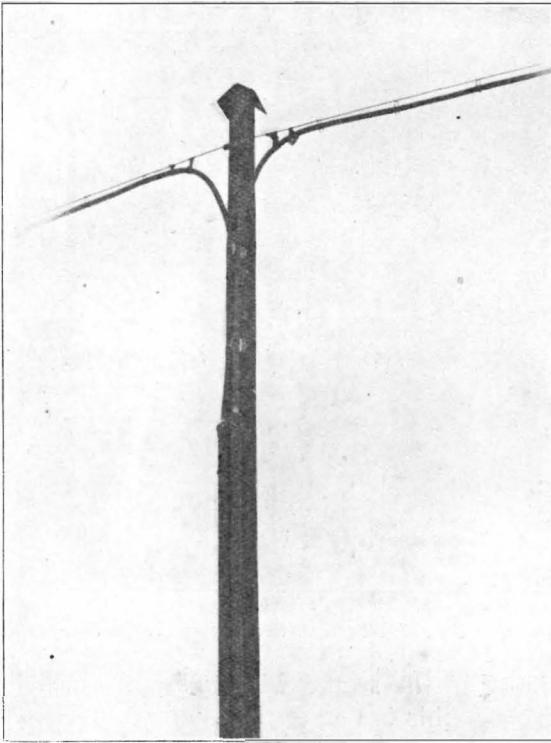


FIG. 2.—METHOD OF LEADING CABLE DOWN POLES.

The side stays are made off 12 inches above the suspender strand, and line stays 4 inches below.

The suspension wire is of  $7/10$  S.W.G. galvanised steel, the breaking strength being 13,000 lbs. It was supplied on drums in half-mile lengths which were run out and used to the maximum length practicable. It is not an easy wire to handle.

Brackets, known as No. 13, which occupy the same side of the pole route throughout, are used to grip the strand wire.

Each bracket is supported by a bolt passing through the pole at right angles to the cable, the bolts being screwed at each

THE ROMFORD TO SOUTHEND-ON-SEA LOADED AERIAL CABLE.

end, so that a second bracket can be added on the other side of the pole when required. An extra washer or nut is inserted between the bracket and the pole in order to give sufficient clearance for the cable.

The strand wire was run out over the ground, lifted over the bracket bolts and then placed in the bracket clamps, which were tightened so as to hold the strand wire but not to injure the galvanizing while the wire was being strained up.

To joint the strand wire, the ends are looped round interlocked thimbles and secured by clamps, three clamps being used on each side.

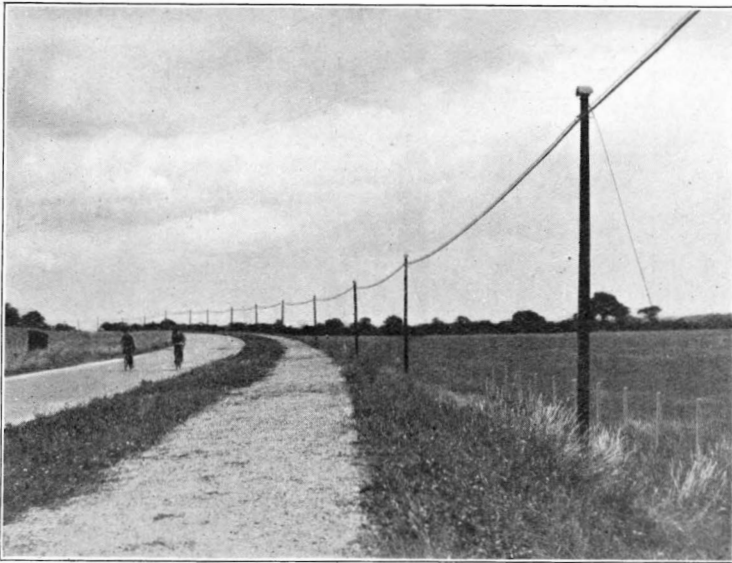


FIG. 3.—TYPICAL SECTION OF ROUTE.

The straining of the strand wire was performed by means of blocks and tackle: this is one of the main features of this type of construction, and the most costly as regards labour. The tension on the unloaded strand was approximately 3,000 lbs. (calculated for the cable, weighing 3.5 lbs. per foot).

The straining of the strand wire was checked by the vibration method, *i.e.*, by counting the vertical oscillations which result from placing a line over the middle of the span and releasing it suddenly. The dip at the centre of a 40-yard span at 40°F. was 19.6 inches and the number of seconds for 40 vibrations was 17.4.

The galvanized steel cable rings are of the "Bonita" type and oval in shape. They are fixed by a man riding in a bosun's chair running on the strand wire, and are spaced 20 inches apart normally and 12 inches at railway crossings.

## INTRODUCTION OF UTILITY SERVICE MOTOR VEHICLE.

The chair is hauled along as required by another man by a line attached to the running block and as each ring is fixed a line is threaded through it, to be used later as a draw line. Knots made in the line give the ring fitter the correct spacing.

The cable is 54 pair/40 lb. P.C., M.T., Aerial, external diameter 1.64 inches, and 50 pairs are loaded.

The sheath is an alloy containing 99% lead and 1% antimony, .101 of an inch in thickness and capable of withstanding an internal air pressure of 75 lbs. per sq. inch.

All joints are made at poles. The loading points are at intervals of 1.6 miles and at these points the cable is led into manholes specially designed.

### SUMMARY OF WORK.

Poles erected	...	...	...	905
Stays	„	...	...	441
Struts	„	...	...	40
Number of rings	...	...	62,150	
Length of cable drawn in	—20.65 miles.			

## INTRODUCTION OF UTILITY SERVICE MOTOR VEHICLE IN THE ENGINEERING DEPARTMENT.

THE vehicle about to be described has been specially designed for use in rural areas, where travelling facilities are poor and much

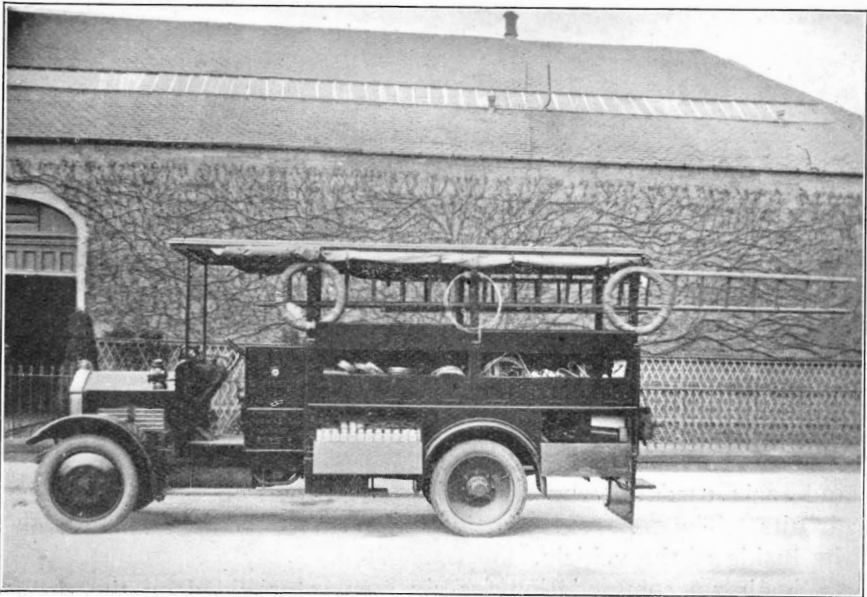


FIG. 1.—SIDE VIEW SHOWING LOCKERS.

## INTRODUCTION OF UTILITY SERVICE MOTOR VEHICLE.

time is lost in going to and from the points where new telephone services are required.

The body, attached to a 30-cwt. Albion chassis, subsidy type, is fitted with locker compartments, accessible from the outside, for the various overhead line stores, internal wiring stores, apparatus



FIG. 2.—REAR VIEW SHOWING INTERIOR EQUIPMENT.

and tools used in connection with the provision of subscribers' circuits. The tops of these lockers form convenient shelves on the inside of the vehicle.

Seating accommodation for six men is provided on the right hand side of the gangway between the lockers. The full length of

## INTRODUCTION OF UTILITY SERVICE MOTOR VEHICLE.

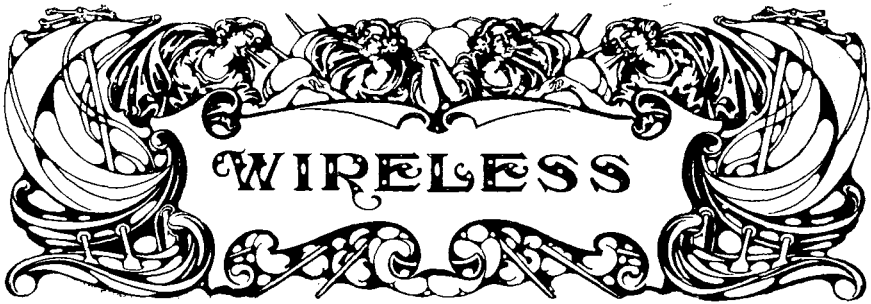
the vehicle has been made available for passengers by hinging the step to the tail board.

Complete protection from the weather is afforded by curtains on the sides and rear of the body. Those in the illustration have been rolled up to show clearly how the ladders are supported by the hooks on the stanchions. Four ladders can be carried.

The experiment has proved very successful and six more vehicles will shortly be brought into commission.

R.T.R.





## QUARTZ CRYSTAL RESONATORS.

By F. E. NANCARROW, A.R.C.Sc., A.M.I.E.E., M.I.R.E.

EARLY standards of, or means of measuring, the frequency of an oscillating current of radio frequency were based upon accurate knowledge of the characteristics of some standard circuit consisting of an inductance joined across a condenser. Sometimes these circuits were fitted with an indicating device, such as the Neon Tube, in the case of the early Fleming Cymometer, or a rectifying device and telephones, as in the case of the Marconi "Wave-meter."

The modern standard is based upon the frequency of oscillation of a valve-maintained tuning fork, usually of the order of 1000 cycles per second, which frequency can be compared against standard time. This method, which was the subject of an article by the present writer in the October number of this Journal of last year, is probably, and is likely to remain, the most accurate method of measuring radio frequencies.

There are, however, other sub-standards of high frequency oscillations depending neither upon the electrical characteristics of an oscillatory circuit nor upon the low frequency vibration of a tuning fork, but directly upon the frequency of longitudinal vibration of rods of quartz crystal. Their utilisation depends upon two factors; the natural frequency of vibration of a quartz rod and the phenomena known as the piezo-electric effect exhibited by many crystalline substances.

A crystal is said to be piezo-electric when if it be mechanically strained it exhibits an electric polarisation, and conversely when electrically polarised it suffers mechanical strain. An alternating electric stress properly applied will thus set up an alternating condition of mechanical strain.

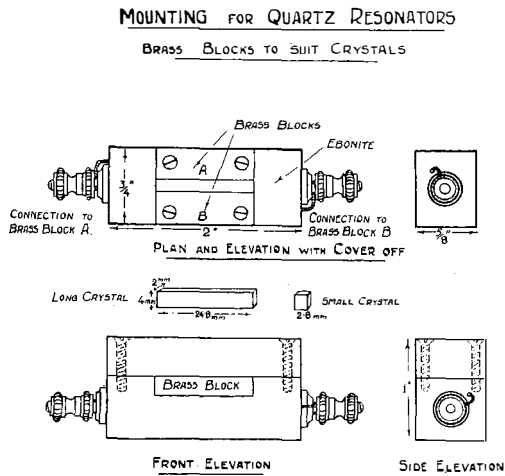
Rochelle Salt and Quartz are the two crystalline substances



## QUARTZ CRYSTAL RESONATORS.

which have been mainly studied in this connection, the former by Nicolson\* and the latter by Cady,† who has carried out all the pioneer investigation into the usage of quartz crystals at radio frequencies.

Quite small voltages are sufficient to set a rod of quartz crystal into oscillation when the frequency of the applied voltage coincides with the mechanical frequency of vibration of the rod, and the low mechanical resistance of the quartz makes it eminently suitable as a standard of frequency. The curves given and specified later illustrate the point very remarkably.



The constants of quartz, *i.e.*, the density and elasticity, are such that if  $l$  be the length of a suitably cut rod in m.m., then the resonant frequency of vibration is approximately given by the relation

$$f = \frac{2.7 \times 10^3}{l} \text{ kilo cycles per second.}$$

In practice, rods can be cut ranging in frequency from about 1000 to 100 kilo cycles per second, *i.e.*, with lengths ranging from 2.7 to 27 m.m. The cross section may be 1 m.m.  $\times$  2 m.m., so that the rods are always quite small. In order to electrically operate upon the rods they can be mounted loosely between two sheets of a conducting material. Fig. 1 illustrates the type of mounting which has been used in the Radio Laboratory. As is seen, the quartz rods when mounted are eminently portable. Actually the

\* Proceedings. American I.E.E., 1919.

† Proceedings. Institute Radio Engineers, Apl., 1922.

## QUARTZ CRYSTAL RESONATORS.

rod is loosely contained within the mounting, the gross clearance in any direction being of the order of 0.5 m.m.

To demonstrate the resonant frequency of a quartz crystal resonator a circuit arranged as in Fig. 2 can be used. Here A is a valve oscillator arranged so that the capacity element by its variation allows of a fine degree variation of the frequency. B is a normal oscillatory circuit consisting of an inductance and capacity, with a thermo-couple and galvanometer inserted in order to read the current. If, now, the circuit B be kept fixed and the frequency of A varied, the readings of the galvanometer will give, providing the coupling between the two circuits is suitably weak, the resonance curve for the circuit B. If, however, the quartz crystal resonator be connected across the condenser of the circuit

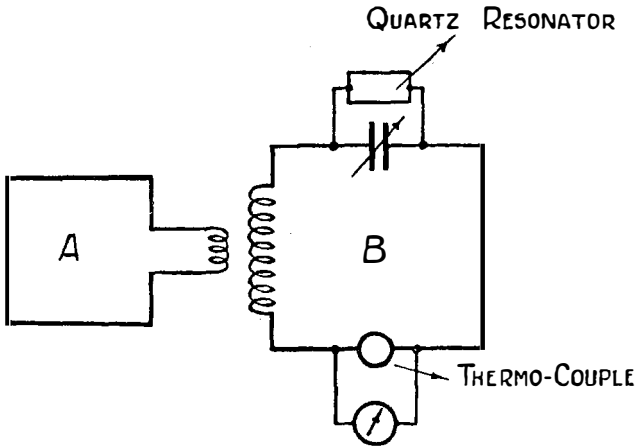


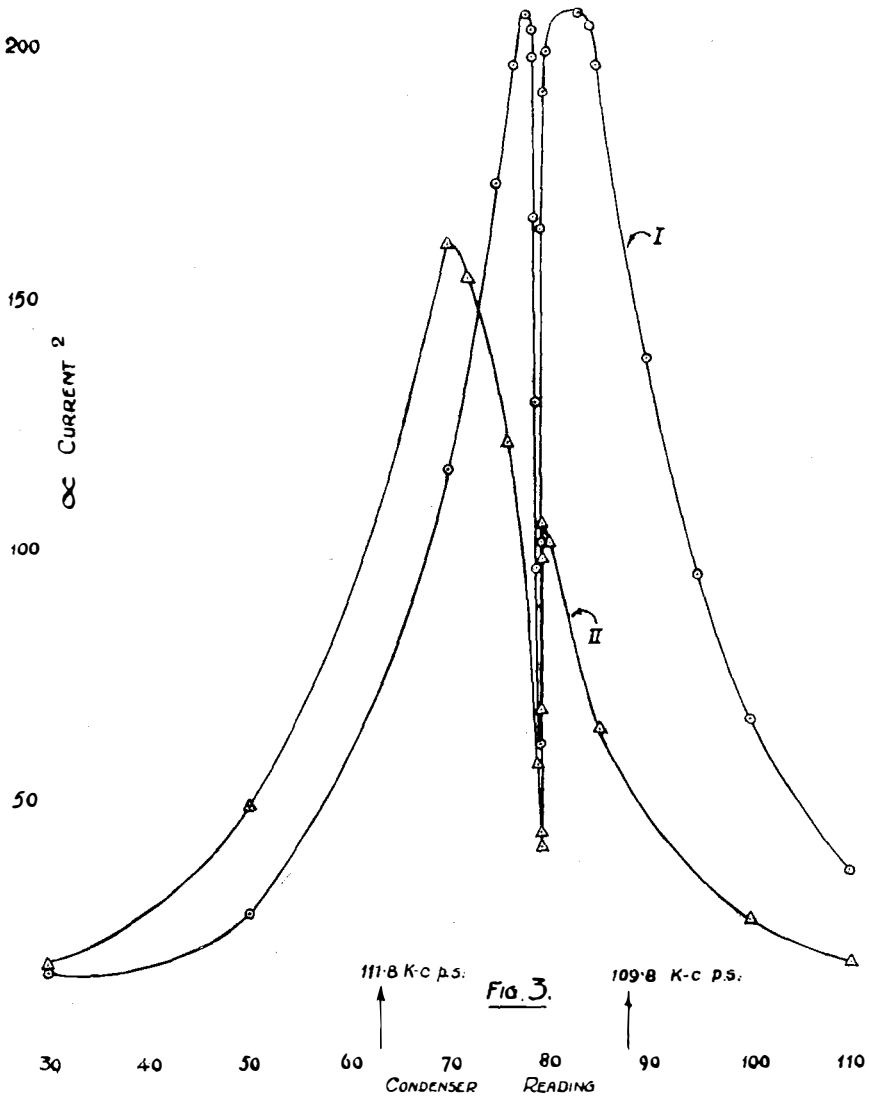
FIG. 2.—CIRCUIT.

B, with B set initially to approximately the frequency of the crystal, and the same procedure followed, a frequency will be reached at which the quartz rod is set into oscillation and the consequent absorption of energy will cause the current in the circuit B to fall. How critical is this coincidence of frequency and how marked the result is well shown in Fig. 3, which illustrates the results obtained with a quartz rod 24.8 m.m. in length. Curve I. was obtained with the circuit B initially set to approximately the resonant frequency of the quartz rod and affords an interesting comparison between the electrical damping of the circuit and the mechanical damping of the rod. The ratio between the mechanical damping of the rod and the electrical damping of the circuit can be roughly taken as the ratio between the width of the crevasse due to the quartz resonator and the width of the resonance curve of the circuit, both widths being taken midway between maximum

QUARTZ CRYSTAL RESONATORS.

and minimum values. Curve II. illustrates the effect obtained when the circuit B is initially mistuned.

Actually the precision with which the oscillator could be set to the resonant frequency of the quartz rod in the above cases was



of the order of 1 in 50,000, an accuracy much greater than that with which the absolute frequency of the oscillator, and thus the quartz rod, can be measured. The actual measurement of the resonant frequency, once the coincidence of oscillator and quartz rod has been obtained as shown above, is effected by using the

QUARTZ CRYSTAL RESONATORS

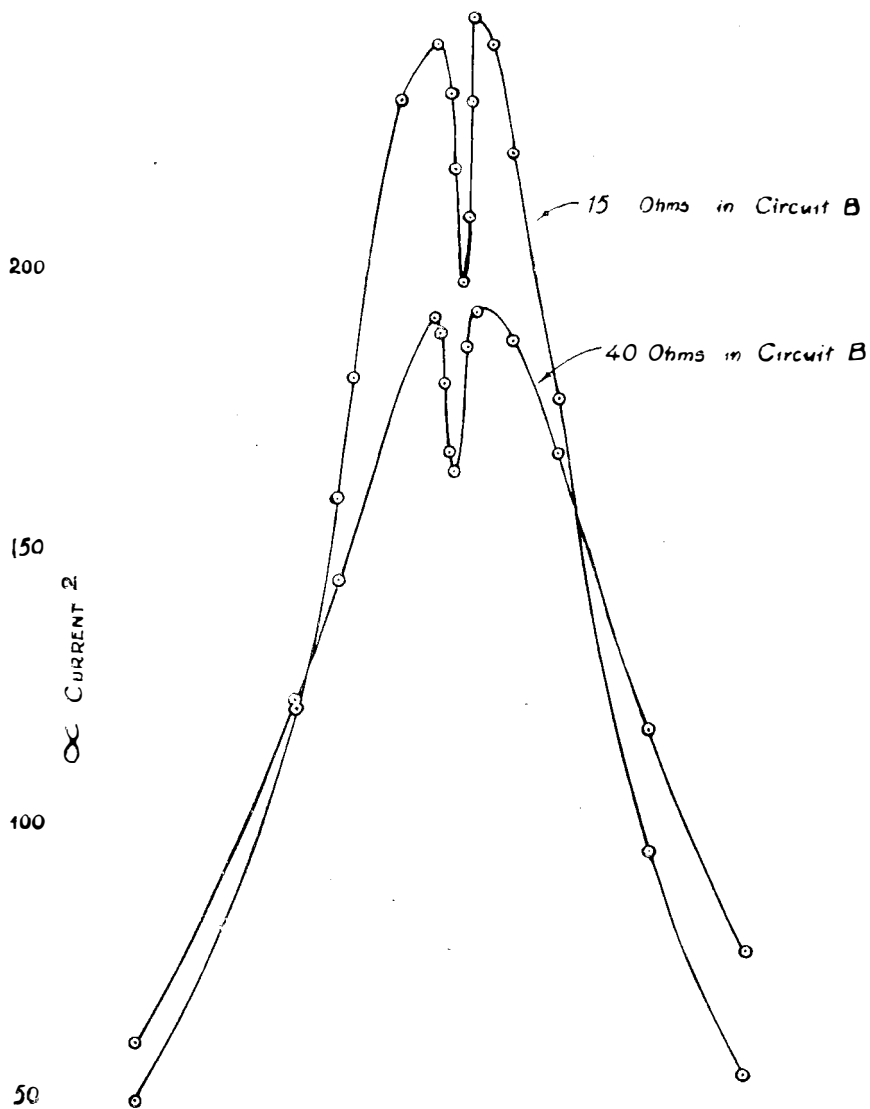


Fig. 4

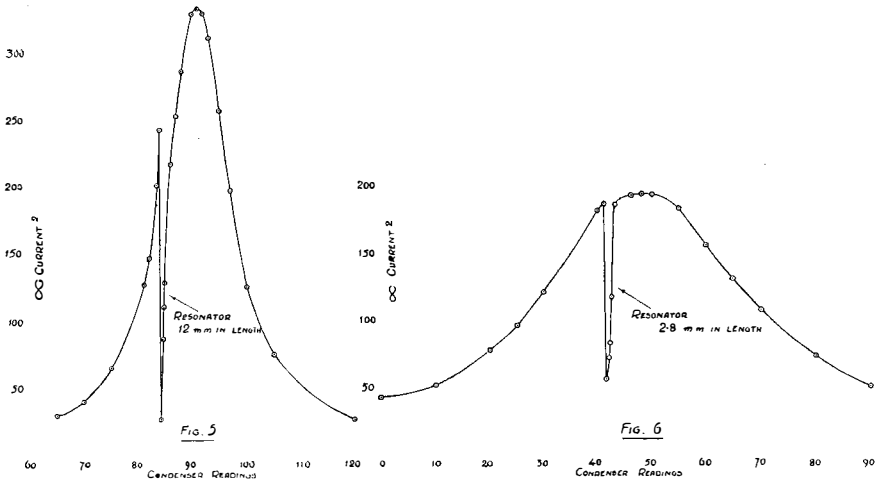
KILO-CYCLES PER SECOND

103 104 105 106 107 108 109 110 111 112 113 114 115 116

QUARTZ CRYSTAL RESONATORS.

Multivibrator apparatus previously mentioned, by which means the quartz resonator can be calibrated to an accuracy of 1 part in 10,000.

The nature of the crevasse due to the quartz resonator and thus the operation of setting an oscillator to the exact frequency of the resonator will depend, assuming the oscillator is capable of the necessary fine variation, upon the decrement of the circuit B. In the case illustrated by the curve in Fig. 3, the circuit had a fairly low decrement, the inductance being of a standard type having a low H.F. resistance. The curves of Fig. 4 give the nature of the crevasses obtained when resistances of fine wire of 15 ohms and 40 ohms respectively had been added to the circuit.



The delineation of the resonant frequency is not so sharply defined as before, but it is still of a precision equal to that with which the absolute frequency can be measured.

Figs. 5 and 6 illustrate the results obtained with rods of lengths 12 m.m. and 2.8 m.m. respectively, and the Table below gives the resonant frequencies and lengths of a trio of quartz rods recently experimented with.

Length of rod.	Resonant Frequency.
2.8 m.m.	957.7 <sub>2</sub> k.c.p.s.
12.0 ,,	221.8 <sub>8</sub> ,,
24.8 ,,	110.4 ,,

Once calibrated, the quartz resonator becomes a portable sub-standard of frequency, and the reverse of the processes described

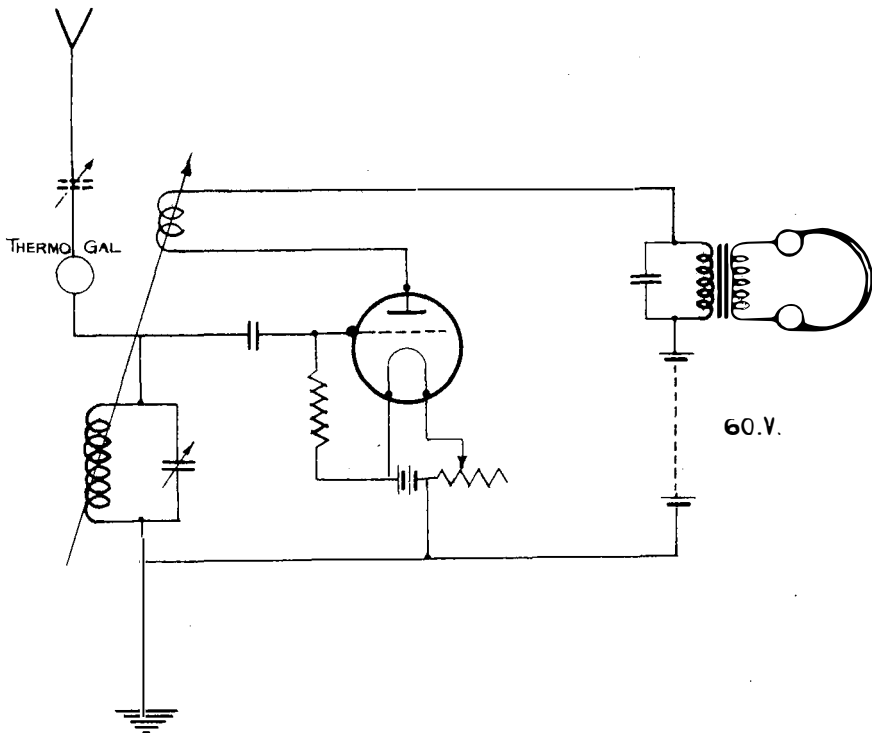
## INTERFERENCE TO BROADCAST RECEPTION.

can be carried out in order to calibrate either an oscillator or a plain oscillatory circuit. Of course a number of such resonators of different frequencies would be required for this purpose.

## INTERFERENCE TO BROADCAST RECEPTION BY OSCILLATING RECEIVERS.

TESTS have been made at the Post Office Research Station at Dollis Hill with a single valve having grid circuit connected to aerial and anode reacting thereon.

A single valve receiver with reaction was used; it was direct coupled on to the antenna. Measurements were taken using two different valves in the receiver, a D.E.3 (.06 amp, filament current) and a V.T.3 valve (.85 amp. filament current).



SINGLE VALVE WITH REACTION.

The oscillating current produced in the receiving aerial was measured with a vacuo-thermo junction and mirror galvanometer. The above is a diagram of the apparatus used.

It will be seen that disturbing currents up to a value of 5 milliamperes may easily be obtained.

INTERFERENCE TO BROADCAST RECEPTION.

	<i>Wavelength.</i>	<i>Valve.</i>	<i>Antenna Coil.</i>	<i>Reaction Coil.</i>	<i>Antenna Current.</i>
Using Series Condenser.	400 metres	D.E.3.	100 $\mu$ H	250 $\mu$ H	1.1—3.3 milliamps.
	" "	V.T.3.	"	"	1.0—2.0 "
	" "	D.E.3.	"	"	1.0—4.0 "
	" "	"	"	500 $\mu$ H	2.15—5.0 "
	" "	V.T.3.	"	250 $\mu$ H	.9 "
	" "	"	"	500 $\mu$ H	1.0—1.8 "
	600 "	D.E.3.	250 $\mu$ H	500 $\mu$ H	.95—3.3 "
	" "	"	"	1000 $\mu$ H	.95—4.1 "
	" "	V.T.3.	"	500 $\mu$ H	Would not oscillate.
	" "	"	"	1000 $\mu$ H	.6—1.8 milliamps.
	1000 "	D.E.3.	"	500 $\mu$ H	.7 "
	" "	"	"	1000 $\mu$ H	.7—1.6 "
	" "	V.T.3.	"	500 $\mu$ H	Would not oscillate.
	" "	"	"	1000 $\mu$ H	.5 milliamps.

As the Dollis Hill aerial used is slightly lower in capacity and of higher resistance than the standard P.M.G. aerial, it is probable that slightly higher current values would be obtained on an ordinary broadcasting receiving aerial.

The large disturbing value of such currents will be realised when it is stated that in some transmission experiments carried out by the Post Office, transmitting at Devizes on a 250' high aerial and a current of 10 MA on a wave-length of 1,800 metres, good CW signals were generally received at Dollis Hill, about 75 miles distant.

On the shorter wave-lengths employed in ordinary broadcast transmissions the amount of radiation would be appreciably greater than on 1,800 metres.



## NOTES AND COMMENTS.

THE paper read before the parent Institution by Colonel Purves on "Automatic Telephony" provides the most complete summary of the history and development of the subject yet published in this country, and traces the progress made towards the complete conversion of the British Post Office system. That the entire switching arrangements will ultimately be automatic in operation no one doubts; the authorities are concerned now with the gradual transfer, which must be accomplished without interfering with the services at present afforded, existing facilities must be fully maintained, the new methods must be applied in the most efficient and most economical manner. A fairly complete summary of the Engineer-in-Chief's paper will appear in our pages, we hope, in due course, but in the meantime a limited number of copies has been obtained with the object of supplying them free to regular subscribers who do not secure copies in the usual way from the Institution of Electrical Engineers. Applications for copies should be sent to the Managing Editor, through the local Agents, and stamps to cover the postage should be enclosed with the application.

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In our last issue we commenced to publish much fuller lists of Staff Changes than formerly, and it is pleasing to understand that the change is being appreciated. In such a large list there is always a possibility of error, but one mistake in the April number demands, we think, a sincere apology. The name of Mr. R. E. Guthrie, Northern District, appeared among the deaths. We are glad to hear that Mr. Guthrie is not dead; he retired from the service on the 31st December last, and we trust he has still



#### NOTES AND COMMENTS.

long years of life ahead. We regret the mistake very much and hope there will be no repetition of such an error.

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We have been advised by the Commercial Information Department of the Trade Delegation of the U.S.S.R. that the development of the radio industry has made enormous strides in Russia recently and that a radio exhibition is being held in the Polytechnic Museum, Moscow. Nine sections will deal with every phase of the history and development of the industry. The exhibition will continue open till the end of August. Applications from foreign firms who wished to participate were required to be sent in before the 1st of June.

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The blowing of one's own trumpet is not always in good taste, but we ourselves are brazen enough to take the opportunity of directing the attention of our readers to a review elsewhere in this issue by Mr. O'dell of a German book on telephone traffic problems. In the bibliography quoted in the book there are 10 references to this journal out of a total of 17 external to the Reich. This is only another proof of the status and influence which the magazine has acquired in the technical literature of our time.

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The following letter from Mr. J. G. Hill will be welcomed by all, not only for the valuable contribution to the subject he treats but for the inevitable inference that he is very much alive and as keen as ever to give of his best to the service of his colleagues. He has just completed a trip to the south-west of France, the land of his adoption, and has returned to Dinard in good health and spirits:—

*The Managing Editor.*

Sir,—I have read Mr. Morice's valuable article on "The Theory of the Shunted Condenser," in your issue of April last, with great interest. The general agreement between the experimental observations and theoretical calculations appears to me to be striking and convincing.

As regards "The 'Law' of the Shunted Condenser," however (Part III, page 10, etc.), I think, without wishing in any way to challenge the conclusions arrived at, that it may be of interest to supplement the useful information the writer has given. It seemed to me, after reading the article, that the following question naturally arises:—Seeing that the supposed "law," if there be a law, has not the meaning which is usually associated with the shunted condenser when the relation  $L=CR^2$  obtains, what pre-

cisely happens when this relation exists?—After some investigation I arrived at certain conclusions, and as these throw light on an old Post Office practice, they may interest your readers, and I therefore give them.

In the first place I find it convenient to reproduce Mr. Morice's equation (2) and to call it (1), viz. :—

$$i = \frac{V}{R + R_1} \left\{ 1 + e^{-at} \left[ \frac{(R + R_1) - L(\alpha + \beta)}{2L\beta} e^{+\beta t} - \frac{(R + R_1) - L(\alpha - \beta)}{2L\beta} e^{-\beta t} \right] \right\} \dots\dots\dots(1)$$

It will suffice for my purpose to consider the case in which  $\beta$  is imaginary, in which case this symbol may be prefixed by the root of  $-1$  or  $\sqrt{-1} = j$ .  $\beta$  then becomes  $j\beta$  and (1) may be written

$$i = \frac{V}{R + R_1} \left[ 1 - e^{-at} \left( \cos \beta t + \left\{ \frac{\alpha}{\beta} - \frac{R + R_1}{L\beta} \right\} \sin \beta t \right) \right] \dots\dots\dots(2)$$

GENERAL.

The angle  $\beta t$  indicates that in  $t$  seconds this angle has revolved through  $\beta t$  radians, and when  $\beta t = 2\pi$ , the angle has revolved through one complete period. In that case  $\beta = \frac{2\pi}{t}$ . Also by a well known relation  $\frac{1}{T} = f$  and therefore  $\beta = 2\pi f$ . Thus, according to the magnitude of  $\beta$  the transient signal has a periodicity  $\beta = 2\pi f$ .

Now the attenuation or damping constant  $a$ , and the angle  $\beta$  are of such dimensions for telegraph signals such as we are considering, that the transient part of the signal is often practically extinguished by the time the angle  $\beta t$  has revolved through  $\pi$  radians (half a period), and always in less than one period.

In such a case it will be seen, on examination, that the slow periodicity of the transient part of the telegraph signal may be utilised to secure the rapid rise, and even the temporary reinforcement of that signal, by variations of the Sine and Cosine of the angle  $\beta t$ , which may be positive or negative.

EXAMINATION OF EQUATION (2).

In order to properly appreciate the results obtained when  $L = CR^2$  it is desirable to first make a brief analysis of equation (2). Three cases may with advantage be considered.

Let the variable part of (2) be written separately and called  $i$ , thus

$$i_1 = e^{-at} \left[ \cos \beta t + \left( \frac{\alpha}{\beta} - \frac{R + R_1}{L\beta} \right) \sin \beta t \right] \dots\dots\dots(2a)$$

Case (1).  $\beta = 0$ . In this case  $\cos 0 = 1$ .  $\sin 0 = 0$  and  $\therefore$  (2a) reduces to

$$i_2 = e^{-at} \dots\dots\dots(2b)$$

In this case the extinction of the transient signal  $i_2$  depends on the magnitude of the attenuation constant  $a$ . This case corresponds to Mr. Morice's example in Table II of the article in question, in which the capacity is 1.483 mf.

Case (2). In (2a) let  $\frac{\alpha}{\beta} = \frac{R + R_1}{L\beta}$ , then (2a) reduces to

$$i_3 = e^{-at} \cos \beta t \dots\dots\dots(2c)$$

$$\text{Also } L = (RR_1 + 2R^2)C \dots\dots\dots(2d)$$

In this case the variations of  $\cos \beta$  between  $\beta t = 0$  and  $\beta t = \pi$  result in an increased rate of rise of the telegraph signal as compared with (2a). If we take the same constants as those used in the article, viz.,  $R_1 = 300$  ohms,  $R = 700$  ohms,  $L = 3.5$  henrys, it is found that the capacity required to satisfy (2d) is 2.94 mf. and it will be further found that the example in Table II, where the capacity is 3 mf., may be approximated to by formula (2c).

Case (3). In (2a) let  $\left( \frac{\alpha}{\beta} - \frac{R + R_1}{L\beta} \right) = -A$ , i.e., let the

quantity in the brackets be negative and call it  $-A$ , assuming that such a coefficient is practicable. Then (2) becomes

$$i_4 = e^{-at} (\cos \beta t - A \sin \beta t) \dots\dots\dots(2e)$$

With this form of equation—other things being equal—the rate of rise of the telegraph signal becomes more and more rapid as  $A$  increases in value. In Mr. Morice's table (2) the two examples having a capacity exceeding 3 mf. are examples which may be calculated by this equation. In the case of the example where 10 mf. capacity is utilised the coefficient  $-A = -1$  approximately. With the constants used this is a coefficient very favourable for rapid rise and temporary reinforcement of the telegraph signal.

There is in reality a fourth case where  $A$  is positive; but it presents no advantage for our purpose, and is neglected.

*Summary of the Analysis of (2a).*

It is possible to choose and arrange the constants of the shunted condenser and relay under (3) heads. In order to obtain a rapid rise and temporary reinforcement of the signals, arrangement No. (3) (equation (2e)) is the most advantageous.

WHEN  $L = CR^2$ .

When  $L = CR^2$  the resulting equation is of the form (2e), Case (3), and is favourable to rapid rise of the telegraph signals.

Let  $L = CR^2$  and substitute this value of  $L$  in (2a). In that case  $\left(\frac{\alpha}{\beta} - \frac{R+R_1}{L\beta}\right)$  becomes  $\frac{\alpha}{\beta} - \frac{R+R_1}{\beta CR^2} = \frac{\alpha}{\beta} - \frac{1}{\beta}$

$$\left(\frac{1}{CR} + \frac{R_1}{CR^2}\right) = \frac{\alpha}{\beta} - \frac{1}{\beta} \left(\frac{1}{CR} + \frac{R_1}{L}\right) = \frac{\alpha}{\beta} - \frac{1}{\beta} \quad \left\{ \frac{1}{2} \right.$$

$$\left(\frac{1}{CR} + \frac{R_1}{L}\right) = \frac{\alpha}{\beta} - \frac{2\alpha}{\beta} = -\frac{\alpha}{\beta} \quad \text{Equation (2a) then becomes}$$

$$i_5 = e^{-\alpha t} (\cos \beta t - \frac{\alpha}{\beta} \sin \beta t) \dots\dots\dots(2f)$$

For values of  $R$  between 300 ohms and 1000 ohms the value of  $-\frac{\alpha}{\beta}$  varies between  $-0.7$  and  $-1$ . These figures are selected as giving a sufficiently wide range of variation of the resistance shunting the condenser in connection with the Post Office Standard "B" relay. If, however, the range of  $R$  is extended beyond 1000 ohms the further change in  $-\frac{\alpha}{\beta}$  is only small. As

an example of (2f), take again the case where  $L=3.5$  henrys,  $R_1=300$  ohms and  $R=700$  ohms. Then for  $L=CR^2$  we have  $C=7.14$  mf. In that case (2f) becomes

$$i_5 = e^{-1.13t} (\cos 1.91t - 0.745 \sin 1.91t).$$

It is evident that when  $\cos 1.91t = 0.745 \sin 1.91t$  (2f) becomes  $e^{-1.13t} \times 0 = 0$ , and (2) becomes  $i = \frac{V}{R+R_1}$  which is the value of the current for the permanent signal, and this value will be attained in a little less than 0.005 second. The current will afterwards be reinforced and temporarily rise above its normal value in an analogous manner to some of the curves in Fig. V of the article in question.

A remarkable case occurs when  $L=CR_1^2$  and  $R=R_1$  for then  $\alpha = \frac{1}{CR}$   $\beta = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{C^2R^2}}$  (Since  $L=CR^2$ )  $= \frac{1}{CR}$ , so that  $\alpha = \beta$  and (2f) becomes

$$i_5 = e^{-\alpha t} (\cos \beta t - \sin \beta t).$$

Now since  $\beta = \frac{1}{\sqrt{CL}}$ , those familiar with this type of equation will recognise that  $\beta = \frac{1}{\sqrt{CL}}$  indicates that the circuit oscillates at the resonance frequency which would occur if there were neither

NOTES AND COMMENTS.

resistance nor leakance in it, although in fact there are both. A relatively low impedance is also indicated. Although the form of the equation indicates a rapid rise of current the equation is not suitable for the required purpose, because the limitation  $R=R_1$  results in a relatively small value of  $\alpha$  and  $\beta$ , which is not the best arrangement for the shunted condenser in connection with the Standard Relay B. The capacity required would also be relatively high. It may be worth noting, however, that the attenuation constant obtained in this case is exactly the same as if neither resistance  $R$  nor capacity  $C$  had been added to the relay circuit. The great advantage in this case (when  $L=CR_1^2$ ) is that an additional powerful effect is obtained from the factor  $\cos \beta t - \sin \beta t$ , in addition to the effect of formula (2b).

Further, in the general case when  $L=CR^2$  the attenuation constant  $\alpha$  varies directly as  $R+R_1$ , for

$$\alpha = \frac{1}{2} \left( \frac{R_1}{L} + \frac{1}{CR} \right) = \frac{1}{2} \left( \frac{R_1}{L} + \frac{R}{CR^2} \right) = \frac{1}{2} \left( \frac{R+R_1}{L} \right)$$

I have assumed throughout, as indicated by Mr. Morice's experiments, that notwithstanding variations of impedance calculations of the type here made give a useful indication of the results to be expected.

*Conclusion.*

When the relation  $L=CR^2$  exists in connection with the shunted condenser arrangement here considered, the conditions are generally favourable for a rapid rise and a temporary reinforcement of the permanent telegraph signal. It does not, however, necessarily follow that this arrangement is the best. Each case should be considered on its merits.

As a rule for application in the absence of more detailed information the relation  $L=CR^2$  may be made very useful if the capacity used is not great (the highest capacity used in the experiments would be well within the permissible limit).

Finally, I may say that this study is not intended to be exhaustive; for example, it is possible to give rules for the best type of signal from permissible constants, but in order to do this it would be necessary for me to have reference to data referring to the transient voltage in the shunted condenser, which I published some time ago. As I am, however, at the moment, far from my sources of information, this must be left.

Yours faithfully,

J. G. HILL.

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MEGA- AND MICRO-.

The mega-volt and the micro-volt may be regarded as appropriate symbols for the two important Conferences which are about

## HEADQUARTERS NOTES.

to take place in Paris, as we go to Press. Big-power is represented by the "International Conference on the extension of High Tension Power Systems," which meets on Tuesday, the 15th June, and little-power by the next Session of the famous "Comité Consultatif Internationale des Communication Telephonique a Grande Distance," which follows a week later. The two Conferences cannot be regarded as entirely independent, so important has the question of interference with telephone service by big-power now become. The danger to life and hearing is not confined to direct contact between the big and little-power conductors, for very appreciable voltages have been picked up inductively by telephone wires. The British Post Office representative at the big-power Conference is S. C. Bartholomew, whose work on the subjects of *interference and protection* are so well known. Mr. Bartholomew attends in the dual capacity of representing the Post Office and the Institution of Electrical Engineers in Paris and it will no doubt be recollected that Mr. Bartholomew's recent paper before the I.E.E. on "Interference" earned the Institution's Webber Award for 1924-5. Both Conferences are discussing *directives* (guiding principles on the subject drawn up by the Comité Consultatif and *big-power* will be represented at *little-power's* Conference.

## HEADQUARTERS NOTES.

### EXCHANGE DEVELOPMENTS.

The following works have been completed :—

Exchange.	Type.	No. of Lines.
Kirkcaldy ... ..	Auto	680
Leeds (Modifications) ...	"	—
Risca ... ..	"	54
Bristol Extension ...	Manual	80
Cheetham Hill Extension..	"	440
Clissold Extension ...	"	1500
Edgbaston Extension ...	"	1060
Enfield New ... ..	"	1800
Higher Broughton New...	"	1320
London Toll Extension ...	"	—
Mill Hill New ... ..	"	600
Northampton Extension ...	"	1040
Tilbury New ... ..	"	666
Weston-super-Mare New...	"	870
Booth & Co. ... ..	P.A.B.X.	40
Cardiff Union ... ..	"	50
Coopers Stores, Glasgow...	"	80
Dunlops Extension ...	"	100
Lovell & Christmas ...	"	40
Scottish Auto Assn. ...	"	50
Willis Faber Extension ...	"	10

## LONDON DISTRICT NOTES.

Orders have been placed for the following New Exchanges :—

Exchange.	Type.	No. of Lines.
Bedford ... ..	Auto	1450
Coventry ... ..	"	3100
Morningside, Edinburgh...	"	2335
Murrayfield, Edinburgh ...	"	1605
Newington, " ... ..	"	1980
Camberley ... ..	Manual	720
Gravesend ... ..	"	1240
Slough ... ..	"	540
Balfour, Ltd. ... ..	P.A.B.X.	30
Birmingham Maternity Hospital ... ..	"	20
Co-op. Wholesale Society..	"	160
Crosse & Blackwell ... ..	"	180
Langs Bread ... ..	"	30
London Express Newspaper	"	120
Shell-Mex, Ipswich ... ..	"	25
Wallpaper Manufacturers..	"	30

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

Exchange.	Type.	No. of Lines.
Stanningley ... ..	Auto	260
Stockport ... ..	"	880
Swansea ... ..	"	440
Barnsley ... ..	Manual	300
Chester ... ..	"	460
Clissold ... ..	"	2700
Ravensbourne ... ..	"	1200
Rossendale ... ..	"	320
Rusholme ... ..	"	500

### TELEPHONE REPEATER STATIONS.

The installations of the following Repeater Stations have been completed by the Contractors :—

Fenny Stratford (Permanent), Derby (Permanent) and Aldeburgh.

We hope to be able to give a complete detailed description of a typical telephone repeater station in our next issue.

## LONDON DISTRICT NOTES.

### MILEAGE STATISTICS.

DURING the three months ended 31st March, 1925, the following changes have occurred :—

*Telegraphs.*—Nett decrease in open wire of 135 miles and a nett increase in underground of 131 miles.

*Telephone (Exchange).*—Nett increases in open wire and

LONDON DISTRICT NOTES.

underground of 277 miles and 17,409 miles respectively, and a nett decrease in aerial cable of 882 miles.

*Telephone (Trunks).*—Nett increases of 6 miles and 1,666 miles in open wire and underground respectively.

*Pole Line.*—Nett increase of 94 miles, bringing the total to date to 5,078 miles.

*Pipe Line.*—Nett increase of 147 miles, making the total to date 5,904 miles.

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

Telegraphs	...	...	...	...	23,866
Telephone (Exchange)	...	...	...	...	1,573,001
Telephone (Trunks)	...	...	...	...	53,325
Spares	...	...	...	...	49,915

EXTERNAL CONSTRUCTION.

Exchange Lines and Extensions provided and recovered during the quarter ended 31st March, 1925 :—

	Exchange Lines.	Internal Extensions.	External Extensions.
Provided	9,728	7,261	1,006
Recovered	2,841	2,979	582
	<u>6,887</u>	<u>4,282</u>	<u>424</u>

INTERNAL CONSTRUCTION.

*New Exchanges.*—New Manual Exchanges have been opened at Malden (C.B.10. 700 lines), Palmers Green (C.B.1. 2200 lines), Mill Hill (C.B.1. 600 lines) and Tilbury (C.B.10. 700 lines). The construction of new Manual Exchanges at Enfield, Albert Docks and Sloane (temporary) is nearing completion.

*Exchange Extensions.*—Extensions of Exchange equipment are in progress at over 50 of the Exchanges in the London Engineering District.

*P.A.B.X.'s.*—The Private Automatic Branch Exchanges which are being installed under contract by Messrs. Siemens Brothers for the Port of London Authority at the various Docks are nearing completion, and it is anticipated that the installation will be brought into commission during July. The P.A.B.X. for the Prudential Assurance Company has been completed.

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MR. JOSEPH HENRY STANHOPE.

MR. J. H. STANHOPE, Assistant Superintending Engineer, London Engineering District, terminated his service with the



## LONDON DISTRICT NOTES.

Department on 30th April, 1925, after completing 44½ years' service in the Post Office, of which 29 years were spent in the Engineering Department.

Mr. Stanhope entered the Service at Leeds in 1880. He grew to be a man of exceptional physical strength and great energy. It was his habit to walk the nine miles to and from his place of duty at whatever hour his duty began and terminated. He was always jovial, good natured, and under his somewhat bluff exterior a most sympathetic and kindly man. Many officers in the Engineering Department will miss his cheerful personality and his very ready and valuable advice.

At the transfer of the Telephone Trunks to the Department, Mr. Stanhope was one of the officers selected for the work of fitting up Exchanges and he dealt with the equipment at many places in the North of England. In 1896 he was appointed Sub-Engineer in the Leeds Section. In 1898, he was promoted to 2nd Class Engineer at Headquarters, and in 1901, he became a First Class Engineer in charge of the Bradford Section. He was transferred to London in 1903 as First Class Engineer in charge of the Central Exchange and the Trunk Exchange at the G.P.O. South, where he remained until 1909, when he was promoted to be Assistant Superintending Engineer in the South Metropolitan District. In 1906 Mr. Stanhope was commended by the Postmaster-General in connection with the transfer of the City and Central Exchanges and again in 1908 he received the commendation of the Secretary and the Engineer-in-Chief for the successful manner in which the work in connection with the Knighttrider Street extension of the Central Exchange was carried through. On the amalgamation of the Metropolitan Districts at the end of September, 1912, he became an Assistant Superintending Engineer in the London Engineering District. When Mr. Stanhope came to the District the number of faults per station per annum was 3.52. In the fault returns for April, 1925, the number was .93. This marked improvement is a glowing testimony to the energy displayed by him in his duties as Assistant Superintending Engineer in charge of Internal and External Maintenance.

As a token of the respect in which he is held, Mr. Stanhope was presented on the day of his retirement with a gold watch, suitably inscribed, and a pair of Goerz binoculars, together with a gold brooch for his mother, with whom he resides. The presentation was made at Denman Street by Mr. R. McIlroy, Superintending Engineer, in a very human and kindly manner, before a large and representative gathering. Many expressions of good feeling were forthcoming on all hands, among the speakers being Mr. Alex. Moir (late Superintending Engineer). Several humorous references were made to Mr. Stanhope's characteristic

mode of expression, and a cheerful note, which was specially welcome, accompanied the proceedings throughout.

Mr. Stanhope's many friends will learn with interest that he has taken up the position of Engineer of the Jersey States Telephones. His success in this position will be assured if he exerts anything approaching the energy he has displayed during his service with the Post Office.

All his colleagues wish him good health and happiness in his new sphere.

R.A.W.

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## THE INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS.

### ANNUAL MEETING.

THE Nineteenth Annual Meeting of the Institution was held at the Institution of Electrical Engineers, London, on the 12th May, the President, Colonel T. F. Purves, in the Chair.

The Annual Report of the Council was presented by the Assistant Secretary and was approved by the meeting on the motion of Mr. S. C. Bartholomew, seconded by Capt. J. G. Hines.

The financial statements for the year were presented by the Treasurer, Mr. E. H. Shaughnessy, and were adopted on the motion of Major H. Brown, seconded by Mr. A. O. Gibbon.

Colonel Purves then presented the following medals awarded for the Session 1923/24 :—

*Senior Silver Medal* to Capt. J. G. Hines for his paper on "Some considerations affecting the Lay-out of Telephone Plant in a Multi-Exchange Area."

*Junior Silver Medals* to Messrs. A. J. Pratt and G. H. A. Wildgoose for their joint paper on "The Economical Provision of Plant for Telephone Development."

A hearty vote of thanks, proposed by Mr. A. L. DeLattre, Vice-President, and seconded by Mr. A. J. W. Dauncey, was accorded to the retiring members of Council—Messrs. E. H. Shaughnessy, E. J. Wilby, W. H. Cresswell and R. Towers—for their services during the past three years.

The Council and Officers for the year 1925-6 are as follows :—  
Chairman—Mr. A. L. DeLattre.

Representing Staff of the Engineer-in-Chief's Office :—

Mr. J. W. Atkinson and Mr. G. F. O'dell.

„ Executive Engineers—

London : Mr. A. Wright.

Provinces : Mr. F. W. Best.

THE INSTITUTION OF P.O. ELECTRICAL ENGINEERS.



THE INSTITUTION MEDALISTS FOR SESSION 1923-4.

*Senior Silver Medal* : Captain J. G. Hines (top).

*Junior Silver Medal* : Messrs. A. J. Pratt (right) and G. H. A. Wildgoose.

(Mr. Wildgoose's photo is by Guttenberg, Manchester.)

THE INSTITUTION OF P.O. ELECTRICAL ENGINEERS.

- Representing Assistant and Second Class Engineers—  
London : Mr. W. Dolton.  
Provinces : Mr. C. E. Morgan.
- „ Chief Inspectors :  
London : Mr. W. A. Romain.  
Provinces : Mr. A. S. Carr.
- „ Clerical Staff—  
London : Mr. E. H. M. Slattery.  
Provinces : Mr. T. E. Cramp and Mr.  
A. J. W. Dauncey.
- „ Inspectors—  
London : Mr. C. W. Messenger.  
Provinces : Mr. R. P. Collins.
- „ Draughtsmen—  
London and Provinces : Mr. H. J. Millett.
- Honorary Treasurer—Mr. B. O. Anson.  
Secretary—Mr. R. V. Hansford.

COUNCIL NOTES.

The last meeting of the Council for the year 1924-25 was held in London on the 12th May.

The Council approved the Report of the Judges for the recent Essay Competition and the following is the order of the prize winners :—

1. F. J. Gibbs, Repeater Station, Marlborough.  
“Telephone Repeaters in Practice.”
2. S. H. Johnson, External Section, Birmingham.  
“Fault Locating in Local Underground Cables.”
3. A. F. Strudwick, Tunbridge Wells.  
“Small Matters that need Reform in the P.O.E.D.”
4. H. S. Twort, Tunbridge Wells.  
“Making a Local Development Survey.”
5. H. C. A. Linck, Internal Section, Cardiff.  
“The Extension of Large Multiples.”

The Council authorised the printing of the following paper :—  
“Siemens No. 16 Automatic Telephony Equipment,” by  
C. W. Brown (E.-in-C.O.).

The Council received and approved the annual reports of the various Committees of Council and passed the Annual Report of the Council.

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The first meeting of the Council for the year 1925-6 was held in London on the 12th May, 1925.

The Council elected the Committees of Council and re-appointed the officers for the ensuing year.

## LOCAL CENTRE NOTES.

The Council discussed the proposed activities of the Institution for the ensuing session and, *inter alia*, decided to hold another Essay Competition for Workmen.

The probable financial results of the year's working were discussed, and an estimate of the revenue and expenditure for the year was approved.

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## LOCAL CENTRE NOTES.

### LONDON CENTRE.

#### SESSION 1924-25—SECOND HALF.

Arrangements were made with the General Electric Co. for a visit to their Osram Lamp Works at Brook Green, Hammersmith. The number of members wishing to visit the works was so large that the Company kindly offered seven afternoons, taking a party of 32 on each occasion. The visit was much enjoyed and the Committee would like to take the opportunity of thanking the Managing Director and his staff for the personal interest taken in the matter.

On 13th January, 1925, Mr. J. S. Brown, M.I.E.E., read a paper on "Submarine Cable Work in Tidal Waters." An abstract of the paper appears in the April, 1925, number of this Journal.

On 10th February, 1925, Mr. W. S. Mountain gave a lecture on "Contracts." A synopsis of the lecture is given under the Northern Centre notes in the January, 1925, number of this Journal.

On 28th April, Mr. J. E. Statters read a paper on "Telephone Transmission." A brief outline of the scope of the paper is given in the South Midland Centre notes in the April, 1925, number of this Journal.

At the conclusion of the Annual General Meeting of the Institution on 10th May, Mr. F. O. Barralet, M.Inst. of Metals, A.M.I.E.E., read a paper on "Some Applications of Optical Methods to the Investigation of Engineering Materials." The author gave a brief description of the microscope and its accessories, the adaptation of the microscope to the examination of metals, and practical examples of its use; the Greenough binocular microscope; the Quartz Spectrograph and its use in qualitative and quantitative analysis, and the specification of colour by means of the method of mono-chromatic analysis and the Nutting calorimeter.

An outstanding feature of the Session just closed was the inauguration of informal meetings. The Committee considered

LOCAL CENTRE NOTES.

that the work of the Institution would be very usefully extended by holding such meetings, one of the principal objects being to encourage the younger members to take part in the discussions. The innovation has met with striking success. The application for short papers, occupying about a quarter of an hour to read, met with a ready response. The subjects selected were as follows :—

<i>Subject.</i>	<i>Date.</i>
(1) " Some aspects of Development Studies " ...	28-10-24
(2) " The duties of Clerk of Works on Telephone Exchange Installations " ... ..	15-11-24
(3) " Automatic Exchanges in Director Areas. Circuit and Operation of the Final Selector for P.B.X. groups, 2—10 lines "	16-12-24
(4) " Wireless. Low Frequency Amplification "	20-1-25
(5) " Fitting Work " ... ..	24-2-25

The average attendance was 52 and the interest shown in the discussions has been most encouraging. Informal meetings will form a definite part of the London programme in future. The expenditure incurred in connection with these meetings was quite small; any travelling expenses were borne by the members.

COMMITTEE FOR SESSION 1925-6.

Chairman : Mr. F. L. Henley.

Vice-Chairman : Mr. J. P. Price.

*Headquarters Representatives :*

Staff Engineers—Mr. P. T. Wood.

Clerical Staff—

Executive Engineers—

Messrs. W. Pennington and E. V. Smart.

Assistant Engineers—

Messrs. W. Dolton and A. J. Sharpley.

Chief Inspectors—

Messrs. J. Prescott and W. A. B. Romain.

Inspectors—

Messrs. W. H. Cresswell and D. C. D. P. Maddocks.

Draughtsmen—

Mr. H. Taylour.

London Clerical Staff—

Messrs. E. T. Larner and E. H. M. Slattery.

*South Eastern District—*

Engineering Staff—Mr. W. J. Jenkins.

Clerical Staff—Mr. P. J. Dodgson.

R.T.R.

## LOCAL CENTRE NOTES.

### SCOTLAND WEST CENTRE.

The final meeting for Session 1924-25 was held in the Royal Technical College, Glasgow, on 27th April, Capt. Crompton presiding.

After disposal of the business, appropriate to the Annual General Meeting, Mr. T. Bell delivered his lecture on "Cable Balancing" which was held over from January meeting.

At the outset the lecturer explained the necessity for cable balancing, and then explained the various steps taken in making the tests. Slides were shown illustrating the apparatus, cables, layout of plant, and schedules used in recording the results of the tests made preparatory to jointing. Interest was sustained throughout the lecture, and a very good discussion followed. The answers to questions were fully dealt with, and they provided further useful information on the subject.

### SCOTLAND EAST CENTRE.

#### SESSION 1924-25.

The opening meeting of the Session was held at Edinburgh on the 19th November. A lecture on "Contracts" was delivered by Mr. W. S. Mountain, of the Engineer-in-Chief's Office. The subject was dealt with in a masterly manner and was followed by a most useful discussion.

The Lecturer's humorous vein enlivened the proceedings and eventually aroused the local wit, whose seidnitz powder fiz was irresistibly funny.

A hearty vote of thanks was accorded the lecturer for his very interesting, authoritative and informative lecture.

The second lecture which had been arranged had unfortunately to be postponed to another Session owing to the prolonged illness of the lecturer.

The third item on the programme was a paper entitled "Siemens No. 16 Automatic Telephone Equipment," by Mr. C. W. Brown, of the Telephone Section, Engineer-in-Chief's Office. The paper was illustrated by lantern slides and had been specially written for the Scotland East District. The subject was dealt with under the following heads:—

- (1) Some features of the Switches and Banks.
- (2) Messrs. Siemens Bros. diagram scheme and conventions used.
- (3) The tones employed.
- (4) Elements of the Main Circuits.
- (5) Satellite Exchange arrangements.

## LOCAL CENTRE NOTES.

- (6) Testing and Trunk offering switches.
- (7) Auxiliary signals and alarms, etc.

Messrs. Siemens Bros. & Company very kindly loaned a full working model, which was on exhibition at Wembley, and Mr. Long, of their Woolwich Staff came specially down to Edinburgh in connection with the lecture. His excellent demonstration was thoroughly enjoyed.

The discussion was opened by Mr. F. G. Milne, Secretary to the Post Office for Scotland, who expressed his pleasure at being present at the meeting, and spoke in eulogistic terms of the work of the Engineering Department.

Various points of interest were raised by other speakers and fully explained by Mr. Brown.

Mr. D. MacLachlan, in his inimitable way, moved a very hearty vote of thanks—

(1st) To Mr. Brown for his exceedingly interesting and instructive lecture, which had aroused the keenest interest and was rendered more valuable by the fact that the system was shortly to be installed at Edinburgh.

(2nd) To Mr. Long for his excellent demonstration.

(3rd) To Messrs. Siemens Bros, and Company for placing at the disposal of the Centre the Model Automatic Equipment and also the services of Mr. Long, at very considerable expense to themselves. Messrs. Siemens Bros. had also agreed to the continued loan of the demonstration equipment for educational purposes.

The audience included members of other Government Departments and outside Technical Bodies, and was the largest since the inception of the Institution.

Owing to the illness of Mr. J. E. Statters, after his arrival at Edinburgh, the arrangements made for his lecture on "Telephone Transmission" had perforce to be cancelled. The members had been eagerly looking forward to a lecture on this important subject, and it was with very great regret that they learned of Mr. Statters's indisposition.

The lecture, "Some Notes on the Edinburgh-Newcastle Main Underground Work," by Messrs. G. Innes, P. G. Martin and J. Gilbert, has also unavoidably been cancelled, Mr. Martin having been for some time in England undergoing a special course of training, and Mr. J. Gilbert, since his transfer to Edinburgh, had been fully occupied in connection with the extensive alterations at the Central Telephone Exchange. They had, therefore, been unable to devote the necessary time to the preparation of the papers.



## LOCAL CENTRE NOTES.

The concluding meeting of the Session was held on 28th April, when Mr. J. W. Jarvis read a paper on "Main Cable Testing." The subject is one of especial interest at the present time and a vast amount of information was imparted by the lecturer in the time at his disposal. The various points dealt with were illustrated by an excellent series of lantern slides. A useful discussion followed, and the lecturer was complimented on the masterly manner in which he had dealt with the subject. A hearty vote of thanks was carried with acclamation.

## NORTH WALES CENTRE.

The last meeting of the 1924-5 Session took place on 10th March, 1925, when "Transmission Efficiency of Telephone Circuits—External Plant" was dealt with by Messrs. W. C. Burbridge, A.M.I.E.E., and E. A. Pearson, A.M.I.E.E. Mr. T. Plummer, M.I.E.E., occupied the chair.

Mr. Pearson in introducing the subject dealt with line transmission and traffic circulation and the types of circuits required between (a) small exchanges and group centres; (b) group centres and zone centres, and (c) between different zone centres. He laid special emphasis upon the importance of avoiding even very short lengths of low gauge underground in zone centre circuits.

Mr. Burbridge's contribution dealt more specifically with the design of junction cables, and the difficulties met with in forecasting conductor requirements at the estimate stage in view of the unforeseen factors which frequently altered the whole aspect of a case.

An admirable discussion drew many interesting points, which were replied to by the lecturers.

The Session has been a most successful one both in the attendances at the meetings and in the quality of the papers presented, and it is satisfactory to know that a complete programme has already been arranged for the coming Session. The membership has been increased to 156, which represents 90% of the eligible number.

It is perhaps worthy of note in commenting on the progress of the Centre that the Chairman, Mr. T. Plummer, M.I.E.E., has only been absent from the Centre meetings on two occasions since he became Chairman in 1910.

It is pleasing to the members of the Centre to observe that the District was represented in the list of prize winners in the essay competition for workmen arranged by the Council, Mr. S. H. Johnson, of the Birmingham External Section, being successful with an essay on "Fault Locating in Local Underground Cables."

LOCAL CENTRE NOTES.

SOUTH MIDLAND CENTRE.

The concluding lecture of last Session, entitled "Aids to Efficiency," was given by Mr. W. Atkins, A.M.I.E.E., on the 25th March. The Lecturer stated that every worker, irrespective of his grade, had abundant opportunities for striving for maximum efficiency, and he considered that that desideratum is obtainable by the possession of a retentive memory, a sense of order and method, and an appreciation of perspective.

He enlarged upon the value of a good memory and explained how that gift could be improved by exercise. Muddle was condemned and a few useful general tips for ensuring order and method were described. The systematizing of correspondence was stressed and the filing arrangements adopted by the author were explained in some detail.

The importance of precision in correspondence was enlarged upon and the ludicrousness of the literal meaning of some amusing examples of loosely worded notices which are commonly displayed was greeted with laughter.

Mr. Atkins advocated the adoption of the key-coding system for correspondence emanating from larger offices, which arrangement, he claimed, would reduce delay.

The lecture concluded with a plea for broad-mindedness, initiative and courage and convincing illustrations were given of undesirable results obtained when these qualities were lacking or deficient.

Messrs. Peck, C. L. Perkins, Lines, Harris, J. S. Brown and the Chairman in turn expressed gratitude to the Lecturer for a paper which had shown them how to reduce their official cares, and Mr. Atkins replied to the questions asked.

The Chairman thanked Mr. Atkins for his paper, and the meeting concluded with the endorsing applause of the audience.

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There was an average attendance of 58 at the six meetings of this Centre held last winter in the University College, Reading.

The Local Committee are pleased to announce that at the end of June there had already been a 30 per cent. increase in membership since the end of the 1924-5 Session and that a full and interesting programme for next Session has now been arranged.

A.W.L.

THOMAS PATTERSON.

## THOMAS PATTERSON.

THE Post Office Engineering Department has suffered a severe loss by the death of Mr. T. Patterson, Executive Engineer, London District, which took place on the 8th June. He had suffered from gastric trouble for some years, and although, latterly, it was realised that he was seriously ill, the end came with unexpected suddenness. He was 55 years of age.

Mr. Patterson entered the Post Office service in 1887 and served successively as Sorting Clerk and Telegraphist; Junior Clerk, Engineering Department; Sub-Engineer; 2nd Class



MR. THOMAS PATTERSON.

Engineer; Assistant Engineer; and Executive Engineer. He was a man of generous impulse and wide sympathies, which were readily translated into practical expression when the occasion arose. The magnetism of his personality gained him a large circle of friends, which extended much beyond the confines of the Engineering Department. His geniality and goodwill were infectious—he radiated friendliness.

Apart from his attractive personal qualities, which alone would have sufficed to keep him in grateful memory, Patterson will be

THOMAS PATTERSON.

remembered as one of those who took a prominent part in the movement which resulted in the introduction of Whitleyism into the Civil Service, and the establishment of a separate Whitley Council for the Post Office Engineering Department. The report of the Government Committee presided over by Mr. Whitley, issued in the closing months of the war, stirred his imagination and fired his enthusiasm. Its appeal to representative men "with pride in their calling" to come together and apply themselves to promoting harmony and efficiency was like a clarion call to him and he threw himself heart and soul into the struggle to bring about the realisation in the Civil Service of the vision which the Whitley report had inspired. For, be it remembered, the Government of the day had no intention of applying the Whitley scheme to the Civil Service, and they gave way only after an intense campaign had demonstrated that the whole of the Civil Service was united in its desire to test the merits of the new scheme. Patterson was at this time Chairman of the Executive Committee of the Society of Post Office Engineers and he took a large part in the further struggle to gain recognition for the Engineering Department as a separate unit for Whitley purposes. When this had been successful he became the first Chairman of the Staff Side of the Engineering Departmental Whitley Council, an office which he held for two years. Perhaps his most important work during that period was his participation in the framing of the present recruitment scheme for the Post Office Engineering Department.

Patterson was an able member of his profession. To the tasks which confront the Sectional Engineer of to-day he applied himself with a characteristic zeal which was an inspiration to his staff. In the fateful days of the war he had to meet the exacting requirements in connection with the installation and maintenance of defence and other emergency communications (*e.g.*, those required between searchlight and gun stations in the sector of the London defences controlled by him), and subsequently he had taken his part in the solution of the general problem of how to meet the situation arising from the introduction of automatic telephones and the rapidly expanding development of the Service. In particular, he had a high conception of what was required of a Sectional Engineer in his dealings with the public: he stood for the principle of providing the very best service that could be given and no complaint ever came to his notice which was not treated from the standpoint that investigation might reveal a weakness in some part of the system which was impairing its efficiency.

G.B.

## BOOK REVIEWS.

### MR. HENRY FORD'S INDUSTRIAL PHILOSOPHY.

The last hundred years has seen this country and others transformed by what is termed industrialism and we have reached a period when all the methods by which industry has been carried on are being challenged.

The relative merits of the private business, the joint stock company and the State industry are discussed and yet economic theories are heard on every platform and published in all sections of the press.

This being the atmosphere surrounding our activities it is well for us at times to detach ourselves from our theoretical studies and seek a perspective which will enable us also to view the human and practical difficulties which beset us in every sphere of our commercial life.

The reading of Mr. Henry Ford's book " My Life and Work " is a valuable aid in enabling us to focus our attention on these problems in the light of the experience of one whose methods of business are being discussed the world over.

It may be urged that Motor Cars are not Telephones, and that Tractors are not Telegraphs, and that Post Office engineering, comprising as it does a widely scattered staff with an extensive administrative area, cannot be compared with centralised manufacturing plants such as that controlled by Mr. Ford. Whilst this may be true in many respects, it will be admitted, I think, that the views of any successful administrator regarding human tendencies and relationships as he sees them can usually be considered with profit.

Mr. Ford endeavours to upset many preconceived notions bearing on the conduct of business and time will show to what extent his philosophy is accepted.

Dealing with administration he says:—

“ That which one has to fight hardest against in bringing together a large number of people to do work, is excess organisation and consequent red tape. To my mind there is no bent of mind more dangerous than that which is sometimes described as the 'genius for organisation.' This usually results in the birth of a great big chart, showing after the fashion of a family tree how authority ramifies. The tree is heavy with nice round berries, each of which bears the name of a man or of an office. Every man has a title and certain duties which are strictly limited by the circumference of his being.

“ If a straw boss wants to say something to the general superintendent his message has to go through the sub-

## BOOK REVIEWS.

foreman, the foreman, the department head, and all the assistant superintendents before, in the course of time, it reaches the general superintendent. It is passed to and fro and all responsibility is dodged by individuals—following the lazy notion that two heads are better than one.”

It may shock some people to learn that

“ It is not necessary to have meetings to establish good feeling between individuals or departments. It is not necessary for people to love each other in order to work together. Too much fellowship may indeed be a very bad thing, for it may lead to one man trying to cover up the faults of another. That is bad for both men.”

Much has been done in recent years to reduce the number of titles in the Civil Service. It has undoubtedly added to the mobility of the staff, and in many ways led to more efficient and economical administration. It is, however, doubtful whether the advocates of reduction in or out of the Service would be prepared to endorse all that Mr. Ford has to say on this interesting subject.

“ The effect of a title is very peculiar. It has been used too much as a sign of emancipation from work. It is almost equivalent to a badge bearing the legend :

“ ‘ This man has nothing to do but regard himself as important and all others as inferior.’ ”

“ Not only is a title often injurious to the wearer but it has its effect on others as well. There is perhaps no greater single source of personal dissatisfaction among men than the fact that the title-bearers are not always the real leaders. Everybody acknowledges a real leader—a man who is fit to plan and command. And when you find a real leader who bears a title you will have to enquire of someone else what his title is. He doesn't boast about it.

“ Titles in business have been greatly overdone and business has suffered. One of the bad features is the division of responsibility according to titles, which goes so far as to amount to a removal altogether of responsibility. Where responsibility is broken up into many small bits and divided among many departments, each department under its own titular head, who in turn is surrounded by a gang bearing their nice sub-titles, it is difficult to find any one who really feels responsibility.

“ A few titles may be legally necessary ; a few may be useful in directing the public to do business with the concern, but for the rest the best rule is simple, ‘ Get rid of them.’ ”

Consolation will be carried to many readers by the following paragraph :—

“ Every business that is growing is at the same time

creating new places for capable men. It cannot help but do so. This does not mean that new openings come every day and in groups. Not at all. They come only after hard work; it is the fellow who can stand the gaff of routine and still keep himself alive and alert who finally gets into direction. It is not sensational brilliance that one seeks in business, but sound substantial dependability. Big enterprises of necessity move slowly and cautiously. The young man with ambition ought to take a long look ahead and leave an ample margin of time for things to happen."

The tendency to slacken effort after a time and to rest on one's laurels is treated in characteristic fashion, and those who under pressure might admit the impeachment will be interested in Mr. Ford's views.

"I noticed a tendency among many men in business to feel that their lot was hard—they worked against a day when they might retire and live on an income—get out of the strife. Life to them was a battle to be ended as soon as possible. That was another point I could not understand for, as I reasoned, life is not a battle except with our own tendency to sag with the downfall of 'getting settled.' If to petrify is success all one has to do is to humour the lazy side of the mind; but if to grow is success then we must wake up anew every morning and keep awake all day.

"Even the man who feels himself 'settled' is not settled—he is probably sagging back. Everything is in flux and was meant to be. Life flows. We may live at the same number of the street, but it is never the same man who lives there.

"It could almost be written down as a formula that when a man has at last found his method he had better begin a most searching examination of himself to see whether some part of his brain has not gone to sleep.

"The man who is too set to change is dead already. The funeral is a mere detail."

As befits a man whose output of motor cars runs into thousands a day he has some pungent remarks to make regarding the purchasing power of the people and the methods of increasing the demand for a commodity.

"If the prices of goods are above the incomes of the people then get the prices down to the incomes.

"Get the costs down by better management. Get the prices down to the buying power. Cutting wages is the easiest and most slovenly way to handle the situation, not to speak of its being an inhuman way.

"It is, in effect, throwing upon labour the incompetency

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of the managers of the business. If we only knew it, every depression is a challenge to every manufacturer to put more brains into his business—to overcome by management what other people try to overcome by wage reduction. To tamper with wages before all else is changed is to evade the real issue. And if the real issue is tackled first, no reduction of wages may be necessary. That has been my experience.”

In several places Mr. Ford shows his disdain for various types of records, and it breaks out again in the following reference to experiments.

“The factory keeps no record of experiments. The foreman and superintendents remember what has been done. If a certain method has formerly been tried and failed somebody will remember it—but I am not particularly anxious for the man to remember what someone else has tried to do in the past, for then we might quickly accumulate far too many things that could not be done. That is one of the troubles with extensive records. If you keep on recording all of your failures you will shortly have a list showing that there is nothing left for you to try—whereas it by no means follows because one man has failed in a certain method that another man will not succeed.

“Then, too, a record of failures—particularly if it is a from trying. We get some of our best results from letting fools rush in where angels fear to tread.”

Space will not permit an expression of opinion on the views contained in this remarkable book, but its perusal is well worth the time of anyone. There is much no doubt with which the reader will disagree, but he will be forced to admit that as far as achievement is concerned Mr. Ford has contributed something in his day and generation.

He has great confidence that the progress of the race is assured and that if true service is individually given “Everything is possible. . . . Faith is the substance of things hoped for, the evidence of things not seen.”

The book is in the Institution Library.

A.J.W.D.

“Der Fernsprechverkehr als Massenerscheinung Mit Starken Schwankungen.” By Dr. G. Rückle and Dr.-Ing. F. Lubberger.

Here at last is a book on telephone traffic, more particularly with reference to automatic exchanges. It has long been a matter for regret that this subject has received such scant attention in the published literature of automatic telephony. It would be possible to criticise the present work from the opposite standpoint, for,



## BOOK REVIEWS.

while there is great need for a book dealing comprehensively with automatic trunking, Dr. Rückle and Dr. Lubberger have confined themselves almost exclusively to the theoretical side of the subject. References to checks on theoretical results by actual traffic observations are meagre and no description is given of the means provided for carrying out trunking work in actual exchanges. While it is perhaps ungracious thus to criticise the scope of the work, it is felt that an extension of that scope would have made the book useful to a wider circle of readers.

On the theoretical side of the subject, however, the book is admirable. The authors are well known as having made notable and original contributions to the subject, but in this work full publicity is given to the contributions of other investigators, including numerous references to the published works of these investigators. It is thus possible from the present volume alone to gain a good idea of the present position of this fascinating subject.

After a few introductory pages, the authors develop the fundamental equations giving the relation between number of switches or circuits occupied and amount of traffic. They then develop the idea of lost traffic and proceed to estimate its amount. The influence on the fundamental equations of certain magnitudes, such as the number of subscribers, is then discussed. In later sections the traffic carried by each individual switch in a group, the effect of abnormal call durations, and other matters are dealt with.

Finally, a method of estimating the traffic capacity of gradings is developed. It is interesting to note that this method is similar to one which was under consideration in this Department some years ago and was actually under test at the time when the present work was being read for review.

It is not surprising to find a few misprints in a work of this nature. Thus the letters used for distinguishing the various curves in Fig. 10 do not agree with those in the text.

The value of the work is materially increased by a good bibliography containing 34 references. Half of these are to various German publications. The 10 English references are all to our own Journal, for the issues of Oct. 1910, April 1915, Jan. and Oct. 1918, Oct. 1920, Jan., April and July 1922, Oct. 1923, Jan. and April 1924. The remaining references are to American, Danish, Dutch, French, and Italian sources.

Even if it is not possible to agree to all the conclusions of the authors there is no doubt that the book goes far to satisfy a need which has long been acute.

G. F. O'DELL.

## BOOK REVIEWS.

“The History of the Telephone in the United Kingdom.”  
By F. G. C. Baldwin. Chapman & Hall, Ltd. £2 2s. 0d. net.

Not only the author, but the publishers are to be congratulated on the production of this book. It contains over 700 pages of most absorbing matter together with nearly 200 excellent illustrations.

There are many of us in the telephone business in Great Britain who are optimistic enough to think that a wave of great development is before us, and although the vicissitudes of the past have had a seriously retarding effect, we think that they were difficulties of policy that have now come to an end and that in this country, as in others, we can now quote as our motto *One Policy, One System, Universal Service*.

As regards Mr. Baldwin's book, we think that it would be difficult to give a more appropriate review than to quote, *in extenso*, the foreword to the volume which is contributed by Mr. F. Gill, Past President of the Institution of Electrical Engineers, and we make no apology for doing so.

Mr. Gill says :—

“Every telephone man, and many others, will feel an immense debt of gratitude to Mr. Baldwin for this fine piece of research into the history of the telephone, primarily in this country, but with many sidelights on similar history in the United States. It must indeed have been no light task which he took up, and while it is likely that in such a multitude of detail there may well be some errors, yet I believe these are few and that a second edition will see them, if they exist, eliminated.

“The history of the telephone is the history of a very important movement; man isolated and by himself is impotent and defenceless—in association with others of his kind, on the contrary, he is capable of much, and a primary condition for this association is communication. First, speech, limited to a few yards distance; then writing, which extended the distance while imposing a call for learning; then printing, with its facility for the increased distribution of communication; later telegraphy by visual signals, then the electric telegraph—virtually writing at a distance; then, from 1876, telephony gradually abolished the distance limitation to speech, so that now it is technically possible to construct telephone circuits over any land distance on the earth, and to operate them between centres of population at prices which people are willing to pay. Telephony has some of the properties both of the letter and of the newspaper; it can be clothed with privacy, given to one individual only, or it can be broadcast to millions simultaneously. Starting on a strictly local basis it spread

## BOOK REVIEWS.

until now it covers the whole country, and, extending still further, is beginning to develop into a system for intimate communication between individuals of different nationalities. The end is inevitable. Each system of any credit will have good communication between all its stations; there will also be good communication between systems—hence any station on such system will be able to have speech with any other, bearing in mind that probably there will always be some stations which are not intended to have a radius of action of more than a very limited extent. But a great deal has yet to be done before this end is achieved as regards Europe, the immediate field. With so many nationalities responsible for the telephone service, the matter is one which has many political aspects, and these, if allowed to have undue influence, may well jeopardise the efficiency of the communication system. The technical men have been ready since the termination of the war; it remains for the business men to arrange an efficient organisation. When that has been effected there can be quick, reliable service given between all the centres of population in Europe desiring it. In the absence of an efficient organisation, a lame, inefficient, second-rate kind of service is all that can be expected; one in which the transmission is poor, the delays in completing connections are very long and many calls cancelled because of the delays; these are all marks of lack of grip in the International service; the price is a secondary matter, the really important things are accuracy, speed and quality. Upon how this organisation is worked out will depend the verdict upon the labours of the Consultative Committee for International Telephony in Europe.

“But comparative telephone history has another aspect which is of interest and indeed of importance. It was a pioneer industry when it started; no one then knew if it would succeed. Would the public take to it? Would they continue to use it? What would be the cost of running it? All these questions and many more were at that time unanswered, and the men who risked their money and time in starting this pioneer business which was to prove of such immense value to mankind, had as backing, only that which they received from their faith; they got none from their country. Readers of this book will learn something, but not all, of the difficult and harassing conditions under which these pioneers worked, and will realise something of the reason for the backwardness of this country in the use of telephone service.

“Some of the history of the telephone in the United Kingdom for the period 1904-1912 has not yet been written,

## BOOK REVIEWS.

perhaps never will be; but it is no reflection upon Mr. Baldwin's book that there should be certain gaps in the history he narrates; these matters were known to few, and death has removed a number of those intimately concerned.

"There is much in this book of great interest, but I think it has, to the student of social history, a value possibly even greater than to the student of telephony."

B.O.A.

"Principles of Transmission in Telephony." By M. P. Weinbach, A.B., B.S. in E.E., A.M. Pp. xiv. × 303. The Macmillan Co. Price 17s. net.

This book is designed as a text-book for students of electrical engineering. It gives a thorough and straightforward development of the theory of telephonic transmission.

The first three chapters give an introduction to the subject and an outline of the mathematical methods employed, including representation of harmonic functions, Fourier analysis, vector operations and hyperbolic functions.

In Chapter 4 are developed the general equations of electric wave propagation along lines. Data are given for a number of types of telephonic circuits and the method of calculating the transmission constants is illustrated in the case of a No. 10 B. & S. aerial line. In this example and throughout the book it is assumed that a voltage of 50 at a frequency of 796 cycles per sec. is applied to the line. Voltages such as this do not occur in practice, especially when applied to a line containing amplifiers, as is assumed later on in the book. It would be preferable to take a more usual value, such as 2 volts, in order to avoid misleading readers who are not familiar with practical telephone work.

Chapters 5, 6, 7 and 8 deal with the application of the theory to special cases, viz., infinitely long circuits and circuits with the distant end open, short-circuited or closed by an impedance. Chapter 6 deals with the "Ferranti" effect, which is of especial interest in connection with power lines.

Chapter 9 deals with power transfer and reflection phenomena. In this chapter the mechanism of the transfer of energy between electric and magnetic forms is discussed. Perhaps the statement

on p. 102, that the velocity of propagation  $\sqrt{\frac{1}{LC}}$  is equal to that of light, should be limited to the case of unloaded aerial lines. It does not even approximately apply to cable circuits.

Chapter 10 deals with power relations in lines. Such problems

## BOOK REVIEWS.

as the question of the most suitable impedance for receiving instruments are dealt with.

Chapter 11 deals fully with the equivalent circuit, *i.e.*, the representation of actual circuits by means of comparatively simple impedance networks.

Chapter 12 deals with distortion of telephonic speech due to the variations of line impedance, attenuation and velocity of propagation with frequency. The conditions for distortionless transmission are obtained. This leads up to Chapter 13, which deals with loaded circuits. The effects of lumping the load is considered and a number of examples are worked out.

Chapters 14 and 15 deal with amplifiers and their application to lines. This is now a wide subject and only an outline of it can be given in the space available. The particulars given of the "standard amplifying tube" do not compare favourably with the British P.O. valve used on telephone repeaters.

Chapter 16 deals with the impedance of lines and its measurement. The effect of irregularities upon the smoothness of the impedance-frequency curve is discussed. The use of balancing networks is mentioned, but no details of the method of design are given.

Chapter 17 deals with transmission equivalents, including the standard cable and the "TU." The methods of making transmission measurements with the voice and with transmission measuring sets is described. The method of making speech tests described on p. 275 would, it is thought, give very unreliable results.

The book terminates with a short bibliography.

Noticeable omissions from the book are the subjects of transient phenomena and harmonic filters, both of which are of practical importance in modern telephony.

The great merit of the book is the clear and logical manner in which the theory is worked out from fundamental principles. The printing and diagrams are excellent. The book can be strongly recommended both to students and to electrical engineers.

## STAFF CHANGES.

## STAFF CHANGES.

## POST OFFICE ENGINEERING DEPARTMENT.

## PROMOTIONS.

Name.	Grade.	Promoted to	Date.
Wilson, R. ... ..	Executive Engineer, E.-in-C. Office.	Asst. Superintending Engineer, London District.	17-5-25
Brocklesby, C. ... ..	Assistant Engineer, N. Wales District.	Executive Engineer, S. Lancs District.	1-4-25
De Wardt, R. G. ... ..	Assistant Engineer, (Tempy. O/C. Oxford Wireless Station).	Executive Engineer, In Charge Oxford Wireless Station.	1-4-25
Glover, J. B. ... ..	Assistant Engineer, N. West District.	Executive Engineer, Scot. East District.	31-5-25
Buften, C. W. M. ... ..	Chief Inspector, S. East District.	Asst. Engineer, S. West District.	1-5-25
Davis, H. ... ..	Chief Inspector, Testing Branch.	Asst. Engineer, E.-in-C. Office.	12-4-25
Flanagan, F. ... ..	Chief Inspector, N. Wales District.	Asst. Engineer, N. Wales District.	19-4-25
Cox, W. S. ... ..	Chief Inspector, N. Mid. District.	Asst. Engineer, N. Mid. District.	7-4-25
Hamilton, W. D. ... ..	Chief Inspector, E.-in-C. Office.	Asst. Engineer, E.-in-C. Office.	19-4-25
Blake, Capt. E. C. ... ..	Chief Inspector, Testing Branch.	Asst. Engineer, E.-in-C. Office.	19-4-25
Hebden, E. D. ... ..	Chief Inspector, E.-in-C. Office.	Asst. Engineer, E.-in-C. Office.	To be fixed later.
Cory, B. G. ... ..	Chief Inspector, Met. Power District	Asst. Engineer, S. Wales District.	7-5-25
Evans, G. T. ... ..	Inspector, E.-in-C. Office.	Asst. Engineer, E.-in-C. Office.	To be fixed later.
Kennard, T. G. ... ..	Inspector, E.-in-C. Office.	Chief Inspector, E.-in-C. Office.	29-1-25
Irwin, A ... ..	Inspector, E.-in-C. Office.	Chief Inspector, E.-in-C. Office.	29-1-25
Moller, P. D. ... ..	Draughtsman. Cl. I., E.-in-C. Office.	Chief Inspector, E.-in-C. Office.	29-1-25
Towers, R. ... ..	Draughtsman, Cl. II. S. Lancs. District.	Chief Inspector, E.-in-C. Office.	To be fixed later.
Gusterson, H. N. ... ..	Draughtsman, Cl. I., E.-in-C. Office.	Senior Draughtsman, E.-in-C. Office.	11-9-24
Willmot, A. S. ... ..	Draughtsman, Cl. I. E.-in-C. Office.	Senior Draughtsman, E.-in-C. Office.	11-9-24
Blackstaffe, H. P. ... ..	Draughtsman, Cl. I. E.-in-C. Office.	Senior Draughtsman, E.-in-C. Office.	11-9-24
Lucena, H. J. ... ..	S.W.I.	Inspector, N. Wales District.	5-1-25
Hassall, W. H. ... ..	S.W.I.	Inspector, N. Wales District.	25-8-24
Stockton, A. ... ..	S.W.I.	Inspector, N. Wales District.	5-1-25
Kendall, C. A. ... ..	S.W.I.	Inspector, N. Wales District.	5-3-23
Harman, W. J. ... ..	S.W.I.	Inspector, N. Wales District.	25-8-24
Inscoc, E. S. ... ..	S.W.I.	Inspector, N. Wales District.	5-1-25
Wordley, C. H. ... ..	S.W.I.	Inspector, N. Wales District.	25-8-24
Sursham, H. D. ... ..	S.W.I.	Inspector, East District.	6-11-23

STAFF CHANGES.

PROMOTIONS—continued.

Name.	Grade.	Promoted to.	Date.
Tansley, I. W. ...	S.W.1.	Inspector, East District.	13-6-24
Castle, H. V. ...	S.W.1.	Inspector, East District.	5-1-25
Ilett, J. E. W. ...	S.W.1.	Inspector, East District.	5-1-25
Batch, G. B. ...	S.W.1.	Inspector, East District.	16-2-25
Jones, C. J. ...	S.W.1.	Inspector, East District.	6-2-25
Guest, F. ...	S.W.1.	Inspector, East District.	4-2-25
Smithson, W. ...	S.W.1.	Inspector, N.E. District.	28-12-24
Shaw, J. W. ...	S.W.1.	Inspector, N.E. District.	14-12-24
Vear, F. ...	S.W.1.	Inspector, N.E. District.	15-3-25
Kershaw, S. ...	S.W.1.	Inspector, N.E. District.	1-10-24
Robinson, P. ...	S.W.1.	Inspector, N.E. District.	4-3-25
Keighley, A. ...	S.W.1.	Inspector, N.E. District.	4-3-25
Greene, A. H....	S.W.1.	Inspector, N.E. District.	3-3-25
Livingstone, J. ...	S.W.1.	Inspector, Scot. W. District.	21-12-24
Wells, R. ...	S.W.1.	Inspector, Scot. W. District.	21-12-24
Brown, A. ...	S.W.1.	Inspector, Scot. W. District.	22-12-24
Sutherland, A. ...	S.W.1.	Inspector, Scot. W. District.	15-9-24
Gayes, W. E. ...	S.W.1.	Inspector, Met. Power District.	8-10-23
Sturgess, H. E. ...	S.W.1.	Inspector, E.-in-C. Office.	7-2-25
Hodge, G. W....	S.W.2.	Inspector, E.-in-C. Office.	7-2-25
South, W. B....	Inspector,	Inspector, N.Wa. Dist., resumed from Nigeria.	9-3-25
Laidler, W. ...	S.W.2.	Inspector, Northern District.	5-1-25
Worthington, C. E. ...	S.W.2.	Inspector, Northern District.	5-1-25
Smith, J. ...	S.W.2.	Inspector, Northern District.	5-1-25
Dean, W. J. ...	S.W.1.	Inspector, N. Mid. District.	25-2-25
Wilcock, J. ...	S.W.1.	Inspector, N. West District.	5-1-25
Minshall, G. W. ...	S.W.1.	Inspector, N. West District.	29-3-25
Leyland, T. ...	S.W.1.	Inspector, N. West District.	29-3-25
Baldwin, F. ...	S.W.1.	Inspector, N. West District.	5-1-25
Wiper, H. S. ...	S.W.1.	Inspector, N. West District.	25-2-25
Megson, F. W. ...	S.W.1.	Inspector, N. West District.	5-1-25
Thompson, W. H. S....	S.W.1.	Inspector, London District.	7-4-25

STAFF CHANGES.

PROMOTIONS—continued.

Name.	Grade.	Promoted to.	Date.
Harris, W. J. ...	S.W.1.	Inspector, S. Wales District.	5-1-25
Plummer, E. S. ...	S.W.1.	Inspector, S. West District.	5-1-25
Seward, W. J. ...	S.W.1.	Inspector, S. West District.	5-1-25
Roach, H. C. ...	S.W.1.	Inspector, S. West District.	5-1-25
Brown, R. C. C. ...	S.W.2.	Inspector, S. West District.	5-1-25
Pilsbury, J. H. ...	S.W.1.	Inspector, S. Lancs. District.	5-1-25
Payne, C. F. ...	S.W.1.	Inspector, S. Lancs. District.	5-1-25
Moon, F. H. ...	S.W.1.	Inspector, S. Lancs. District.	5-1-25
Warburton, T. E. ...	S.W.1.	Inspector, S. Lancs. District.	14-12-24
Lundv, E. H. ...	S.W.1.	Inspector, S. Lancs. District.	9-12-24
Rowland, W. ...	S.W.1.	Inspector, S. Lancs. District.	5-1-25
Harrison J. ...	S.W.1.	Inspector, S. Lancs. District.	5-1-25
Jones, W. ...	S.W.1.	Inspector, S. Lancs. District.	25-8-24
Tansley, W. ...	S.W.1.	Inspector, S. Lancs. District.	25-8-24
Cleary, H. ...	S.W.1.	Inspector, S. Lancs. District.	1-1-25
Hibbert, J., Sr. ...	S.W.1.	Inspector, S. Lancs. District.	25-8-24
Lythoge, W. J. ...	S.W.1.	Inspector, S. Lancs. District.	25-8-24
Hannah, W. W. ...	S.W.1.	Inspector, S. Lancs. District.	7-12-24
Davies, R. C. ...	S.W.1.	Inspector, S. Lancs. District.	7-12-24
Phipps, A. ...	S.W.1.	Inspector, S. Mid. District.	5-1-25
Stephens, H. N. ...	S.W.1.	Inspector, S. Mid. District.	5-1-25
Naylor, W. H. G. ...	S.W.1.	Inspector, S. Mid. District.	5-1-25
Gibbs, F. J. ...	S.W.1.	Inspector, S. Mid. District.	5-1-25
Brown, E. P. ...	S.W.1.	Inspector, S. Mid. District.	5-1-25
Tomkins, G. E. ...	S.W.1.	Inspector, S. Wales District.	1-4-25
Mann, F. ...	S.W.1.	Inspector, East District.	18-3-25
Owen, J. McA. ...	Probationary Inspector.	Inspector, E.-in-C. Office.	1-4-25
Wylie, T. O. K. ...	Probationary Inspector.	Inspector, E.-in-C. Office.	1-4-25
King, A. G. ...	Probationary Inspector.	Inspector, E.-in-C. Office.	1-4-25
Smith, H. S. ...	Probationary Inspector.	Inspector, E.-in-C. Office.	1-4-25
Paul, F. M. ...	Probationary Inspector.	Inspector, E.-in-C. Office.	1-4-25
Rogers, H. ...	Probationary Inspector.	Inspector, E.-in-C. Office.	1-4-25



STAFF CHANGES.

PROMOTIONS.—continued.

Name.	Grade	Promoted to.	Date.
Limb, F. ... ..	Probationary Inspector.	Inspector, E.-in-C. Office.	1-4-25
Smith, S. J. ... ..	Probationary Inspector.	Inspector, E.-in-C. Office.	1-4-25
Wilson, G. ... ..	Probationary Inspector.	Inspector, S. Wales District.	1-4-25
McKie, A. N. ... ..	Telegraphist.	Repeater Officer Cl. II., S.W. Dist.	1-1-25
Bulman, G. R. ... ..	Telegraphist.	Repeater Officer Cl. II., S.W. Dist.	1-1-25
Wright, J. S. ... ..	Probationary Inspector.	<i>Appointed to</i> Testing Branch.	26-4-25
Spears, G. ... ..	Probationary Inspector.	E.-in-C. Office.	26-4-25
Casterton, E. J. ... ..	Probationary Inspector.	E.-in-C. Office.	26-4-25
Chapman, F. B. ... ..	Probationary Inspector.	E.-in-C. Office.	4-5-25
McMillan, D. ... ..	Probationary Inspector.	Testing Branch.	7-5-25
Wright, C. H. ... ..	Probationary Inspector.	London District.	1-5-25
Stretch, W. ... ..	Probationary Inspector.	E.-in-C. Office.	1-5-25
Sephton, N. F. ... ..	Probationary Inspector.	E.-in-C. Office.	1-5-25
Todd, A. K. ... ..	Probationary Inspector.	N.E. District.	1-5-25
Dinck, W. H. ... ..	Probationary Inspector.	E.-in-C. Office.	10-5-25
Dudley, J. C. ... ..	Probationary Inspector.	Testing Branch.	11-5-25
Miller, G. S. ... ..	Probationary Inspector.	Testing Branch.	10-5-25
Gill, F. W. ... ..	Probationary Inspector.	Testing Branch.	12-5-25
Riley, C. ... ..	Probationary Inspector.	Testing Branch.	12-5-25
Creighton, J. L. ... ..	Probationary Inspector.	Testing Branch.	15-5-25
Folkard, G. F. ... ..	Probationary Inspector.	Testing Branch.	18-5-25
Hedley, D. J. ... ..	Probationary Inspector.	Testing Branch,	18-5-25
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Knee, H. ... ..	Probationary Inspector.	Testing Branch, Provs.	27-5-25
Duff, J. ... ..	Probationary Inspector.	E.-in-C. Office.	2-6-25

## STAFF CHANGES.

### APPOINTMENTS.

Name.	Grade.	Appointed.	Date.
Millard, C. W. ...	Probationary Assistant Engineers.	Assistant Engineers.	1-4-25
Tolley, L. L. ...	"	"	"
Mumford, A. H. ...	"	"	"
Epps, H. F. ...	"	"	"
Carter, F. C. ...	"	"	"
Ashdown, H. A. ...	"	"	"
Smith, W. F. ...	"	"	"
Parsens, R. A. E. ...	"	"	"
Gracie, A. I. A. ...	"	"	"

### TRANSFERS.

Name	Grade.	Transferred.		Date.
		From	To.	
Fleetwood, H. O....	Asst. Engineer.	S. Wales Dist.	Met. Power District.	3-5-25
Smith, W. F. ...	Asst. Engineer.	E.-in-C. Office.	Oxford W.S.	1-4-25
Halton, E. ...	Asst. Engineer.	N. Wales Dist.	N. West Dist.	1-6-25
West, A. S. ...	Inspector.	Oxford Radio.	E.-in-C. Office.	16-4-25

### RETIREMENTS.

Name	Grade.	District	Date.
Stanhope, J. H. ...	Asst. Suptg. Engr.	London.	30-4-25
Jeffreyes, G. C. ...	Executive Engineer.	Scotland East.	1-5-25
Roberts, A. H. ...	Executive Engineer.	E.-in-C. Office.	31-3-25
Blomley, C. ...	Assistant Engineer.	North Midland.	30-4-25
James, J. ...	Assistant Engineer.	South Wales.	25-5-25
Day, T. F. ...	Assistant Engineer.	E.-in-C. Office.	11-4-25
McCloskey, A. E. ...	Chief Inspector.	London.	16-5-25
Pendreigh, W. ...	Inspector.	London.	9-5-25

### RESIGNATIONS.

Name.	Grade.	Office.	Date.
Revner, J. H. ...	Probationary Assistant Engineer.	E.-in-C. Office.	30-6-25

### DEATHS.

Name.	Grade.	District.	Date.
Barnard, W. T. ..	Inspector.	London.	6-4-25

STAFF CHANGES.

CLERICAL ESTABLISHMENT.

PROMOTION.

Name.	Grade.	Promoted to	Date.
Crotch, A. ... ..	Executive Officer, E.-in-C. Office.	Higher Exec. Officer, E.-in-C. Office.	16-3-25

APPOINTMENTS AS CLERICAL OFFICER.

Name	District.	Date.
McHugh, C. J. ... ..	S. Lancs.	1-3-25
Thomson, J. A. McA. ... ..	E.-in-C.O.	29-3-25
Clarke, C. E. ... ..	E.-in-C.O.	29-3-25
Watts, A. W. ... ..	London	2-4-25
Granville, H. G. ... ..	E.-in-C.O.	19-4-25
Hannaford, E. J. G. ... ..	E.-in-C.O.	19-4-25
Hepewell, J. W. ... ..	N. Midland	26-4-25
Davies, W. M. ... ..	S. Lancs.	1-5-25
Baliard, W. S. ... ..	E.-in-C.O.	3-5-25

TRANSFERS.

Name.	Rank.	Transferred.		Date.
		From.	To.	
Eaton, J. C. ... ..	Higher Clerical Officer.	Eastern Dist.	S. Mid. Dist.	5-4-25
Cunliffe, L. ... ..	Clerical Officer.	Ministry of Pensions.	S. Lancs. Dist.	12-1-25
Nobles, E. ... ..	"	N. Mid. Dist.	Rugby Radio Station.	11-3-25
Seward, V. J. ... ..	"	Surveyor's Office,	S. East Dist.	15-3-25
Bailey, R. H. B... ..	"	N. Wales Dist. Ministry of Pensions.	S. Wales Dist.	15-3-25
Giles, C. R. ... ..	"	"	"	15-3-25
Kedzlie, J. A. ... ..	"	"	"	15-3-25
Blake, J. S. ... ..	"	"	"	26-3-25
Hawtin, W. J. ... ..	"	"	"	26-3-25
Tarrant, J. A. ... ..	"	"	"	26-3-25
Randall, F. W. ... ..	"	"	S. West Dist.	26-3-25
Jessop, R. H. ... ..	"	Savings Bank Department.	E.-in-C. Office.	22-3-25
Holt, H. V. ... ..	"	N. Wales Dist.	S. East Dist.	5-4-25
Ough, C. ... ..	"	Air Ministry.	S. West Dist.	5-4-25
McIntyre, G. J. ... ..	"	Scot. West District.	Nat. Insurance Audit Dept.	1-5-25
Crompton, C. H... ..	"	Ministry of Pensions.	S. Lancs. Dist.	1-5-25
Harrison, E. ... ..	"	London Dist.	N. Mid. Dist.	3-5-25
Lubertz, C. ... ..	"	E.-in-C. Office.	L.P.S.	24-5-25

## STAFF CHANGES.

### OTHER CHANGES.

Name.	Rank.	District.	Cause.	Date.
Pestell, G. ...	Higher Clerical Officer.	S. West.	Superannuation	2-4-25
Holman, A. R. ...	Clerical Asst.	S. Mid.	,,	19-5-25
Sweeney, P. ...	Clerical Officer.	S. Lancs.	,,	20-5-25
Keane, W. ...	,,	London.	Decease.	17-5-25
Terry, R. V. H. ...	,,	E.-in-C. Office.	Appointed Asst. Surveyor, Posts & Tghs. Nigeria	29-4-25

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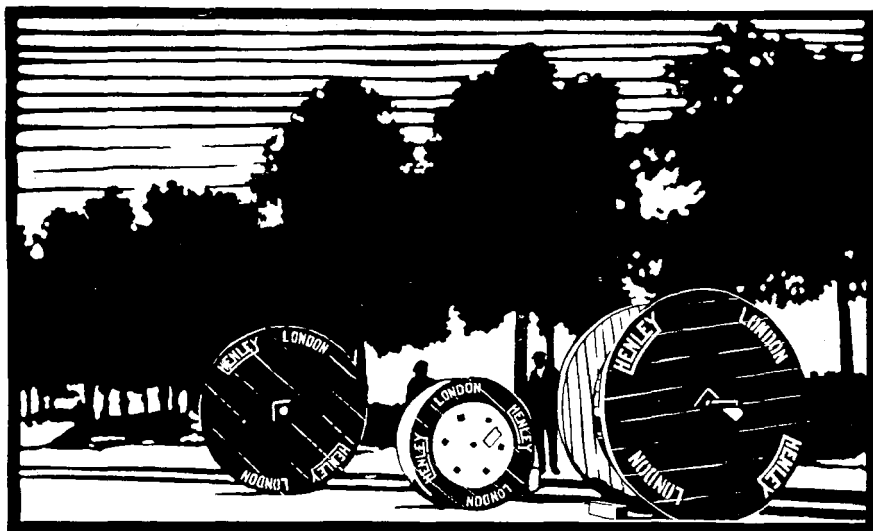
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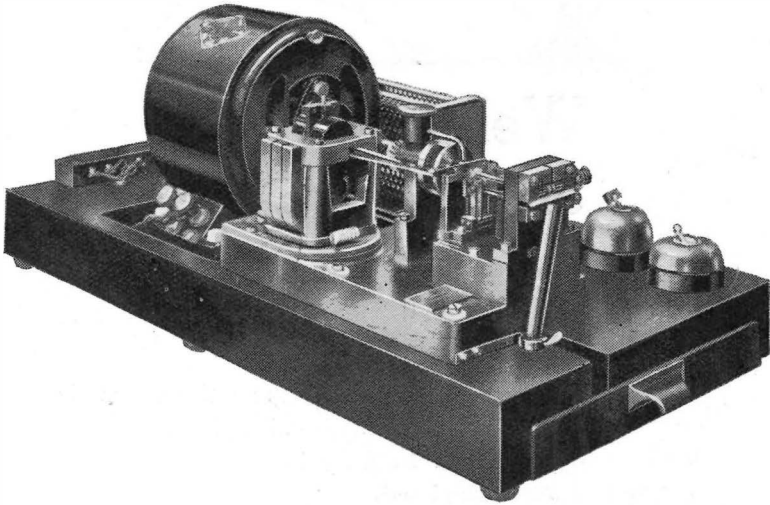
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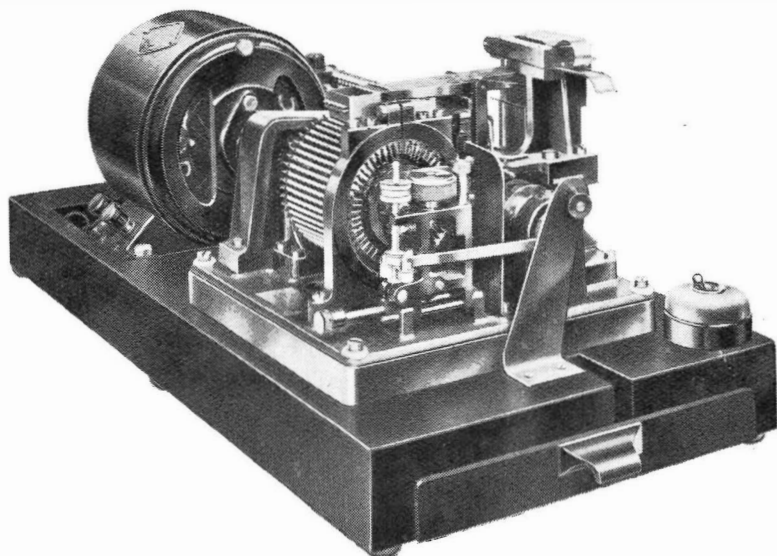
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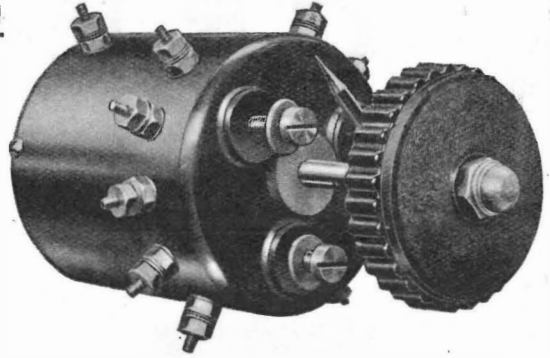
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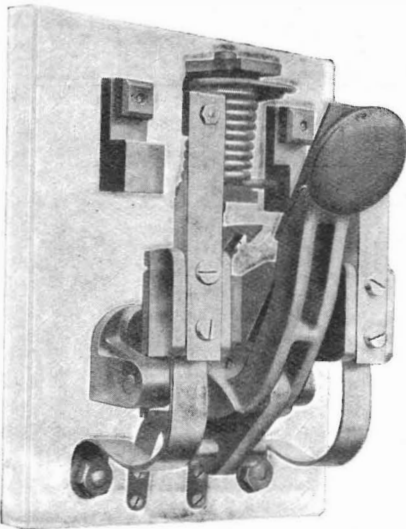
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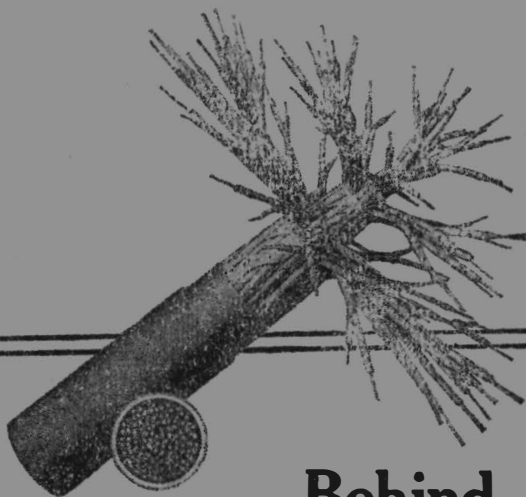
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