THE
Post Office Electrical Engineers' Journal

SUMMARY OF INAUGURAL ADDRESS BY COLONEL SIR THOMAS F. PURVES, PRESIDENT, I.E.E.

Delivered before The Institution, 24th October, 1929, and published here by the kind permission of the Institution.

AFTER acknowledging his election to the office as a tribute of friendship and goodwill to himself and as a gracious compliment to the P.O. Engineering Department, the President proceeded to discuss the question of the education of the engineer. He was of the opinion that the teaching of detailed applications of technology in the schools will have to be abandoned. The fundamental technique of electrical science and engineering, and its general application, already furnish more than sufficient material for a full college course. We may well be content if the graduates are men with sound fundamental knowledge and with faculties trained to continue the processes of absorption and assimilation, men who know what the tools of science and technology are and how they can be used, and if possible endowed with vision and enterprise.

Sir Thomas then made reference to Mr. F. Gill's address in 1922, and after claiming a place in the sun for the " milliampere man " he reviewed the position of automatic telephony and the progress made, both in London and the provinces, since his own paper on the subject five years ago. It is anticipated that in seven years' time the number of automatic exchanges in the central London business area will have reached 100, leaving only five manual exchanges for subsequent conversion. In this country there are now 163 automatic exchanges operating in urban areas with about 500,000 stations; automatic equipment capable of serving about 100,000 lines is being installed annually. At the present rate about 1,000 new telephones are installed each working day throughout the year. Rural automatic exchanges, giving a 24-hours per day service, are being installed in simple buildings of the " garage " type and are left unattended beyond a weekly visit from a lineman.

Line economics was then treated and the importance of detailed surveys, which take into account all the known social and commercial factors of growing and changing localities, was emphasised. These surveys have to be revised from time to time, in order that adequate plant may be laid down for growth, without unduly spending capital on unproductive ducts and cable. In the development of the service in this country, new telephone stations and increased use of those already existing are necessary. Reluctance to hire a telephone and to use it after it has been hired may be a British characteristic, but the Engineer-in-Chief is quite sure that it is not an unchangeable characteristic.

A feature of communications engineering is

the manner in which electrical considerations affecting the transmission line have advanced into prominence. The author paid a tribute to the work of Oliver Heaviside, the pioneer in the art of adding inductance to a line possessing inherent capacity, Pupin and Campbell, and then proceeded to discuss modern practice with regard to loading, showing the relations between propagation speeds and frequencies with different loadings. Attenuation and distortion can be reduced by compensating networks, but cross-talk must be eliminated before repeaters could be relied upon entirely if loading were omitted. Never did the seed of an invention fall upon more fruitful ground than did the telephone repeater, developed on the basis of De Forest's conversion of the Fleming valve into a triode amplifier, and never was a long-standing fundamental problem solved in a more complete and satisfying manner. Two-wire and four-wire repeaters, echo suppressors and repeater refinements were then touched upon. The speaker next proceeded to deal with the work of the C.C.I., and how the work of telephoning Europe internationally had proceeded amicably and steadily through the united efforts of the various administrations. The transmission units agreed upon by the C.C.I.—and incidentally also by America—were defined and explained, and mention was made of the Standard Reference System set up in Paris, which is owned and operated by the C.C.I.

The enormous advances made in the Radio field were detailed; the Rugby station, which is capable of reaching any properly equipped ship in any part of the globe; the wonderful service of broadcasting throughout the world; and the trans-Atlantic circuits between London and New York which link together all the millions of telephone users in America and in Europe. The original long-wave channel forms the main link, but there are also two short-wave channels, each using waves of the order of 16, 24 and 30 metres and radiating 5 kW, against the 60 kW of the long-wave channel, and apparatus for a third short-wave channel is in course of construction. The combination of the two systems ensures practically a 100 per cent. service. The President explained the single side-band method of transmission used on the 5,000 metre channel, and pointed out how improvement had been effected by a careful location of stations; the short-wave channels have the advantage of directional transmission and reception, which imparts a certain measure of privacy. On the long-wave service, the elimination of the carrier, and the suppression of one side-band entirely and non-essential portions of the other present difficulties to would-be listeners, but methods of securing secrecy have been devised and close attention is being given to their development. Many of the special features of the trans-Atlantic radio system are devices intimately connected with, and in some cases borrowed from, the developments of line telephony.

Work is now going forward actively at the Bell Telephone Laboratories on the development of a continuously loaded telephone cable for connection between London and New York, and it is possible that the cable (which will yield only one telephone channel with probably a telegraph channel superposed) will be available for service as early as 1932. The loading material will be one of the series of alloys designated as " perminvars." These are composed of nickel, iron and cobalt to which may be added small amounts of non-magnetic metals such as molybdenum. " Perminvars " are characterised by high resistivity and by a wonderfully constant permeability over a wide range of magnetising force. The conductor will be insulated with a new dielectric material known as " paragutta," which is similar in mechanical properties to gutta percha, but the combination and treatment of its constituents endow it with superior electrical properties, approximately equal to those of tightly packed dry paper. The attenuation on the cable will be immensely greater than that of any other telephone circuit yet planned, the ratio of input to output being about 10^{15}, or 150 decibels, for the high frequencies of the voice range. It is anticipated, however, that the received speech will be successfully amplified and passed forward in good shape to the next section of the line. The end repeaters will be single-direction amplifiers and voice-operated switching mechanisms will be employed to control the direction of transmission.

The great success achieved in the trans-Atlantic service has led to investigations into the possibilities of opening telephone services with the British Dominions. Experimental trials

have been maintained for some time between this country and Australia, and it is hoped that a commercial service will be opened very soon, to be followed later by services to South Africa, India, New Zealand, etc.

To illustrate the enormous advance made in world wide communications, and also the successful application of the thermionic valve repeater, the President quoted details of a circuit extending from Stockholm to America, crossing that continent $2\frac{1}{2}$ times and terminating in New Jersey, over which a fair grade of conversation was maintained. (Details of the circuit were given in this Journal, April, 1928). The transmission equivalent of the chain would not be less than 240 Bels, *i.e.*, the ratio of power sent to power received would be 1 to 10^{-240}. To deliver 1 micro-watt at the far end without repeaters on such a circuit would require the application of the energy of the entire universe $\times 10^{177}$!

A description of the operation of the photo-cell and its application to fac-simile transmissions and also to the " talkies " concluded the address. [See note under Notes and Comments.]

BROADCAST OF PRESIDENTIAL ADDRESS TO I.E.E.

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

As will be known to many readers, the inaugural address of Sir Thomas Fortune Purves, Engineer-in-Chief, G.P.O., as President of the Institution of Electrical Engineers, was broadcast to local centres of the Institution, and particulars of the arrangements made on that occasion may be of interest.

It was originally intended that all the local centres, including Dublin, should be included in the arrangements, but this was not found possible on account of the shortage of suitable lines. Ultimately, the following towns were linked up, viz., London, Glasgow, Newcastle, Leeds, Liverpool, Manchester, Birmingham, Cardiff, Southampton and Portsmouth. In London, at the Institution, arrangements were also made whereby all the speeches could be heard from loud-speakers in the Library and the tea room. The scheme proposed was that the President's address should be broadcast from loud-speakers at each of the local centres, the vote of thanks being proposed by Mr. Harcourt Williams at Manchester, and seconded by Prof. McLean at Glasgow. The vote of thanks and the seconding thereof were to be broadcast from loud-speakers at all stations, including London. In addition, arrangements were made whereby, on the retiring President addressing each station in turn, before the presidential address, they could each, in turn, announce to all the others that they were in session.

The general outlines of the arrangements were settled at a meeting of representatives of the Lines, Telephone and Research Sections, and it was then agreed that the conditions could be most satisfactorily met by the use of four-wire circuits to each place. To prevent howling, it was decided to hand switch the lines from " Talk " to " Listen " as required; except during the preliminary roll call, this would not involve any special precautions. Details are given later. The Research Section was to select patterns of suitable transmitters and loud-speakers, to provide models of the amplifiers required, and to be responsible for the provision of all the equipment required at the Institution Building in London. The Telephone Section arranged for the provision of all the local equipment, from the models supplied, and for making all the local arrangements in conjunction with the Districts concerned. The Lines Section selected and tested the various lines required and made all arrangements for the necessary switching.

Microphones.—To pick up the President's speech it was decided to make use of a condenser microphone as being likely to give the best results. Actually a condenser microphone,

designed and built in the Research Section, was used with a four-stage amplifier. The amplifier circuit is shown in Fig. **1**.

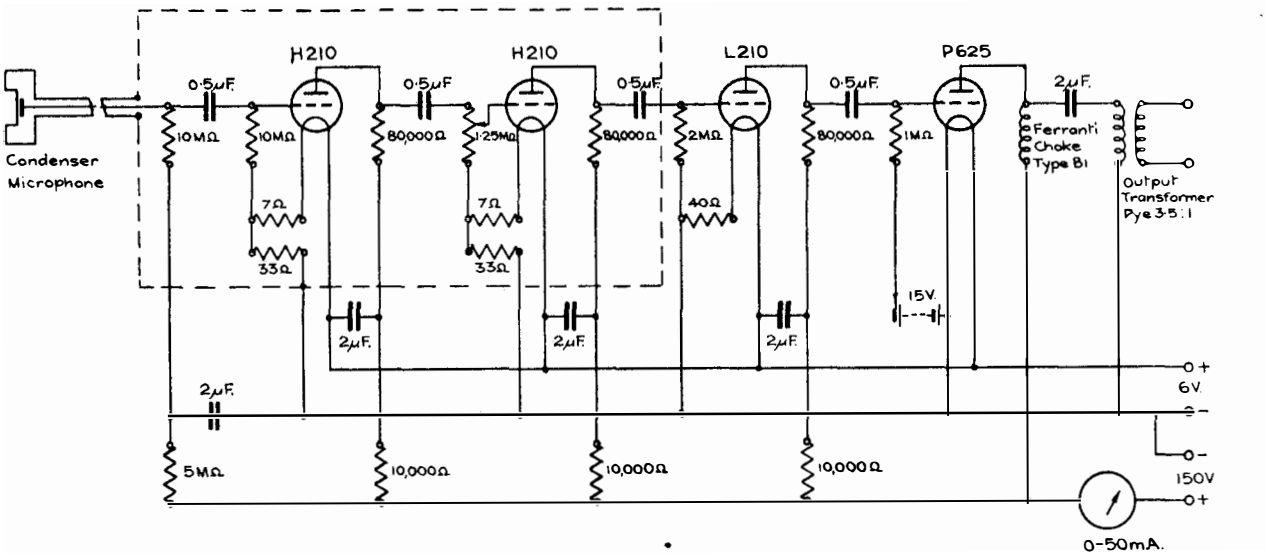


FIG. **1**.

For the local stations it was not thought necessary to provide condenser microphones. A sufficient number of these were not available at the time and, moreover, a somewhat sensitive amplifier is required. Good results from the point of view of articulation had been obtained

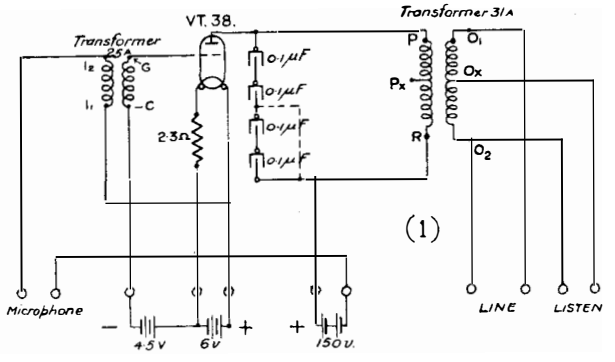


FIG. **2**.

with microphones as used in the new micro-telephones about to be brought into service, and it was found in some preliminary trials, that if the damping were increased, they would give excellent results, even when used to a loud-speaker. These instruments thus modified were actually used, mounted in small wooden cases. Spoken to from two or three feet away, they only need one stage amplifiers; the circuit for these is shown in Fig. **2**. The H.T. used was 150 volts from W size dry cells. The four 0.1 mfd. condensers in series on the amplifier output were provided to give some tone control. Two condensers in series were actually used. Each station was provided with a spare microphone.

Lines and Switching.—Preliminary tests indicated that to obtain a natural tone from the loud-speakers it would be necessary to make use of lines with a higher cut-off than is normally required for speech transmission. It was found that a nominal cut-off of not less than 4000 ~ was advisable and this limited the number of available lines. Fig. **3** shows diagrammatically the arrangement finally adopted. The main switching point was at Leeds, with secondary switching points at the London repeater station (for Southampton, Portsmouth, Leeds and the Institution) and at Manchester (for Liverpool). At each switching point it will be seen the microphone lines and the loud-speaker lines were connected to keys, so that any selected microphone line and all the loud-speaker lines, except that associated with the particular microphone line, could be coupled together as required. The lines actually used are given in the accompany-

ing table. " Speaker " lines were allotted at each place and arranged to be cut over if required to the working circuits should any fault develop on these.

DETAILS OF LINES USED IN I.E.E. BROADCAST.

Section.	*Conductor.*	*Loading.*	*Cut off frequency.*
London—Leeds	20lb. Side Circuit	44 mh. at 1.136 miles	5570 ~
Leeds—Edinburgh	20lb. Side Circuit	44 mh. at 1.136 miles	5570
Edinburgh—Glasgow	40lb.	Unloaded Phantom	—
Leeds—Newcastle	20lb. Part Side	89 mh. at 1.136 ,,	3920
	Part Phantom	47.3 mh. at 1.136 ,,	
Leeds—Derby	20lb. Part Side	89 mh. at 1.136 ,,	3920
	Part Phantom	47.3 mh. at 1.136 ,,	
Derby—Birmingham	20lb. Side	89 mh. at 1.136 ,,	3920
Leeds—Derby	20lb. Phantom	22 mh. at 1.136 ,,	6300
Derby—Cardiff	20lb. Side	89 mh. at 1.136 ,,	3920
Leeds—Manchester	40lb.	Unloaded Phantom	—
London—Portsmouth	Aerial.		
	Mixed, 150, 200, 300 and 400lb. Copper with some 40lb., 150lb., and 200lb. U.G.	Unloaded	—
London—Southampton ...	20lb. Phantoms.	250 mh. at 1.136 miles	2320

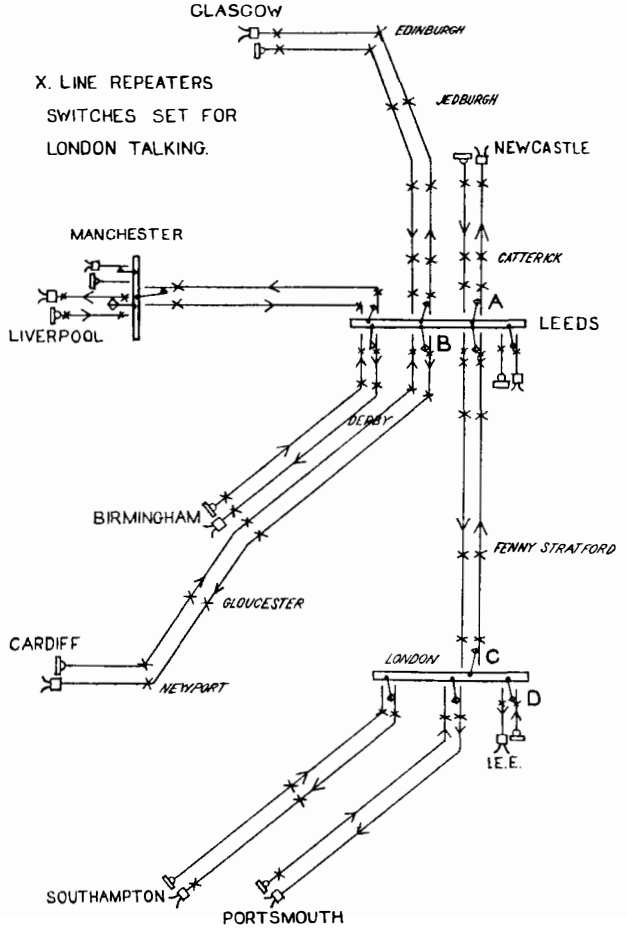


FIG. 3.

The loaded lines, except those to Southampton, were all equalised by the insertion of tuned circuits at suitable repeater stations to give level transmission characteristics from approximately 200 ~ to 3000 ~.

Loud-speakers.—Tests made some time previously of a number of various types of loud-speaker had shown that the Amplion Lion type 41 was a very satisfactory instrument with the advantage that no additional polarising current was required, and it was decided to use these. The makers very kindly offered to lend as many as might be required and in fact did supply 26. These were allotted as follows:—Four in the Lecture Hall at Savoy Place, two in the Library there, one in the tea room and two at each of the local centres. A three stage amplifier was provided for each station with arrangements for cutting out one stage if required. A potentiometer was provided on the input in each case to serve as a volume control, but no tone control was fitted. 300 volts in W size dry cells were used at each local station, and 400 from accumulators in London. Provision was made for two LS5A type valves (not shown in figure) in the last stage at each local station.

Fig. 4 shows the amplifier circuits for the local centres.

At the London end the conditions were rather more elaborate. Provision was made for two

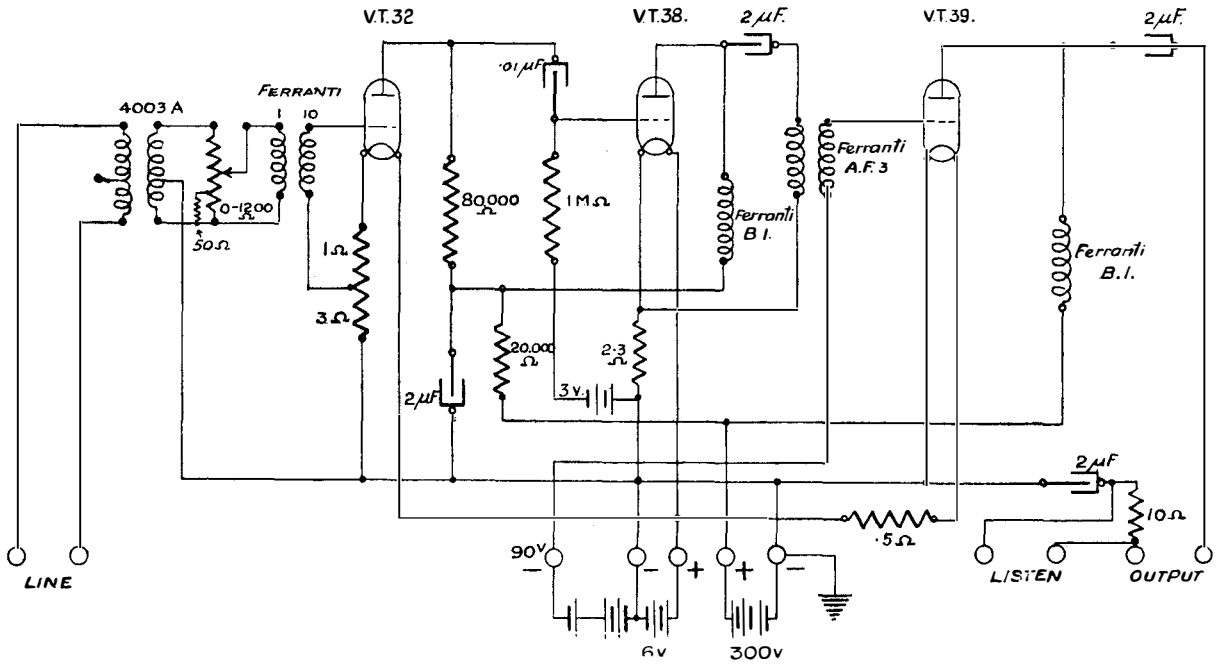


FIG. 4.

overflow meetings to receive all speeches from all stations if required. A line plan of the arrangements is shown in Fig. **5** and the circuit details in Fig. **6**. Provision was made (not

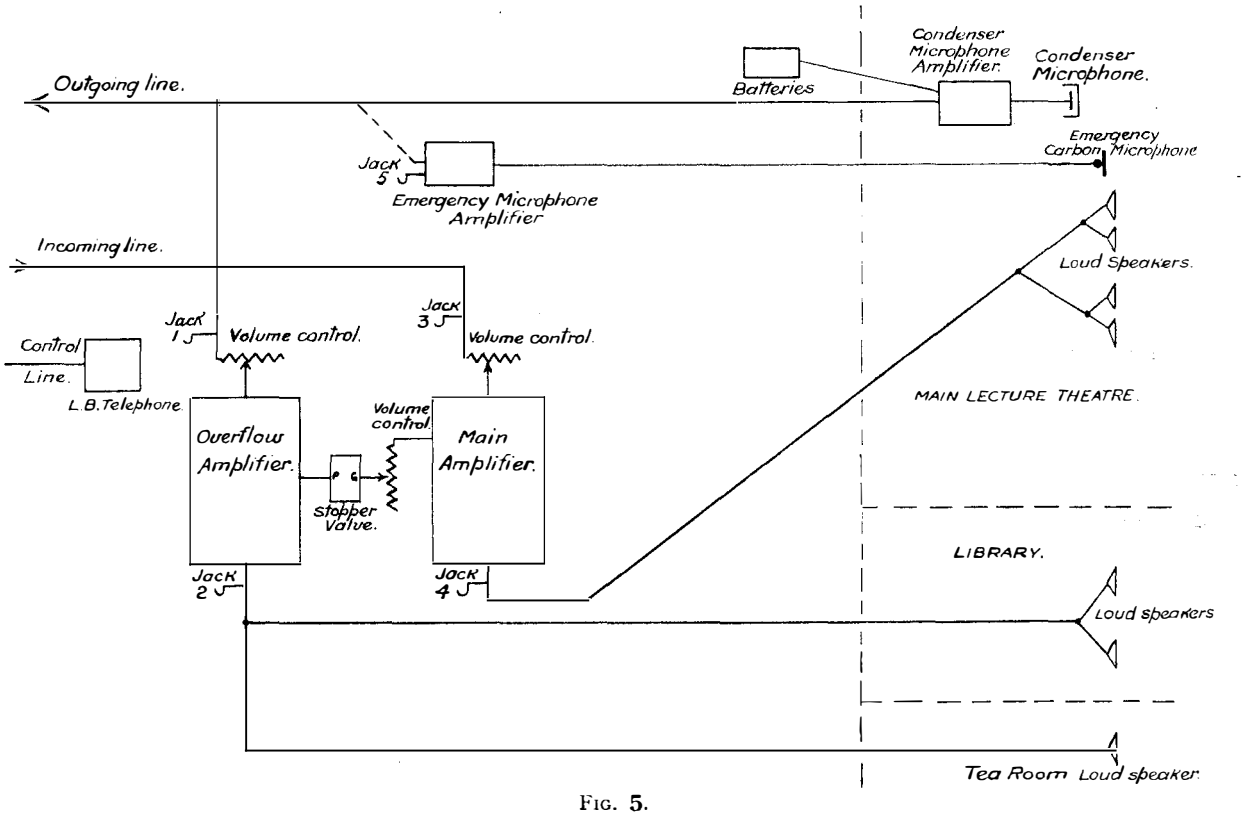


FIG. 5.

shown in Fig. 6) for four valves in parallel in the output stage, but only two were actually used. Reference to Fig. 5 will show that the overflow meetings obtain the President's address *via* the overflow amplifier. They receive the local stations *via* part of the main amplifier, stopper valve, and part of the overflow amplifier. The stopper valve prevents the President's address appearing in the loud-speakers in the hall in which he is speaking.

to distribute the sound beams (fairly pronounced at the higher frequencies) over the lecture room. A rehearsal was held on Thursday afternoon to ensure that all was in order and to enable final adjustments to be made and familiarise all concerned with the procedure to be adopted. An attempt was also made at this time to adjust the volume levels from the different stations. The whole of the operations were controlled at the actual meeting by the President in London.

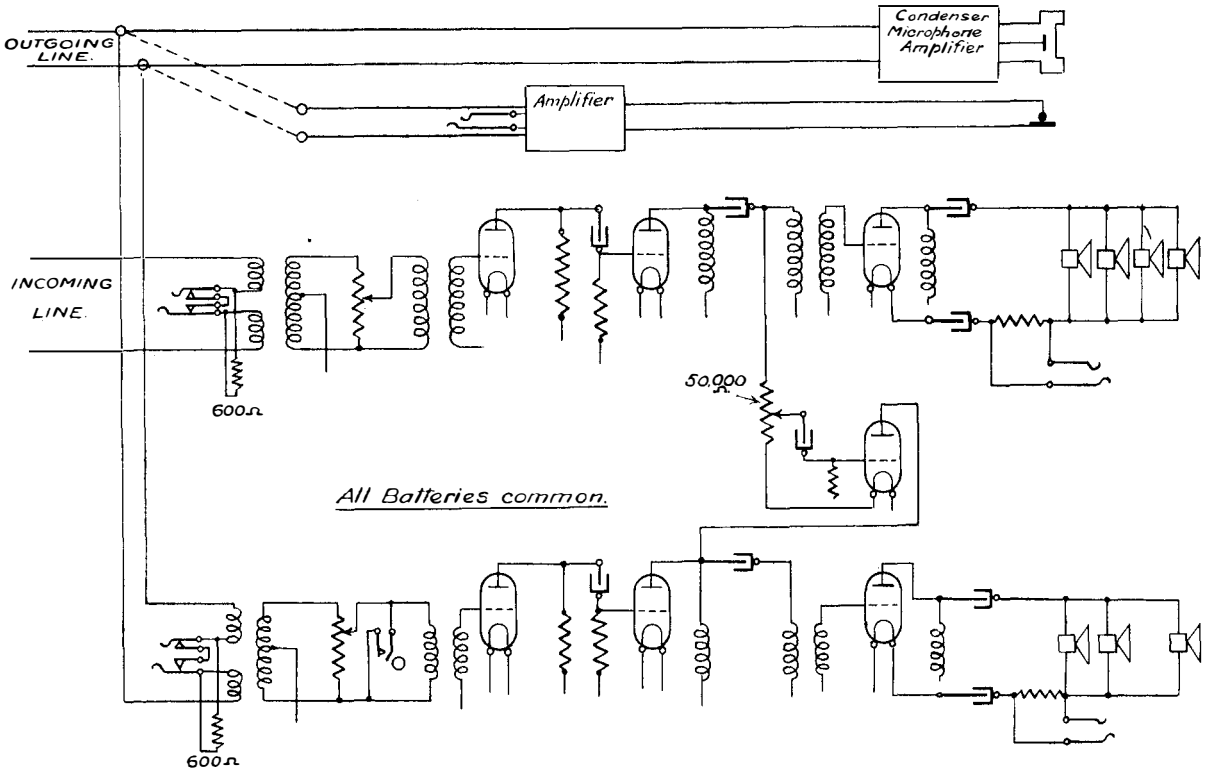


FIG. 6.

Monitoring at each receiving station was carried out by listening across a small resistance in the loud-speaker circuit.

General Arrangements.—The inspectors in charge at the local stations were given a demonstration of the apparatus at Dollis Hill. The apparatus for each station was then dispatched so that preliminary trials could be made locally as to the best disposition of the loud-speakers and so that the officers could familiarise themselves with the arrangements. In London the only convenient place for the loud-speakers was over the doorways on either side behind the President's chair. These were arranged so as

While he was speaking the London microphone circuit was commoned to all the other loud-speaker circuits, the remaining microphone circuits being disconnected as shown in Fig. 3. The President then, for example, called over all circuits upon Newcastle to indicate if they were in session. Keys A and B were thrown by the Leeds control officer and C and D by the London control officer. Newcastle was then in a position to speak to all stations. Immediately he had finished the keys were thrown for " London talking " and the procedure repeated with each station in turn. The arrangement was found to work quite satisfactorily.

Remarks.—The general opinion obtained both from observers in London and the local centres was that the broadcast was a distinct success. Reception appears to have been good at all places except when Glasgow was transmitting. The speech from Manchester was received extremely well at all stations and Birmingham reported "Reception exceptionally good." Some difficulty was experienced at Portsmouth due to the rather awkward room, but this was reduced by the provision of two additional loud-speakers and the draping of the room. The articulation at Southampton was not as good as was desired, but this was due to the unavoidable use of unloaded U/G circuits. The reception of the President's address in the overflow meetings in London was very natural and better than that obtained in some parts of the Lecture Hall itself. Probably the chief defect of the demonstration was the variation in volume level from the various centres. A volume control was fitted on each loud-speaker amplifier, but most of the centres were not transmitting for a sufficient length of time for it to be very effectively used. The preliminary adjustment, made during rehearsal, though helpful, could not be very definite, especially at the local centres. To have ensured a definite and uniform level would have necessitated a considerable increase in the local equipment and more time than was available in regulating the transmission levels over each part of the system.

It may be of interest to state about 2,000 miles of circuit were used, 62 line repeaters and 22 local amplifiers.

SOUTH MIDLAND CENTRE, I.E.E.

The annual dinner was held at the Grand Hotel, Birmingham, on 29th November, 1929, and was presided over by Mr. G. R. J. Parkinson, Chairman of the Centre. Mr. Neville Chamberlain, M.P., Col. Sir T. F. Purves, President of the Institution, and Sir Andrew Duncan, Chairman of the Central Electricity Board, were the principal speakers. The function was very well attended, the Grosvenor Room of the Grand Hotel being filled to capacity.

In addition to the presence of the Engineer-in-Chief as President of the Institution, the P.O. Engineering Staff of the North Wales District was represented by the Superintending Engineer, two Assstant Superintending Engineers, and five Executive Engineers.

The speeches have been fully reported in other Journals, but it is worthy of note that the I.P.O.E.E. members participate fully in the various I.E.E. functions at Birmingham. The re-union which took place after the dinner afforded a welcome opportunitv of fraternising with members of other branches of the electrical industry who are met in the ordinary course of official business. Occasions of this kind give the Department's representatives an excellent opportunity of enhancing the prestige of the Post Office Engineering Department and full advantage of the occasion was taken.

NORTH-WEST CENTRE, I.E.E.

On the 22nd October, Mr. T. E. Herbert (Asst. Superintending Engineer, South Lancashire District) delivered his address as Chairman of the Centre at the inaugural meeting of the Session. After sketching the history of "Inland Telegraphs," there followed a suggestion as to the possible trend of development in the direction of automatic switching, thereby enabling many communications now sent by post to be typed direct to the recipient's office.

The address was illustrated by working circuits: (i) Teleprinter 3A; (ii) Full Wheatstone; (iii) Creed Keyboard Perforator, Receiving Perforator and Printer; (iv) The Mendonça Baudot.

On the 29th October, Mr. T. E. Herbert addressed the Students' Section on the subject of "Recent Advances in Submarine Telegraphy." Special attention was devoted to the use of regenerative repeaters used in connection with multiplex circuits on trans-Atlantic cables

—a development rendered possible by the use of thermionic valves for reception on loaded cables.

The Annual Dinner of the Centre took place on the 19th November, the guests including the President, Col. Sir Thomas F. Purves, Lord Colwyn, Dr. S. Z. de Ferranti, Dr. Daniel Adamson, President of the Institution of Mechanical Engineers. The toast of the Institution was proposed by Lord Colwyn, who pointed out that the electrical industry was equally concerned with all others in the great problems with which the country was now face to face. The young men in electrical engineering were equipped with brain power and other qualities of mind suited to play their part in solving these problems. He issued an emphatic warning against financial speculation, since it served neither the country nor did it bring honour to the participants, whereas honest work did both.

In reply to the toast, Sir Thomas first expressed his pleasure in meeting such a magnificent assembly (close on 300 sat down to dinner) in Manchester honourably associated with the industry, art, science and thought of England. Each Centre of the Institution had its individual life and power to act independently of the parent body, but all were united to bring their collective wisdom to bear upon the problems which presented themselves. He was doubly pleased to be present, because the Centre was presided over by an old friend and colleague and because it was the most virile and active of all the Centres.

The toast of the guests was proposed by the Chairman. Mr. T. E. Herbert said that this year, as always, the Centre had been honoured by the presence of many learned and distinguished guests whom they were delighted to honour.

NORTH-EAST CENTRE, I.E.E.

The annual dinner and re-union of the members of the North-East Centre was held at the Station Hotel, Newcastle-upon-Tyne, on the 3rd ult., and was attended by the Civic dignitaries and many prominent men in mining, shipbuilding and engineering circles. The Post Office Engineering Department was strongly represented and included Col. Sir T. F. Purves (the President of the Institution), Mr. J. R. M. Elliott, Superintending Engineer, and Mr. F. G. C. Baldwin, Assistant Superintending Engineer, who is a past chairman of the local centre. Mr. J. R. Andrews (P.O. Engineer), Chairman of the Freemen of Newcastle-upon-Tyne, and for some years Honorary Secretary of the local Institution Centre, proposed the toast of the Lord Mayor and Corporation in a felicitous speech, in which he paid tribute to the Corporation and its work, and in particular to their able assistance in the ready granting of wayleave facilities in Newcastle and help in other directions which was much appreciated by the Post Office.

The Deputy Lord Mayor and Sheriff suitably responded.

Professor Henry Louis, President of the Iron and Steel Institute, proposed the toast of the Institution of Electrical Engineers and said he was keenly sensible of the help the Institution had given to the great industries of the country and to the community at large. He was also glad to have the opportunity of publicly acknowledging the work of its President, which was so important to the country and yet the public scarcely knew of him. Col. Purves, before replying, was the chief spectator of a one-act comedy, the entire company singing " All alone on the telephone " with great gusto. Sir Thomas in the course of his reply said he always felt that much of the best brain and the hardest work of the Institution came from the provincial centres. He considered that one powerful institution embracing all classes of electrical engineers with rationalized organisation was bound to be a far more effective instrument for good than a number of independent electrical societies. On this principle the Institution was striving hard to cater for all classes of electrical engineers throughout the country. The North-East centre brought to the Institution a great deal of technical knowledge and ability, and he was sure that the Tyneside character would show itself with equal effect in the administration of the Institution's affairs.

The proceedings were brightened by many humorous anecdotes and altogether the event was one of the most successful ever held in the North-East Centre.

AN ARTIFICIAL EAR.

W. WEST, B.A., A.M.I.E.E.

SUMMARY.—A description of the construction and performance of apparatus designed to comply with the specification that the acoustical impedance shall lie within the range of normal variations obtained for real ears. The construction comprises a coupling device associated with a condenser transmitter whose frequency characteristic is not seriously affected thereby. Possibilities are indicated for the use of this apparatus for replacing real ears in transmission measurements.

1. In a large number of investigations in connection with telephone transmission testing, a need has been felt for a mechanical or electrical device which can be used for recording the sound pressures developed by a telephone receiver when in use under its working conditions, *i.e.*, when held to an ear. Such a device, or "artificial ear," should offer, to an applied telephone receiver, an acoustical impedance substantially equivalent to that of a normal real ear, and should incorporate sound measuring apparatus whose performance is practically free from distortion.

As a result of a recent investigation,* information is available of the magnitudes of acoustical impedances liable to be encountered on normal ears over a considerable range of frequencies. Attempt has not been made to match exactly the acoustical impedance of the artificial ear to the mean impedance found for real ears at all frequencies, since it is thought that it will be sufficient to provide an impedance lying within the normal range of variation at all frequencies. Experience with high quality sound detectors led to the selection of a condenser transmitter for incorporation in the artificial ear.

The problem of design therefore consists in the construction of a coupling device, between a telephone receiver and the condenser transmitter, which shall present a suitable acoustical impedance to the receiver, and at the same time shall not seriously impair the frequency characteristic of the condenser transmitter. Experience has shown that a coupling device of the kind originally accepted for use for calibrating the International Reference Standard Receiver is unsatisfactory, owing to the formation of an acoustical resonator in front of the diaphragm of the condenser transmitter.

It has been observed that the acoustical resistance of a semi-infinite rigid walled tube of about $\frac{1}{4}$ inch internal diameter provides a good match to that of a real ear. The construction of the artificial ear to be described makes use of such a tube for providing the necessary dissipation of sound energy, some lack of rigidity in the wall of the tube being permitted locally for operating the condenser transmitter.

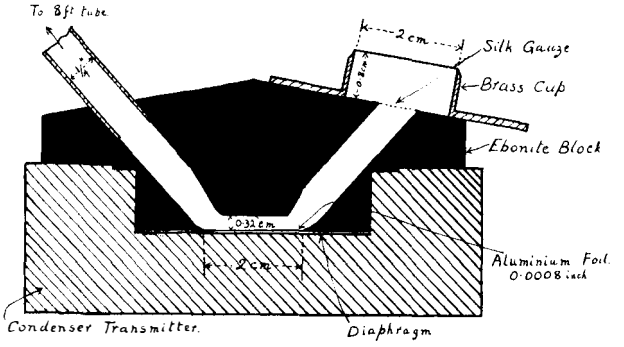


FIG. 1.

2. *Constructional Details.* — The essential details are shown in Fig. 1, which illustrates an elevation cross-section through the coupling device in position on a condenser transmitter. A block of ebonite was made to fit closely over the diaphragm of the transmitter. In the centre of the block, immediately over the diaphragm, a groove, 2 cm. long by 1 cm. wide and about 0.32 cm. deep, was cut, and two $\frac{1}{4}$ inch diameter holes were bored outwards from the ends of the groove to the sides of the block. At the junctions with the groove the passage was shaped so that the cross-sectional area remained practically constant. At the base of the block, covering the groove, a sheet of thin (0.0008 inch) aluminium

* *See previous article in this Journal, Vol. 21, Part 4, January, 1929, p. 293.*

foil was stretched and cemented to the block. At one end the passage was continued into an 8 ft. length of $\frac{1}{4}$ inch diameter (nominal) lead composition tube which was coiled, on a 9 inch diameter, round the condenser transmitter; to the far end of this tube was drawn a bundle of 10 strands of darning wool in the manner and for the purpose stated in the reference cited above. The other end of the passage was covered with a dust screen of silk gauze and surrounded by a short brass cylinder forming a cup 2 cm. in diameter and 0.8 cm. deep. The rim of this cup was cut to a knife edge, and the transmitter was mounted at a slight angle on a base board so that the rim lay in a horizontal plane. A telephone receiver is simply placed over the cup, generally an air seal is ensured by the application of a little plasticine or mineral jelly at the rim. The ebonite block is secured in position on the transmitter and suitable arrangements for the electrical connection of the transmitter to an amplifier are provided on the base board. The exact dimension of the gap between the aluminium foil at the base of the block and the diaphragm of the transmitter cannot be stated; it is, however, known to be less than 0.005 inch.

3. *Performance.*—The artificial ear has been tested for acoustical resistance and reactance and for frequency characteristic; it has also been substituted for real ears in a volume efficiency test of standard C.B. transmitters.

(*a*) *Acoustical Resistance.*—The method employed for carrying out these measurements has already been described.* A stationary wave method is used, the acoustical impedance under test being applied at one end of a tube, 2.75 inches in diameter, and comparison is made between the sound pressures generated in the tube when terminated by this impedance, and by certain acoustical resistances of known values. This apparatus has been in use for the measurement of the sound absorbing properties of materials, and the extended use has necessitated some modifications. The rubber seal between the cork piston of the driving unit and the tube has been replaced by one of 0.01 inch thick sheet lead, and the condenser transmitter has been transferred to the driving end of the tube, where a slit of 0.5 by 0.05 cm. is provided in the wall of the tube. Table I. shows the acoustical resistance found for the artificial ear, together with the range of resistances found for normal ears, reproduced from the previous article.

* *loc. cit.*

TABLE I.

Frequency (Cycles per sec.)	Resistence of Artificial Ear.	Extreme resistences of real ears.
370	106	100—300
745	102	90—350
1100	111	105—190
1500		80—145
1670	111	—
2600	72	13—125

The theoretical resistance of a $\frac{1}{4}$ inch tube is about 130; it will be observed that the coupling device of the artificial ear exerts a somewhat greater absorption than that of a simple tube. Although the resistance of the artificial ear lies within the range of normal variation for real ears at all frequencies it is below the mean value at lower frequencies and above the mean at the higher frequencies.

(*b*) *Acoustical Reactance.*—For this measurement advantage was taken of the sound measuring apparatus, forming part of the artificial ear, to measure the resonant frequencies of Bell type receivers having diaphragms of different constructions; comparison was made with the resonant frequencies observed with the same receivers held to the known variable reactance which has been described in the previous article. The results, reduced to terms of the equivalent volume of the reactance, are shown in Table II., together with the range of variation for normal ears.

TABLE II.

Frequency (Cycles per sec.)	Equivalent Volume of artificial ear. (C.C.)	Range of equivt. volume of real ears (C.C.)
500	3.1	+ 4.0 to − 4.0
1100	2.7	+ 5.0 to + 1.0
1600	2.5	+ 5.0 to + 2.0

The actual volume of the cavity is about 2.5 cc. It is not certain whether the somewhat larger

value observed at the lowest frequency is attributable to experimental error or not.

(*c*) *Frequency Characteristic.*—It was required to know the performance of the instrument in terms of the ratio of the e.m.f. generated by the transmitter to the sound pressures on the "outer ear." The calibration was therefore effected by means of a Rayleigh disc mounted in a tube, one end of which was closed by the artificial ear and the other end by a source of sound. This method gives results applicable to working conditions provided that the change of acoustical impedance, as between the resonating tube (non-reactive) and the receiver in position on the ear (elastic reactance), does not appreciably affect the performance of the transmitter.

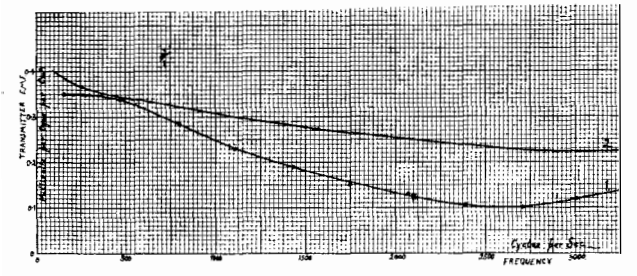


FIG. 2.

Curve 1 of Fig. 2 shows the frequency characteristic of the artificial ear, and Curve 2 shows that of the same transmitter (No. 111, type 370 W) taken in terms of pressures on the diaphragm, before attachment to the artificial ear. In an attachment of this kind, care is necessary to ensure that the small air chamber formed over the diaphragm of the transmitter does not act in conjunction with the foil at the base of the coupling device (or with the mass of the air in the passage if the foil is omitted) to form a resonator. For this reason the air gap should be very small, so that the acoustical resistance, imposed by lateral motion of the air between two surfaces close together, provides sufficient damping. If the thickness of the air gap is increased, a resonant peak may therefore appear in the frequency characteristic of the artificial ear. The presence of such a peak is liable to introduce error, due to the fact that its position on the frequency scale may be appreciably altered by a change of acoustical load on the artificial ear.

The curve for the artificial ear shows evidence of sufficient damping to reduce any effect due to the change of acoustical impedance to negligible proportions.

As it stands, the curve shows that variations of sensitivity with frequency do not exceed 3.5 to 1, which is a reasonable figure for acoustical apparatus. Since, moreover, the curve is a smooth one, a simple modification of the amplifier following the transmitter will suffice to compensate for the irregularity by reducing the sensitivity at the lower frequencies. A further reduction at the lower frequencies would be necessary in order to simulate the frequency sensitivity of a normal real ear (vide Fletcher and Wegel, Physical Review, 1922, Vol. 19, p. 553). For transmission measurements of sounds of speech it is probably unnecessary to consider frequencies above, say, 3,000 cycles per sec.

(*d*) *On Transmission Testing Circuit.*—The artificial ear was substituted for a real ear in an efficiency test of 12 Research Section Standard C.B. transmitters on the usual transmission testing circuit. The condenser transmitter of the artificial ear was connected through a three stage amplifier to a volume measuring set provided with an instrument calibrated to read directly in terms of standard miles of cable. A set of this kind has been described in an earlier number of this Journal (A. J. Aldridge and A. Hudson, "A Method for the Measurement of the Transmission Efficiency of Telephone Apparatus at a Subscribers' Office," Vol. 17, Part 2, July, 1924). The transmitters were tested in pairs, each of three speakers giving alternately from 3 to 5 consecutive counts of "one—two—three—four—five" on each transmitter. The artificial ear is far more sensitive to changes of volume than a real ear, and the chief difficulty of the test was due to variations in intensity of speech of which the speakers were unaware. It was frequently observed that the intensity varied considerably during a series of counts on a single transmitter; in such cases no reading was recorded.

The results are summarised in Table III. together with the corresponding figures (quoted in the last column) obtained from the stated transmission efficiencies of the transmitters at the time of the test. The agreement is seen to be very close for a test of this kind.

TABLE III.

Transmitter A	Transmitter B	Receiver.	(A—B) Transmission Efficiencies in S.M.	
			On Artificial Ear Set.	By Standard Method
B 13	R.S. 99	R.S. 80	4.0	5.0
B 10	,, 24		4.0	3.2
RS114	,, 104		2.0	2.0
B 11	,, 5		1.0	1.6
B 20	,, 80		1.5	1.0
B 16	,, 14		0	0.1
	,, 80		1.5	0.8
	,, 5		0	0.5
	,, 104		1.0	0.5
	,, 24		1.0	1.4
	,, 99		1.5	2.3
B 14	B 16	R.S. 78	1.0	−0.1
	B 20		1.0	−0.5
	B 11		0	−1.0
	R.S.114		−1.0	−1.5
	B 10		−2.0	−2.0
	R.S. 13		−2.5	−2.5

4. *Possible uses of an Artificial Ear.*—For measurements, in absolute units, of the performance of receivers under their working conditions, an artificial ear is almost essential. Such a device has already been used to measure the sound pressures developed, for a given electrical input to the receiver, for speech and single frequency currents. An artificial ear would also be required for carrying out a more extensive investigation of the performance of receivers when held to the ear, to include for example the nature and extent of any non-linear and transient distortions. Measurements of this kind on a receiver have hitherto suffered neglect, since these types of distortion are probably less serious in the receiver than in the existing patterns of carbon granule transmitter; this, however, may not always be the case.

An artificial ear has, however, other and perhaps more important possibilities in replacing real ears for volume measurements of telephone transmission. The tests recorded in paragraph (*d*) of the previous section indicate possibilities in this direction, but the full technique of transmission testing by artificial ear has yet to be developed and proved. In this connection it is advisable to differentiate between comparisons of circuits or instruments without and with appreciable tone difference. When there is no tone difference the real ear provides an accurate relative comparison between different conditions of circuit or instrument; it provides, however, no permanent record that is not dependent on the reproduceability of the performance of the standard circuits and instruments. As the tone difference increases, wider discrepancies between results with different observers necessitate a larger number of tests and observers in order to obtain a representative average. Under these circumstances, the elimination of personal bias by the use of an artificial ear becomes more important. It should be noted that the test results recorded above refer to the condition of no appreciable tone difference, and that no modifications of the existing frequency characteristic of the artificial ear were made. It is probable that, for tests with tone difference, it will be necessary to adjust the frequency characteristic (*e.g.*, in the amplifier of the condenser transmitter) to conform approximately with that of a normal ear. If, as a result of experience, it is found that a measurement by artificial ear suffices to differentiate between the relative volumes of speech on different circuits, then, by eliminating distortion from one of the circuits, it will be possible to measure the volume efficiency of a distorting circuit in absolute units—obtained from a calibration of the distortionless circuit.

The replacement of real ears by an artificial ear in transmission testing, if practicable, should result in a considerable saving of testing time. Variations necessitating repeat tests will, however, still exist unless more definite control is exercised on the intensity of the source of sound, which is at present the human voice. Such control might take the form of a suitably placed volume indicator, or alternatively the human voice might be replaced by an essentially equivalent mechanically or electrically operated source of sound. The latter alternative is probably the more desirable from the point of view of convenience in carrying out the tests.

CIRCUIT DIAGRAM STUDIES.

W. WHEELER.

THE intricacies of modern telephone circuits and the considerable staffs regularly using diagrams on maintenance, installation, and development work have often impressed the writer as forming a subject on which economy in time and mental effort might be combined with greater efficiency provided circuit diagrams could be made self-explanatory with regard to movement controls and timings. Hitherto, efforts to improve efficiency appear to have been mainly directed towards depicting circuit connections as simply as possible, so that given some knowledge of the results to be achieved readers may be enabled to ascertain working details of the different interdependent controls by careful examination of the circuit connections.

Failures to memorise many of the innumerable details associated with circuits (together with maintenance duties in which circuit considerations play a minor but necessary part) have often created a hostile attitude towards present day methods which impose considerable memory tests upon officers of all ranks—presenting problems which might perhaps be considered as comparable in some degree with those of the cross-word type. Repeated attempts to analyse

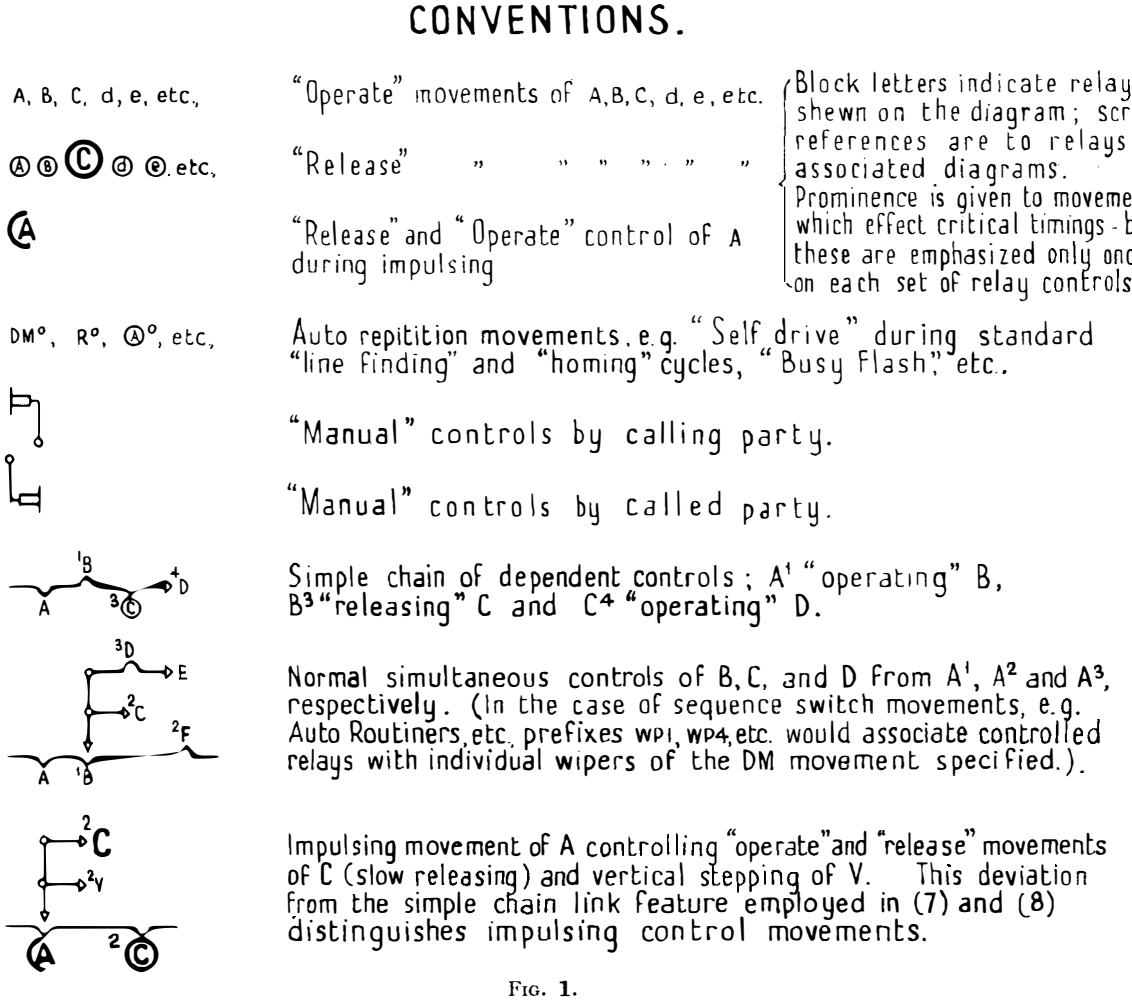


FIG. 1.

the fundamental causes of these difficulties have led, a step at a time, to the development of a scheme which promises an easy, effective and uniform method of approach to these cases. Readers may find an interest in a perusal of the ground covered in these endeavours towards simplification—all attempts which can stimulate effective interest in the cause of simplification must make for progress.

Diagram studies usually resolve themselves into threading one's way through chains of relay and magnet movements, in which process memory and skill combine in endeavours to get a correct appreciation of each function performed in the various chains of auto and manual-auto movements. Much time is often spent in locating detached contacts (which, together with relay coils, are uniformly distributed about the diagram) these searches interrupting the continuity of efforts to get a complete mental picture of all features. A more efficient method would be to employ records which detail in concise terms and correct sequence all movements and controls. Employing such aids and consistently working from the " supply " side (*i.e.*, battery or earth) of each relay, magnet coil, or lamp, towards given " direct control " contacts one is able to make accurate and rapid progress through a circuit. To the writer's mind the simplest way of depicting controls and sequences would be by the employment of graphs or key diagrams on the circuit connection diagrams. Such records of causes and effects would be analagous to moving pictures (" moving " at one's own speed and available when wanted) in which authoritative records of individual controls could be examined as desired with a mind freed from the need for determining the designers' sequences and from consideration of preceding control links.

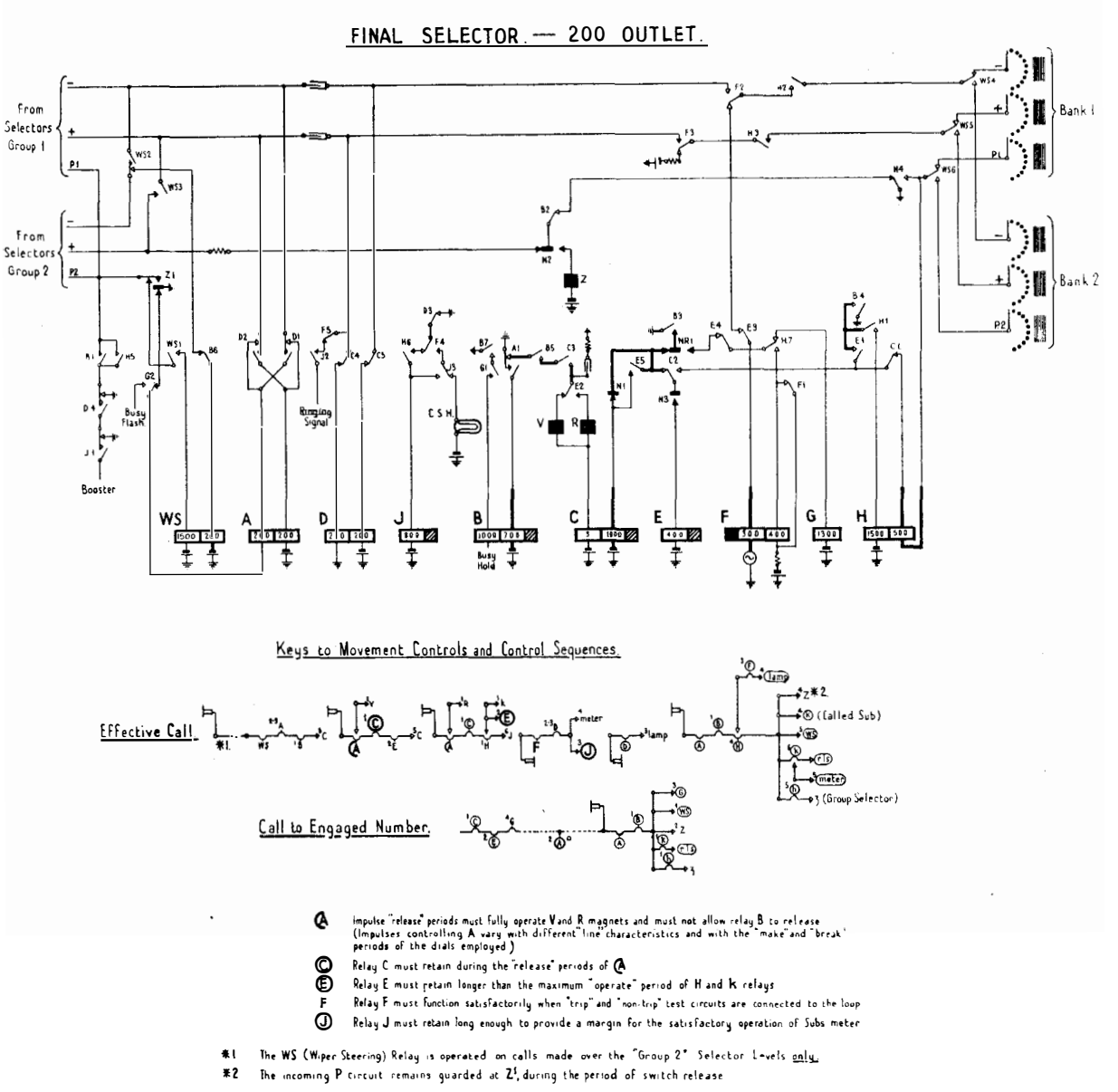
There is sometimes difficulty in gaining a clear conception of the critical " timed " controls which operate simultaneously with others; the employment of sequence diagrams seems likely to be of special value in this connection. As will be seen from the specimens given, these diagrams enable a reader's attention to be easily directed to those operating or releasing movements which have to fulfil the " timing " requirements essential to satisfactory functioning. Such pointers would be of value when a proposed circuit is under review—clearly indicating also to the maintenance staffs and to students the weaker or marginal links.

In order to lead up to the point where circuit closing actually takes place, written circuit descriptions are usually punctuated by references to the movements of circuit-preparing contacts. In the scheme suggested, " operating " and " releasing " controls only are quoted, there being no necessity for the majority of purposes to make direct references to the closure of circuit-preparing contacts. In order, however, to enable the features in design to be fully understood at the time a new circuit is being examined, schedules tabulating all the contacts employed might be prepared, brief notes being made against each contact indicating its utility. Such records together with supplementary designing notes based on circuit Laboratory test reports, etc., would doubtless be of value in connection with the consideration of improvements and modifications suggested at a later date.

A list of conventions relating to these proposals together with specimen cases is given. Footnotes relating to the more important control features appear on the specimen diagrams. Some of the points covered by these notes relate to matters which are gradually becoming general information and there may be differences of opinion as to the extent to which detailed notes should appear on all relevant diagrams. In this connection, and bearing in mind the endeavours usually made to memorise the circuit principles generally employed and the significance of the different relay letters, the case of relay " J " in Fig. **5** may be of interest. The releasing time of " J " in Booster Metering Exchanges is generally associated with the period of application of " operate " currents to subscribers' meters. (See Figs. **2** and **4**). The " J " Relay in Fig. **5** connects the Booster battery, but remains locked for the duration of the call. In this instance Relay " B " is disconnected by the operation of " J," the releasing lag of " B " determining the period of application of the metering current. It will probably be remembered that in most Systems " B " relays remain operated until the calling party clears.

It will be seen from the specimen cases given that some variation has been made during the preparation of these diagrams from the lay-out

methods more generally employed. The principal feature aimed at has been the giving of prominence to all the main reference points (relay and magnet coils, etc.) involved in detailed examinations of the controls. The connections to the "operate" windings of ordinary 2-coil relays are shown in heavy lines when the windings have different functions.



(A) Impulse "release" periods must fully operate V and R magnets and must not allow relay B to release (Impulses controlling A vary with different "line" characteristics and with the "make" and "break" periods of the dials employed.)

(C) Relay C must retain during the "release" periods of (A)

(E) Relay E must retain longer than the maximum "operate" period of H and K relays

F Relay F must function satisfactorily when "trip" and "non-trip" test circuits are connected to the loop

(J) Relay J must retain long enough to provide a margin for the satisfactory operation of Subs meter

*1 The WS (Wiper Steering) Relay is operated on calls made over the "Group 2" Selector Levels only.

*2 The incoming P circuit remains guarded at Z^1, during the period of switch release

FIG. 2.

The following notes relate to the different circuits dealt with:—

Fig. **2.** *200 Outlet Final Selector.*—This type of switch affords access to a subscribers' multiple of 200 lines capacity. Double sets of wipers are employed together with a 20-level bank of the standard 10-point type. The addition of a single relay (known as the Wiper Steering relay) furnishes the additional controls necessary. Certain improvements in circuit design are, however, being introduced with this new rank of Switch.

Fig. **3.** *Dialling-in Repeater.*—These repeaters which are in use in a number of Pro-

vincial Exchanges link the interests of Manual and Auto Exchange Staffs. This type of repeater is being abandoned, but, as a small collection of relays providing controls which cannot be picked up unaided without a certain amount of study, this case has a certain amount of interest. One " slow " relay only is required.

the outgoing side during impulsing with the application of Earth connections to both wires for other signalling and circuit-holding purposes; this Repeater does not include the Shunt Field type relay found in the majority of cases.

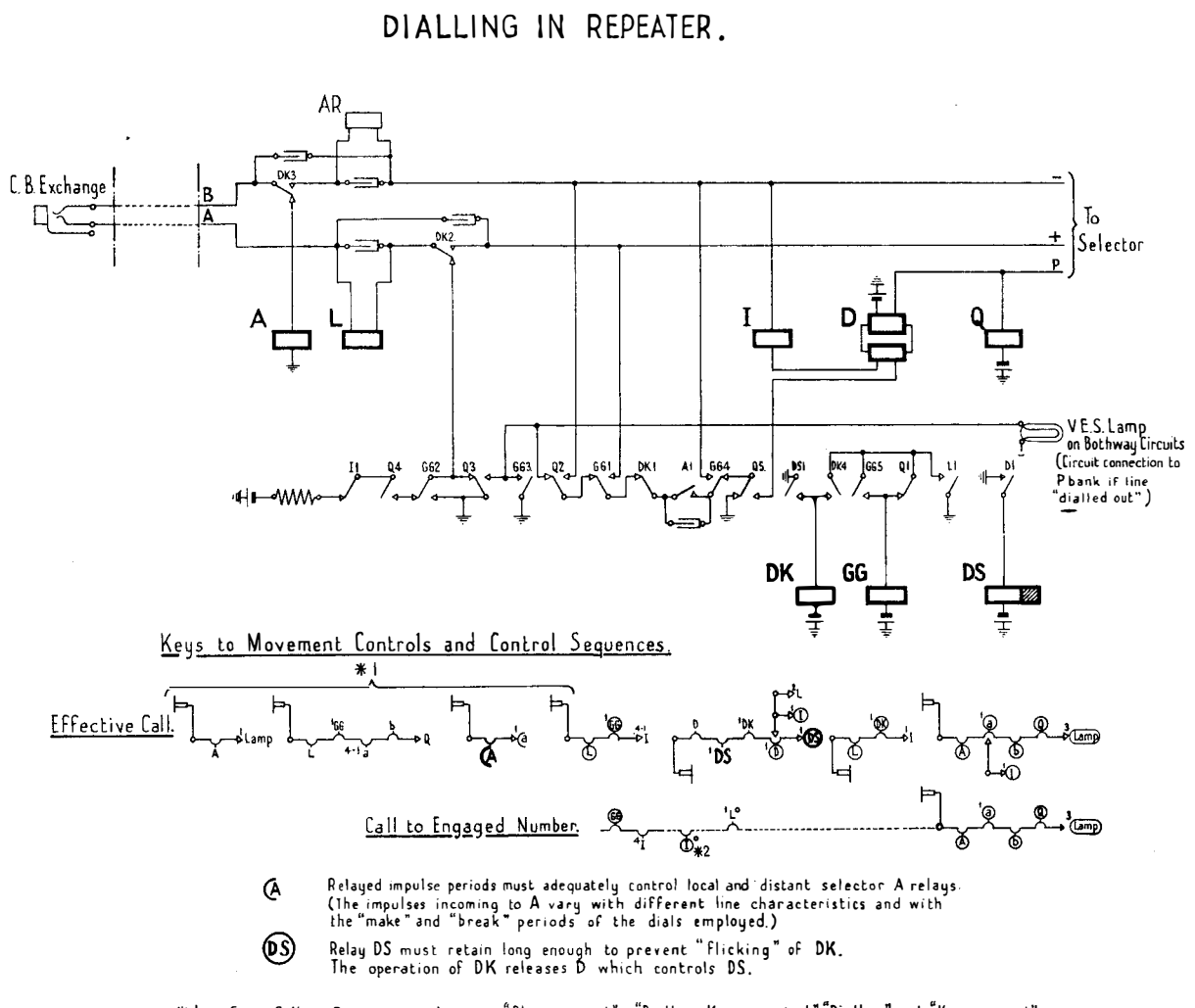


FIG. 3.

Fig. **4.** *Auto-to-Auto Repeater.*—This circuit will be unfamiliar to the large majority of readers. A point of interest here is the inclusion in one diagram of two features which, although not new in themselves, have not been combined in one circuit hitherto. These features are:—

(*a*) The employment of loop conditions on the outgoing side during impulsing with the application of Earth connections to both wires for other signalling and circuit-holding purposes; this Repeater does not include the Shunt Field type relay found in the majority of cases.

(*b*) The current reversal is arranged on the supply side of the windings of the A relay, a condenser being bridged across this supply. These features aim at the suppression of clicks.

Fig. **5.** *Satellite-to-Main Auto Repeater.*—This repeater is associated with a Discriminating

Selector scheme and is employed beyond the point in each call where discrimination takes place, only when the call has to be routed *via* the main Exchange. The means of providing the junction engaged (with facilities for his own Auto release) should the external junction circuit be disconnected or short-circuited. Although this facility has been provided in a few areas,

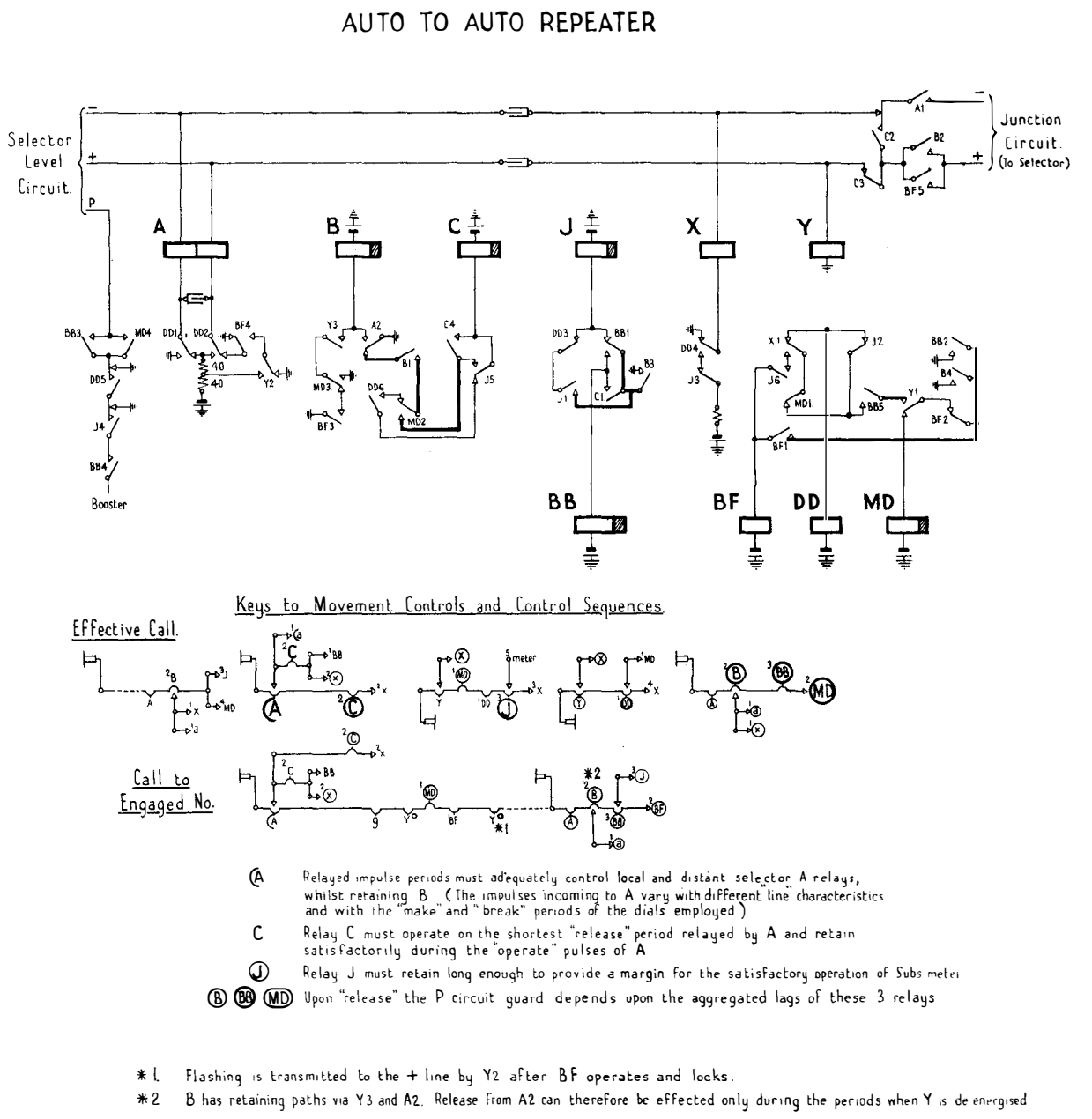


FIG. 4.

"manual hold" facilities are somewhat involved and not very common. Another point of interest is the provision of an "open trunk alarm" facility which causes a calling subscriber to leave the fault liability of junction circuits is not now considered to justify the complication and other costs of standardising this facility.

Objection has been raised to the scheme on the

grounds that circuit diagrams are already overloaded and that any efforts at providing readers with improved facilities would make the work of understanding circuits too easy, resulting in a less complete grasp of detail and a less sound final understanding of circuits. While such an argument may have some value in the case of a few officers whose sole work is connected with circuit design, the author thinks it invalid when applied to the vast majority of officers to whom economy and efficiency in the conduct of fairly large groups appears to depend unnecessarily upon individual intuition. The methods followed in competitive manufacture appear to aim in every practicable way at the elimination from routine work of unnecessary dependance upon individual initiative, in order to set such initiative free for development.

To turn to another aspect of the case, it has been suggested that the methods now proposed

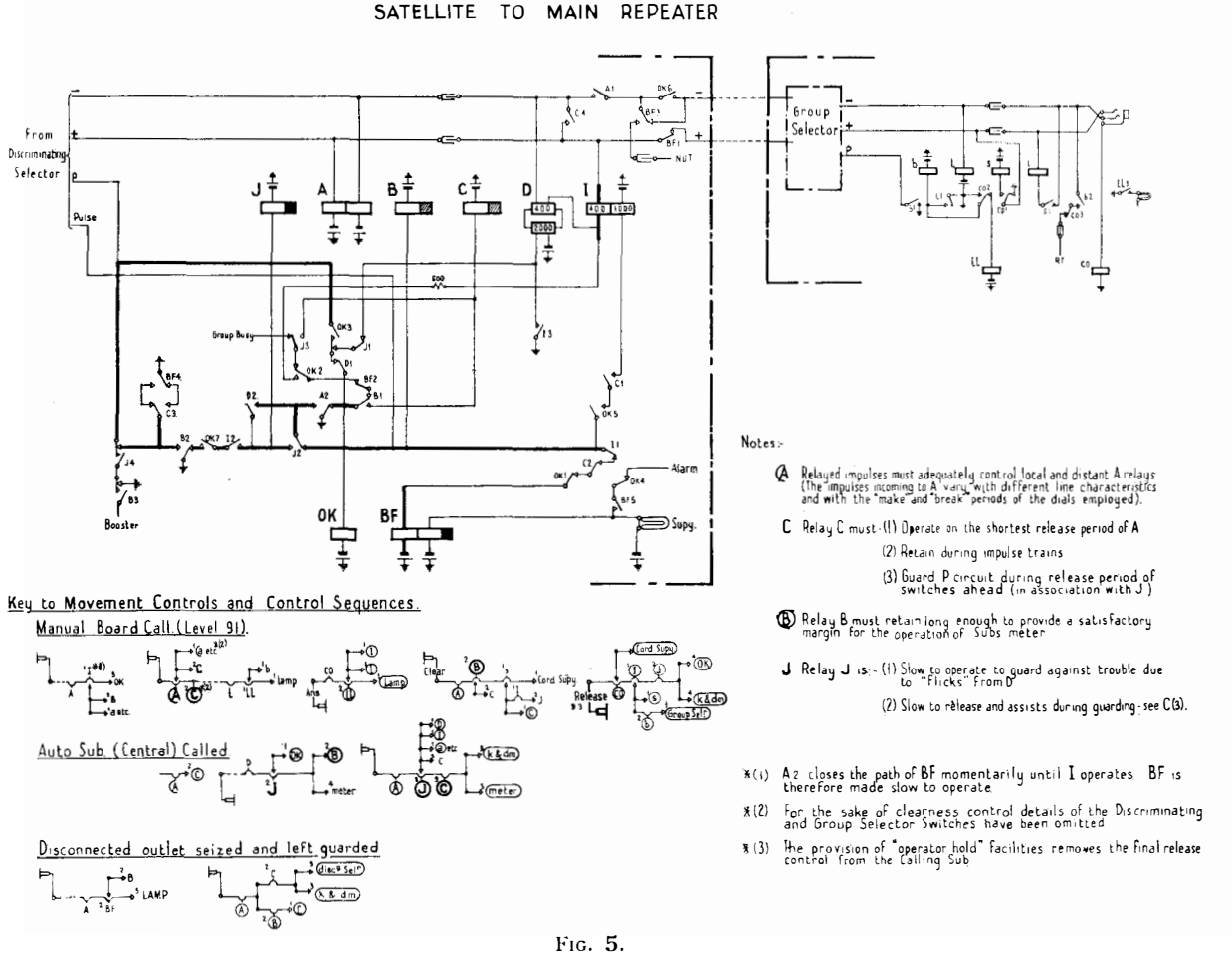


FIG. 5.

circuit considerations represent only one phase of a variety of activities—technical and otherwise. It seems unfortunate that the circuit expert rarely, if ever, gives a lead through the medium of articles in the technical press to show the best method of approach employing existing diagrams, whereby a grasp of these may be within the reach of all without the employment of memory cramming methods. In the absence of such guidance, are inadequate for the more complicated cases (*e.g.*, Director working), where the setting up of each call involves inter-working between different multi-relay groups. The reply to this is that the case as put forward is believed to furnish a complete framework of principles quite capable of practical adaptation to the most complicated problems. It is not disputed that skill and care may be necessary—careful thought is often neces-

sary in the efficient presentation of complex cases.

In framing the present proposals, endeavour has been made to attain clearness with regard to main principles, and to avoid an undue amount of application detail. It is believed that undue attention to application details can obscure the value of main principles when men are confronted with proposals which stand in contrast with methods which have been followed for years.

Quite apart from the provision of sufficient space to permit of the inclusion of control details on the front of circuit diagrams it is conceivable that some convention scheme of detailing controls might offer advantages in Maintenance Bulletins, Circuit Laboratory Reports and Journal Articles, etc., over the lengthy written circuit descriptions. Students and teachers might also gain some relaxation from a certain amount of study, hurried note making, and lecture work in class by the employment of simple convention "explanations."

Any complete scheme of Automatic Switching —and the same may be said of many principal sections of such schemes—furnishes a good example of "team" work accomplished by very numerous "members" or team components capable of causing complete failure. In many of the present day circuits different contractors employ different means of accomplishing the same end. In the present writer's view the case for the association with each auto diagram, of a simple authoritative record of the place and control function of each team component is well beyond dispute, provided an acceptable scheme can be developed.

TELEGRAPH AND TELEPHONE PLANT IN THE UNITED KINGDOM.

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

No. of Telephones owned and maintained by the Post Office.	Overhead Wire Mileages.				Engineering District.	Underground Wire Mileages.			
	Telegraph.	Trunk.	Exchange.	Spare.		Telegraph.	Trunk.	Exchange.	Spare.
649,664	529	3,968	52,596	122	London	24,964	93,400	2,479,629	106,842
85,166	2,150	21,058	67,971	2,408	S. East	4,053	56,911	235,840	28,575
88,417	4,498	31,560	61,261	3,641	S. West	21,577	14,338	170,173	66,214
70,645	6,329	38,709	63,905	4,478	Eastern	24,644	42,305	146,308	66,625
102,828	8,644	45,161	62,048	4,259	N. Mid.	32,492	56,469	258,911	112,328
86,862	4,828	30,577	76,008	4,310	S. Mid.	12,266	27,423	207,756	84,734
60,963	4,805	29,942	55,951	3,482	S. Wales	6,579	28,264	134,506	70,968
111,379	7,926	26,962	52,766	4,077	N. Wales	13,899	42,147	296,331	60,556
165,951	1,476	15,751	44,346	3,098	S. Lancs.	14,631	81,518	503,262	49,159
97,885	6,212	30,262	48,064	3,682	N. East	13,189	45,516	258,117	74,850
67,516	3,893	23,971	39,651	2,728	N. West	8,588	36,210	174,320	30,186
50,180	2,577	16,138	26,668	2,809	Northern	6,861	20,200	135,431	41,315
22,646	4,541	8,788	13,664	531	Ireland N.	137	2,909	51,148	2,650
69,906	5,412	27,047	39,564	1,273	Scot. East	5,874	15,241	161,541	43,245
92,320	7,238	24,447	44,069	1,077	Scot. West	12,252	26,124	228,249	34,994
1,822,328	71,058	374,341	748,532	41,975	Total	202,066	588,075	5,441,522	873,241
1,793,252	70,880	371,967	736,838	41,538	Figures as at 30th June, 1929.	198,580	561,582	5,348,082	881,136

LONDON AUTOMATIC EXCHANGE SYSTEM: SATELLITE WORKING.

H. MORTIMER
(Engineer-in-Chief's Office).

ON July 20th, 1929, Satellite working was introduced in the London Automatic Area by the opening of the Maida Vale and Edgware Automatic Exchanges, which form part of a Satellite Scheme in the London area. Hendon and Colindale were opened on 23rd November, and 3rd October respectively.

The parent or main exchange is Maida Vale, the satellite exchanges being Edgware, Hendon and Colindale; Colindale being worked hypothetically on the Hendon equipment until 1932 when Colindale becomes a main exchange. A few particulars concerning each exchange are as follows:—

Exchange.	Multiple Capacity.	Lines transferred at opening.		Contractor.
		Subscribers.	Junctions.	
Maida Vale	7,600	2,115	991	Siemens Bros.
Hendon ...	3,200	1,993	180	Automatic Telephone Manufacturing Co., Ltd.
Colindale ...	1,200	497	251	Automatic Telephone Manufacturing Co., Ltd.
Edgware ...	1,300	748	151	General Electric Co., Ltd.

The following positions have been provided in Maida Vale Automatic Exchange building:—

Positions.	Maida Vale.	Hendon and Colindale.	Edgware.
		*	
A	←	35	→
B	8	2	1
Monitors	←	1	→

* Includes Supervisors and Service Positions.

As in the usual satellite working for Non-Director Areas the common equipment is situated at the main exchange, in this case in Maida Vale Automatic Exchange; the switching plant at the Satellite exchanges comprising Discriminating Selector Repeaters and Junction Finders, 1st and 2nd Numerical and Final Selector Switches. It will be observed that no A digit, or Director switches are provided at the Satellites, these being fitted at the Main Exchange and are common plant for the whole area.

It should be stated that the D.S.Rs. (see photograph) which are fitted at the Satellite exchanges have been developed by British Post Office engineers, and are now standard both for Director and Non-Director areas. The circuit of the Repeater has been designed to discriminate either on the 1st, 2nd or 3rd digit and to give the usual standard supervision; the rest of the apparatus at the Satellite exchanges is of the standard type used in all exchanges in Director areas.

The trunking arrangements at the Main and Satellite exchanges are somewhat complicated as compared with a Straight Director exchange, therefore it is proposed to briefly explain the routing of the various classes of calls and the reasons for so doing. The straight line trunking diagram for Edgware and Maida Vale should be considered in conjunction with the notes.

EDGWARE AUTOMATIC EXCHANGE.

The routing shown for Edgware can be taken as typical of the other satellite exchange.

It will be observed from a perusal of the diagram that separate groups of Rotary Line Switches and D.S.Rs. are provided for the Main and Barred trunk groups of subscribers respectively, this being necessary so that all calls, other than unit fee calls, can be trapped on the Auto Manual board at Maida Vale, in the case of the Barred Trunk Group.

To avoid transmission losses on calls *via* Toll,

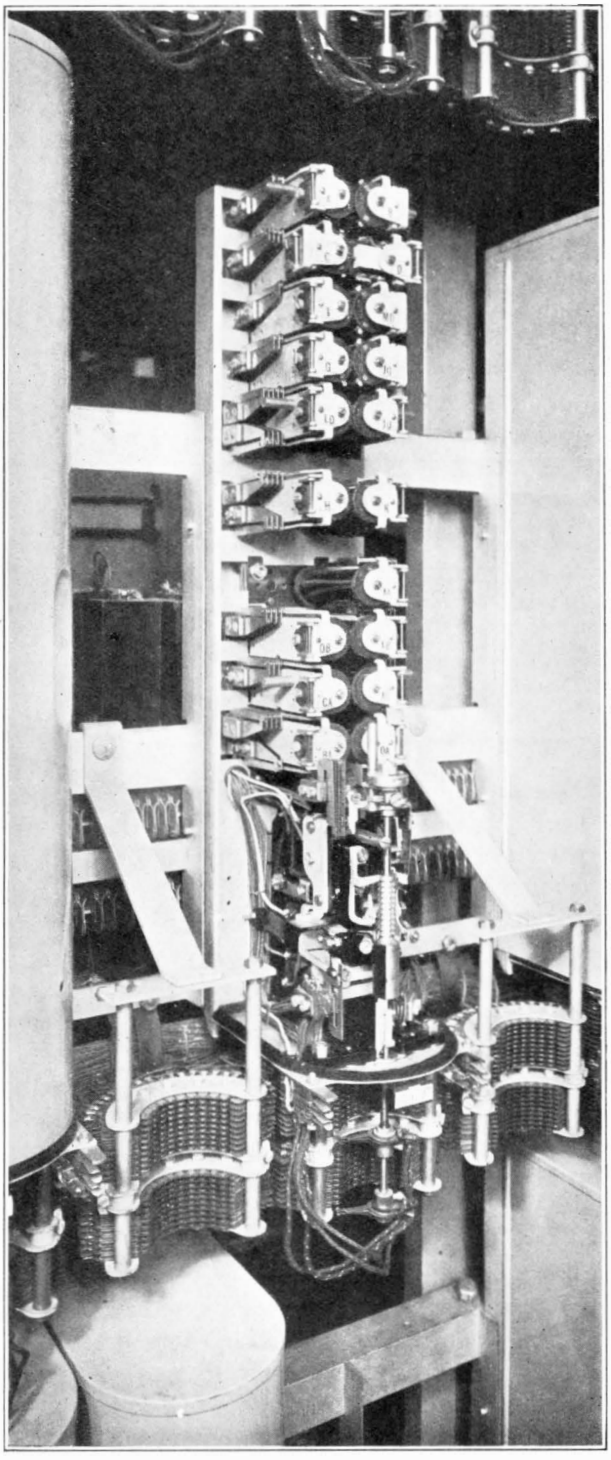


FIG. 1.—DISCRIMINATING SELECTOR REPEATER.

high-grade circuits are provided direct from level 5 of the D.S.Rs., the discrimination taking place after L has been dialled; it is also necessary to provide direct high-grade circuits from O level of the D.S.Rs. of the Barred Trunk Group, so as to avoid transmission losses on calls completed *via* the Auto Manual Board to Toll, etc. It is of course recognised that Coin Box Subscribers can obtain Toll Calls, the fee being collected by the A operator in the Maida Vale Auto Manual Exchange.

Had the Barred Trunk O level calls been routed from a 2nd Code level at Maida Vale, additional transmission losses would have been introduced by the O level calling equipment at Maida Vale.

It will perhaps be convenient at this stage to describe the routes of the various classes of calls from Edgware Auto Exchange (Satellite).

Main Group Subscribers.

(1) *Local Calls.* Assume that the Edgware subscriber requires Edgware 1234. On the calling subscriber lifting the receiver, the Rotary Line Switch seizes a free D.S.R. and also an Incoming 1st Code Switch at Maida Vale *via* a Junction Finder Line Switch. The calling subscriber dials E, and D.S.R. steps up to level 3 and then releases. D is then dialled, the switch steps up to level 3 and again releases, and the same occurs when G is dialled, except that the 4th level is now reached and again released. When the 1 is dialled the D.S.R. now functions as a 1st Numerical Selector and a corresponding 2nd Numerical Selector is seized. The rest of the figures are dialled on to the remaining switches in the usual way.

It should be stated that during the time the subscriber is dialling EDG, the A digit and Director switches at Maida Vale will have been operated, but on the discrimination taking place, *i.e.*, after G has been dialled, the junction and switches at Maida Vale are released for further use.

(2) *Toll.* TOL is dialled by the subscriber, and the D.S.R. and the switches at Maida Vale respond similarly to those for a local call. The discrimination takes place on L (5); the junction and switches at Maida Vale are then released, and the caller connected direct to Toll.

(3) *Hendon.* HEN is dialled, and in this case discrimination takes place on N being dialled. The D.S.R. in this case acts as for a local call, *i.e.*, the 4 numerical digits being dialled

on to the 1st, 2nd and Final Selectors Switches at Hendon. Direct junctions are provided between Edgware and Hendon, which terminate on 1st Numerical Selectors in Hendon Automatic Exchange.

(4) *Colindale.* Although the Colindale Equipment is part of the Hendon plant, a call for Colindale from an Edgware or Hendon subscriber has to be routed *via* the main exchange, as it will be seen that the codes TOL and COL are similar. Therefore, as Toll calls are routed direct *via* the D.S.R (level 5) it becomes necessary to route Colindale traffic *via* Maida Vale in a similar manner to a junction call.

to the A positions in the Auto-Manual Board in Maida Vale Auto Exchange. There the route procedure is as stated for a junction call.

(7) *Test Desk.* In this case the engineering officer dials XMA or XMD, the call is routed *via* Maida Vale as for a junction call. Local discrimination is not given for Test Desk calls, as several of the exchange names in the London area begin with W (9). It therefore becomes necessary to route the Test Desk traffic *via* the main exchange, two junctions being used, *i.e.*, one to Maida Vale and one back to Edgware 1st Numerical Selector Switches from level 36 of 2nd Code Selector switches at Maida Vale.

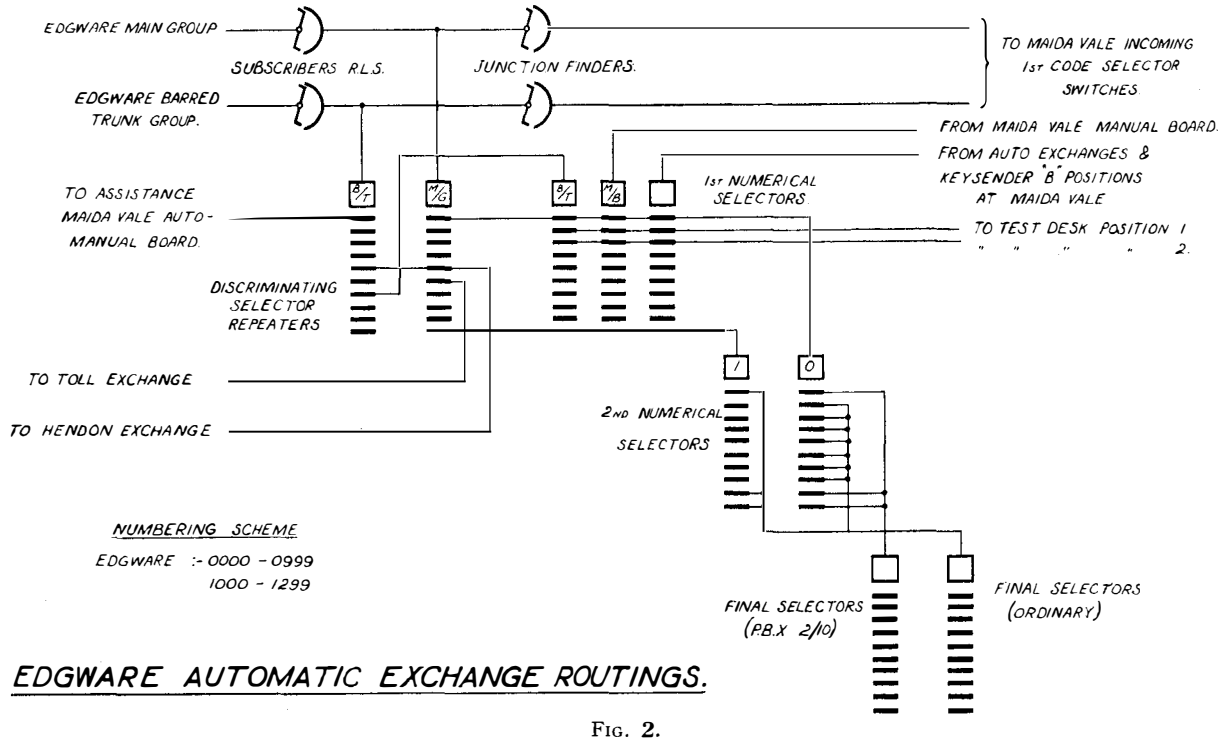


FIG. 2.

(5) *Junction Calls.* Assume Brixton 2345 is required, the D.S.R. junction and the Incoming 1st Code Switch at Maida Vale is seized in the usual way. When B is dialled the D.S.R. steps up to level 2, junction discrimination takes place, and the D.S.R. remains on level 2 until the completion of the call, but the wipers are disconnected so that no interference on this level takes place. The call is then routed *via* the plant at Maida Vale as in other Director Exchanges.

(6) *Level O.* This traffic is routed off 2nd Code Selector switch levels at Maida Vale direct

Barred Trunk Group Subscribers.

(1) *Local Calls.* Owing to the fact that O level calls are routed direct from the O level of the D.S.R., for reasons stated previously, it is necessary to provide a separate group of 1st Numerical Selectors for local calls. In this case local discrimination takes place when G has been dialled.

(2) *O Level Calls.* O is dialled by the calling subscribers, and immediately a free outlet is obtained the junction to the Incoming 1st Code Switch at Maida Vale is released, and the caller

connected direct to the A position at Maida Vale. Local discrimination takes place in this class of call.

Barred trunk subscribers requiring calls other than local and junction calls, (unit fee) should dial O, but in case the caller dials TOL or TEL or TRU, a separate group of circuits are provided at Maida Vale for "trapping purposes." See notes on Maida Vale.

(3) *Excess Fee Calls.* (Main and Barred Trunk Group Subscribers). Several exchanges in the London Automatic Area are excess fee calls to the Satellite exchanges. Therefore it is necessary to adopt some means of recording all excess fee calls originating from these exchanges. To do this, means are provided at Maida Vale for routing all excess fee calls to the Auto-Manual board, where the calls are completed by the A operators. The actual routing is given in the Maida Vale notes.

(4) *Incoming Calls.* A group of 1st Numerical Selector switches are provided at each Satellite exchange, to which the A operators on the Automatic Manual Board at Maida Vale have access. Only four numerical figures have to be dialled in this case. Groups of 1st Numerical Selector Switches are also provided at each Satellite exchange for calls originating in manual and automatic exchanges. In some cases, the traffic from automatic and manual exchanges is routed *via* Tandem, and in others those from the automatic exchanges are routed direct to the 1st Numericals at the satellites; and in the case of the manual exchanges these are routed *via* the Key Sender B positions at Maida Vale or *via* Tandem Key Sender B positions.

Maida Vale Automatic Exchange.

The routings from levels 2, 3, 4, 5, and 6 of 1st Code Selector Switches at Maida Vale Automatic exchange have not been shown, as these routings follow the usual course as for a straight Director exchange. It will be seen that level 1 of all 1st code Selector Switches has been set apart to cater for the "trapping" or excess fee calls, also for calls to Assistance, Trunks, Toll and Telegrams for the Main and each Satellite exchange to the Auto Manual board. The following is a list of the various routings that had to be provided for *via* level 1:—

(1) Calls Excess Fee from Edgware and not to Hendon or Colindale.

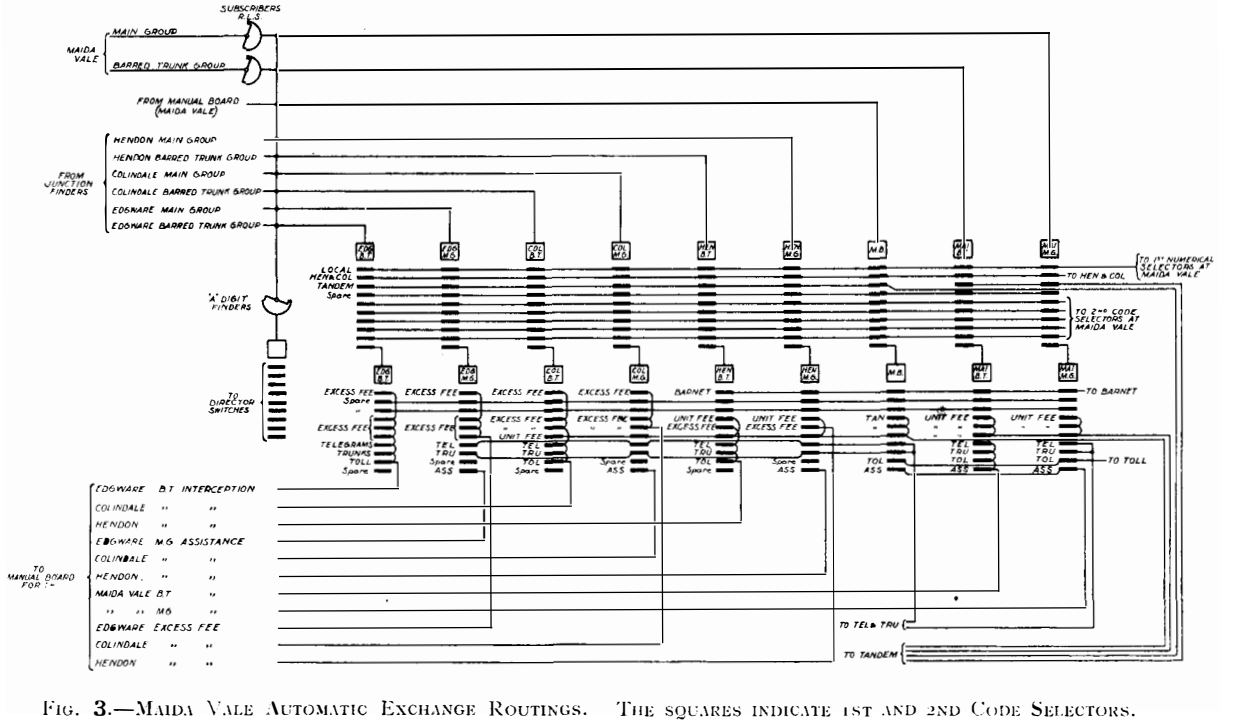


FIG. 3.—MAIDA VALE AUTOMATIC EXCHANGE ROUTINGS. THE SQUARES INDICATE 1ST AND 2ND CODE SELECTORS.

(2) Calls Excess Fee from Edgware, Hendon and Colindale.
(3) Calls Excess Fee from Edgware and Colindale, but not from Hendon.
(4) Assistance Calls for Edgware main group of subscribers.
(5) Assistance Calls for Hendon main group of subscribers.
(6) Assistance Calls for Colindale main group of subscribers.
(7) Assistance Calls for Maida Vale main and Barred Trunk group of subscribers.
(8) Interception circuits for Edgware barred trunk group of subscribers.
(9) Interception circuits for Colindale barred trunk group of subscribers.
(10) Interception circuits for Hendon barred trunk group of subscribers.
(11) Calls to Telegrams, Trunks for each of the Satellite and Main Exchanges.

Attention is drawn to the fact that the Incoming 1st Code Selector Switches provided at Maida Vale for the Satellite exchanges are somewhat different from those of the ordinary type fitted in Director exchanges, as it is necessary for these switches to send back to the Satellite exchange reversed battery conditions for metering purposes, a condition which is not required in a straight Director exchange 1st Code Switch. These Incoming 1st Code Selector Switches have been developed by the British Post Office engineers and are now accepted as standard.

It will perhaps be as well, at this stage, if the routing from each level of the 1st and 2nd Code Selector Switches was explained in Level order. The levels set apart for the "trapping" of excess fee calls are as follows:—

Calls Excess Fee to Edgware and not to Hendon and Colindale, Level 15.
Calls Excess Fee to Edgware, Hendon and Colindale, Level 16.
Calls Excess Fee to Edgware and Colindale only, Level 17.

As there are no excess fee calls from Maida Vale subscribers, no special arrangements have to be made in this case; therefore levels 15, 16 and 17 route unit fee call *via* Tandem exchange.

Levels 1, 2, 3, 4, 5 and 6. 1st Code to 2nd Code. Selector Switches.

Level 7. Spare.

Level 8. This level is set apart for all unit fee calls routed *via* Tandem from the Satellite exchanges, and the Auto Manual board. The junctions to Tandem are of high-grade type, and are provided so as to avoid transmission losses. Level 8 also covers the traffic routed *via* Tandem for Maida Vale subscribers; high-grade circuits are not required in this case.

Level 9. For all calls to Hendon subscribers from Maida Vale, and to Colindale subscribers from Maida Vale and Satellite exchanges.

Level 0. Calls from all the area subscribers are routed *via* this level to the Maida Vale subscribers.

Level 11. (Assistance).

It will be seen that separate groups of circuits have been provided for Assistance calls for each Satellite Main group of subscribers, and also separate groups of circuits for the Main Exchange Main group, and Barred Trunk group of subscribers; this being necessary so that the operators at the Auto Manual board can identify the origination of the call.

No circuits are provided for the Satellite Barred Trunk group of subscribers, as it will be seen that Assistance calls in this case are routed direct from the O level of the D.S.R. at the Satellite exchange. (See notes on Edgware).

Levels 12, 13 and 14. In the case of the Barred Trunk group of subscribers from the Satellite exchanges, these levels are teed together and connected to the Auto Manual board, this arrangement being desirable so that should a Coin Box subscriber dial TOL, TRU, or TEL the call will be routed to the Auto Manual board. Of course, as previously stated, a Coin Box subscriber should dial O for all calls other than unit fee, and as Call offices are often used by regular subscribers who are in the habit of dialling TOL, etc., from their own telephone, it was decided to guard against this happening by the provision of a special group of circuits shown as BT interception.

Should a call be received on these circuits at the Auto Manual board, the subscriber will be unable to speak to the operator unless the subscriber presses Button A on the Coin Box, in which case the operator will then complete the call, but should the operator be unable to hear the calling subscriber, the operator will inform the subscriber to dial O for the call and press

Button B (which returns the coins to the caller).

Level 15. This level is set apart for the purpose of routing excess fee calls from Edgware Main group subscribers to the Auto Manual board, and it will be seen that a separate group of circuits have been provided for this purpose. It will also be noticed that level 15, to which Hendon and Colindale Main and Barred Trunk subscribers have access, is available for unit fee calls and is not therefore "trapped" on the Auto Manual board. For excess fee calls from the Edgware Barred Trunk subscribers, it will be seen that levels 15, 16, 17 and 10 are teed to levels 12, 13 and 14 and routed to the Manual board. The subscriber should, in these cases, dial O, as previously stated; therefore this class of call will not be considered when the routing of excess fee calls from the Satellite Main groups is being explained. For the Maida Vale Main and Barred Trunk subscribers, level 15 is a unit fee call level, and these calls are routed *via* Tandem.

The procedure followed when an Edgware subscriber dials for an excess fee call. (The procedure laid down will be the same as that for the other Satellite exchanges). Assume a call is being made to Albert Dock 2345, the direct translation will be 1542-2345, 1542 being the translation to route the call *via* Tandem. On the 15 being sent out by the Director Switch, a First Code Switch of the Edgware group steps up to level 1 of the 1st Code, then the 2nd Code Switch steps up to level 5 of the 2nd Code, and an outlet to the Auto Manual board is obtained, the remaining impulses, *i.e.*, 42-2345, being received on the calling lamp on the Auto Manual board. As the calling lamp will flicker under these conditions, the operator delays answering the call until the remaining impulses have been received.

The operator in answering the call ascertains from the subscriber his requirements (in this case ALB 2345); the operator then originates the call *via* the Manual Board 1st Code Selector Switches. The A digit and Director switch again accepts ALB 2345, when dialled by the operator, which is again translated into 1542-2345, but on 15 beng sent out it will be seen that the call is routed to Tandem, and not to the Auto Manual board *via* level 5 of the Manual board 2nd Code Selector Switches, 42 being accepted by the switches at Tandem (level 42 being the level in Tandem for all calls to Albert Dock), the 2345 appearing on the C.C.I. display at Albert Dock Manual Exchange in the usual manner.

Level 15 in the case of the Colindale Main and Barred Trunk group, and also the Hendon Main and Barred Trunk Switches, is provided for calls that are unit fee for these exchanges. The calls originated by subscribers in these groups are routed similarly to calls originated from the Auto Manual board, as quoted in the foregoing paragraph.

Level 16. This level provides for the routing of calls to the Auto Manual board that are excess fee to all Satellite exchanges, and it will be seen that the separate groups of excess fee circuits are required for each exchange, it being necessary to provide these separate groups for identification purposes from a traffic point of view.

The treatment of calls is as stated in the case of excess fee calls for Level 15. Beckenham exchange is an excess fee call from all the Satellite exchanges; therefore a call to Beckenham 2345 will be translated to 1603-2345 and level 16 will route the call to the Auto Manual board in the case of the originating subscribers, and *via* Tandem to Beckenham when the call is originated from the Auto Manual board. Level 16 of the Barred Trunk group is teed to the Barred Trunk Interception circuits for reasons previously stated.

Level 17. This level provides for calls to exchanges that are excess fee to Edgware and Colindale, but not to Hendon. The call is dealt with in a similar manner as for calls on levels 15 and 16.

The calls from Hendon which are unit fee calls are routed *via* Tandem, as will be seen from the routing diagram.

Grangewood is an exchange that is an excess fee call from Edgware and Colindale and a unit fee from Hendon; therefore a call originated by a Hendon subscriber and from the Auto Manual board will be routed *via* Tandem, where Level 58 is set apart for calls to Grangewood, the full translation of Grangewood 2345 being 1758-2345.

Levels 18 and 19 are spare.

Level 10. In this case a direct group of junctions is provided from Maida Vale Auto ex-

change to Barnet, and Barnet being an excess fee call to Edgware and Colindale subscribers but not to Hendon, it becomes necessary to set apart a separate level for routing calls to this exchange. The translation in the Director Switch for a call to Barnet 2345 will be 10-2345 and the treatment of the call to this exchange will be as for other excess fee exchanges.

It will be seen that all excess fee calls other than those to Barnet are routed *via* Tandem, this being economical from an engineering point of view.

It is not proposed to explain the routing *via* levels 2, 3, 4, 5, and 6 of the 1st Code Selector Switches, as these follow the usual practice as for other Director exchanges in the London Automatic area.

Incoming Calls (Automatic).—In the case of calls originating at other automatic exchanges in the London area, the calls are routed, either direct from the automatic exchange or *via* Tandem exchange. In the case of direct routing the incoming junctions terminate on separate groups of 1st Numerical Selector Switches, either in the Main or Satellite exchanges, but if the calls are routed *via* Tandem a group of 1st Numerical Selector Switches at the Main or Satellite exchanges are utilised.

Incoming Calls (Manual).—Calls from these exchanges are routed *via* the Key Sender B positions at Maida Vale. The 1st Numerical Selector Switches for groups of junctions from each Manual exchange provided with direct groups of junctions are situated in the respective exchanges.

A typical example of the routing of an incoming Manual call is as follows:—

The distant A operator demands a call over the order wire, say, to the operator on the Edgware Key Sender B position in the Maida Vale exchange. The operator on this position keys up the four numerical digits, and the selector switches at Edgware respond to the impulses sent out by the sender. (A common group of senders is provided at Maida Vale for all Key Sender B positions).

If a call is received for Maida Vale, or Hendon and Colindale the same procedure is adopted, but the respective Key Sender B positions are used and the Selector Switches, at the respective exchanges, are brought into operation.

All incoming calls from manual exchanges which do not warrant direct groups of circuits are routed *via* the Key Sender B positions at Tandem, and are then completed *via* the incoming Tandem group of 1st Numerical Selector Switches at the respective exchanges.

The operators at Tandem in the disposal of these calls, key up the exchange code and the numerical digits. (7 digits).

As it will not be possible to give full details of all the service circuits that are connected to the A position, two of the more important services provided, with remarks thereon, are as follows:—

Monitors and Service Calls.—The usual practice is followed as for other Director exchanges, the code and numbers to be dialled are:—

	Maida Vale	Hendon and Colindale.	Edgware.
Monitor	Mai 0001	Col. 0001 or Hen. 0001	Edg 0001
Service	Mai 0101	Col. 0101 or Hen. 0101	Edg 0101

The calls are routed from the Final Selector Switches at the respective exchanges to the A positions in Maida Vale exchange.

It is not intended that the above monitor circuits should be obtained from subscribers' telephones in the London Auto Area, as registration of the meter would take place when the operator answered. The subscriber is instructed to dial O for all Assistance (Monitor) or Service calls.

The circuits are provided to enable other Auto Manual board and Manual exchange operators to obtain Monitor or Service calls at these exchanges. (Maida Vale, Edgware, Hendon and Colindale).

Centralised Observation. — Observations of subscribers' service are being carried out on a centralised basis in the London Automatic Area. The centralised observation positions are situated in a room in the Metropolitan-National Automatic Exchange building.

To enable subscribers' circuits to be connected for observation, tapping equipments are provided at each automatic exchange. The equipment provided at each exchange in this area is as follows:—

Maida Vale	—14	Tapping equipments	+ 1	Junction.
Hendon	—10	,, ,,	+ 1	,,
Colindale	— 6	,, ,,		
Edgware	—12	,, ,,	+ 1	,,

It should be noted that observation of the subscribers' service at each exchange is on an auto-selective basis; therefore the observation officer has no control over the choice of any particular subscriber's circuit in a group connected to the tapping equipments for observation purposes.

I am indebted to Messrs. Automatic Telephone Manufacturing Co., Ltd., of Liverpool, for the photograph of the Discriminating Selector Repeater.

FULHAM EXCHANGE, LONDON.

Contributed by

STANDARD TELEPHONES & CABLES LTD., LONDON.

BY the opening of Fulham Automatic Telephone Exchange which was successfully brought into service at 2 p.m. on Saturday, 27th July, 1929, another link was added to the rapidly growing network of automatic exchanges in the London Telephone Area.

The exchange has capacity for 9,700 lines, the present equipment being for 7,500 lines; of this number 2,400 were actually cut-over on the date mentioned. The quantity of each type of apparatus installed can be readily ascertained from the diagram (Fig. 1) showing the switching scheme for the exchange.

The exchange is accommodated in a new four-storey building, near the junction of Lillie Road and North End Road, Fulham. The automatic equipment is distributed over the 1st and 2nd floors of this building, whilst the manual switch-

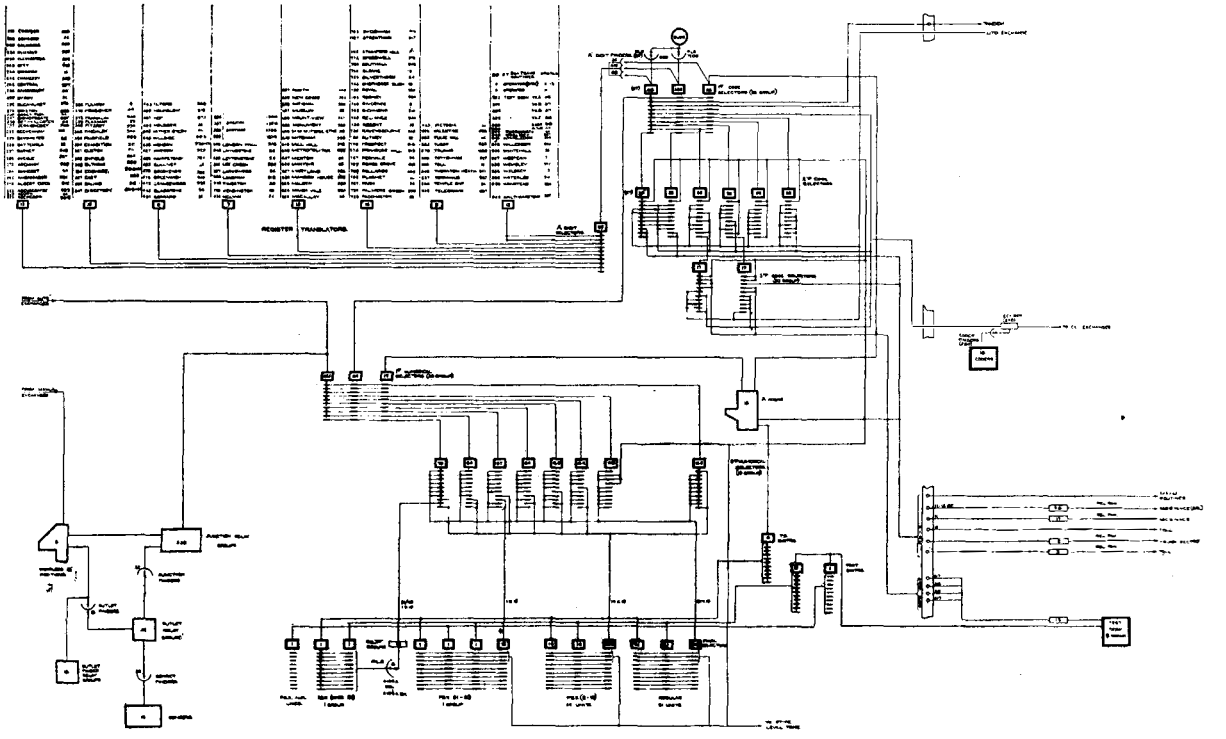


FIG. 1.—SWITCHING SCHEME.

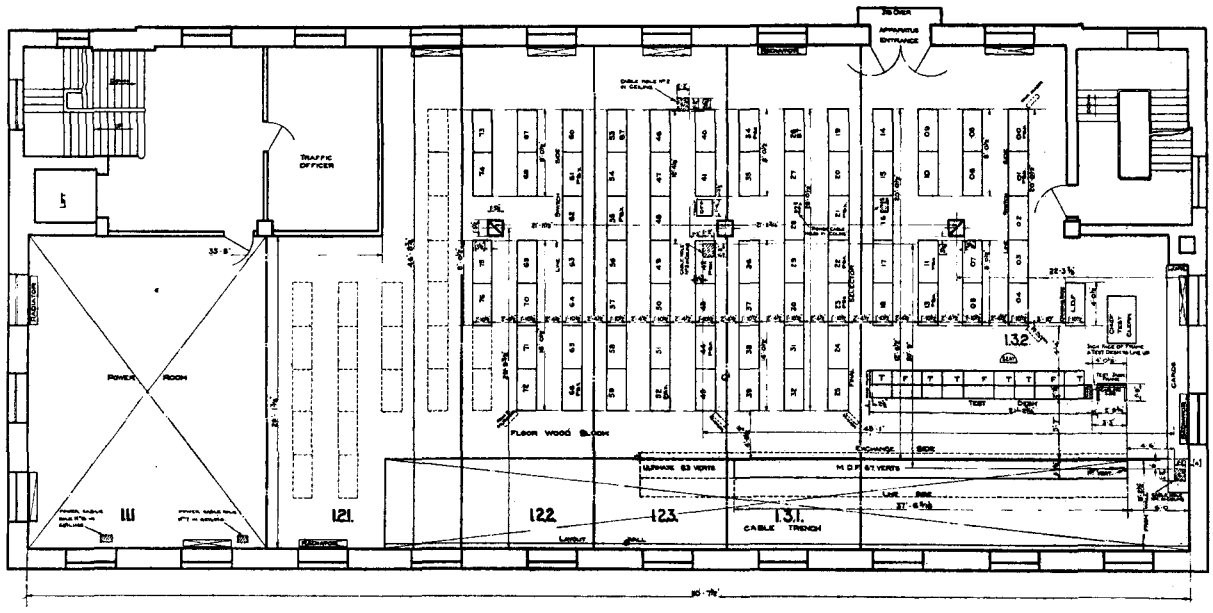


FIG. 2.—AUTOMATIC SWITCHROOM, FIRST FLOOR.

boards are located on the 3rd floor. The lay-out of the equipment on each of these floors is shown in Figs. **2**, **3** and **4**, and it will be seen that the accessibility of all apparatus has been carefully studied, to facilitate maintenance work. The equipment was manufactured and installed by Standard Telephones & Cables, Ltd., and constitutes the first exchange in the London area supplied by this contractor in which the geographical supervisory scheme, designed by the Department's engineers, has been adopted. This scheme enables the maintenance officers to supervise the whole of the equipment from any position in either of the automatic switchrooms. For the exploitation of the scheme the equipment on each floor has been divided into two sections, and six sub-sections. In a prominent position on each apparatus floor, is situated an alarm

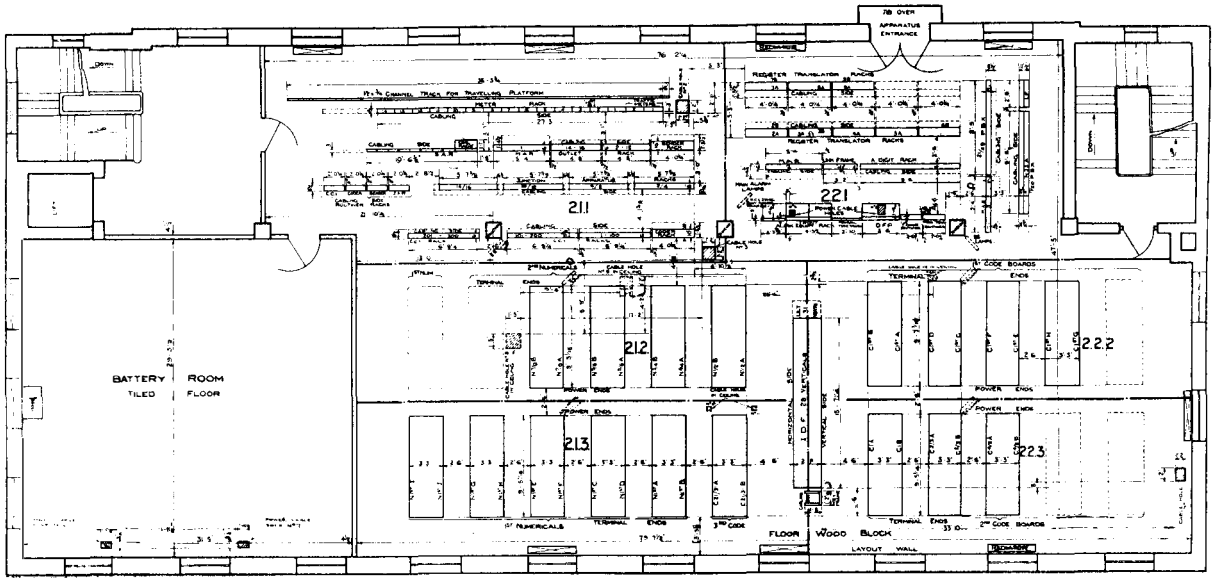


FIG. 3.—AUTOMATIC SWITCHROOM, SECOND FLOOR.

centre consisting of illuminated indicator boxes, which, in the event of a fault occurring show on which floor and in which section the faulty apparatus is located. The rapid location of the fault is further facilitated by the provision of section and sub-section supervisory lamps.

First Floor.—On the 1st floor are found the subscribers' line and final selector units, the link distributing frame, the M.D.F., and test desks, whilst at the other end of the same floor, the charging machines and the power board are located.

and the " A " digit and register translator racks immediately to the rear, whilst their respective routiners are in line with them.

The minor switches on the register translators are fitted with the cup spring in place of the spiral spring originally adopted.

A new design of " A " digit rack has been introduced, having all the apparatus on one side only, and in line with each level of switches is situated the grading and routiner access equipment associated with it. This feature also

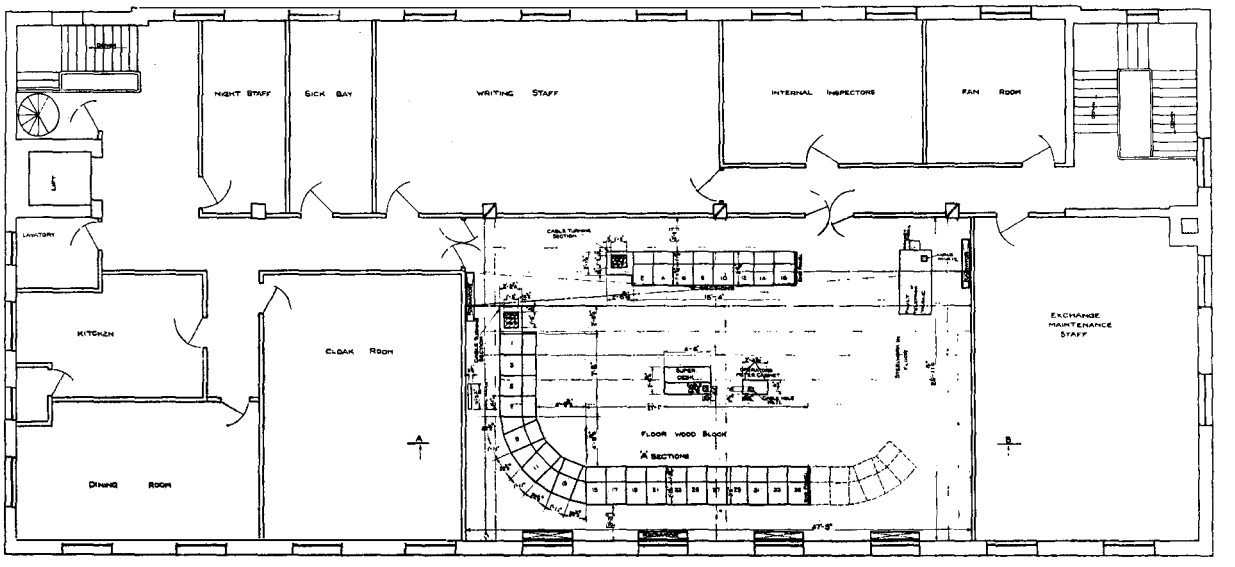


FIG. 4.—MANUAL OPERATING ROOM.

The equipment is so arranged with relation to the windows that full advantage is taken of the daylight. In Fig. **5**, in which a view of the subscribers' line and final units is shown, it will be observed that busbars are used for power distribution. These are of special interest since they are of aluminium, and Fulham is the first telephone exchange to be opened in this country where aluminium busbars have been employed for power distribution.

Second Floor.—This floor carries the remainder of the automatic equipment and exchange apparatus, the lay-out of which has been very well arranged. The Message Register Rack is placed facing the window so that under normal daylight conditions no artificial light is required. The distribution fuse panel and alarm equipment racks are situated in the centre of the room with the 1st code selector boards in front, appears on the P.B.X. final selector rack. The C.C.I., coder, sender, and junction apparatus routiners, shown in Fig. **7**, are adjacent to the apparatus with which they are associated.

A view is included of the 1st code selector racks in Fig. **8**: the two sides of each of the 1st code selector racks can now be dissociated for N.U. tone and busy flash, a new U-link being embodied in the type of distribution point now employed.

The local alarm lamps on the sender racks consist of P.O. No. 2 lamps, mounted on phenol fibre fuse panels, at about shoulder height, instead of the tubular pattern hitherto employed and mounted at the top of the racks.

Three miscellaneous apparatus racks are accommodated on the 2nd floor, of which one is for the " O " level and linesmen's circuits, one for T. and T.O. distributors, and T. and T.O.

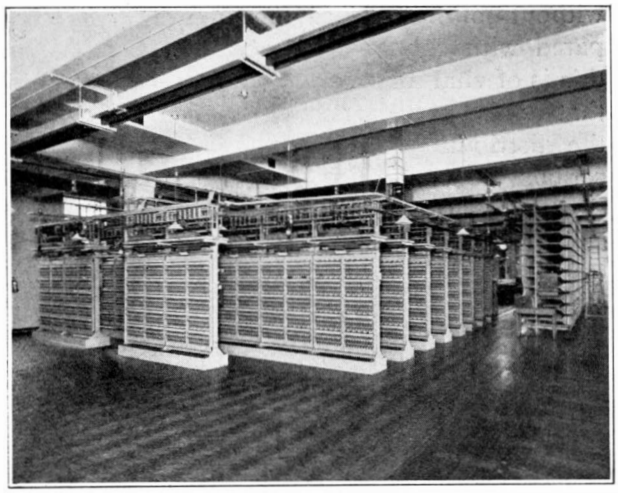


FIG. 5.—SUBSCRIBERS' LINE AND FINAL SELECTOR UNITS.

and P.B.X. final selectors, and the third is for changed number circuits. The object of the last-named circuit is to route a call for a subscriber whose number has been changed, directly and automatically to a changed number jack on the manual board, where an operator informs the caller of the new number and completes the call.

One noticeable feature of the automatic rooms is the quieter operation of the equipment, steps having been taken to reduce noise wherever possible; as an example the new type of time pulse count relays may be mentioned. In this case the interminable . . . "clack" . . . . "clack" . . . of the relay-operated pivoted rachet, has been eliminated by utilizing a switch of the RLS type which takes a step every 1½ seconds until the delayed alarm period contact has been reached.

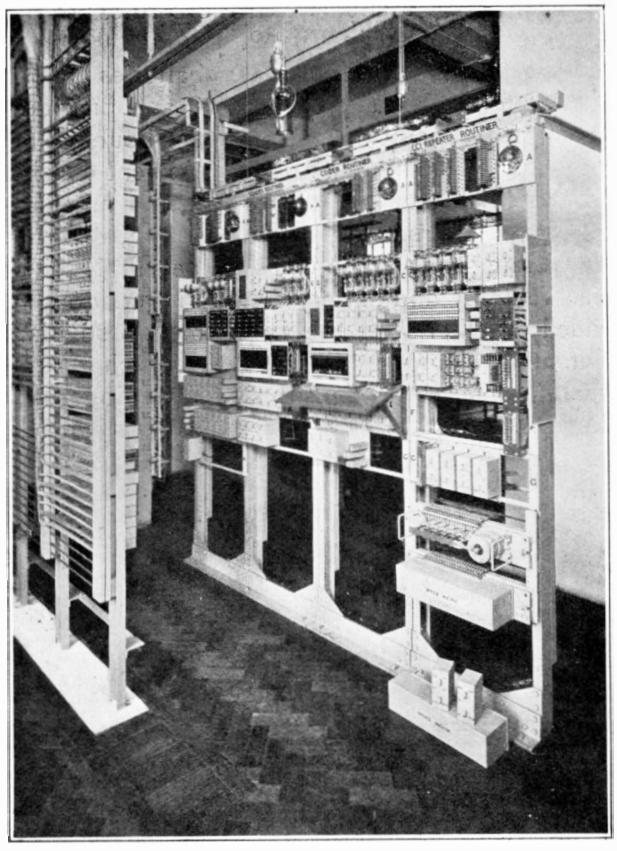


FIG. 7.—ROUTINERS.

Third Floor.—The manual operating room is a light, well ventilated apartment at the top of the building. A view of this room showing the

FIG. 6.—TEST DESK AND M.D.F.

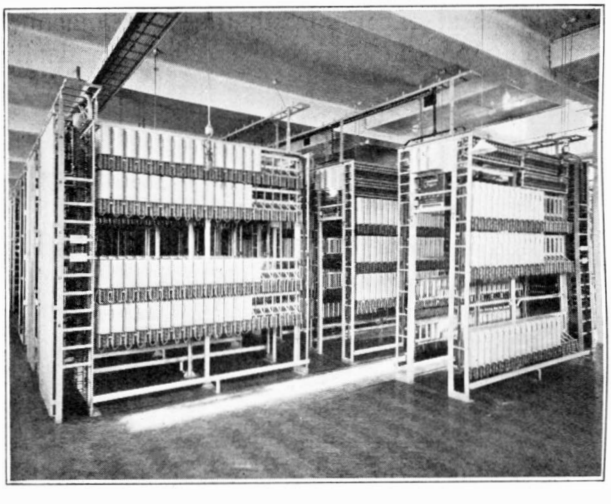


FIG. 8.—SELECTOR BOARDS.

manual " A " sections, and the cordless " B " sections, is shown in Fig. **9**.

Power Plant. — Duplicate batteries of 25 Chloride " Planté " type cells are provided, having a capacity of 3,900 ampere hours at the 9 hour rate. This charging equipment consists of two 35 KW motor generator sets manufactured by Messrs. Crompton Parkinson, designed to operate from the 200 volt 2 phase supply. The usual supply and battery-driven ringers are provided together with the Department's standard automatic change-over equipment which ensures that, in the event of the supply-driven ringer failing, the stand-by battery-driven set is started up and the ringing and tone circuits are automatically transferred. Duplicate rotary converter-alternator sets are provided to generate 3 phase alternating current at 40 and 20 cycles to drive the small A.C. motors associated with the coder, director and sender impulsing equipment. Each rotary converter is provided with a vibrating centrifugal governor arranged to vary the resistance in the converter field in such a manner as to maintain the speed of the machine within limits of $1\frac{1}{2}\%$ on either side of the normal for all conditions of load, supply voltage and machine temperature. Since the speed of the individual motors operating the separate impulsing interruptors depends on the frequency generated by the main driving machines, the rate of impulsing is maintained constant within remarkably close limits. Provision is also made so that in the event of the speed of the main driving machine exceeding predetermined limits, or in the event of a failure in any of the supply leads, the faulty machine is at once stopped, the spare machine started up, and the load transferred automatically with a minimum of disturbance to the exchange.

Reference has already been made to the use of the aluminium busbars at this exchange. With regard to the power plant also, aluminium is used in place of copper for power distribution, and the installation, if considered as an experiment, has proved entirely successful, a considerable reduction in weight having been achieved without any electrical disadvantages. All joints are clamped and though the amount of overlap is only about $2\frac{1}{2}$ inches, the resistance of one foot of conductor including joint is invariably less than one foot of the same conductor without joint. The saving in weight as compared with copper is approximately 50%, and this is of vital importance when it is remembered that in the very large exchanges the weight of the distributing conductors is becoming a very serious problem. For the conductors between the generator and the power board, aluminium rod has been substituted for the usual V.I.R. lead-covered cable. This rod is carried in floor chases supported on porcelain insulators. This again is a novel feature which can be adopted with considerable advantage in the case of large

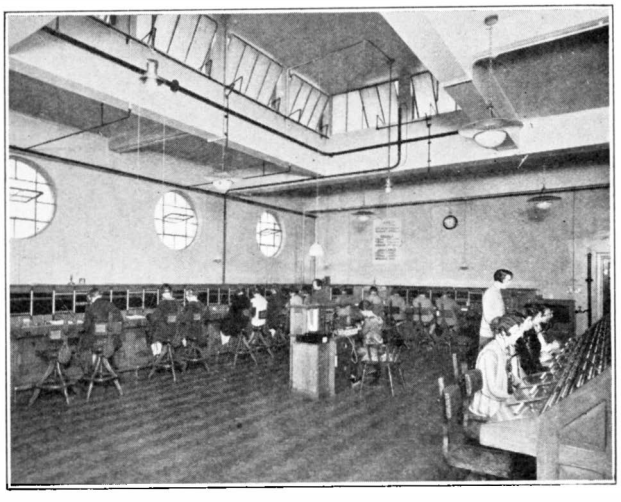


FIG. 9.—MANUAL OPERATING ROOM.

generators where, hitherto, it has been the practice to employ a number of heavy cables which are difficult to place in position and which cannot be bent over a short radius. It might be mentioned here that the Department's engineers were among the first to make use of aluminium for power distribution. Through the courtesy of the Engineer-in-Chief, our engineers were permitted to inspect the aluminium busbars in the substations at Mount Pleasant and St. Martin's le Grand, and the adoption of aluminium at Fulham Exchange is largely the result of impressions obtained during these visits. The authors are indebted to the Engineer-in-Chief of the Post Office for permission to publish this article, and to the courtesy of the Board of Editors of this Journal for its publication.

PORTABLE EMERGENCY BATTERY CHARGING SETS.

H. C. JONES, B.Sc. (Hons.).

PROBABLY the most important consideration underlying the design of telephone exchange power plant is reliability and the necessity for obviating as far as possible any chance of interruption of the power supply. Despite the fact that all large exchanges are provided with duplicate batteries and charging machines and are often served by two separate power supplies, the failure of the charging arrangements has occurred sufficiently frequently to justify the provision of an additional means, in the form of portable charging sets, to safeguard the service. A number of small portable sets, several having outputs of up to 300 amps., have been available in various parts of the country for a number of years, and these, although not specially designed for the job, have given useful service. The development of large automatic exchanges and repeater stations has, however, necessitated the provision of much larger and reliable machines, and the first of these has recently been put into commission in the London District for use in case of emergency at any large installation in South-East England.

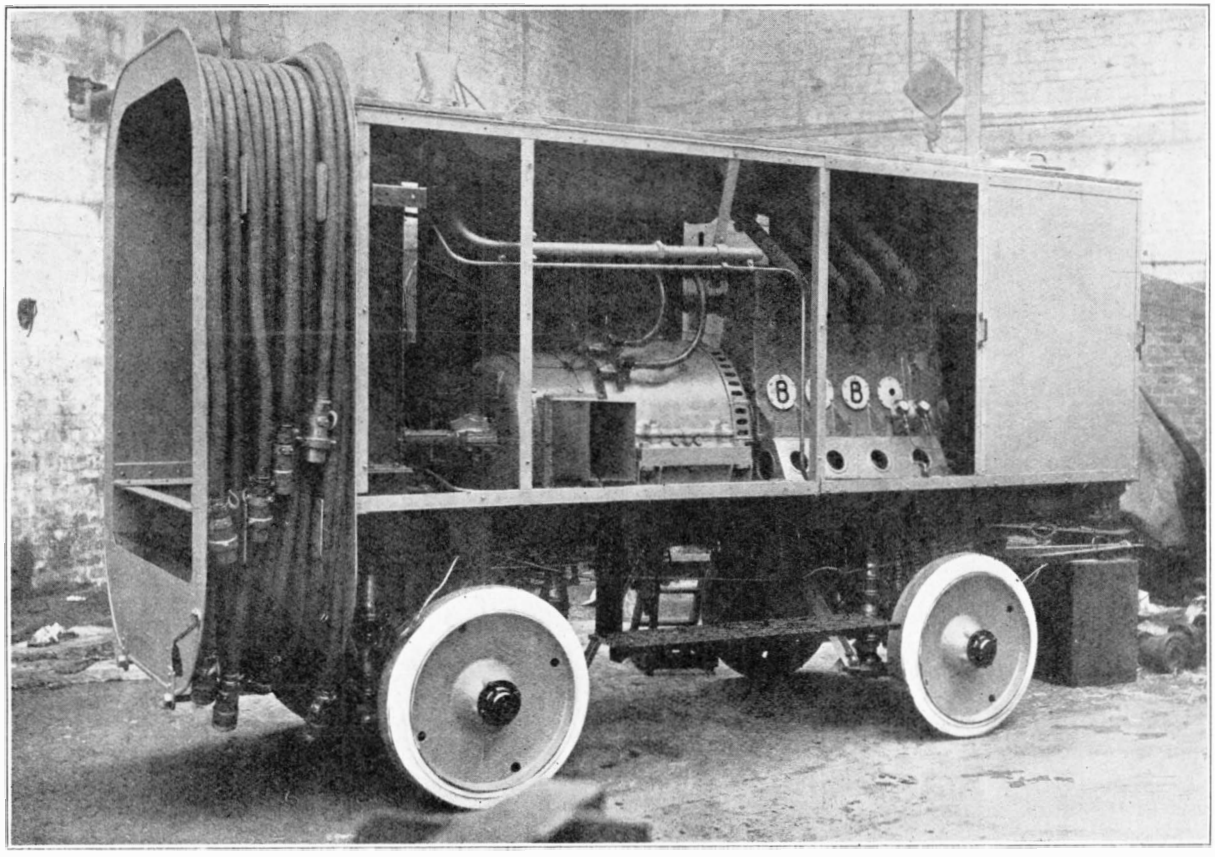


FIG. 1.—EMERGENCY BATTERY CHARGING SET.

It will be followed shortly by three other similar machines for serving installations in other parts of the country.

The accompanying photographs are self-explanatory, and give an idea of the size and construction of the set, which was constructed by Messrs. W. Beardmore & Co., of Glasgow. The prime mover is a high speed, light weight, 4-

cylinder Diesel Engine, and is of the same type as those used on the new airship, the R 101, but is, of course, considerably smaller. It runs on crude oil, which is injected under pressure into the cylinders, and is fired automatically by the heat produced during compression stroke. The fuel consumption is approximately 0.45 lbs. per B.H.P., and the fuel tank holds about 50 gallons, which is approximately the quantity necessary to fully charge the largest batteries at present installed in Post Office premises. Crude oil has an obvious advantage over petrol from the point of view of safety, and is also at least 50 per cent. cheaper to use. The engine is rated at 100 B.H.P. when running at its full speed of 1,200 R.P.M., but the speed can be adjusted at will by regulating the loading of the governor. The engine is water-cooled, the water being pumped through the circulating system and cooled by a fan-cooled radiator.

The method of starting is very simple, yet effective. Prior to starting, all the exhaust valves are opened by the hand operation of a special cam shaft, and compression in the cylinders during the starting operation is thus prevented. A small petrol engine of the motor cycle type with twin cylinders is started by hand and drives through a Hookes joint, a shaft carrying a grooved friction wheel. By virtue of the flexibility allowed by the Hookes joint, the friction wheel can be engaged with the flywheel on the engine crank shaft, which is thus caused to rotate. The engine having been brought up to speed, the exhaust valves are released and the inertia of the moving parts is then sufficient to overcome the compression and start the engine. The starting engine is then shut down.

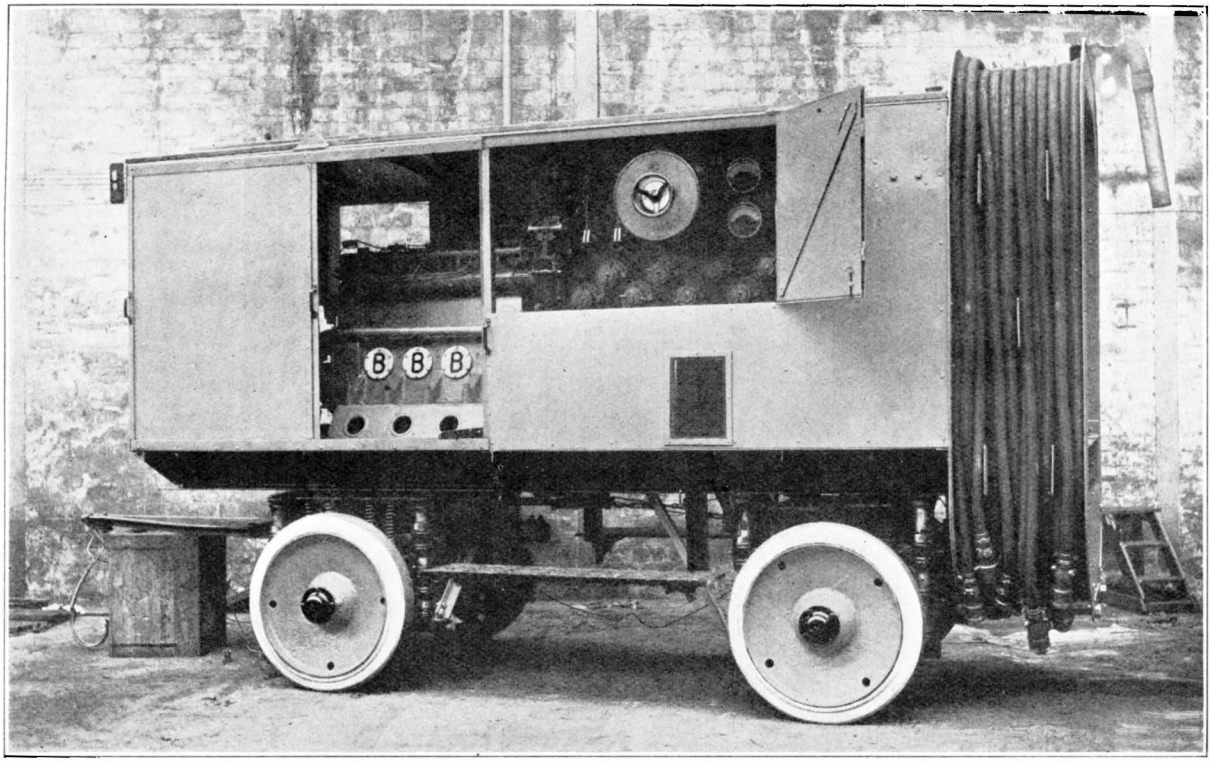


FIG. 2.—EMERGENCY BATTERY CHARGING SET, SHOWING SWITCHBOARD

The generator, which was manufactured by the British Thomson Houston Co., is a pipe-ventilated shunt-wound machine, capable of supplying 1,000 amps. at up to 67 volts or an equivalent amount of power up to 100 volts. Its output is regulated by a combination of variation of engine speed and field regulation. It is controlled by a switchboard, which can be seen in the photographs, upon which the instruments

are flexibly mounted, so as to nullify the effects of vibration.

Eight 60 ft. lengths of 646/.029″ (0.4 sq. in.) single, flexible, cab tyre, asbestos-sheathed cable with 500 amp. plugs and sockets are provided for distributing the power from the switchboard to the exchange batteries. The cables, which in all weigh about ¾ ton, are accommodated, when not in use, on a rectangular drum on the end of the vehicle.

The chassis is specially sprung to keep the engine in a vertical position irrespective of the lie of the ground and, in view of the weight of the vehicle, about 8½ tons, special attention has been paid to braking. In addition to the ordinary braking, an arrangement is fitted to automatically apply the brakes should the vehicle move backwards and, in order to facilitate manœuvring, a braking device is also fitted on the turntable.

Several tests which have already been made under actual working conditions have demonstrated the suitability of the set for emergency use. In spite of its weight, it holds the road well, and can rapidly be hauled from place to place. Having arrived on site, the cables, under average conditions, can be led into the building and coupled up and charging commenced within half-an-hour. The only defect in the set was the fact that at first it created a considerable noise when operating on full load. A number of modifications, which included the provision of additional stays for the sheet iron canopy, modifications to the silencer, lining the canopy with sound-absorbing material and the provision of a partition to prevent noise from passing outside from the engine *via* the radiator, have very considerably reduced this trouble, however, and the set can now be considered to be satisfactory in all respects.

MANCHESTER AUTOMATIC AREA: NEW UNDERGROUND LINES.

IN connection with the conversion to automatic working of the Manchester Telephone Area, some very considerable underground works have been undertaken during the past four years in the Cities of Manchester and Salford, and it is thought that a brief account of these works may be of general interest.

A very large Exchange building, designed to accommodate three 10,000 line automatic subscribers' units, the manual board for the Manchester Automatic area, and the new Toll Exchange, has been erected in Chapel Street, Salford, and the new duct line network radiates from this point.

Fig. 1 is an outline plan of the main sections of new duct-work. It will be observed that very large nests of ducts have been provided in certain thoroughfares, the heaviest sections being those connecting the new Exchange building with the Head Post Office (Trunk Exchange, Repeater Room, etc.) and the existing City and Central Exchanges in York Street.

Fig. 2 illustrates the construction of the new Exchange manhole in Chapel Street. The in-

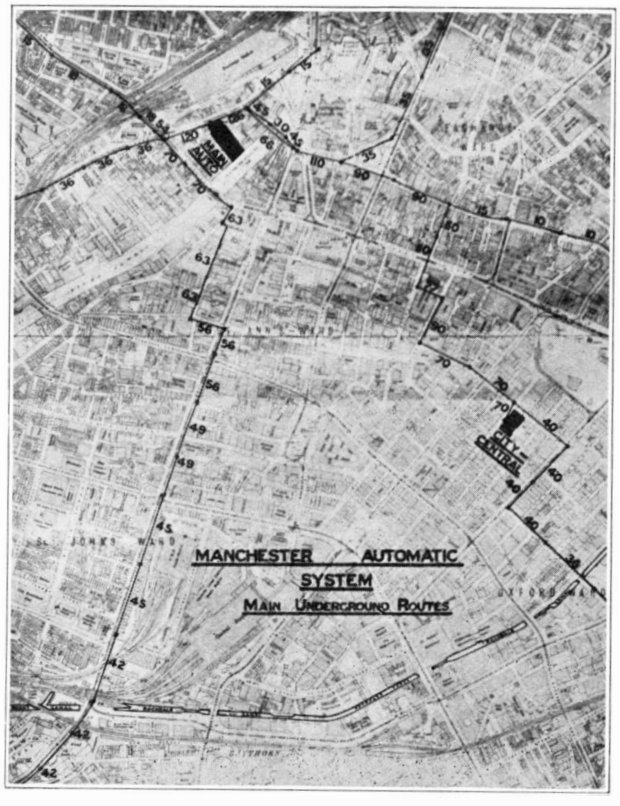


FIG. 1.—OUTLINE OF NEW DUCT-WORK.

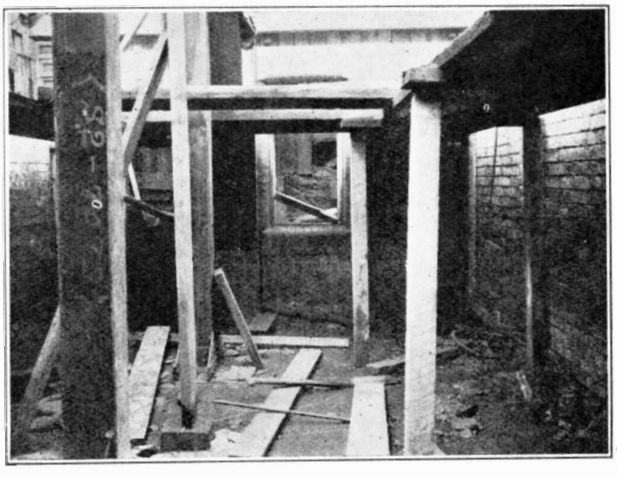


FIG. 2.—CONSTRUCTION OF EXCHANGE MANHOLE.

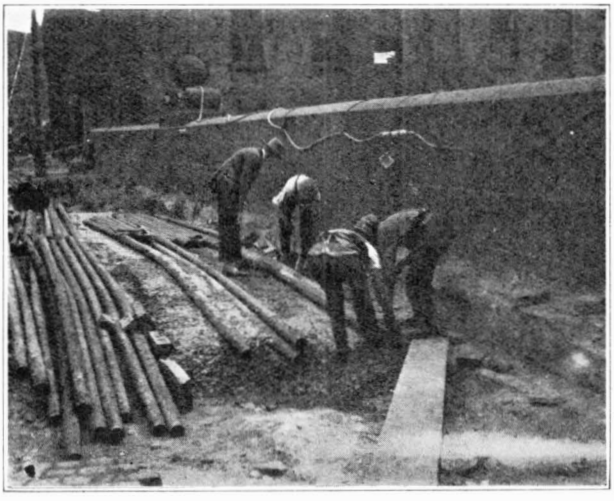


FIG. 3.—VICTORIA BRIDGE. LAYING STEEL PIPES.

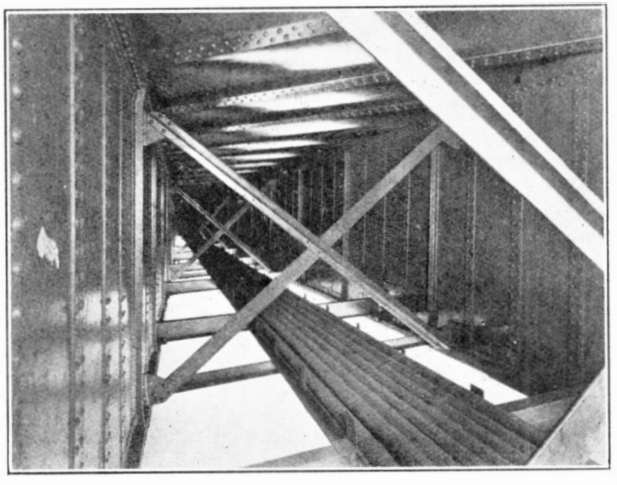


FIG. 4.—STEEL PIPES CROSSING PALATINE BRIDGE.

ternal dimensions of this manhole are—length 20′, width 14′, height 10′ 3″. The walls are of 21″ Accrington Brickwork, and the roof consists of an 8″ reinforced concrete slab resting on steel joists, of which the main member is a girder, 21′ long and of 14″ × 6″ section, stiffened by two uprights of 8″ × 6″ section. The floor is of reinforced concrete in two layers of 5″ and 12″ respectively, interposed between which is a 1″ layer of mastic asphalte. This asphalte layer is taken out to the back of the brickwork, up behind the walls, and in over the roof, so completely enclosing the manhole, except where it abuts on the Exchange building, in a watertight envelope. Three entrances are provided to facilitate access and cabling.

One of the most difficult sections of the work was that crossing the River Irwell by the Victoria Bridge. 110 ducts were scheduled for this section, but owing to lack of "cover" on the bridge it was found possible to lay only 96, these being taken across in two separate tracks, 66 on the South side and 30 on the North. At either end of this section octagonal ducts were laid, but on the bridge proper, double-spigot steel tubes were used (Fig. 3), jointed by means of short W.I. collars. At the shallowest point, tubes specially bent had to be used. The tubes were jointed to the octagonal ducts at either end by bedding in cement mortar after the abutting ends had been wrapped with calico strips.

In consequence of the many obstructions the completed duct-line section, in which is included the bridge crossing, unavoidably contained highly complex curves in both vertical and horizontal planes, and anxiety was felt as to its practicability for cabling. Every stage of the

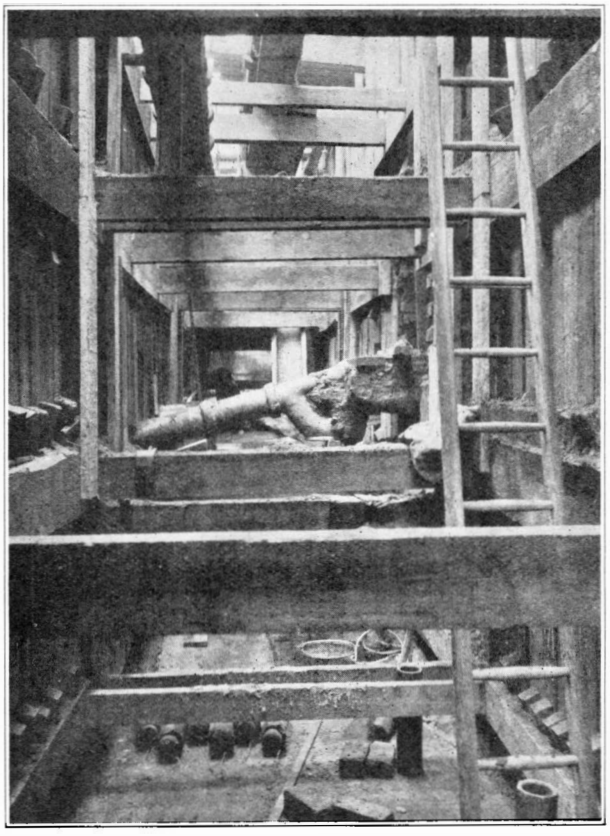


FIG. 5.—TRENCH FOR 126-WAY DUCT-LINE IN CHAPEL STREET, SALFORD.

FIG. 6.—PARTLY CONSTRUCTED 126-WAY DUCT.

work, however, was closely watched and tested, and cables of the largest size have since been drawn in without difficulty.

The lay-out of the lines in this part of the area was considerably affected by unrecorded and unexpected obstructions in the form of disused vaults, passages, cellars and old foundation works generally. In one case a heading which was being driven under Deansgate for the accommodation of the 66-way line from Victoria Bridge Street ran into a series of vaults of great size and very solid construction. There were seven of these vaults, with walls four feet thick, lying in our track, and it was found necessary to build an extra manhole of considerable size in order to obtain a sufficient deflection of the track.

Fig. **4** shows a nest of 15 steel pipes accommodated on the steel under-structure of Palatine Bridge, another of the bridges crossing the River Irwell.

Figs. **5** and **6** show work in progress on the 126-way octagonal duct section in Chapel Street, Salford.

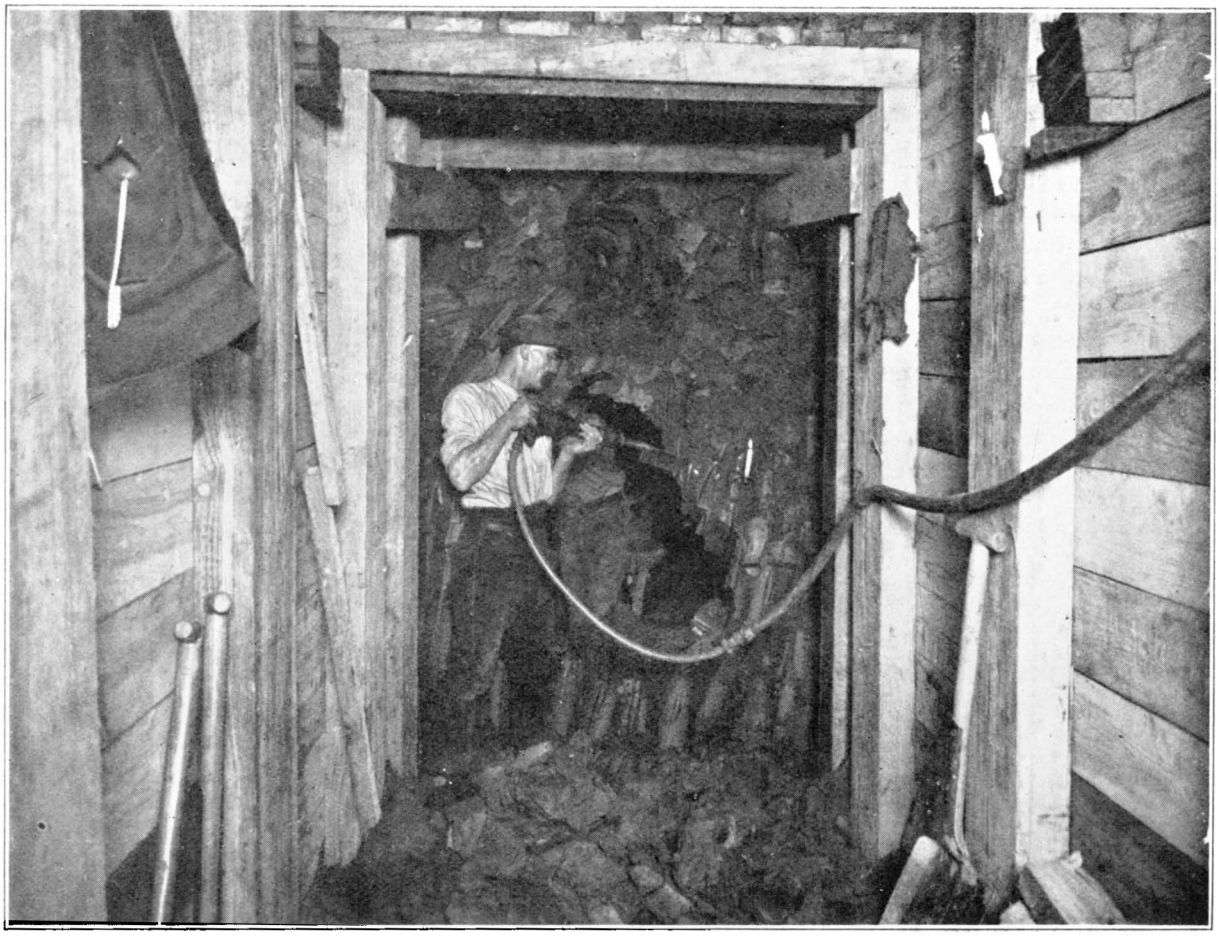


FIG. 7.—EXCAVATION OF A TUNNEL.

Owing to shallow obstructions and heavy street traffic, sections of duct-line aggregating to about 2,000 yards in length were constructed in tunnel. Figs. **7—10** illustrate the general nature of the operations involved. Fig. **7** shows the joining up at the centre point of two headings driven from opposite ends of a section. Fig. **8** shows a heading completed and the work of brick

full height in one operation by the use of the "formers" seen in the illustration. This method was adopted in order to make the walls more nearly watertight by avoiding the numerous horizontal joints in the concrete entailed by the ordinary method.

Fig. **11** shows the work on the 70-way duct section in Blackfriars Street in progress. It will

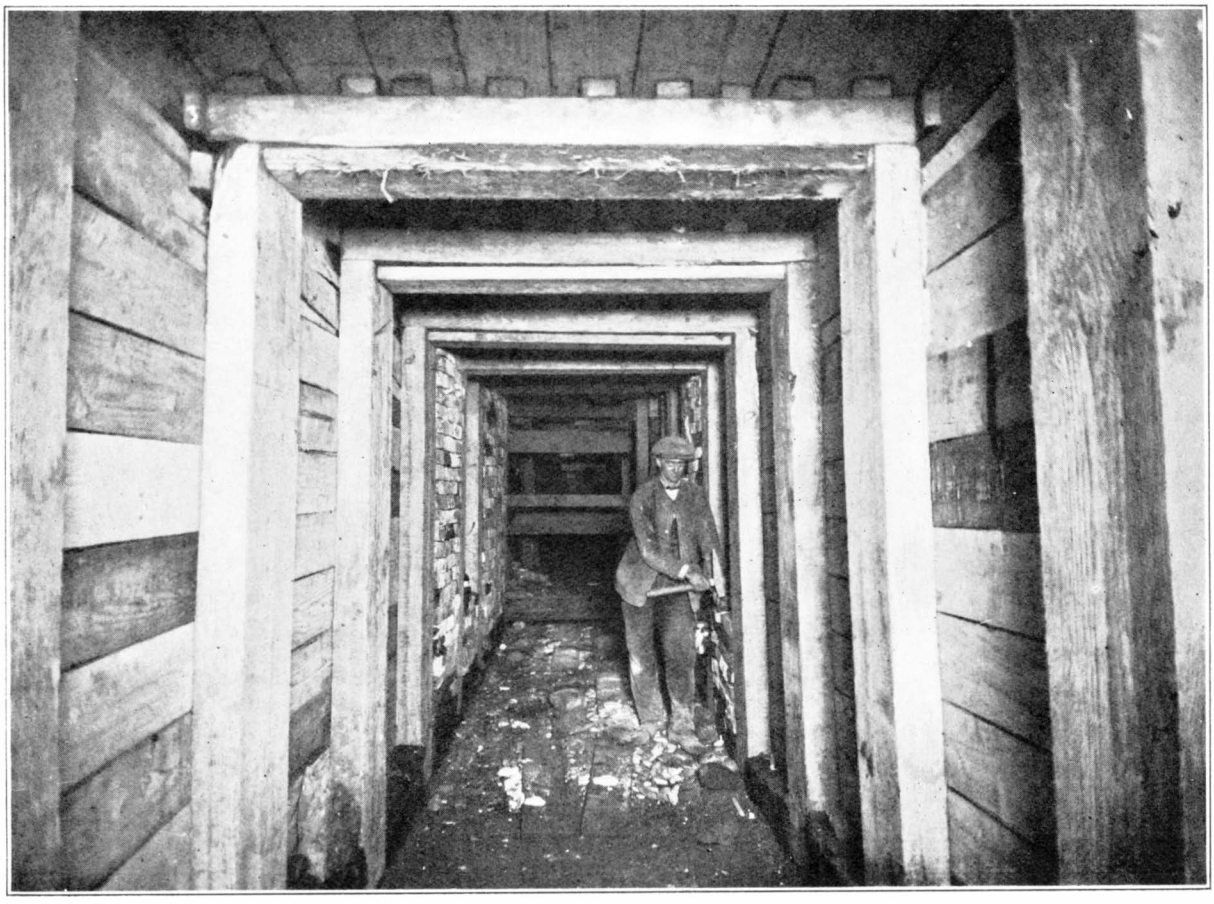


FIG. 8.—TUNNELLING: PACKING OF SPACING BETWEEN SIDE TREES.

packing the spaces between the side trees in progress. Fig. **9** shows the "formers" for the concrete side walls of the chase intended to contain the octagonal ducts. It will be observed that the walls were constructed by a method differing somewhat from that described in T.I.XIV., inasmuch as, instead of being built up in shallow strips in step with the laying of the several tiers of ducts, they were built to their

be seen that several mains had to be supported in the trench. This necessity frequently arose in the course of the operations. Fig. **12** shows another case of a foreign main supported in one of our headings.

Several large manholes were built in part under tramlines, the excavations ranging up to 16′ in length. In a typical case the affected tramline was carried during the work on a 12″

balk of timber, supported on similar uprights. After completion of the manhole a 9″ wall was built up off the manhole roof to afford permanent support to the rail.

A 77-way section of octagonal ducts was laid under the whole width of the Head Post Office, from Spring Gardens to Brown Street, in a trench cut through the floor of the basement. anxious moments. Trench timber of the most substantial description had to be used, and much of this timber was left permanently in position. Further, after the laying of the ducts, the trenches were filled solid with to to 1 concrete up to the foundation levels, and above these levels struts of concrete 12″ in width were built across the trenches almost up to the paving levels every

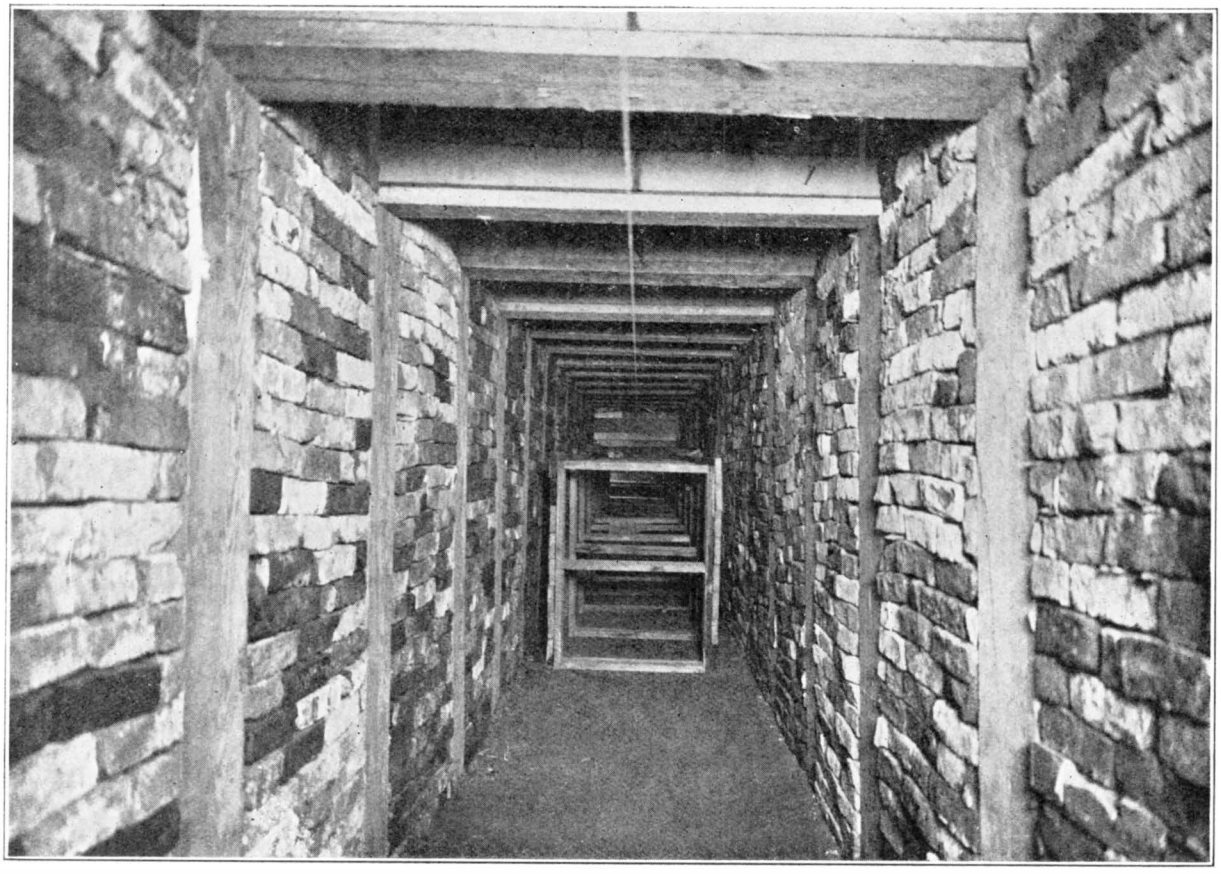


Fig. 9.—Tunnelling: Formers for Concrete Walls in position.

This device was adopted in consequence of the extreme congestion existing underground in the narrow connecting street.

In Chapel Street and at other points on the various routes, trenches ranging to 15′ in depth had to be excavated very close to high buildings, and extending down to levels below those of the foundations. As at many points the subsoil is loose gravel this work naturally produced some few feet. These measures were successful in avoiding damage.

Fig. **13** shows a somewhat unusual form of construction, *i.e.*, a cable subway about 10 yards long designed to avoid the construction of a manhole, with the consequent necessity for a surface entrance, at an angle in the track located at the junction of two very narrow and congested streets—Parsonage Lane and College Land.

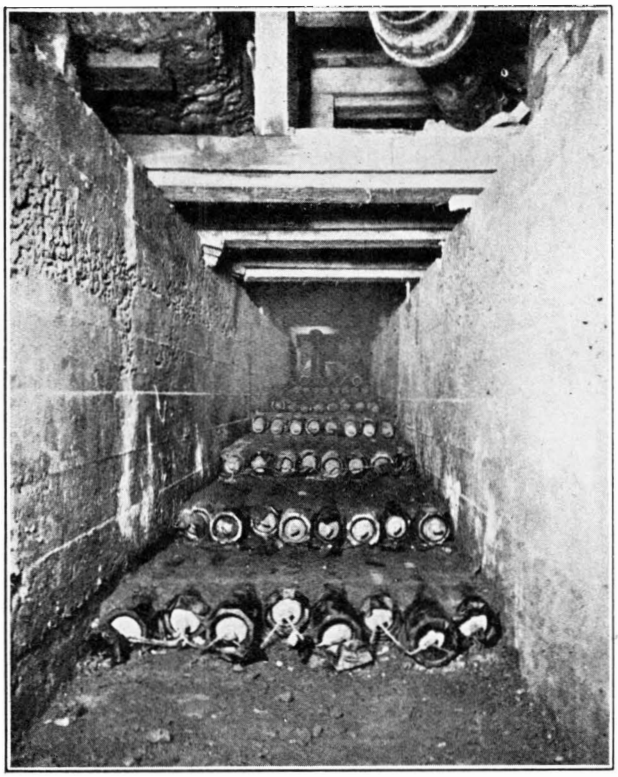


FIG. 10.—PARTLY CONSTRUCTED DUCT-LINE IN TUNNEL.

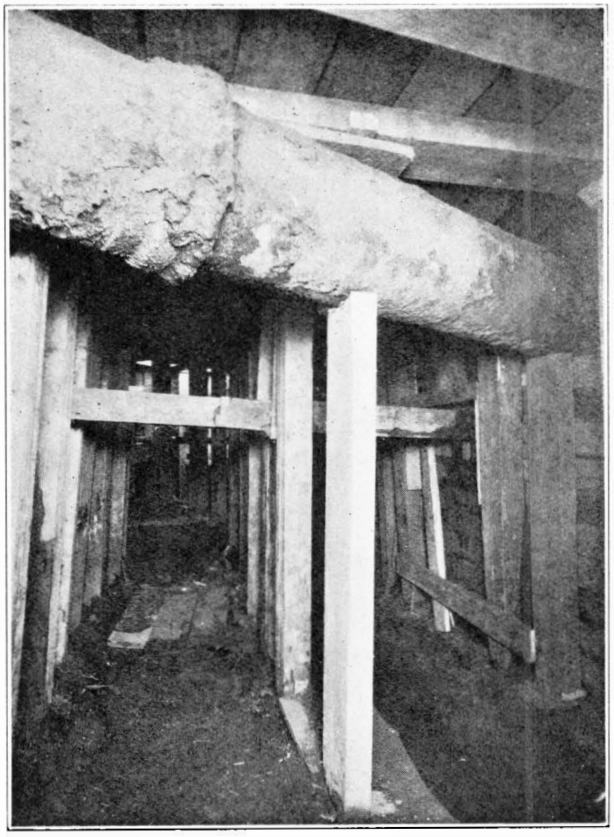


FIG. 12.—TUNNEL AT JUNCTION OF BLACKFRIARS STREET AND CHAPEL STREET.

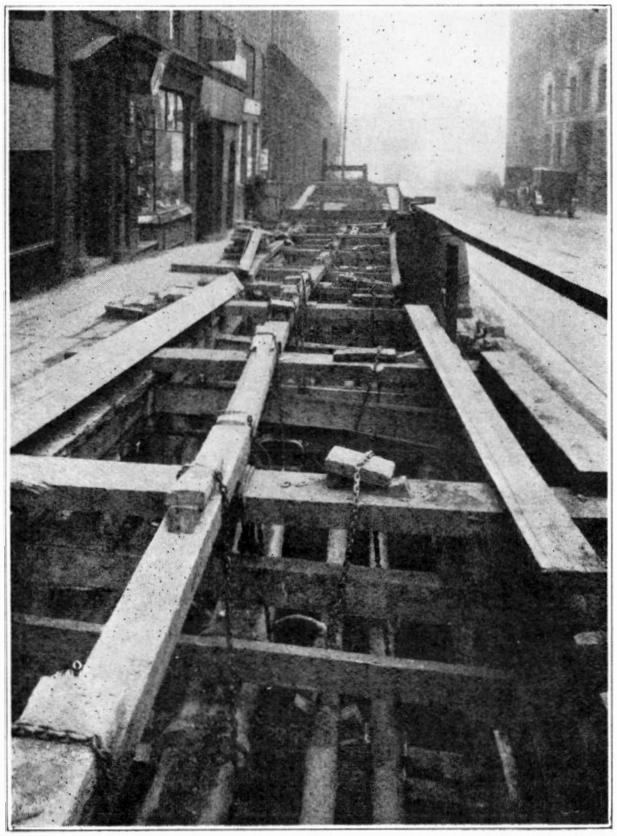


FIG. 11.—TRENCH FOR 70-WAY DUCT-LINE, BLACKFRIARS STREET, SALFORD.

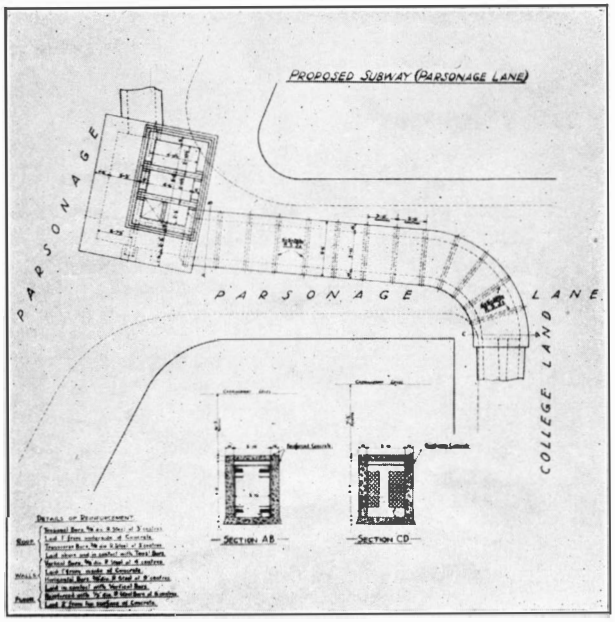


FIG. 13.—CABLE SUBWAY.

Cable bearers are provided on the sides of this subway between the ends of the ducts and the manhole in The Parsonage.

One of the most interesting sections of the work was that running along Deansgate, perhaps the most important of the main roads through Manchester. The duct track varies from 66-ways at the Exchange end to 35-ways at the remote end, nearly a mile to the South. Very formidable obstructions were encountered in the section between John Dalton Street and Bridgewater Street, with the result that it was ultimately found necessary to tunnel through solid rock at an average depth of 25′. The depth to the floor level of the John Dalton Street manhole—the deepest manhole constructed in connection with these works—is 37′. At this manhole a change of duct-line level of 14′ had to be effected. The exceptionally deep manholes in this part of the route have usually a cabling entrance in the carriageway, but in order to avoid obstruction to traffic when jointing only is in progress, and also to promote ventilation, there is in most cases a side shaft entrance from the footway. Ventilating pipes have also been fitted in several of these manholes and led to convenient points on adjoining buildings, etc.

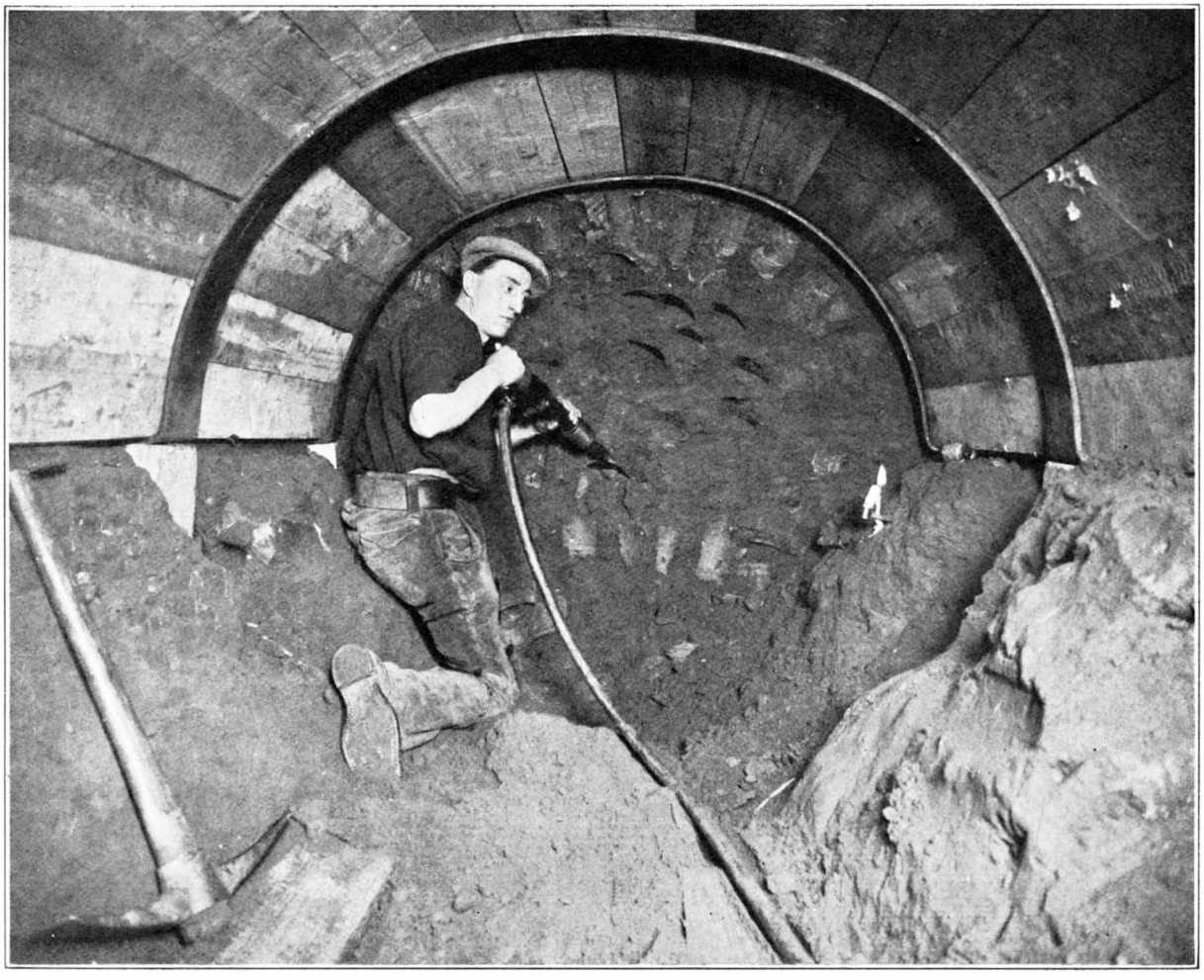


FIG. 14.—TUNNEL UNDER MANCHESTER-ROCHDALE CANAL: EXCAVATING.

Another point of interest in the Deansgate

section is the crossing of the Rochdale Canal. Here, owing to innumerable underground obstructions, it was found necessary to effect the crossing by means of a tunnel under the canal. This tunnel was driven in solid rock at a maximum depth of 32'. No serious difficulty was encountered. A similar tunnel under the same canal in the line of Sackville Street was also found necessary, but in this case the tunnel was for the greater part in clay, with a thin seam of sand lying on top of sandstone at the lowest point. In view of the less satisfactory nature of the subsoil here, a circular brick culvert was constructed to contain the ducts, and to afford due support to the canal bottom and to the piers of the Sackville Street Bridge, which crosses the canal at this point. Figs. **14**—**16** illustrate the construction of this subway.

The manholes built on the main sections of this work number about 70, and their cubical contents approximate to 90,000 cubic feet. Approximately 300,000 yards of single way duct are included in the routes shown in Fig. **1**, *i.e.*, in the more central portions of the scheme.

J. CLEAVER.

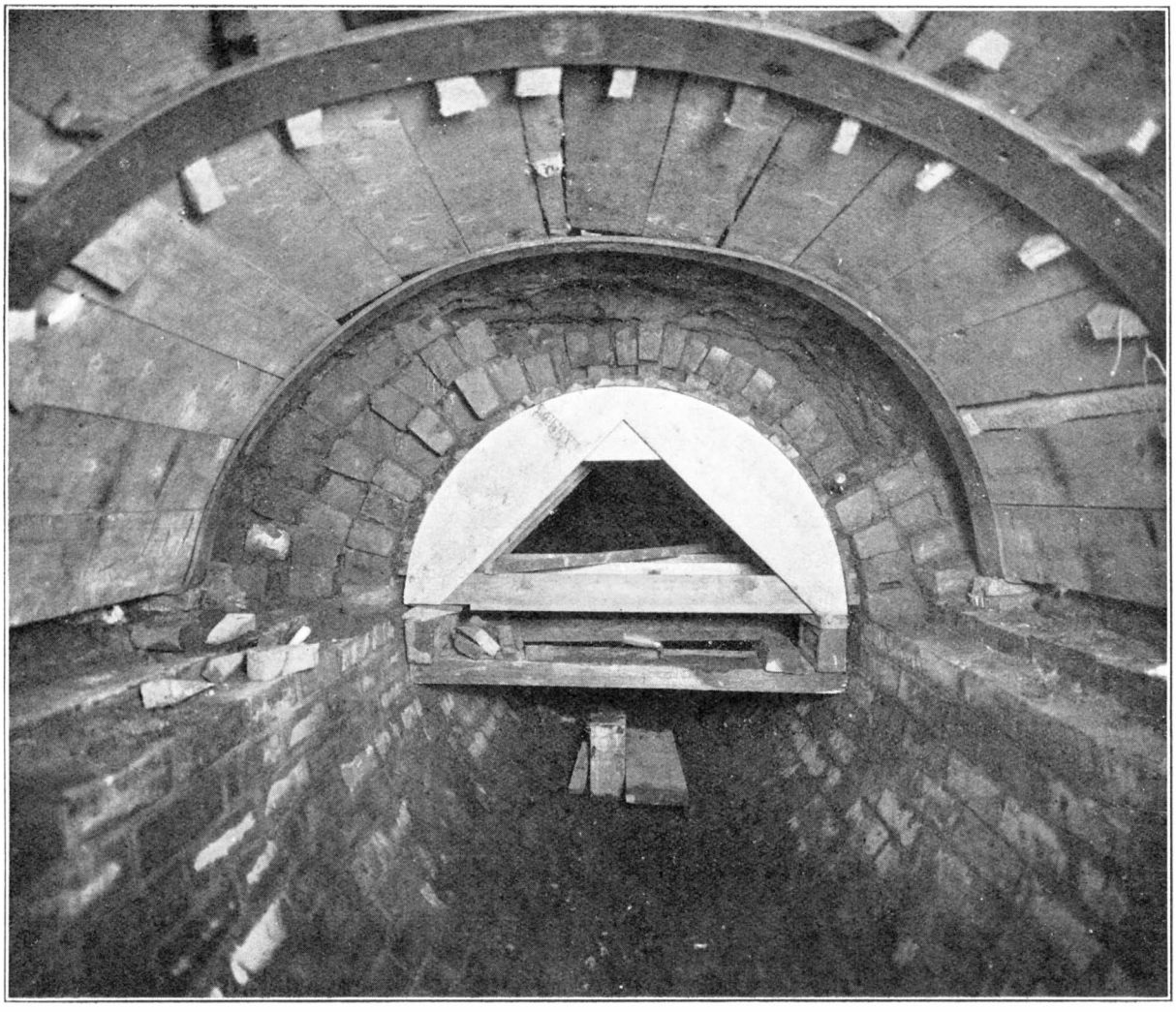


FIG. **15.**—TUNNEL UNDER MANCHESTER-ROCHDALE CANAL: CONSTRUCTION OF BRICK SUBWAY.

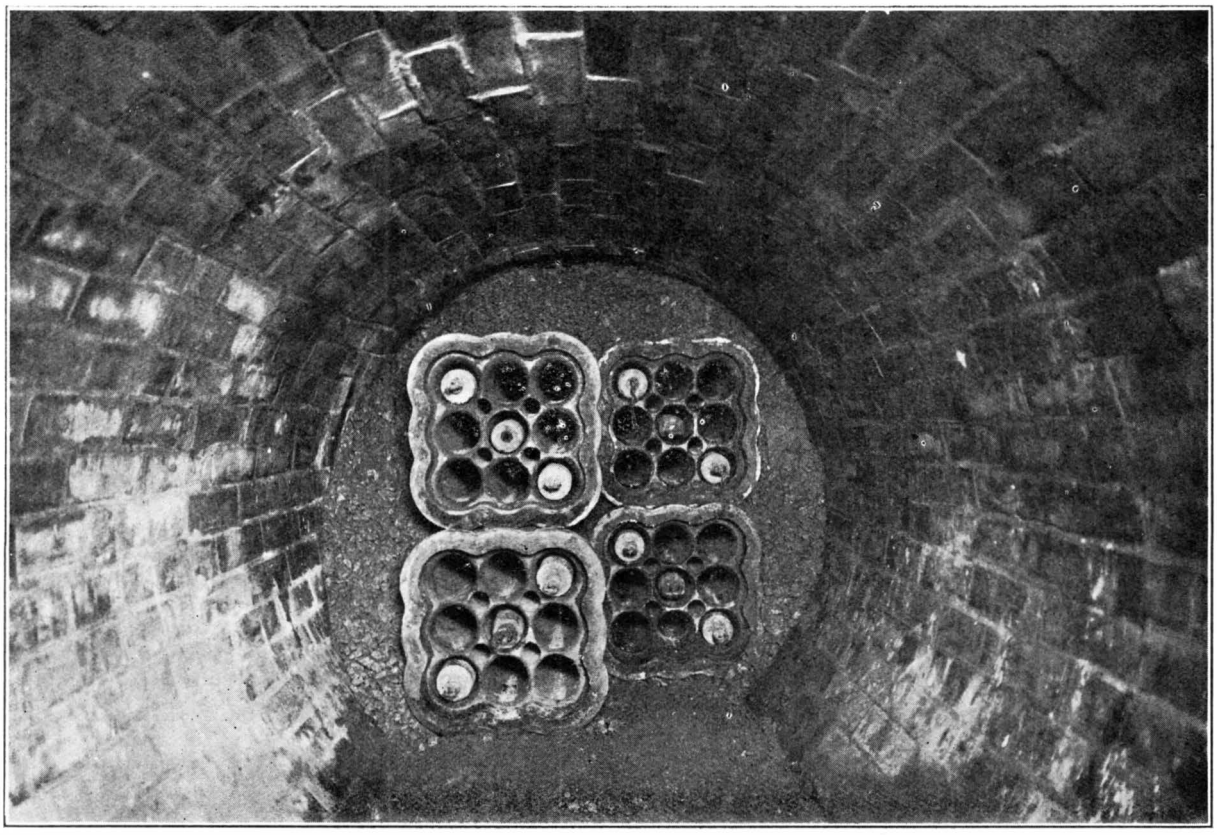


FIG. 16.—TUNNEL UNDER MANCHESTER-ROCHDALE CANAL: SUBWAY COMPLETED AND DUCT LAYING IN PROGRESS.

MECHANICAL AIDS TO WORKS OF UNDERGROUND CABLING.

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(Late of Engineer-in-Chief's Office, G.P.O.).

THE article which appeared in the volume of this Journal for October, 1929, under the above title, has no doubt been read with interest by a large number of cable engineers, and the following notes have been prepared as an addendum, stating practices carried out by an undertaking outside the Post Office Service, together with comments upon certain current practices in construction.

The equipment and methods of cabling will, of course, depend upon the required out-put in miles per week and also whether the duct route is in a city or in the open country.

A common rate of progress for cable contracts is thirty to forty lengths per week, *i.e.*, 6—7 lengths per day.

The article describes a bogey capable of carrying one cable drum at a time from the nearest railway station to the manhole site. It would seem that this method of delivery is only suitable for delivery to manholes within, say, three or four miles of the railway station, otherwise it would be difficult to average 5 drums per day without the use of two or more bogeys.

For feeding a route in a busy thoroughfare from a dump or stores which is only a few miles from the route, the low loading type of motor vehicle carrying but one drum has been found

quite suitable. It is fairly fast and easily loaded and unloaded.

It is part of the scheme mentioned to pay out the cable without unloading the drum from the bogey, and this is a good scheme in busy thoroughfares. Unless, however, the tractor is also used for drawing in the cable, there is a decided objection to the tractor standing by until the cable drum is emptied. Similarly, with only one bogey, the cable gang must stand by whilst the bogey is collecting another drum of cable.

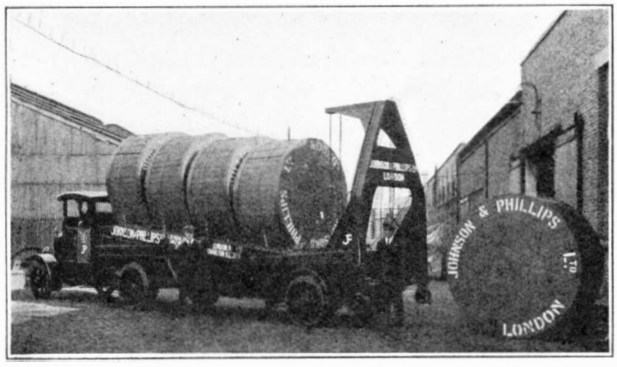


FIG. 1.—J. AND P. 6-WHEELER.

In the opinion of the writer, the processes of "Cable delivery" and "Drawing in" must be two distinct services.

Regarding the first service, delivery by rail has been abandoned for some years. The objections to the system are that the drums have to be loaded and unloaded three times instead of once, and at some Railway Stations the only handling facility is a "Dock" which necessitates the use of special trucks and man-handling of drums. Trucks with full side flaps are necessary and even then a special disposition of the drums has to be arranged, otherwise the trucks may be loaded with a crane at the sending end and cannot be unloaded by rolling at the receiving end.

The process favoured is to load the cable into special vehicles at the Cable Works, and to deliver them to the precise spot where required for cabling. This process has been employed in cases where manhole sites are two hundred and fifty miles from the Cable Works. For greater distances than this, cable has been sent by sea, and a special vehicle used for delivery from dock to manhole site. The chief drawback to the former system is the return of empty drums, and a heavy accumulation of these on site may occur unless the traffic is properly regulated, and this will require special journeys to collect empty drums, which of course is unprofitable.

Two types of vehicles, capable of carrying up to 10 or 12 tons, have been employed for cable delivery, namely, the J. & P. 6-wheeler and, latterly, the Scammell 8-wheeler. These are shown in the accompanying photographs and are equipped with facilities for loading and unload-

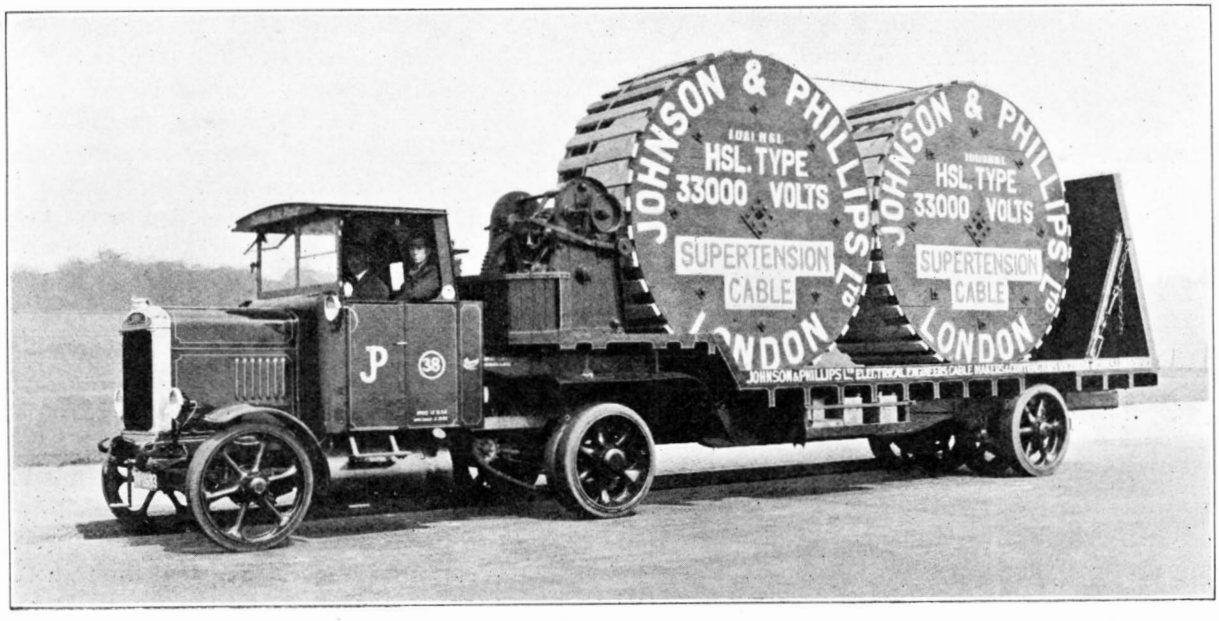


FIG. 2.—SCAMMELL 8-WHEELER.

ing of drums. The four-wheeled back axle is to be noted in the case of the latter vehicle.

Regarding the process of drawing in, as the author of the original article points out, it is a common mistake to deal only with the actual hauling of the cable through the ducts by mechanical means. If a programme of five or six lengths per day is to be undertaken, it is also necessary to consider the shifting of the gear and gang by mechanical means. The early forms of motor winches consisted of a motor driven winch mounted on a four-wheel truck, but these winches themselves occupy a considerable amount of time to shift them from one point to another.

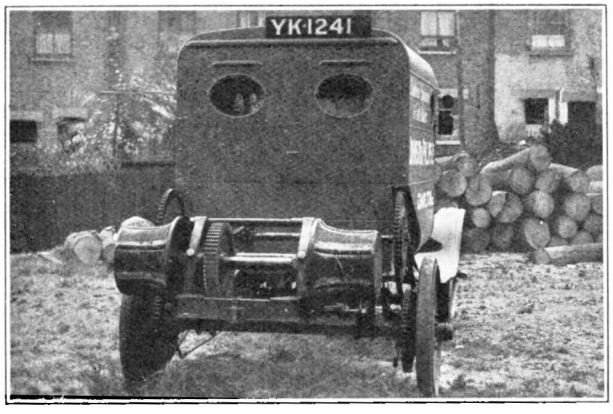


FIG. 3.—J. AND P. CABLING MACHINE.

Taking five lengths of cable as a normal day's work, it will be appreciated that the shifting of gear and gang represents a very important part of the work, seeing that the time in which cable is in motion is only about 1½ hours for five lengths of cable.

In the opinion of the writer the correct mechanical equipment includes two parts. (*a*) A power unit or Cabling Machine, as it is called, in the form of a lorry which incorporates a winch which can be driven by the same motor as that which propels the lorry, and (*b*) a large four-wheeled trailer with a flat truck body. This carries all the equipment required at the paying-in end of the duct, namely, Screw Jacks, Spindle, Grips, Jelly, etc.

The two vehicles are necessary, and one is stationed at each end of the duct section. When the cable has been drawn in, all the gear and gang are put into the unit at each end of the section and the cabling machine returns to pick up the trailer and tows it to its correct position for the next section to be cabled.

The cabling machine employed is shown in accompanying photograph. It has drawn in over five hundred miles of cable for the G.P.O. and differs from the machine described in the original article in the following respects:—

(1) It is equipped with two bollards mounted on the extremities of a horizontal shaft at rear of the vehicle instead of one bollard or capstan mounted on a vertical shaft in the middle of the floor of the vehicle. This enables a bollard to be placed right over the manhole opening.

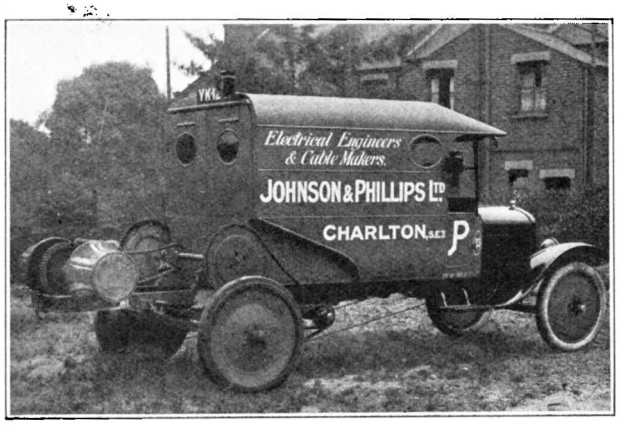


FIG. 4.—CABLING MACHINE.

(2) In its original form a drum was mounted on the vehicle for the reception of the hauling rope, as shown in the original article. This was soon abandoned as being wrong for the following reasons: When the cable has been drawn into the duct, the rope is then wound on a drum mounted on the vehicle. The rope has next to be drawn into another duct section.

This obviously cannot be done by the cabling machine until the rope has been taken off that vehicle. It could be drawn in by hand, but this requires the effort of four or five men. It has been found better to mount the rope drum on a pair of wheels quite separate from the cabling machine and to tow it from place to place.

(3) The question of a motor driven pump

has also received attention. For this purpose a cylinder-piston pump of the type described in the original article was considered unsuitable owing to the risk of the valves becoming inoperative by stones and dirt. A floodgate or diaphragm pump, with a 2″ delivery pipe, was fitted to the cabling machine. This has a discharge of 800 gallons per hour, and is considered to be too small. A 3″ floodgate pump with a discharge of 3,000 gallons per hour would be adequate, but such a pump is found to be too large and heavy to be fitted as part of the equipment of the cabling machine.

It is perhaps not out of place here to comment on the use of buried jointing boxes. The installation of these used to be governed by the class of the road service above them. Obviously, if the paving is of an expensive type it would be profitable to instal a surface entrance chamber. In arriving at the economical type of chamber to use it must, however, be remembered that in laying a modern trunk cable a number of these boxes have to be opened four times, not once, *i.e.*, at least once for the following operations: Cabling, Testing, Jointing and Pressure testing.

It is thought that four separate openings of the same hole for one cable would almost justify the provision of a surface entrance box for even cheap forms of reinstatement especially if the excavation is difficult. Four openings could always be regarded as necessary at the chamber at the mid-point of a Loading Coil Section.

Buried boxes are provided with concrete slabs for the cover. Each of these slabs has an inverted U shaped piece of iron rod to serve as a handle. These handles are somewhat inconvenient, pick heads catch beneath them when digging. They impede the removal of the soil with a shovel and, moreover, prevent the slabs from being readily brushed before the slabs are removed. This results in dirt being tipped into the jointing chamber. Matters would be improved if this handle were fitted to one slab only. This slab could be removed first and as this exposes the edge of the next slab the necessity for handles on subsequent slabs practically disappears.

Regarding marking posts. One of the first operations for a Cabling Contractor is to identify the marking posts by numbering them.

With balanced cables it is essential that there shall be no mistake about the identity of a jointing point.

This identification must still be necessary during the maintenance of the cable, and it is thought that the points might be permanently numbered by the Department.

It is convenient to allocate a number to a section length and not to a jointing point. This involves the placing of two numbers on a marking post. Thus, three on one side of the post, and four on the other would indicate the junction point of lengths 3 and 4. Loading Sections are indicated by a number. Thus L.C.S. 1 is the section from the starting point to loading point No. 1. By also painting the number of the Loading Section on the tops of the marking post any length of cable can be at once identified. These points may seem elementary, but the making of a selected joint at the wrong place or "upside down" and having to break it down again, soon establishes the necessity for very definite rules on the matter.

Pursuing the question of efficiency of underground construction, the following notes have been prepared regarding the process of jointing.

The jointing of a dry core telephone cable has frequently to be carried out in adverse circumstances. One of the adverse factors is dampness, and some attention has been given to the production of a dry joint.

Laboratory experiments were made to determine the effect of drying and exposure of paper sleeves such as are used for making a joint.

The result is shown in Fig. 5. From points A—B the sleeves were heated in a tin with the lid removed at a temperature of 275°F. and weighed periodically and the loss of weight noted. From B onwards the source of heat was removed and moisture was re-absorbed.

This Fig. is instructive and indicates two important points, firstly, that paper jointing sleeves as issued by the makers in cardboard boxes require a temperature of 275°F. for 5 hours before they are dry, and, secondly, that the moisture under laboratory conditions at all events is re-absorbed at a much slower rate.

It is clearly undesirable that the five hour drying period should be spent after the sleeves have

been used in a joint. For this reason it is now a standard practice that all paper sleeves are dried in the cable ovens for a period of five hours. They are then placed in airtight tins which contain about 120 40lb. sleeves.

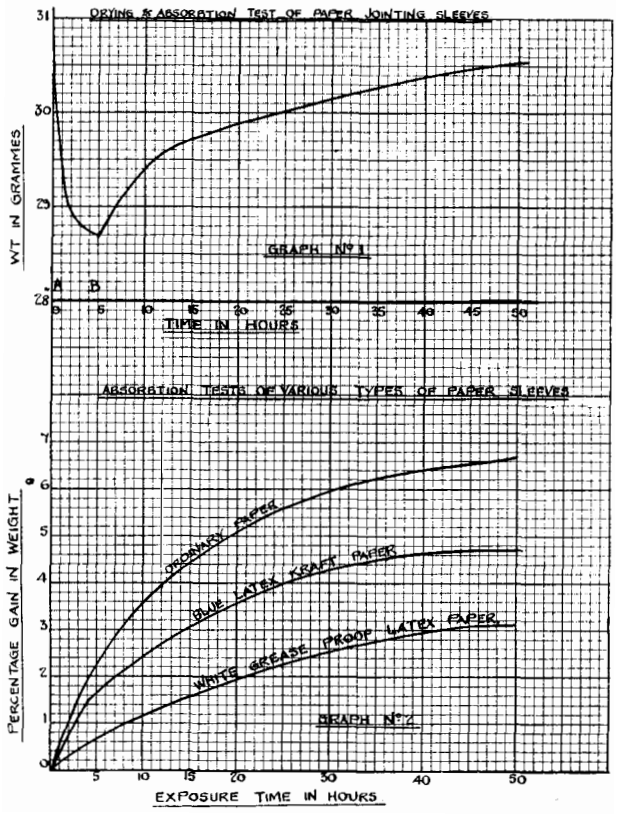


Fig. 5.—Graphs 1 and 2.

The use of tins containing more sleeves would result in a longer period of exposure from the time that the tin is opened until the last sleeve is used. The tins are generally damaged in use and are seldom recovered. The cost of the tin is of the same order as the value of the sleeves which it contains. Nevertheless, it is considered that the practice of drying and issuing sleeves in airtight tins is a sound one.

Before leaving the question of drying paper sleeves it may be of interest to record that absorbtion tests were made with sleeves made with two kinds of rubber latex paper. The result of these tests are shown in Graph 2, Fig. **5**.

It will be seen that the ordinary sleeves absorb more moisture in a given time than either of the latex papers, and it seems desirable that this matter should be pursued.

Drying and absorbtion tests similar to those made on paper sleeves were also made with a Ball of Whipping, and a Roll of Insulation Paper, both of the type used for making a telephone cable joint. The general characteristics of the Drying and Absorbtion figures were similar to that obtained with the paper sleeve. The actual weights may be of interest.

	Ball of Whipping.	Roll of Insulation Paper.
Weight before drying	330.55 grams.	1283.109 grams.
Weight after drying (5 hrs.)	311.30 ,,	(7 hrs.) 1193.16 ,,
Weight of moisture expelled	19.25 ,,	89.94 ,,

Complete re-absorbtion did not occur in over 100 hours.

The method adopted in practice with regard to the whipping is to dry it and then place it in a special container. This consists of a lever lid tin with a Dry Air Nozzle sweated over a full-sized hole in the side of a tin. (See Fig. **6**).

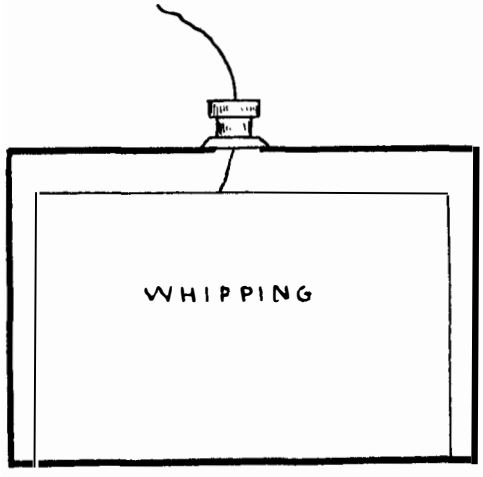


Fig. 6.—Whipping Container.

The end of the whipping is passed through this hole and through a small hole in the cap of the nozzle. The whipping can then be withdrawn as required. When issued, a rubber washer is contained in the cap of the nozzle and the passage of the whipping through the rubber washer makes an excellent airtight joint. In practice, however, the rubber washer has its drawbacks and is frequently discarded. The reason for this is that if the whipping should

break it cannot be passed through the washer again without the aid of a needle, which is seldom to be found in a jointer's kit.

The container is, however, quite serviceable without the rubber washer. The same principle is employed in the container for the Insulation Paper. The paper is dried and placed in a large flat tin fitted with a rubber flap covering a slit in the side of the tin. See Fig. **7**. The paper is readily withdrawn through the slit as required.

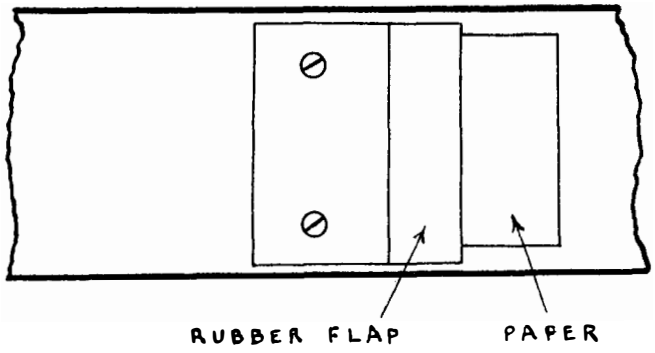


FIG. **7**.—PORTION OF SIDE OF PAPER CONTAINER.

Another point to which attention has been given, is that of " Drying Out " a joint before the lead sleeves is placed and plumbed in position. There appears to be several types of " Drying Out " trays or ovens in use.

One type consists of a metal case placed over the joint from above and left open on the underside. Lamps are then placed below the oven for the purpose of drying the joint. Criticism is levelled at the principle of these ovens on the ground that the drying process is retarded as damp air from the bottom of the jointing pit arises therefrom and is continually passing through the joint.

The type of appliance favoured by the writer is a tray placed around the joint from below, and a lid placed on from above. Lamps are then applied to the bottom or sides of the tray.

This overcomes the detrimental effect of damp rising through the joint to be dried.

A general view of the Drying Out tray is shown in Fig. **8**.

In order to prevent scorching of the joint a baffle plate is fitted inside the tray to prevent the joint actually touching the tray proper. An inspection door is fitted to the lid.

A series of adjustments were made to the space between the junction of the end of the tray and the lid. This space was made such that with two lamps operating on the side or bottom of the tray the temperature of the joint did not exceed 220°F. This temperature was reached after one and a half hours heating and was not exceeded after the heating was continued for another half hour.

The use of mechanical appliances for actually twisting the wires of a joint have not been successful up to the present, and the jointer has made better progress with his fingers than with any special appliance.

Seeing that telephone cable jointing involves a great amount of repetition work, it would seem to be an excellent subject for the application of motion study. The chief reason for retarding progress in this direction seems to be the variety of positions and conditions in which joints have to be made. One series of operations, however, which can be catered for, is that of putting down the soldering iron after a sweat has been made in a position in which the iron is again heated and ready to be picked up again when required. The reception appliance must be strong, capable of accepting the iron, somewhat roughly, and must not be rickety and liable to fall over.

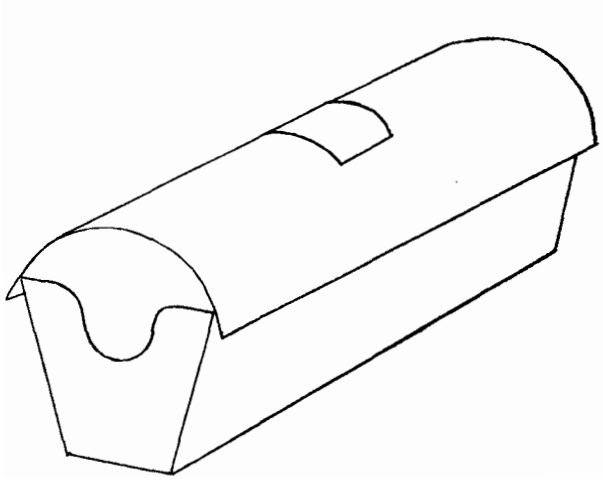


FIG. **8**.—" DRYING OUT " TRAY.

Provision for these operations is made in what is known as a Lamp Shade; for in addition to fulfilling the requirements mentioned it also pro-

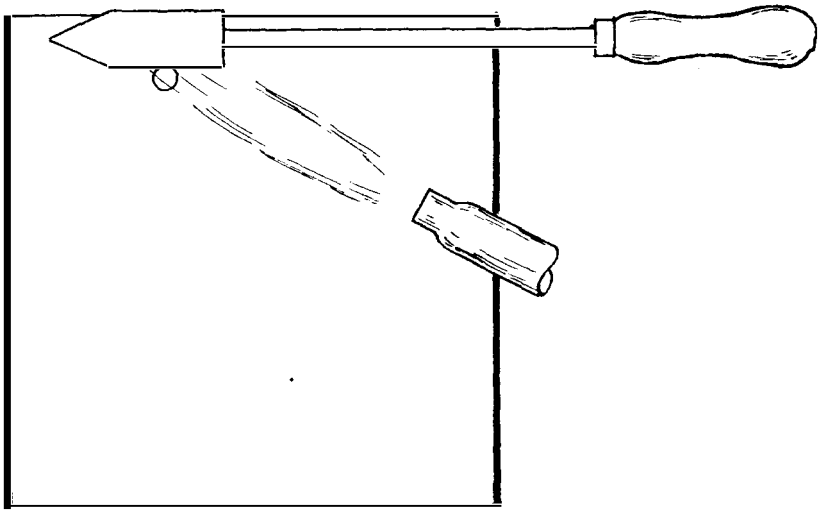
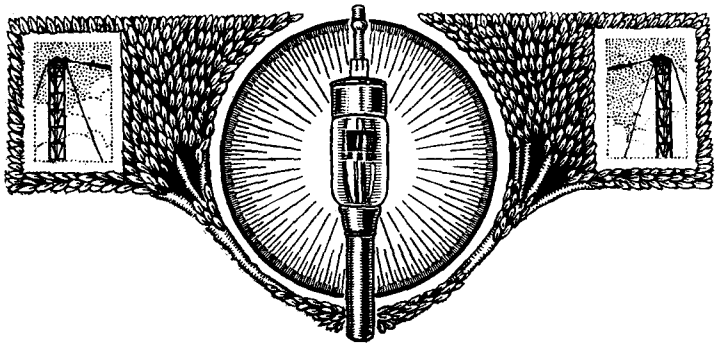
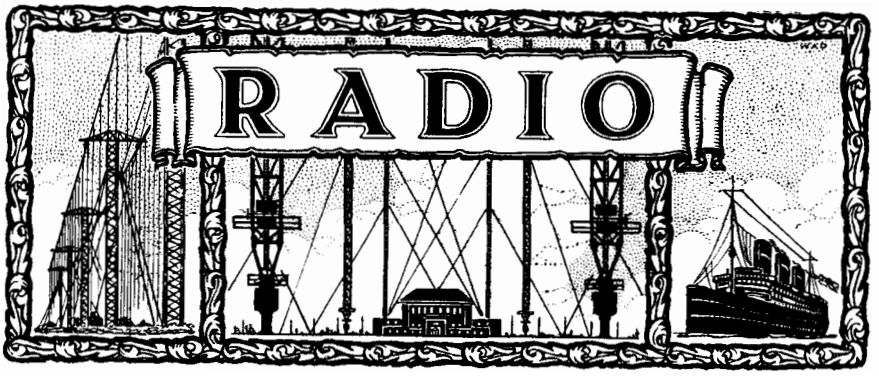


FIG. 9.—LAMP SHADE.

tects the lamp flame from draughts. The Lamp Shade consists merely of a sheet iron box without top or bottom. See Fig. 9. A slot is provided at the side for the insertion of the nozzle of the lamp. The top ledge of the shade is suitably notched for the reception of the iron. This very simple appliance is found to be most serviceable in practice.





THE HAGUE RADIOTELEGRAPHIC CONFERENCE, 1929.

THE International Radiotelegraphic Convention of Washington in 1927 provided for the formation of a Technical Consultative Committee whose duty it would be to consider the various technical problems arising out of the decisions of the Convention.

The functions of the Committee are thus purely of an advisory or recommendatory character. The decisions and recommendations of the Committee, however, cannot fail to have a marked influence on the trend of development of radio in the future, while in the case of unanimous recommendations it is probable that administrations will put these into effect without waiting for the formal endorsement of the next Convention.

The first meeting of this technical committee, known as the Comite Consultatif Technique des Communications Radioelectriques (usually abbreviated to the initials C.C.I.R.), took place at the Hague from September 18th to October 2nd last.

About fifty countries, self-governing colonies and exploiting organisations were represented, and the total number of delegates and experts present exceeded two hundred.

The British delegation consisted of seven members, the chief of the delegation being Lt.-Col. A. G. Lee, Assistant Engineer-in-Chief of the Post Office.

Organisation.—Owing to the fact that this was the first meeting much of the work involved dealt with the organisation of the Committee itself. It was decided not to establish a permanent secretariat nor to appoint commissions of rapporteurs to carry on work after the termination of the main committee, but that the study of any outstanding question should be handed over to a particular nation to deal with, while other nations interested would be at liberty to collaborate in such studies if they desired. In these respects the C.C.I.R. will differ fundamentally from the C.C.I. Telephonique which possesses both a permanent secretariat and commissions.

Definitions.—Other work of the Committee lay in the enunciation of definitions and of methods of rating radio transmitters. Up to the present the rating of a transmitter might mean anything from the power input to the radio frequency power output. Thus a transmitter rated by one manufacturer at, say, 5 K.W., might be identical with that rated by another manufacturer at 20 K.W. Of course this did not matter very much in actual practice, since when one was specifying or purchasing a transmitter one took care to say how the power was to be measured. The disparity between the different methods of rating involved difficulties in the preparation of International lists of stations. It was recommended that, in future, transmitters should be rated by the power supplied to the antenna, measured, either in the antenna itself or by absorbtion in a dummy antenna or by measuring the power at another point in the transmitter and taking into account

the efficiency of the intervening circuits. Telegraph transmitters are to be measured with the key down, and telephone transmitters are to be measured on full power with maximum modulation on a single frequency, with the condition that the sum of the modulation harmonics is at least 20 decibels below the fundamental.

Definitions were also laid down regarding the nomenclature of waves or frequencies as follows:—

Low frequencies (long waves) below 100 kc./s. (above 3,000m.).
Medium frequencies (medium waves) 100 to 1,500kc./s. (3,000-200m.).
Medium - high frequencies (intermediate waves) 1,500-6,000kc./s. (200-50m.).
High frequencies (short wave) 6,000-30,000 kc./s. (50-10m.).
Very high frequencies (very short waves) above 30,000kc./s. (below 10m.).

In regard to the measurement of frequency the view was expressed that the national standard of frequency used by administrations should have a precision of at least 1 part in 100,000.

Frequency meters utilised in transmitting stations, if provided with special features such as crystals, thermostats, etc., can at the present time attain a precision of from 2 to 5 parts in 100,000 metres; unprovided with these special features can attain a precision of 1 part in 10,000.

Frequency Tolerance.—The frequency tolerance or permissible divergence of the frequency of a transmitting station from its assigned frequency was the subject of consideration by the Committee which drew up two lists of tolerances, one immediately applicable and a more stringent list for the near future. On long waves, both lists are identical, being ± 0.1% for fixed and land stations and ± 0.5% for mobile stations. In the latter case the limit only exists during a single transmission, as a mobile station has a right to change its wave-length within its allocated band.

Broadcasting stations on the 200 metres to 545 metres band were limited to ± 300 cycles per sec. immediately and ± 50 cycles per sec. in the future.

On the 200 metres to 50 metres band, fixed stations were limited to ± 0.05% immediately and ± 0.02% in the future. Land stations were limited to ± 0.1% and ± 0.02%, while mobile stations and low power (not exceeding 250 watts in antenna) fixed and land stations working in the shared bands were permitted a tolerance of ± 5 Kilocycles per sec. present and future during a transmission.

On the short waves of 50 metres to 13 metres, the tolerances for fixed stations are ± 0.05% and ± 0.01%, for land stations ± 0.10% and ± 0.02%, and for mobile and low power fixed and land stations 10 Kilocycles per sec. for the present and 5 Kilocycles per sec. for the future, the latter figures applying during a transmission only and in the case of land and fixed stations when working in the shared bands.

The effect of these recommendations will be to compel all low power short wave stations unequipped with precision frequency control to work in the shared fixed and mobile bands, and thus leave the fixed service bands clear for the better equipped high power stations.

Channelling Scheme.—One of the subjects on the agenda was the question of dividing the frequency spectrum into a definite number of frequency channels. Owing to the rapidly changing technique it was considered inadvisable to proceed with the question. In order to promote orderliness in the allocation of wave-lengths, however, it was recommended that administration should allocate frequencies above 6,000 Kilocycles per sec. in definite multiples of 5 Kilocycles.

In allocating frequencies, it was recommended that 6,000 to 23,000 Kilocycles per sec. (50 metres to 13 metres) should be reserved for long distance communication, but that 6,000 to 9,000 Kilocycles per sec. (50 to 33 metres) could be used for medium distance communication in daylight. Frequencies of 6,000 to 3,500 Kilocycles per sec. (50 to 85 metres) should be reserved for medium distance working and 3,500 to 1,500 Kilocycles per sec. (85 to 200 metres) reserved for short distance working.

Prevention of Interference.—On the question of the suppression of unessential emissions by transmitting stations it is interesting to record that the Committee accepted a document submitted by the British delegation as furnishing a sufficiently detailed exploration of the problem. It was decided that it was impossible to draw up regulations on the subject at the present time.

Limit of Power Broadcasting Stations.—The Committee recommended that European broadcasting stations using the band of frequencies 550 to 1,500 Kilocycles per sec. (545 to 200 metres), with the exception of Russian stations, should be limited provisionally to a power of the order of a hundred kilowatts. The words used in the French text are " une centaine de kilowatts " which does not definitely limit the power to a hundred kilowatts but to something between a hundred and a hundred and twenty kilowatts. As this is the power to the antenna, the limit is a generous one and well beyond the power of any existing or contemplated station.

General.—As all the decisions of the Committee were unanimous, and often the compromise between different opposing interests, the results of the first meeting of the C.C.I.R. may be regarded as highly satisfactory.

The Committee decided to accept the invitation of the Danish Government to hold the next meeting at Copenhagen in 1931.

RADIO TELEGRAPH RECEIVERS.

A. J. Gill and G. H. Farnes.

IT may be of interest to give a brief description of two radio telegraph receivers recently constructed at the Dollis Hill Experimental Station, as furnishing an indication of the present trend of development in such apparatus. The complexity of radio receivers has increased to such an extent during the last few years that it has been found necessary to abandon the more familiar type of construction in which a complete receiver is mounted in a wooden case with an ebonite panel containing the controls. The use of high amplification made screening between stages necessary, while ebonite, because of its tendency to warp and surface deterioration, was not entirely satisfactory as a mounting medium.

As a result all modern receivers have been built on the lines of telephone repeater equipment, the apparatus being mounted on metal panels and the panels assembled vertically on steel racks of the same dimensions as standard repeater racks.

The panels used are of cast aluminium alloy and are machined on the front surfaces and edges. They are provided at the back with a cast register which is also machined. A metal screening and dust cover fits over the register and is held on by spring clips.

The switchboard type of construction has proved to be the only possible means of mounting a large receiving set. Whereas ten years ago the largest receiving set had a panel surface of three or four square feet a fully equipped short-wave radio telephone receiver at the present day has a panel area of about 70 square feet!

The assembly shown in Fig. 1 consists of four monitoring long-wave receivers for the Central Radio Office, London. As these receivers have to receive the outgoing signals from the radio transmitters at Rugby and Leafield (which are remote controlled from London) a high sensitivity was not essential.

The four receivers are mounted on two standard racks and have a common meter panel for measuring any filament voltage or anode current.

Each receiver consists of a tuned coupled aerial circuit, a tuned-anode, tuned-grid oscillating detector valve operating on anode bend detection and three low frequency stages. A note filter is incorporated between the second and third low-frequency stages giving a choice of three audio frequency notes of the order of 800 cycles, 1000 cycles and 1200 cycles.

The output from each receiver is fed *via* an output transformer to a distribution board from whence it can be plugged to any position on the control bench for operating a loud-speaker.

As there is always a temptation to anybody to twist the knobs on a radio receiver, and as it was very desirable in this case that the receivers should be always ready for use, it was decided to place all the tuning controls under lock and key. The aerial grid and anode controls are placed

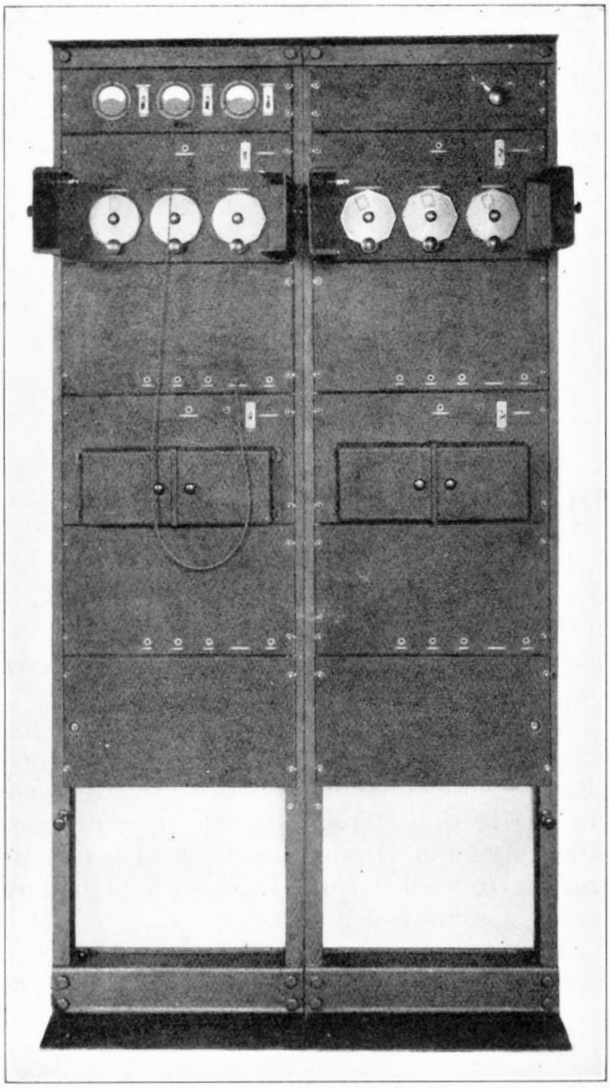


FIG. 1.—MONITORING SETS FOR C.R.O.

under hinged covers which can be locked by the handles at the bottom of each rack. The covers at the back of the receiver can be locked in the same way.

The other receiver, Fig. **2** and Fig. **3**, is of a more sensitive type and is intended for general observation work at the Wick Radio Station, where commercial traffic does not engage the full time of the staff.

The range of the receiver is from 300 metres to 20,000 metres, and this range is covered by means of three sets of plug-in coils, as follows :— Range A covers 20,000 to 6,000 metres, Range B covers 6,000 to 2,000 metres and Range C covers from 2,000 metres to 300 metres.

Looking at the back of the receiver, Fig. **3**, the various panels are as follows :—Left rack, top, spare valves, coil box, heterodyne oscillator, note filter and recorder. Right rack, top, meter panel, aerial tuning panel, high-frequency amplifier panel, detector and low-frequency amplifier panel.

The set consists of two high-frequency stages, using screened grid valves, a separate heterodyne oscillator working on the tuned anode-tuned grid circuit, anode bend detector, three low-frequency amplifier stages and final detector for recording signals on a Wheatstone receiver.

A note filter circuit is incorporated between the second and third low-frequency amplifier and a monitoring circuit is provided after the third low-frequency stage to enable signals to be received on telephones. The loading coil used

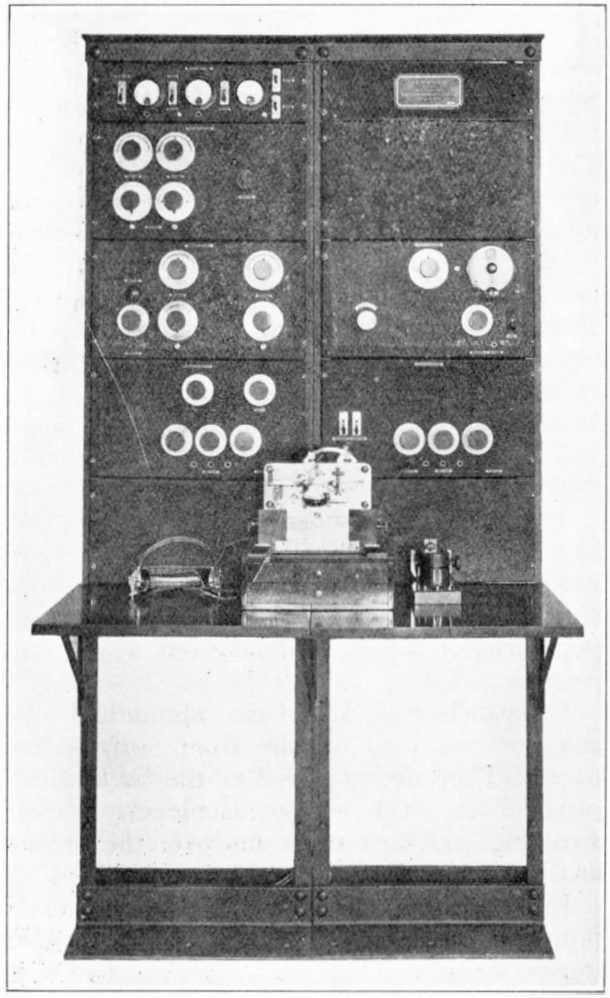


FIG. 2.—WICK INTERCEPTION RECEIVER. FRONT.

on the note circuit filter can be seen on the bottom left panel, Fig. **3**.

The aerial tuning panel contains a tuned aerial circuit coupled to a second tuned circuit which is connected across the grid filament circuit of the first screened grid valve. The anode circuits of both screened grid valves are tuned so that in order to set the receiver to any wave it is necessary to adjust five different circuits, including the heterodyne. This is not so simple as the one knob control met with on many modern broadcast receivers, but the selectivity and sensitivity is much improved, while tables giving the settings for different wave-lengths have been prepared and facilitate tuning.

The two high-frequency stages are screened one from the other by a cast aluminium partition. Each screened grid valve is mounted in a copper pot and the anode connection projects in proximity to the tuned circuit to which it is connected. The grid circuit connections are brought into the pot through copper screening tubes.

The long ranges on each set of coils have been obtained by providing fixed condensers connected to dial switches which extend the range of the variable condensers fitted.

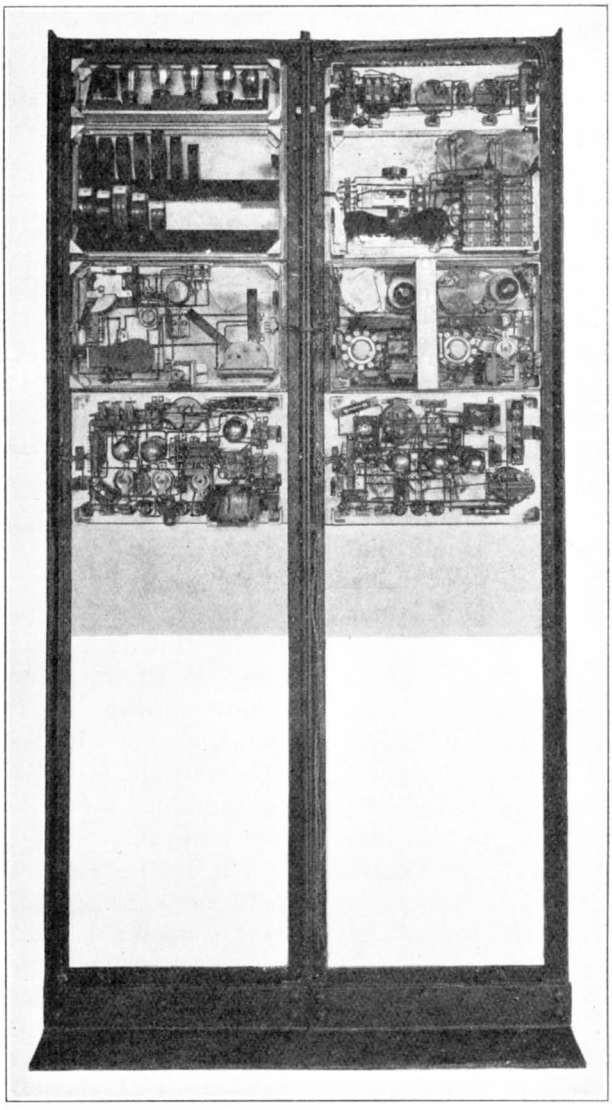


FIG. 3.—WICK INTERCEPTION RECEIVER. BACK.

NOTES & COMMENTS

WE give elsewhere in this issue a summary of the Inaugural Address of Col. Sir T. F. Purves, Engineer-in-Chief, in his capacity as President of the Institution of Electrical Engineers, and also a description of the methods employed in broadcasting the address by Trunk lines to the various Local Centres of the Institution. Although many officers of the Department will receive copies of the address in due course when it appears verbatim in the Journal of the Institution, the Board of Editors of this Journal considers that a wider circulation would serve a good purpose and we have accordingly obtained a limited supply of advance copies from the Institution. The Council of the I.E.E. has given us permission to distribute the copies among our readers, and those members of the staff who would like copies should apply to their local agent, or direct to the Managing Editor, E.-in-C.'s Office, Alder House.

By the death of Dr. Hansford the Institution of Post Office Electrical Engineers has lost an energetic and very capable secretary, the Department one of its best and most promising officers and the Journal one of its most enthusiastic supporters and constructive critics. We commend the attention of our readers to the memoir which appears in this issue from the pen of one of his earliest friends and colleagues in the Department.

Our attention has been directed to two errors that appeared in the October issue. The first was in the article on " A New C.B. Microtelephone." On page 188, the last column in the table under the heading Head Horizontal should read :—

Not tested.
16% W
3% W
4% W
8% W

The second mistake appeared in the article on " The Mechanical Testing of Transmitter and Receiver Efficiencies." On page 193, line 18 of the second column should read " ranges from 600 to 1600 cycles per second at 250."

BROADCASTING IN CANADA.

ROYAL COMMISSION REPORTS IN FAVOUR OF PUBLIC OWNERSHIP.

The Report of the Royal Commission on Radio Broadcasting in Canada, which has just been issued, recommends the establishment of a Government-owned Company, to be known as the Canadian Radio Broadcasting Company, which would be to control and operate stations throughout Canada for the organisation of wireless programmes.

The Board of Directors of the proposed Company, it is suggested, should be composed of twelve members, three more particularly representing the Dominion Government, and one representing each of the Provinces. The Royal Commission recommends that broadcasting should be carried on as a public service; that a Provincial Radio Broadcasting Director should be appointed to control the preparation and transmission of programmes in that area, and

that a Provincial Advisory Council on Radio Broadcasting should be set up in each Province.

If the Report should be adopted, seven high-power radio stations would be erected in Canada to provide the service initially suggested by the Radio Commission. These would be 50,000-watt stations, and supplementary stations of lower power would, if necessary, be erected in local areas not effectively covered by the main stations. The estimated cost of the main stations is $3,000,000, and of the smaller units $250,000, and the estimated cost of operating the entire organisation is $2,500,000 annually.

The Commission recommends that, pending the inauguration and completion of the proposed system, provisional services should be provided through certain existing stations. Compensation to the owners of existing stations should be met out of an appropriation made by Parliament, but expenditures necessary for the operation and maintenance of the proposed broadcasting services should be made out of revenue from license fees and advertising rentals, supplemented by a Dominion Government subsidy. License fees for receiving sets would be increased from $1 to $3 a year, bringing in approximately $900,000 per annum, in addition to $700,000 being the revenue expected from indirect advertising. A Federal Government Grant of $1,000,000 annually is recommended to make up the deficiency between revenue and cost of operation.

Legislation will be necessary to implement the recommendations of the Radio Commission, if decided on by the Federal and Provincial Governments. It is understood that the Provinces are ready and willing to enter into negotiations with the Federal Government with a view to collaboration.

The Board of Editors has decided to issue the Index of Contents for the current Volume as an insert in the April issue. In future the Index for the volume will be bound in the January issue, the last number of each volume.

HEADQUARTER'S NOTES.

EXCHANGE DEVELOPMENTS.

The following works have been completed :—

Exchange.	Type.	No. of Lines
Ardwick	New Auto.	3050
B'ham Northern (Advance) ...	,,	Main Frame
Flaxman	,,	9900
Haxby	,,	100
Hendon	,,	3100
Ilford	,,	2850
Metropolitan	,,	9500
Mumbles	,,	570
National	,,	9400
Western	,,	6800
Burslem	Auto Extn.	250
Epsom	,,	300
Exeter	,,	760
Foleshill	,,	100
Longton	,,	100
Newcastle-on-Tyne	,,	160
Stockport	,,	360
Stoke	,,	110
Bourne End	New Manual	880
Eghorn	,,	780
Emberbrook	,,	1700
Stanmore	,,	560
Cantebury	Manual Extensions	700
Crosby Extn.	,,	900
Cerebos Salt	P.A.B.X.	30
Hunt & Winterbotham ...	,,	20
Hyde Co-op.	,,	20
Preston Co-op.	,,	30
Shell Mex (Brixton)	,,	30
Waring & Gillow	,,	Re-arrangement

Orders have been placed for the following works :—

Exchange.	Type.	No. of Lines
Terminus	New Auto	Main Frame
Whitehall	,,	7000
Basford	Auto Extn.	570
Headington	,,	200
Rochdale	,,	Modfn.
Southend	,,	Obsn. Desk.
Whitworth	,,	100
Hindhead	New Manual	650
Merrylee	,,	1600
Morecambe	,,	1080
Scotstoun	,,	2200
Silverthorne	,,	1660
Didsbury	Manual Extensions.	900
Popesgrove	,,	1040
Rockferry	,,	1420
Woking	,,	400
Airworks, Ltd.	P.A.B.X's.	20
Bond Worth & Son	,,	30
Clark & Son	,,	30
Decca Gramophone Co. ...	,,	30
Horlicks Malted Milk	,,	30
Lanarkshire County Council ...	,,	30
Lighting Trades	,,	30
Mickley Coal Co.	,,	20
Shell Mex (Brixton)	,,	30
Waring & Gillow	,,	Re-arrangements
Wellsteeds, Ltd.	,,	30

RICHARD VERNON HANSFORD.

THE sad tidings that Dr. R. V. Hansford had died as the result of a slip on the staircase of his home, as he was about to leave for the office on the morning of October 5th, came as a shock almost without precedent in the annals of the Engineer-in-Chief's Office. The blow fell with staggering effect upon his colleagues in the Radio Section, and the men who had striven and laboured with him to place Post Office radio in a position of honour in the world of communication engineering found it difficult to realise that Hansford had left them for ever. His death at the early age of 41 years has taken from our midst an officer of outstanding ability and charming personality, and has left an ache in the hearts of his friends which not even time will completely heal. Physically not robust, he brimmed over with life and energy and he proceeded from one task to another, from one triumph to another, with little interest in past successes but with his eyes always fixed upon a new goal and an unshakeable faith in his ability to reach it by the shortest path. He worked for sheer love of work and with an entire lack of self-interest or self-aggrandisement.

Hansford entered the engineering profession by obtaining first position in an examination for apprenticeship in H.M. Dockyard, Chatham. He served the full period of six years, but towards the end he won a Kent County Council Major Scholarship and was granted leave of absence by the Admiralty to enable him to study at the University of Glasgow. There he obtained prizes in the Departments of Natural Philosophy, Mathematics and Engineering, and he was awarded the George Young Bursary for the best record in the First Science Examination. He graduated in 1910 as B.Sc. in Naval Architecture with Special Distinction in Mathematics, Natural Philosophy and Physical Laboratory, and Engineering. After graduating he was awarded the James Watt Research Scholarship, but resigned it to take up an appointment as Second Class Engineer in the Post Office Engineering Department. He had casually applied for nomination to compete for this post, merely because the examination appeared to be one which he could take in his stride, but almost before he realised the extent of the change in his career he had left shipbuilding behind and was attacking the problems of communication engineering and mastering the somewhat complicated organisation of a department which carries out work in every town and village and on or under nearly every road in the Kingdom.

After a short period of training, Hansford took up duty in Edinburgh, serving in that City about a year, partly in Edinburgh Section and partly in the District Office. He was then transferred to Inverness. The writer met him for the first time on his arrival there in August, 1912. After mutual introductions, Hansford proceeded to explain, with his inimitable laugh and without any trace of feeling, that his presence was due to his "own silly mistake." He had applied for transfer to London and had been sent to Inverness. With his eighteen months' experience of the ways of a Government Department he ought to have known that he should have applied for Inverness if he wanted to go to London. The incident is slight, but it is typical of Hansford's outlook of life. He invariably treated his personal disappointments lightly, humorously and with the laugh against himself. Something gone wrong was something to be put right and not something to be complained about.

The war years found Hansford bearing his share of the national burden in strenuous work to provide naval and military communications in the north of Scotland. The telephoning of Scapa Flow and Cromarty Firth, with their huge temporary populations, the erection of an extensive coastal system of look-out lines on the mainland, and in the Orkneys, Shetlands and Hebrides, continual changes and extensions as the war developed, and latterly the provision of communications for the American mining bases and fleet, with some hundreds of lesser works, more than fully occupied the sectional staff, reduced by the demands of war in other directions, and the frequent temporary additions made to it from other districts. In these early efforts Hansford showed the same thoroughness and accuracy which characterised his work to the end. A date named for the completion of a job was a date to be adhered to, whatever the fore-

seen or unforeseen difficulties. In country devoid of transport facilities and of living accommodation for the men, unforeseen difficulties were by no means unusual or slight, and any sigh of relief at being "over the peak" was usually stifled by the sight of a stiffer peak ahead.

In August, 1919, Hansford left Inverness and joined the Radio Section at the Head Office. It was here that he found the work for which he will be remembered. A wiser selection for service in a new and rapidly developing branch of engineering could not have been made, for Hansford was by nature and temperament a pioneer, with little interest in trodden paths, but ready and able to cut a way for himself, and others, in the untracked and the unknown. The art of valve radio transmission was an entirely new field for exploration at this time and Hansford entered it with all his immense enthusiasm. Experiments at Caister and Stonehaven were followed up by the erection at these stations of transmitters using air-cooled valves. Stonehaven remained in successful operation for Continental traffic until a few months ago, when it was closed for reasons of policy. In 1923, the high-power transmitter for Rugby was in view, and advantage was taken of the building of the Northolt valve transmitter to try, on a comparatively small scale, the methods to be applied to the larger scheme. Northolt is a 30-kilowatt transmitter, using three 10-kilowatt water-cooled valves in the output stage. Rugby with its 54 valves of the same type followed; nothing on so large a scale had previously been attempted, and the task was one requiring professional courage as well as professional skill. Hansford, with H. Faulkner collaborating, was mainly responsible for the design in detail, construction and testing of the transmitter itself, the huge mast system and power plant falling to other members of the little band of engineers who laboured unitedly at what, having regard to its pioneer character, was perhaps the most onerous single effort ever undertaken by the Post Office Engineering Department. Rugby has been visited by radio engineers from all parts of the world, and although the policy which led to the building of the station may have been criticised, not always fairly, there has been nothing but praise and admiration for its engineering design and lay-out.

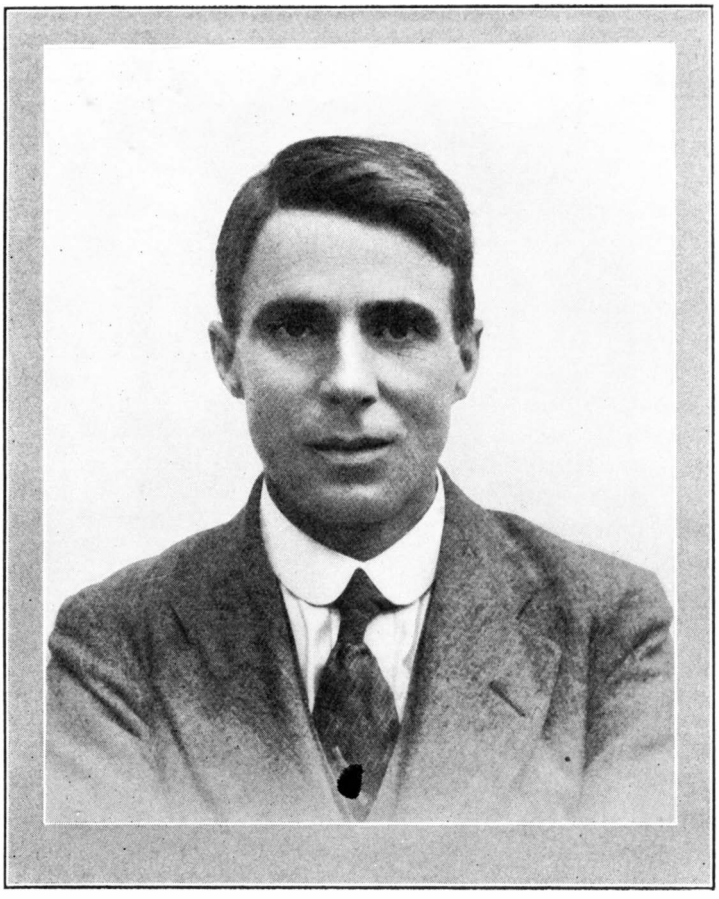
Hansford was also intimately concerned in the inauguration and development of the Anglo-American telephone service, and its extension to the continent of Europe. The main problem to be solved in designing such a service was not so much the transmission of speech across the Atlantic, as the devising of equipment for speaking in both directions on the same wave-length, and for translation to the land line telephone systems at each end of the radio link. The long-wave channel with which the service opened was followed quickly by the addition of a short-wave channel, and a second short-wave channel was opened recently. In all these undertakings Hansford took his part, in personal work and in using his experience and knowledge to co-ordinate the efforts of others, difficulties disappearing as if by magic under his touch. He visited America and many European countries to forge and strengthen links in the rapidly lengthening chain of world communication, the completion of which had been made possible by the progress in long distance radio telephony. The recent experimental transmissions between London and Sydney, Australia, and the extension of this channel to New York, were the culminating successes of the group of engineers working under Hansford.

Glasgow University conferred the degree of Doctor of Science upon Hansford in 1926 for a thesis upon some aspects in the design of a high-power radio-telegraph transmitter, in which the scientific and practical considerations underlying his original work in connection with Rugby were set forth and described. The initial tests of Rugby were occupying him throughout the day and far into the night when this thesis was in preparation, and the time limit for its submission was within a fortnight of expiration when, without warning, demand was made upon him to examine the case for revision of Scales to be submitted to the Industrial Court by the Society of Post Office Engineers, and to appear as a witness before the Court. With his usual selflessness he put aside his own interests, and it is no secret that his trenchant criticism caused the case to be entirely remodelled at the eleventh hour, and that he tuned up his fellow witnesses in the inimitable Hansford way. The decision reached by the Court will be remembered as one of the rare cases adjudicated upon in which im-

Richard Vernon Hansford

The face of Death is toward the Sun of Life,
His shadow darkens earth: his truer name - -
Is "Onward," no discordance in the roll - - - -
And march of that Eternal Harmony - - - -
Whereto the worlds beat time, tho' faintly heard,
Until the great Hereafter. - - - - - - - - -

Tennyson



proved scales were granted. Hansford returned to his thesis with three or four days in hand and sufficient work outstanding upon it to occupy most men three times that period. Happily the task was accomplished.

The Institution of Electrical Engineers in 1927 awarded its Wireless Premium of £20 to Messrs. Hansford and Faulkner for a joint paper on "Notes on the design details of a Radio Transmitter using Thermionic Valves."

Hansford was appointed Secretary to the Institution of Post Office Electrical Engineers in 1923, and he retained the office until his death. Probably only members who have served on the Council of that body will appreciate fully the value of the services he rendered. The work of the Council was invariably carried on with orderliness and celerity, due largely to the series of Council Papers, which he issued in addition to the Agenda and which placed every member in possession of the essential facts and past history of matters to be discussed. On principle, as Secretary, he rarely intervened in debate except to clear up a doubtful point or to lead a straying discussion into the right path, but he was ever watchful of the interests of the Institution, and it is beyond question that he maintained and improved its position as a real force in the science and practice of communication engineering.

During the past two years Hansford served on the Comité Consultatif International des Communications Telephoniques and he was rapporteur of the Fifth Commission of the Committee. He attended conferences at Como, and Berlin and also the recent conference of the C.C.I. Radioelectrique at the Hague. His value in the deliberations of these international bodies was fully recognised, and the news of his decease brought expressions of sorrow and regret from delegates of many of the countries represented. He was examiner in the subject of Magnetism and Electricity for the examinations conducted by the City and Guilds of London Institute, and he served on an advisory committee to consider the curricula and syllabuses for the subjects of telegraphy, telephony and radio communication. He was also a member of the "Thermionics" sub-committee of the Radio Research Board and of the committee of the Wireless Section of the Institution of Electrical Engineers.

In Hansford's personality were combined high personal qualities, an amazing capacity for work, natural ability of exceptional order and the strength of character to utilise these attributes to the fullest extent. He had only one standard of quality, the highest, and he would not accept mediocrity of performance either from himself or from those who worked under him. On the other hand he was a most patient teacher and leader, and his criticisms were always concluded with a laugh and a jocular remark which removed sting without impairing effect. He knew how to direct and employ staff without imposing unnecessary restrictions on their efforts. He asked for no more than he was willing to give himself, and his subordinates adored him accordingly. He was incapable of idleness; with every minute utilised to the fullest extent his working day was double the length of that of most men. He was impatient only of personal illness, and his impatience arose not from the suffering involved but from its interference with his normal routine. Not even illness could, however, impair the cheerfulness which seemed ingrained in his disposition, and at the first sign of convalescence he would send out an urgent appeal for work. And yet with all his numerous activities Hansford never gave the impression that he was a slave to work: he was indeed always its master. If there were times when his friends feared for his health, and such fears were expressed, he would laugh them aside, and a day or two later he would appear brighter and more energetic than ever.

In everything that makes for pleasant social intercourse Hansford was richly endowed. His keen sense of humour, natural wit, powers of repartee and love of fun made him a central figure in any gathering in which he participated, whether a fireside talk, a children's party, a staff dinner or an informal function of a learned institution. His letters written in perfect idiomatic English and combining sound common-sense with original humour were a delight to their recipients. His laugh and the whimsicalities of expression which he was fond of adopting were infectious to a degree, and those who knew him intimately were often amused to find Hansfordian expressions on their lips or appearing in unexpected quarters. His humour, never used to hurt, was sparkling or subtle as the occasion demanded. His loyalty was unquestioned and unquestionable, and in return he obtained loyalty

without stint from everybody with whom he came in contact. His friendship was indeed a thing to be coveted.

Hansford has left only pleasant memories behind him. Regret at his loss cannot be expressed in words. The gathering at his interment, representative of two continents and many countries, was indicative of his place in the hearts of those with whom he came in contact. He went when at the zenith of his powers, and when a brilliant past seemed to have assured a still more brilliant future, but we, who knew him, loved him and worked with him, will treasure his memory for the innate manliness of his character, for his sincere friendship and his inability to say or do anything inconsistent with our conception of the best type of gentleman. Our heartfelt sympathy will be extended to his sorrowing wife and mother, his two little sons and the other members of his family. Their burden is indeed heavy.

C.J.M.

FRANK WILLIAM DAVEY.

Frank W. Davey.

The many friends and colleagues of Mr. F. W. Davey will be grieved to learn that, as a result of continued ill-health, he has been obliged to retire from the Service at the age of 52. The Engineering Department is the poorer because of the enforced withdrawal of a brilliant product of the telegraphist school of Post Office Engineer; one of that dwindling band of pioneers in a rapidly developing profession.

Mr. Davey commenced his career as a telegraphist in 1892, serving for 3 years in the Inland and 8 years in the Foreign Sections of the Central Telegraph Office. In 1903 he was promoted to the class of Relay Clerk at Lowestoft and after 6 years' experience in this capacity he was advanced to the rank of Second Class Engineer on the Headquarters staff. In 1911 he was made an Assistant Engineer and promoted in 1924 to the rank of Executive Engineer.

Most of Mr. Davey's service at Headquarters has been devoted to specialised duties in telegraphy and wireless. In the development of radio, he has been responsible for much original work and this is exemplified by the following brief references to his professional career. When the wireless coast stations were transferred from the Marconi Company to the Post Office in 1909, Mr. Davey was responsible for the reconditioning and maintenance of the system and, under his direction, the first spark disc discharge set was installed at Fishguard. Later he was responsible for radio installations at the Valencia and Stonehaven stations, the latter being the first fast speed wireless telegraphy station erected for the Post Office. During the war Mr. Davey was responsible for the organisation and administration of the Army Wireless School at Farnborough, where large numbers of Royal Air Force personnel were trained under his direction. He was also retained during the war period as an expert witness in wireless prosecutions under the Defence of the Realm Act.

As an Executive Engineer in the Radio Section at Headquarters Mr. Davey had charge of construction and maintenance work connected with coast stations.

He represented the Engineer-in-Chief on several important committees dealing with radio work. He was a member of the Inter-Departmental Committee on Direction Finding, which led to the equipment of Post Office coast stations with direction finding equipment. Davey also acted as technical adviser to Trinity House in connection with the equipment of light ships and shore stations with wireless telephony.

He was a member of the Radio Research Board's sub-committee dealing with direction finding; a member of the committee appointed by the Board of Trade to deal with the provision of rotating beacon stations for safety of life at sea; also on the Wireless Section committee of the Institution of Electrical Engineers.

Mr. Davey has contributed papers and articles to the technical press, dealing with the theory of radio telegraphy and telephony and, in this connection, it is interesting to note that in 1922 he read a paper on the development of thermionic valves for wireless purposes in which he foreshadowed the opening up of telephonic communication with America.

It is true to say of Frank Davey that his unassuming modest nature shrinks from any sort of publicity. His wide reading makes him an excellent companion and his cheerful outlook on life will always remain a cherished possession to those who are privileged to be numbered among his friends. Now that there is less need for the study of matters scientific and technical, he will be enabled in his quiet country home in Essex to enjoy more fully than heretofore his abiding interest in literature.

A large number of his friends have combined to present Mr. Davey with a silver tea service, and an accompanying album containing the names of those who hold him in affectionate regard. This brief notice may fittingly close on a note of complete endorsement of the inscription in the album.

"To

FRANK WILLIAM DAVEY.

We, your colleagues in the General Post Office, desire your acceptance of the accompanying silver tea service as a token of our esteem and regard and we wish to express our deep sense of the loss we have sustained in your retirement.

We desire to place on record our high appreciation of your ready helpfulness and unfailing courtesy. We wish you many years of enjoyment of health and leisure and trust that many happy recollections of your 37 years' service may remain with you, as they do with us."

A.O.G.

* * * * * * *

In 1913, when I returned to Hearquarters to take up wireless work, I found the expert knowledge and the loyal support of my old friend F. W. Davey of immense value during what might otherwise have been a difficult time. He was always a progressive, bold and enthusiastic worker and I should like to take this opportunity of expressing my indebtedness to, and affection for him. It is a great regret to know that he has to retire, but I trust that, relieved of his arduous labours, he will be spared many years to enjoy a peaceful and happy life.

E. H. SHAUGHNESSY.

LONDON ENGINEERING DISTRICT NOTES.

Telephone Exchange Progress.

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

Exchange.	*No. of equipped lines.*	*Manufacturer.*
Hendon	4,200	A.T.M.
Hillside	2,350	A.T.M.
Ilford	3,000	Siemens

Automatic equipment is being installed in the following new buildings:—

Addiscombe.	Macaulay.
Fairfield.	Primrose.
Amherst.	Shepherds Bush.

New Manual Exchanges.—The following installations are well in hand:—Redhill; Theydon Bois.

Manual Exchange Extensions.—The following extensions of equipment have been completed:—

Sydenham	2,000 lines	
Wembley	680 ,,	
Hounslow	1,220 ,,	
Grangewood	780 ,,	
Albert Dock	900 ,,	
Grosvenor		Extension of C.C.I. equipment.
Langham		
Abercorn		
Speedwell		

Concentration of Night Traffic at London Exchanges.

A measure of concentration of traffic *via* Tandem Exchange during late evening and night hours has recently been introduced which marks an important change in the method of handling traffic during these periods.

At 8.0 p.m. all outgoing junction traffic from Exchanges in the London Telephone area beyond the five mile circle to other Exchanges in the automatic area will be routed *via* Tandem, with a few exceptions, whilst at 9.0 p.m. all outgoing traffic from Exchanges within the five mile circle to Exchanges situated between the five and ten mile circles will also be routed *via* Tandem. As a result the "B" positions, at local exchanges other than the C.C.I., Trunks and Toll positions, will be closed at the above hours.

At Exchanges within the five mile circle, arrangements have been made to modify the order wire breakjack equipment so as to provide for a tone to be connected on the order wire keys of all the closed routes during the night time. If a telephonist depresses the order wire key associated with a route which is not open for traffic, a tone will be heard which will indicate that the traffic for that Exchange is to be routed *via* Tandem. The circuit has been so designed that the tone is only applied to the order wire circuits during the time an order wire button is depressed. This is achieved by the provision of a relay which is energised only when the order wire key is depressed and which, when actuated, joins up the tone. The tone will not, of course, be associated with the order wire breakjack equipment during the day time and its connection for night traffic discrimination will be under the control of the Traffic Staff. The procedure necessary to bring the tone into use is to transfer dummy breakjack plugs (which normally are in position in the top order wire breakjacks associated with the routes to be closed down) from their normal position to the corresponding lower jacks.

The new method will not only allow some economy in staff to be effected, but will also improve the grade of service during the night as the incoming calls will be dealt with at one point instead of being spread over a large switchboard.

Private Branch Exchanges.

In many of the great business houses of London there are telephone installations which are comparable with those of a small town. One has recently been provided for the Midland Bank in Poultry of which the details are as follows:—

7 100-line units.
35 first selectors.
7 second selectors.
63 final selectors.
8 manual boards.

Two 400 A.H. 50 volt batteries are fitted and also one 10 cell counter E.M.F. battery.

The capacity of the installation is 900 lines. At present there are working—

71 Exchange lines.
306 External extensions.
250 Internal extensions.
6 Auto tie lines.

Five Power Conference.

Preparations for the Five Power Conference to be held in London early in 1930 are now in hand and although precise details of the Telegraphic and Telephonic requirements have not been fully developed it is probable that the Engineering Department will be concerned with a large amount of work at St. James' Palace. Requests have already been received for a suite of 50 call office cabinets and a large P.B.X. Provision for between 60 and 70 Exchange lines is being made. The number of extensions likely to be required is not yet known, but is sure to be large.

Telegraphs.

On the 29th September the two Imperial Cables to Halifax, Nova Scotia, and the four Beam telegraph services to Australia, Canada, India and South Africa, which had been so successfully developed by the P.O., together with the associated apparatus, were regretfully handed over to Imperial and International Communications Ltd. The transfer was carried through without the slightest hitch, and without interruption of service.

The equipment of telegraph circuits in the C.T.O. with teleprinter apparatus is still proceeding and 26 sets have been brought into service during the past six months.

Telephone Cabinets.

A suite of handsome oak telephone cabinets has been built in the District Workshops and installed in the headquarters of the London Fruit Exchange Brokers' Association at Spitalfields.

Suites of suitable Cabinets have also been provided at Paddington and Piccadilly railway stations.

Retirement of Mr. J. Cowie.

Mr. Cowie entered the Post Office Engineering Department as a junior clerk in 1899. At that time he was taking a keen interest in technical matters and it was not, therefore, surprising that in 1902, when the Department was seeking suitable officers for employment upon the initial work in connection with the telephoning of London, Mr. Cowie was one of those selected. He was engaged upon this work as a Sub-

James Cowie.

Engineer for five years and was then transferred to Brighton where he acted as Assistant Engineer until 1924. During this period he became so thoroughly identified with the Section that it seemed difficult to think of Brighton without Cowie. Warm tributes were paid in the local press when in 1924 he left Brighton to take up the position of Executive Engineer at Manchester, and there is no doubt that the Department gained by the respect in which he was held by the officials of local authorities.

During the Great War Mr. Cowie was on loan for some time to the War Department for the training of Army Signallers. When he returned to the Post Office he received letters from the Major-General and Brigadier-General thanking him for his " most excellent work." In one of the letters reference was made to his " winning personality "—a phrase which all his civilian colleagues would apply to him.

Mr. Cowie was transferred to London in 1927 as Executive Engineer in charge of one of the most important sections at a time when automatic working on a large scale was being introduced.

He was first in charge of the internal portion of the work with all its new problems, and then was transferred to the external work. To each class of work he applied himself with his

customary thoroughness and has left a mark on the Section which will endure.

He was interested in everything that affected the welfare of the Department and the Staff. He gave many courses of technical lectures and took a keen interest in the I.P.O.E.E., which he served as a member of the Council for a number of years and as Chairman of Sub-Committees.

The official farewell was paid on 28th November when, on behalf of his numerous well-wishers, Mr. Gomersall made a presentation and referred to the manner in which Mr. Cowie had won the esteem and affection of all those who had the privilege of being associated with him. Tributes were also paid by officers representing the various grades of engineering and clerical staff, and there was not the slightest doubt about the universality of the regret with which the farewell was said. Mr. Cowie has retired in excellent health and has returned to live at Brighton, where, it is hoped, he will spend a happy period of retirement with plenty of occupation to keep his active mind and body employed.

J.G.H.

PROVINCIAL DISTRICT NOTES.

DAMAGE TO A DUCT ROUTE BY LIGHTNING.

It is by no means an unusual event for underground cables to be damaged by lightning, and the very full protection now given by the usual protective equipment is a tacit acknowledgment of the existence of this danger. It is, however, most unusual, if not unique, for underground ducts—as distinct from cables—to be damaged by lightning; hence, considerable interest attaches to a case of this nature which happened near Ripon during a storm early last July.

The locality of the damage was Leeming Lane, near Ripon, Yorks, the exact spot being indicated by the standing figure in photograph No. 1. The duct line comprises a 3-way multiple duct, one way carrying the Leeds-Edinburgh Cable, the other two being spare.

In the early hours of Sunday morning, July 7th, 1929, a thunderstorm was in progress in this locality, and a near-by house, known as Theakstone Grange, was struck by lightning, which dislodged a few of the slates and damaged a chimney. This aroused the tenant and whilst looking out on the storm, he saw a lightning flash strike the ash tree (photo No. 1) travel down the trunk and to about half-way across the grass margin where it disappeared into the ground.

Being interested to know what had happened, he took an early opportunity of visiting the spot, and found a hole in the ground, somewhat resembling a rabbit hole. Evidently being aware of the existence of our cable, he reported this to

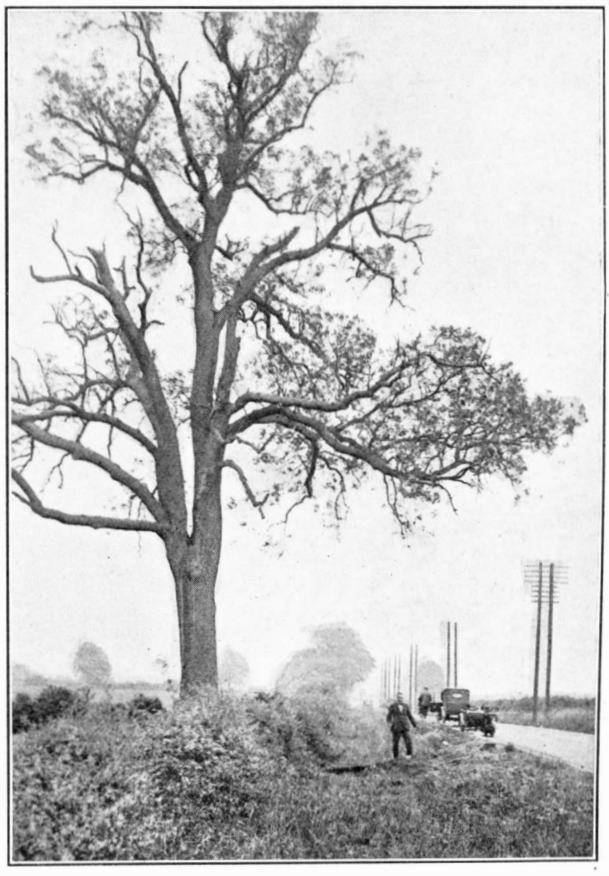


FIG. 1.—SHOWING TRACE OF DISCHARGE DOWN TRUNK.

the lineman, who, on arrival, carefully uncovered the ducts. It was found that three successive ducts had been damaged, the upperway in two of them having been shattered, and in the third, severely cracked around the socket.

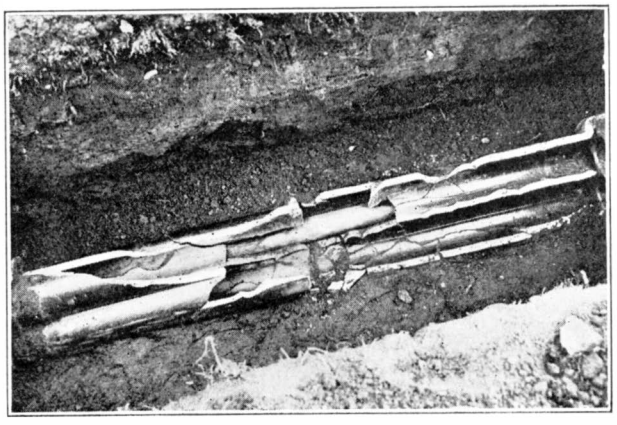


FIG. 2.—DAMAGE TO DUCTS.

The lower ways in all cases were very badly cracked. The photographs clearly show the damage.

Critical examination of the cable failed to

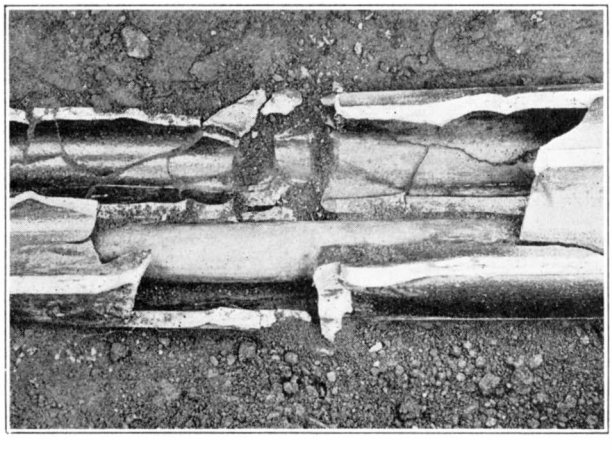


FIG. 3.—CENTRE PORTION OF DUCT SHOWN IN FIG. 2.

bring to light the slightest sign of damage. A " close up " of the cable shows a slight marking found on the surface of the lead, but no sign of penetraton was seen anywhere. No trouble was noticed on the circuits, and the usual monthly test showed the cable was up to standard, so far as insulation was concerned.

It is interesting to note that while no damage was done to the tree, the track of the flash can be seen down the trunk, and appears in the photograph as a white line down the extreme left-hand side.

It seems somewhat remarkable that the lightning should have turned aside from the tree at practically a right angle and travelled a few yards to reach our cable. Perhaps the tree was not efficiently earthed?

The behaviour of the tenant of Theakstone Grange deserves a few words. The man who can take precise and accurate meteorological

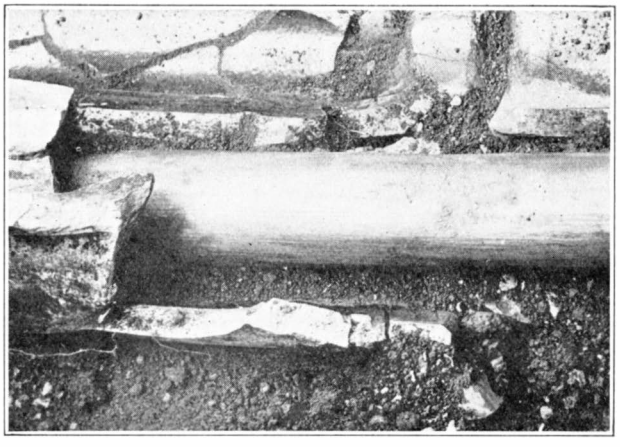


FIG. 4.—CABLE INTACT.

observations, leading to the location of a " fault " on our plant, at a time when his roof slates and chimneys are flying about his ears, must surely command our respectful admiration.

THOS. F. BARLOW.

A LANDMARK GONE.

Until recently the Department had two lattice masts, 120 ft. high, carrying main Trunks and Telegraphs alongside the toll bridge over the River Ouse at Selby, and for more than 30 years they were a conspicuous landmark. Owing to the withdrawal of wayleave

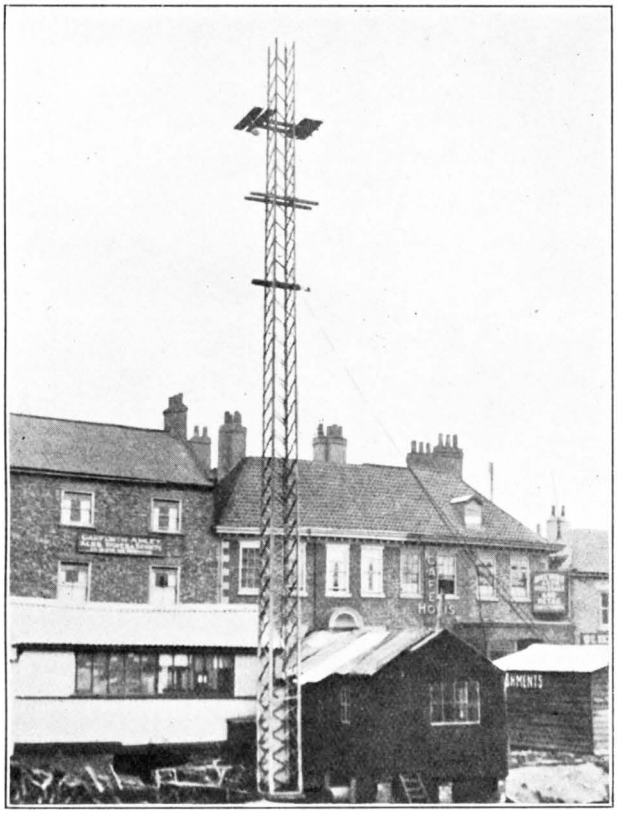


FIG. 1.—STAGING AND OXYACETELYENE APPARATUS.

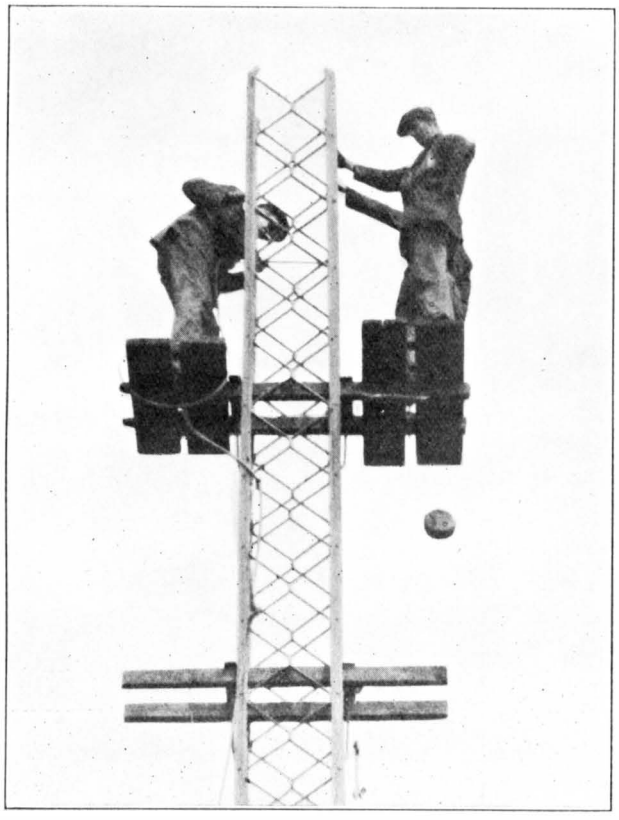


FIG. 2.—BURNING IN PROCESS.

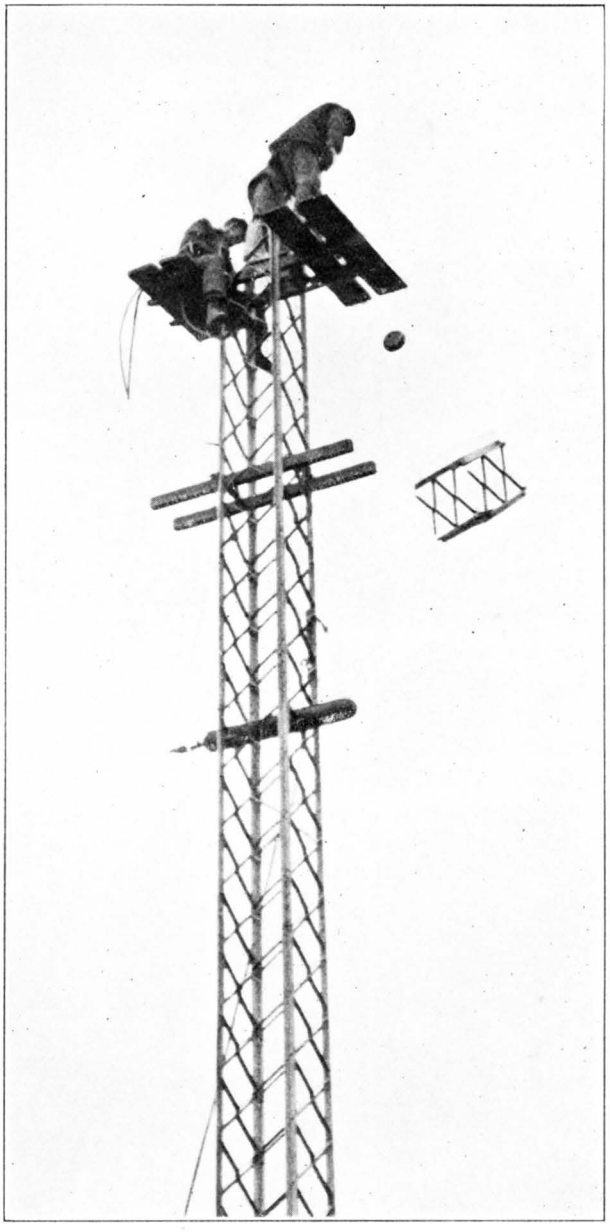


FIG. 3.—SECTIONS CUT AWAY AND ALLOWED TO DROP.

and the impossibility of finding alternative sites, the masts have been demolished, the circuits being diverted to a under-water cable.

The demolition of the masts was carried out by a steeplejack firm. At the commencement of the work the contractor used hack-saws, but later oxyacetylene gas was resorted to. Want of space prevented the masts being felled intact. The accompanying photographs taken by Mr. F. Vear, one of the York Inspectors, will be of interest.

W.P.

NEW CABLE ACROSS RIVER OUSE AT SELBY.

The demolition and removal of the 120 ft. masts on the north side of the toll bridge at

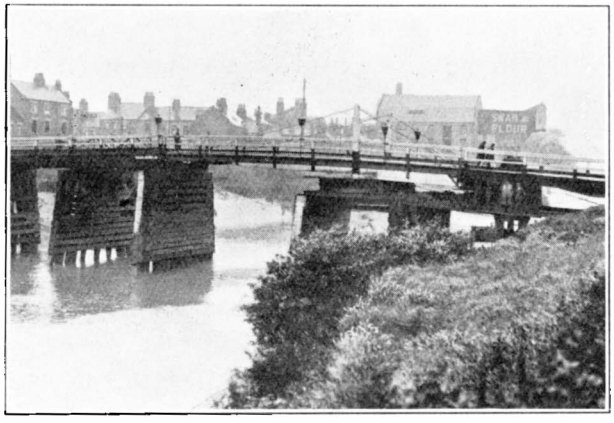


FIG. 1.—TOLL BRIDGE, SELBY.

Selby, referred to in the foregoing article, necessitated the laying of a cable across the river Ouse at that point.

The Leeds-Hull No. 1 cable and a local cable being *in situ* on the east side of the Bridge, the

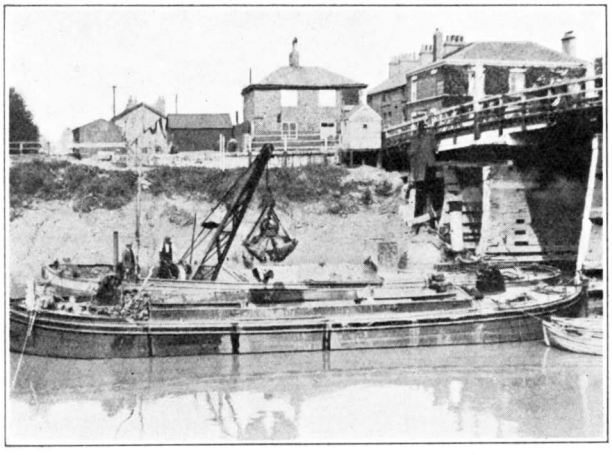


FIG. 2.—DREDGER CUTTING CABLE TRENCH.

west side was chosen for the new cable. In addition to the trunks and telegraphs, provision was made for local circuits and a double-armoured cable containing 7 pr/70 + 46 pr/20 + 102 pr/10 conductors was supplied. The lay-

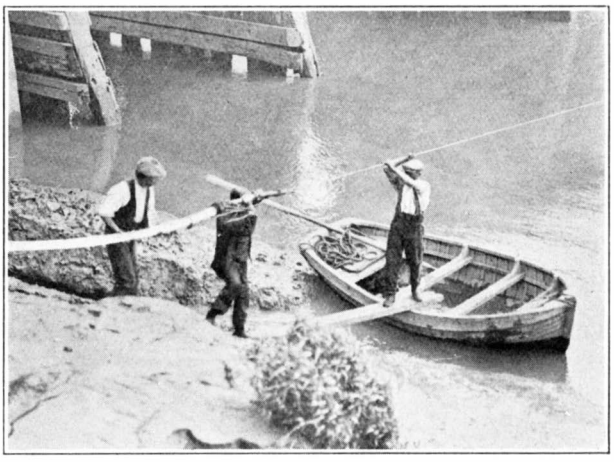


FIG. 3.—CARRYING CABLE TO BOAT.

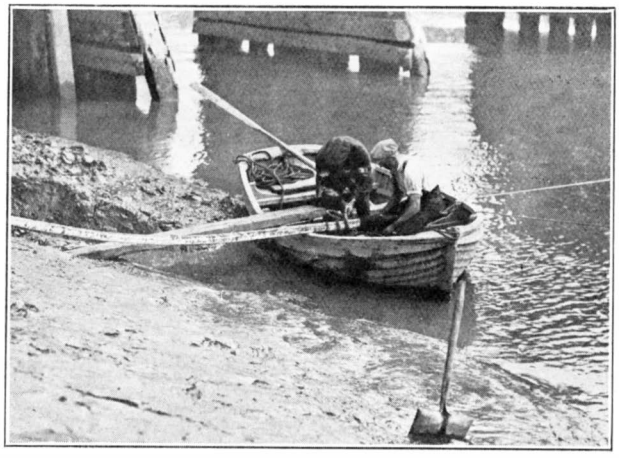


FIG. 4.—LASHING CABLE TO BOAT.

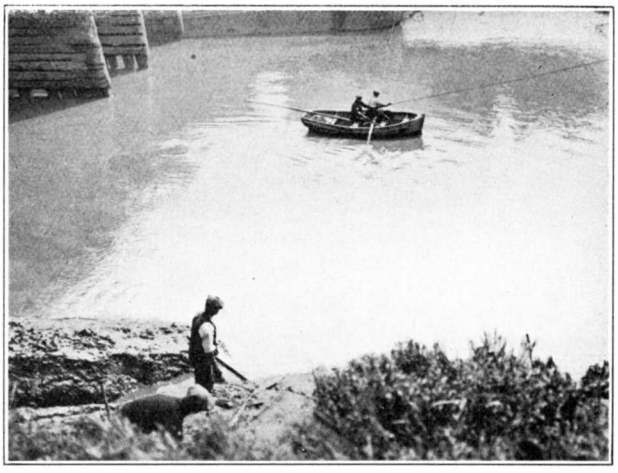


FIG. 5.—CONVEYING CABLE ACROSS RIVER.

FIG. 6.—DIVER PREPARING TO DESCEND.

ing of the cable was let to a contractor and the specification provided for a trench 4′ deep in the hard bed of the river. A grab was used for excavating the trench and the cable was hauled across from north to south, the hauling tackle

FIG. 7.—DIVER COMING TO SURFACE.

being on a barge on the south side. Sighting posts were erected on each side of the river as a guide for trenching and cable-laying. A diver verified that the cable was in the trench, which was then filled up with cliff stone. Photographs depicting the various stages of the work are shown.

W.P.

SCHNEIDER TROPHY RACE.

The Special Telegraph and Telephone Arrangements for the Schneider Trophy Race, which took place over Spithead and the Solent in September last, were somewhat unusual. Ryde Pierhead, on the Isle of Wight, was the starting point and also the finishing point of the race. The competing planes were housed at Calshot, an isolated spit on the mainland dividing the Solent from Southampton Water.

It was decided on the 7th July by the Secretary to open two temporary Post Offices with telegraph and telephone facilities—one at Calshot and one at Ryde Pierhead. At Calshot the circuits required were 2 TSX-Calshot (with Repeaters at Southampton) and 6 Calshot-Southampton circuits, 6 additional TSX-SO circuits and 4 TS-Calshot teleprinter circuits. As it was impracticable to add further arms to the Trunk route to Southampton, it was decided to erect 176 miles of 40-lb. cadmium copper wire on eight arm-extension brackets per pole, to erect one mile of aerial cable and to draw underground cable into existing duct and concrete runways at the Aerodrome, where a room was allotted for the Post Office.

This work, together with the erection of eight Silence Cabinets and the Control Switchboard, was completed in three weeks. Two of the teleprinter circuits were superposed on two of the Southampton - Calshot Trunk circuits with smoothing devices, and two by cutting into a Southampton-Isle of Wight Trunk.

At Ryde Pierhead a room was allotted in the Royal Thames Yacht Club for the Post Office and Telegraphs (which consisted of four Wheatstone circuits and one D.C. circuit). The telephones, however, had to be placed in Silence Cabinets erected on a flat roof over the Pier Tramway Depot adjacent to the Post Office. Seventeen Cabinets in all were erected, protected against weather by tarpaulins and awnings, and fitted with electric light, as the circuits were in use up to midnight. The following circuits were provided:—

9 Pierhead-Ryde Ex. Telephone circuits.
1 ,, ,, ,, C.O. Attendants circuit.
7 Pierhead-TS private wires for newspapers and Cable Companies.

3 Pierhead-TSX B.B.C. circuits.
2 Private wires for the Royal Aero Club and the Southern Railway Co.
6 Additional TSX-Ryde Ex. circuits (repeatered at Portsmouth).

Two cables were run along the pier, which is half a mile long, and aerial cable over the Esplanade Railway Station, thence by underground to Ryde Exchange. As the Department had only 28 pair submarine outlets to Ryde from Southsea, permission was given by the Admiralty to use a 10 pr. G.P. cable and the ends were linked up with the P.O. Underground by drawing in $\frac{3}{4}$ mile of 15 pr. cable at Southsea.

The B.B.C. Hut was erected on a flat roof near the Timing Hut at the foot of the dome of the Pier Pavilion.

The arrangements were successfully carried out. Italian calls to Rome and Milan were of daily occurrence and the Broadcast was particularly good.

Complimentary letters were received from the B.B.C., Royal Aero Club, Cable Companies and others.

THE INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS.

BOOTH-BAUDOT AWARD.

The Council wishes to call attention to the "Booth-Baudot Award" of £5 which is now offered annually for the best improvement in Telegraph, Telephone or Wireless Apparatus or Systems. The award for the year 1929 is governed by the following conditions:—

1. The Award will be restricted to employees of the British Post Office.
2. Applications for the Award should be made between 1st January and 31st March, 1930, and such applications should refer to improvements made, or suggested, during the twelve months ending 31st December, 1929.

   Attention is drawn to the fact that recipients of Awards *via* the Post Office Awards Scheme in respect to any improvement in telegraph, telephone or wireless apparatus or systems are eligible to apply for the Booth-Baudot Award in respect thereto.
3. The Award may be withheld at the discretion of the Council of the Institution of Post Office Electrical Engineers if, after full consideration of the applications received, the adjudicators appointed by the Council are of the opinion that no award is warranted.
4. Applications for the Award, accompanied by full details of the improvement, should be addressed to the Secretary, The Institution of Post Office Electrical Engineers, G.P.O. (Alder House), London, E.C.1.

H. L. DUNSTER,
for Secretary.

November, 1929.

LOCAL CENTRE NOTES.

LONDON CENTRE.

The Session was opened on Tuesday, 8th October, by Mr. E. S. Ritter, D.F.H., A.M.I.E.E., who read a paper entitled "Picture Telegraphy." The paper was illustrated by lantern slides and a number of very fine photographs. Mr. Ritter dealt fully with the development of the different systems and the hearty vote of thanks at the close was a tribute to Mr. Ritter's knowledge and lucid exposition of a subject not yet widely known.

Before calling upon Mr. Ritter, the Chairman, Mr. A. B. Hart, M.I.E.E., made sympathetic reference to the death of Dr. Hansford, the members standing as a mark of respect.

The second meeting was held on Tuesday, 12th

November, when Mr. A. Speight, A.M.I.E.E., read a paper entitled "The Development of Automatic Routiners in the British Post Office," the paper being illustrated by lantern slides. Mr. Speight dealt comprehensively with the different types of Routiner and ably replied to the ensuing discussion.

Informal Meetings.

The first Informal Meeting was held on Tuesday, 22nd October, when Mr. F. H. Wise, the Vice-Chairman of the London Centre, gave an opening address entitled "Costs of Works; chiefly External." An interesting and spirited discussion was opened by Major Brown and only the operation of the time limit enabled the meeting to close at the usual time.

The second Informal Meeting was held on Tuesday, 26th November, when Major H. Y. Starkey read a paper entitled "Maintenance Efficiency, Exchange and Subscribers' Apparatus Plant." Some Notes on Maintenance Units, Standards and relative economic considerations. The paper was illustrated by a series of lantern slides that enabled the members to realise the amount of time and thought which had been spent in collecting and co-ordinating the information on which Economic Considerations are based. Capt. J. G. Lucas opened an interesting discussion and the view was expressed by subsequent speakers that some means should be found to circulate the statistics for the benefit of the staff.

Visit.

A successful visit was made to The National Physical Laboratory on November 9th. The members were welcomed by the Director, Sir Thomas Petavel, and afterwards conducted over the Electrical Standards, Wireless, Electrotechnics, Aerodynamics and Tank Departments. The tour was interesting and instructive and tea in the Canteen brought a thoroughly enjoyable visit to a close. T.H.

NORTH WALES CENTRE.

The Session was opened on 9th October, 1929, when the Chairman delivered his opening address. Mr. Weaver commenced with a reference to the diversity of interests in the occupation of a Post Office Engineer and illustrated this by extracts from the Engineer-in-Chief's Annual Report. Following this he pointed out the profuse supply of information afforded to the Staff of the Department on almost every aspect of their work and the various training courses and technical classes organised to help the Staff to become acquainted with their work. He suggested, however, an extension of these activities in the form of a course of instruction for potential engineers in Estimating, P.O. Commercial Accounts, etc. Subsequently, the Chairman referred to the tremendous figures representing capital plant expenditure and compared the telephone statistics of England with those of other countries. He referred also to the brighter industrial outlook and the improved standard of living with the consequent expansion of telephone facilities and the resultant increases of staff and positions. In conclusion he emphasised the undesirability of having no interests other than official duties and of being able to leave business worries behind at the conclusion of office hours.

The second meeting was held at Birmingham on the 14th November, 1929, when Mr. E. S. Ritter, D.F.H., M.I.E.E., of the Engineer-in-Chief's Office, read his paper on "Picture Telegraphy." At the outset Mr. Ritter explained the construction and working of the photo cell and selenium cell and demonstrated the effects of light projected on a photo electric cell. He then proceeded to the methods of transmitting and receiving, synchronisation, phasing, signalling and speaking, and, in the latter part of his paper, the principal types of apparatus now in use. After the reading of the paper an interval was allowed during which the audience examined the exhibition of photographs transmitted over various circuits, which Mr. Ritter had collected. The ensuing discussion brought forth a considerable number of questions and compliments on Mr. Ritter's interesting treatment of the subject.

NORTH MIDLAND DISTRICT.

A presentation, which took the form of a portable wireless set, was made on 30th September, 1929, to Mr. William Allan on his retirement from the Service as Acting Superintending Engineer of the North Midland District.

Mr. A. B. Gilbert, Superintending Engineer, presided over a gathering of over 70 members of the staff. Mr. Gilbert referred to his happy association with Mr. Allan in the early days of their service. The presentation was made by Mr. Arundel and reference was made by Messrs. Blower, Vyle (Clerical), Partridge, Kemp (Sectional Engineers) and Read (Inspector), to the friendship and esteem in which Mr. Allan was held throughout the District and to his unfailing courtesy in dealing with all ranks. Valedictory messages were received from Messrs. Bullock, Nichols, Lomas, Walker, Tissington and the Vice-Chairman of the District Whitley Committee.

SOUTH LANCASHIRE CENTRE.

The Session opened on Monday, 14th October, when the Chairman, Mr. W. J. Medlyn, gave his annual address under the title of " Progress and Development in the Post Office Engineering Department."

The address, which was greatly appreciated by the members and visitors present, gave an interesting outline of the various activities of the Engineering Department and the share which the South Lancashire District has taken in the work.

Several speakers subsequently expressed regret that this would be the last of a series of addresses given by Mr. Medlyn over ten consecutive years, and paid tribute to the excellent manner in which the task had been undertaken.

The second meeting of the Session was held on Monday, November 11th, when Mr. H. M. Turner read a paper on " Small Power Rectifiers."

This paper dealt very fully and clearly with a large number of different types of rectifying devices and aroused considerable interest and discussion.

NORTH WESTERN CENTRE.

SESSION 1929-30. LOCAL ORGANISATION.

Chairman—Mr. J. M. Shackleton, M.I.E.E.
Vice-Chairman—Mr. S. Upton, M.I.E.E.
Representing:—
Executive Engineers—Mr. W. H. Lane.
Assistant Engineers—Mr. A. S. Carr, B.A. (Cantab.), A.M.I.E.E.
Clerical Staff—Mr. W. G. Morris.
Chief Inspectors—Mr. R. A. G. Chambers.
Inspectors—Mr. W. Bocock, A.M.I.E.E.
Draughtsmen—Mr. H. F. Perry.
Librarian—Mr. H. Howarth.
Secretary—Mr. D. Barratt.

The opening meeting of the Session was held in St. George's Hall, Preston, on the 14th October, 1929, when a paper entitled " Telephone Transmission," being a description of the standard arrangements for giving effective transmission to telephone subscribers, was read by Mr. W. H. Lane.

Mr. Lane opened his paper with a reference to the traffic arrangements for the putting through of telephone calls, the functions of Zone, Group and Exchange Areas, and the standards required for each. He then proceeded to deal with the Engineering problem of how best to obtain ideal conditions and explained the subscribers' circuit requirements at length, touching upon the application of the Standard Cable Equivalents and the composition of the various circuits. The paper was illustrated by specially prepared diagrams and was followed by a discussion.

On the 12th November, 1929, Mr. A. Morris, A.R.C.Sc., M.I.E.E., of the Research Section, Engineer-in-Chief's Office, visited Preston and read a paper entitled " Telephone Cable Circuit Interference."

Mr. Morris opened with a review of the main causes of disturbance in telephone cable circuits. The subject was then dealt with under the following headings:—

Telephone Cable Circuit Development, Cable Balancing for interference immunity purposes, Unbalances in telephone cable circuits, Cross Talk, Noises, Interference Characteristics, Prediction of cross-talk results, Control of overall cross-talk and noise in telephone circuits, and concluded with a description of modern improvements in the design and construction of telephone cable circuits from the interference immunity point of view.

The paper was illustrated by lantern slides, and it was evident from the subsequent discussion that the lecture had aroused considerable interest. A number of queries were raised by the various speakers and Mr. Morris replied to them.

The third meeting of the Session was held at Preston on the 9th December, 1929, when a paper entitled "Some Considerations relating to the Clerical Organisation of the Engineering Department" was read by Mr. A. S. Renshaw, of the Engineer-in-Chief's Office. The following is a synopsis of the paper:—

Organisation, Standardisation, Co-ordination, Inspections, Devolution versus Decentralisation, Recruitment of Staff, Review of special aspects of work involved, Current and future developments, Conclusion.

The lecture was exceedingly interesting and informative and provoked an animated discussion.

D.B.

SCOTLAND WEST CENTRE.

The first meeting of the Session took place on 7th October, the proceedings being of an informal character. After the routine business had been disposed of, a vote of welcome to the new Vice-Chairman of the Centre, Major Cameron, centred around the construction of medium open lines in country districts, and the consideration of standardised methods with a view to reduction of costs. All aspects of the day's work of a gang employed on such work were reviewed and a large number of speakers contributed their ideas on the various points raised.

Other subjects for discussion were on the agenda, but time did not permit of these being brought forward. This was the first "Informal" meeting held in the centre, but in view of its unqualified success arrangements will be made for others from time to time.

H.C.M.

THE INSTITUTION OF P.O. ELECTRICAL ENGINEERS.

Officers of Colonial and Foreign Telegraph Administrations who are engaged in Electrical Engineering Works may be admitted as Colonial and Foreign Corresponding Members respectively, after application.

Subscription payable annually in advance on 1st April in each year:

Colonial Members	... ...	£1 0 0
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The Secretary,
Institution of P.O.E. Engineers,
G.P.O. (Alder House), E.C.1.

or the undermentioned gentlemen who have kindly agreed to act as representatives of the Institution in their respective countries:—

R. Badenach, Esq., B.Sc. (Melb.),
Chief Engineer's Office,
Postmaster-General's Department,
Treasury Gardens,
Melbourne, C2,
Australia.

H. C. Brent, Esq.,
District Telegraph Engineer's Office,
Wellington, N.Z.

N. N. Banerjee, Esq., A.M.I.E.E. (Ind.),
Divisional Engineer, Telegraphs,
Calcutta West Division,
8, Wellesley Place,
Calcutta,
India.

A. T. Kingston, Esq., M.B.E., A.M.I.E.E.,
Office of the Chief Engineer,
Telegraphs & Telephones,
C.T.O.,
Colombo,
Ceylon.

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

CENTRAL LIBRARY.

The following books have been added to the Central Library. Applications for the loan of same should be addressed to the Librarian, Institution of P.O. Electrical Engineers, Alder House, E.C.1.

List VI.

No.	*Title.*	*Author.*
886	Naval Electrical Manual (1928) ...	
887	Whittakers Electrical Pocket Book	R. E. Neale.
888	Television	A Dinsdale.
889	Alkaline Accumulators	J. T. Crennell and F. M. Lea.
890	Conduction of Electricity through Gases	Sir J. J. Thomson & J. P. Thompson.
891A	Essays Prize Competition, 1928-29:—	
	(1) Modern Theories of Electricity and Magnetism	G. Franklin.
	(2) Telephone Transmission Measurement on Repeater Circuits	F. E. Wright.
	(3) Maintenance of Subscribers' Apparatus in Automatic Areas	C. H. Hartwell.
	(4) Radio Methods in Telegraphy and Telephony	N. V. Knight.
	(5) General Analysis of Faults in a Director Automatic Exchange	W. H. Owens.
891B	(6) Photo-Copying and the P.O. Engineering Department	R. E. Gray.
	(7) The Preparation of Development Schemes	S. B. Iles.
	(8) Landing the Shore End of a Submarine Cable	W. E. Everson.
	(9) The Study of the Oak ...	H. Chapman.
892	Imperial Telegraphic Communication	C. Bright.
893	Electricity and the Electric Telegraph	J. B. Prescott.
894	Telegraphy and Telephony, including Wireless	E. Mallett.
895	ABC of Television	R. F. Yates.
896	Speech and Hearing	H. Fletcher.
897	Estimating	T. H. Hargrave.
898	Engineering Economics	T. H. Burnham.
899	Practical Geometry and Engineering Graphics	W. Abbott.
900	Differential Equations, Elementary Treatise	H. T. H. Piaggio.
901	A.T.M. Telegraph Engineers' Handbook	
902	Private Auto Branch Exchanges...	R. T. Dennison.

BOOK REVIEWS.

"Telegraphy and Telephony," including Wireless communication. An introductory text-book to the science and art of the electrical communication of intelligence. E. Mallett, D.Sc. (Eng.), London. Chapman & Hall, Ltd. 21/-.

The author of this book is an old friend of many Post Office Engineers. He has had the advantage of practical experience, both in telephone engineering and in teaching engineering subjects. Although he has been engaged now for a good many years on educational practice the contents of the book show that he has kept in close touch with practical engineering work.

The book is intended to fill the gap between text-books dealing with elementary electricity and magnetism and their application to telegraphy and telephony and those more advanced treatises on the various specialised branches such as telephonic transmission or automatic telephony. It deals with the application of the general principles of electricity and magnetism to all branches of communication engineering.

The general method followed in dealing with any given section of telegraphy or telephony is to give a short description of the apparatus or system under consideration, followed by the theoretical considerations involved in its design and action.

The book is divided into three main parts—Line Telegraphy, Line Telephony and Wireless Telegraphy and Telephony. The part dealing with Line Telegraphy includes apparatus, systems and transmission theory over short and long lines. Transient effects are dealt with at some length in this section.

The subject of Line Telephony is introduced by a consideration of the nature and theory of sound, followed by telephone instruments, line transmission, thermionic valves and exchange systems.

The part dealing with Wireless Telegraphy and Telephony includes the transmission of electromagnetic waves, the theory of high-frequency circuits and the generation and reception of high-frequency signals.

At the end of the book are appendices giving mathematical tables and proofs, etc., which could not be included in the text.

The range covered by the book is so wide that it has not been possible to do more than introduce many of the subjects considered. For this reason an extensive series of references is given at the end of each chapter, which enables the reader to pursue the subject further.

There is very little in the book which is open to criticism. It is considered, however, that the following points should receive attention in future editions. A considerable amount of space is devoted to the consideration of transients in telegraphy, but the question of transients in telephony is dealt with in a single paragraph in the chapter on valves, to which it does not appear to belong. In view of the fact that transient effects form the chief limiting factor to the distance over which telephone communication can be established they certainly deserve more consideration. In this connection the statement (on page 177) that "what happens during the transient period . . . is only of minor if of any importance" may be said to belong to pre-repeater days.

In connection with repeaters, the importance of the repeater being of the same impedance as that of the line is not mentioned, and no mention is made of means for regulating the amplification. The method mentioned on page 240 of facilitating the balancing of duplex repeaters by shunting the line with a small condenser has been abandoned as it is liable to produce reflection effects.

No mention is made of "sub-audio" telegraphs, and very little of picture telegraphy, both of which offer excellent pegs on to which to hang mathematics. Perhaps also mention should be made of the telephonic speech standards set up in the United States and in Paris.

It will be seen that most of the above points concern omissions and it is perhaps scarcely fair to criticise a book covering such a wide field on such grounds. It is hoped that the next edition will expand itself into three volumes, which could be easily filled with the material available.

The book fulfils a long-felt want and can be thoroughly recommended to all interested in the technics of communication engineering.

"On the Lichtenberg Figures. Part III., The Positive Figures." By P. O. Pedersen. Copenhagen, Andr. Holst & Son. pp. 138, with 28 plates. Price Kr. 10.00.

The history of electricity provides numerous records of discoveries made, in some cases, when the science was in its infancy, which were regarded for generations merely as interesting phenomena and incapable of utilisation, but which have been applied to practical uses during the last few years.

No better example can be cited than the discovery by Lichtenberg in 1777 of the formation of the electrical dust figures which have been named after him.

Lichtenberg discovered that when a charged conductor was brought close to or made to touch the surface of a cake of resin a charge was left on the resin the distribution of which could be rendered visible by sprinkling the resin with fine dust sifted through muslin. The dust mixture usually consists of red lead and sulphur or vermillion and lycopodium powder. The particles rub one against another and against the muslin and become electrified, the sulphur negatively and the red lead positively. The dust particles are attracted by charges of opposite polarity on the cake of resin and as a result the positively electrified places appear yellow and the negatively electrified places red.

It was subsequently discovered that an ordinary photographic plate could be substituted for the cake of resin and that if developed after electrification similar figures appeared.

There is a marked difference between the shape and general appearance of figures produced by a positive charge and of those produced by a negative charge.

Of recent years photographic records of Lichtenberg figures have been used to study the surges on high tension lines, especially the kind of surges due to lightning. One piece of apparatus used for this purpose is called the Klydonograph. The figures have also been used for the measurement of very short intervals of time down to 10^{-10} seconds and even less.

The Lichtenberg figures have been the subject of exhaustive study by Dr. P. O. Pedersen, Principal and Professor of the Royal Technical College, Copenhagen.

The present volume published in the English language under the auspices of the Royal Danish Society of Science deals with the positive figures and is complementary to two earlier works published in 1919 and 1922 on the negative figures.

One of the most interesting features of the work is the excellent series of photographic reproductions of actual figures taken under various conditions.

As a result of his investigations the author has developed the theory that the spreaders which are such a characteristic feature of the positive figures owe their formation to protons which the strong field at the tip of the spreaders drives out with great velocity. The investigations described further indicate that protons play an important role not only in the formation of positive Lichtenberg figures, but that their importance in connection with spark formation is much greater than hitherto assumed.

The book is a most interesting and authoritative source of information on a subject which is becoming of increasing importance to those engineers and physicists whose work deals with the study of transient electrical phenomena.

"Radio Telegraphy and Telephony." By R. L. Duncan and C. E. Drew. New York, John Wiley & Sons Inc. (London, Chapman & Hall). pp. 950, price 37/6.

This book in a sub-title is claimed to be a complete text-book for students of radio communication. It covers a large range, but deals with the subject in a descriptive manner with a marked absence of mathematical treatment. As a result, the book is not a satisfactory text-book for students who desire to obtain anything more than a superficial knowledge of the subject.

A large portion of the work is taken up with descriptions of actual transmitting sets—more especially those manufactured by the Radio Corporation of America—together with operating instructions for such sets, and is the type of information usually supplied by manufacturers' descriptive pamphlets. This is probably the most interesting feature of the work, as it gives the radio engineer a fairly complete idea of current American practice in transmitter construction.

There are numerous errors in the book, even

in elementary descriptions; for example, on page 511 various types of condensers are described and under the heading " Oil Type Condenser " we read " In this condenser sheets of glass or other insulating material are coated with tinfoil to a reasonable distance from the edges of the glass to prevent brush discharge. The plate and dielectric sections are then placed in a suitable tank containing insulating oil (oil free from all minerals). The pure oil is used for the dielectric material." Now this type of condenser is the well-known glass plate condenser used on many spark installations and the glass plates, not the oil, constitute the dielectric. The function of the oil is merely to prevent brush discharges and to facilitate cooling.

Another example of muddled expression occurs on page 523 under the heading Tuning: " The frequency of an a-c circuit composed of inductance and capacity should be so regulated that at the instant the voltage reaches its peak value the current flowing will have produced considerable energy in the form of magnetic field round the inductance." The foregoing is typical of the kind of explanation offered in this work: there is also much needless repetition.

" Radio Traffic Manual and Operating Regulations." By R. L. Duncan and C. E. Drew. New York, John Wiley & Sons Inc. (London, Chapman & Hall). pp. 187, price 10/-.

This book is intended as a guide book for operators. It consists of six chapters, the first of which deals with the Morse Code and the usual abbreviations. The greater portion of the book is contained in the second and third chapters, which consist respectively of the operating rules and regulations of the Radiomarine Corporation of America and the text of the Washington Convention. The fourth and fifth chapters give the text of two American Acts, the Radio Act of 1927 and the Ship Act of 1912. The final chapter consists of the Regulations covering the issue of operators' licenses in the United States.

There is nothing of an original character in the book and nothing which is not accessible to the public in other ways, except perhaps the operating rules, which of course only apply to the personnel of the particular operating company concerned. As a result the book is not likely to find a large public on this side of the Atlantic.

" Elements of Radio Communication." By John H. Morecroft. New York, John Wiley & Sons Inc. (London, Chapman & Hall). pp. 269, price 15/-.

The present work is intended as an introductory volume to the author's more advanced work " Principles of Radio Communication." The latter work, since its first publication, has been recognised as a thoroughly comprehensive and standard work on the subject, but it is rather too advanced for many students who require a sound elementary knowledge of the subject, but who have not the time to study the larger work.

The present work is not a collection of excerpts from the larger volume, but has been written entirely anew.

Practically no mathematical preparation more advanced than elementary algebra is required for complete mastery of the text.

The book is divided into seven chapters, commencing with the simple laws of the electric circuit and special laws of radio circuits. Chapters three and four deal respectively with general ideas or radio communication and the vacuum tube and its uses. Chapters five and six deal respectively with radio telegraphy and radio telephony, while the final chapter is on receiving sets.

The subject is dealt with in a very thorough manner, within the limits that the author has set. Where necessary to clarify any point numerical examples are given, worked out in full. In addition, at the end of the book are a number of problems grouped under chapter headings. The usefulness of the book to private students would have been increased if the solutions to these problems had been given.

The book contains 170 figures and is also furnished with an index. One of the good features of the book is that the curves used to demonstrate various laws, such as valve characteristics, reactances, etc., have in most cases been plotted from actual measured values.

Altogether this work appears to be a very satisfactory elementary text-book which can be recommended for class use.

"Private Automatic Branch Exchanges." R. T. A. Dennison. Sir Isaac Pitmans. 12/6.

This book is a useful addition to the series of works on Automatic Telephony.

The author's aim is to present a volume giving the essential details of the circuits incorporated in several systems of Automatic P.B.X.'s, provided for subscribers' use in connection with their internal and public exchange services in this country.

To that end the book meets a definite need for a comprehensive treatise devoted to P.A.B.X.'s, which, although secondary in importance to Public exchanges, are not a negligible part of the field covered by the telephone engineer. Approximately 27,000 telephones are working on the P.A.B.X.'s in this country at the present date.

The volume under review describes, in the fullest detail, the circuit operations involved in the following typical systems:—

The Relay Automatic Co.'s 24 and 32 volt system.
The Line Finder system of the Standard Telephones & Cables, Ltd.
The systems of Messrs. Siemens Bros., and
The Automatic Telephone Manufacturing Co., utilising Strowger type equipment.

An outstanding feature is the large number of diagrams and photographs excellently reproduced and clearly described in the letterpress. The large folded diagrams are arranged for ready reference outside the letterpress as required when reading the circuit descriptions, this being particularly useful to the student of such a book.

The subject matter has been well and carefully compiled, and although the majority of the diagrams are copies of official diagrams these have been dissected and portions inserted in the body of the letterpress in explanation of some difficult principle or circuit operation.

The book can be recommended to anyone desirous of obtaining a close detailed knowledge of P.A.B.X. circuits and to others who wish to improve their general acquaintance with the subject.

In future editions a dimensioned sketch of one or two typical P.A.B.X. floor plan lay-outs would be useful, as well as a little more data on actual current consumption, extension to extension calls, extension to manual board, extension to public exchange.

The author can be congratulated, as the book is particularly free from material errors, considering the large number of cross-references used in the diagrams and letterpress.

F.B.

"High Voltage Cables." By P. Dunsheath, O.B.E., M.A. (Cantab), B.Sc.Eng., F.Inst.P., M.I.E.E. 158 pp. Sir Isaac Pitman & Sons, Ltd. Price, 10/6.

Modern developments in the generation and transmission of electrical power at high pressures have rendered the design of cables a matter of great importance, necessitating a large amount of research into the characteristics of dielectrics, especially having regard to changes which may occur after cables are put into service.

This book, which is based on a course of lectures delivered by the author at University College, London, can be thoroughly recommended to any engineer or student interested in the subject. It is both informative and readable, while the illustrations dealing with experimental work are excellent.

The author, after first dealing with the manner in which the growth of underground transmission has affected the problem, discusses very fully the electrical properties of dielectrics, alone and in combination, showing how the presence of other dielectrics, water, gas, etc., affects the distribution of stress. Dielectric power factor and losses, and the various methods employed in measuring these are also dealt with, while the theories underlying the behaviour of the materials are discussed and well illustrated by experiments.

In the final chapters the author concentrates on the properties of impregnated paper cables and their different designs, leading to the use of single core cables for very high voltages. The adoption of these has led to further problems owing to the high sheath losses which may be introduced by the methods of laying adopted for the cables, and these and the use of oil filled cables to overcome the shifting of the dielectric in laying the cables or under the action of gravity are also considered.

References are given, at the end of each chapter, to important papers dealing with the subject, for those who wish to pursue the matter further.

J. McG.

"Loaded Submarine Telephone and Telegraph Cables." Messrs. Siemens Bros. & Co., Ltd., Woolwich.

The volume gives an account of the loaded submarine telephone and telegraph cables manufactured, and in most cases also laid, by the firm, one of the pioneers in this branch of the electrical industry. The opening chapter deals with loading in a general way, while successive chapters contain illustrated descriptions, supplemented by copious tabular matter, of coil-loaded and continuously-loaded telephone cables insulated with gutta-percha and paper respectively, and continuously-loaded gutta-percha insulated telegraph cables.

A brief mathematical treatise on telephonic and telegraphic transmission is given in an Appendix.

The book is sumptuously bound and forms a very worthy record of the valuable work carried out by this firm.

"Das Reichspost Zentralamt." A Commemoration Book. The Post Office Administration has issued a profusely illustrated and finely printed volume as a souvenir of the opening of the new P.O. central buildings in Berlin. The coloured frontispiece gives a fine view of the front administrative blocks, surrounded on two sides by outbuildings and stores, with railway sidings behind. The Administration is to be complimented not only on the accommodation provided, but on the enterprise which evolved such a fine memento of the occasion.

"Overhead Power Lines. Elementary Designs and Calculations." Capt W. Morecombe Chapman & Hall. 15/- net.

The aim of this book seems to be to assist the Engineer engaged in the construction of overhead power lines to prepare his designs so as to fulfil as far a possible within the limitations of the uncertainty which surrounds some of the Regulations of the Electricity Commissioners.

There is a short chapter on the electrical properties of transmission lines, but the greater part of the book is devoted to the problems of mechanical design. Detailed methods of proportioning the various components of overhead structures to satisfy the load conditions are given, and consideration is given to the most recently developed forms of compound wood poles. Considerable attention is devoted to the strength of pole foundations, a subject which is too often neglected.

Ferro-concrete poles are dismissed rather summarily, but this is perhaps natural in view of the small use which has been made of this type of pole in this country. It would, however, have been interesting to have seen the "spun" ferro-concrete pole treated, since apart from the fact that this type of pole cannot be made by the roadside, it appears to be the most promising design both from the point of view of cost and weight compared with wood poles.

The safety requirements of the Electricity Commissioners and of the Post Office are treated fully and reprints of the latest safety regulations are given as appendices.

H.C.

"Worked Examples in Electrical Technology." By F. Peasgood, A.M.I.E.E., and H. G. Boyland, A.M.I.E.E. Oxford University Press. 15/- net.

There has long been a need for a collection of worked examples in Electrical Technology and the authors, who are lecturers in Electrical Engineering at the Northampton Polytechnic Institute, London, are to be congratulated for the business-like manner in which they have treated their subject.

The book is divided into three parts which deal respectively with the Direct Current circuit, the Magnetic circuit and the Alternating Current circuit. The examples, of which there are 110 in all, are graded and have been carefully chosen. They are worked out in that minuteness of detail which delights the eye of an examiner and each part concludes with a number of questions, to which answers are given, on which the reader may try his skill.

This very useful addition to the ever-growing literature on Electrical Engineering should prove

useful alike to engineers desirous of a "refresher" and to students entering for the B.Sc. (Eng.), A.M.I.E.E., or other examinations of a similar standard. The book is excellently printed on stout paper which should withstand the handling to which a book of reference is subject.

"Questions and Solutions in Magnetism and Electricity." Solutions by William J. White, A.M.I.E.E. Third Edition. Sir Isaac Pitman & Sons, Ltd. 5/- net.

The third edition of this useful book makes a welcome appearance. The solutions to the questions set at the examinations in Magnetism and Electricity held during the years 1922-29 by the City and Guilds of London Institute have been added. As a result the book contains nearly twice the number of pages as the previous edition, hence the increase in price.

The second edition was reviewed on p. 282, Vol. 14 of the Journal and the criticisms there made still obtain. In addition, there is a slip on p. 175 where the word "charges" should read "changes."

The book should continue supreme in its sphere of usefulness both to students and lecturers in this subject.

W.S.P.

CURRENT LITERATURE.

The Journal of the Institution of Electrical Engineers, Vol. 67, No. 393, September, 1929.

Direct Generation of Alternating Current at High Voltages. Hon. Sir Charles A. Parsons, O.M., K.C.B., F.R.S., Honorary Member, and J. Rosen, Member.

Recent Developments in Turbo-Generators. J. A. Kuyser, Member.

A Measurement of the Sound Pressures on an Obstacle. W. West, B.A., Associate Member. An investigation of the performance of a small condenser transmitter under different conditions of test. The accuracies of the methods of measurement are discussed.

A Precise Electrometer Method for Voltage-Transformer Testing. R. S. J. Spilsbury, B.Sc., Associate Member.

The Rotor Bearings of Electricity Meters. W. Lawson, Member.

Discussions on "The Construction of the 'Grid' Transmission System in Great Britain," "Practice and Progress in Combustion of Coal as applied to Steam Generation" and on the first two papers quoted above.

Vol. 67, No. 394, October, 1929.

The Testing of Porcelain Insulators. B. L. Goodlet, Associate Member. The paper discusses the technique of porcelain insulator testing, and includes the usual electrical and mechanical tests called for in the various national specifications and also special tests of more recent origin.

The Modern Use of Pulverised Fuel in Power Stations. R. A. Chattock, Past-President.

Some Technical Considerations concerning Power Factor in relation to Tariffs. E. W. Hill, Member.

Directions for the Study of Micanite. Report of the British Electrical and Allied Industries Research Association. Classification of material and Notes on Manufacture, Use and Characteristics. Methods of Test.

A Portable Electric Harmonic Analyser. R. Thornton Coe, M.A., M.Sc.Tech., Associate Member. Paper describes a perfection of the dynamometer method of harmonic analysis in which accuracy and speed of operation have been combined with portability. The method gives the harmonics correct to 1/20th of 1 per cent. of the fundamental and can also be used for the analysis of current waves and for finding the phase angle between harmonics of the same frequency in two different waves.

Vol. 67, No. 395, November, 1929.

The Twentieth Kelvin Lecture. Lightning. Dr. G. C. Simpson, C.B., F.R.S.

Electricity in Agriculture with Special Reference to Electro-Culture. William Phœnix, Associate Member.

Precision Permeability Measurements of Straight Bars and Strips in the Region of High Permeability. C. E. Webb, B.Sc. (Eng.), Associate Member, and L. H. Ford, B.Sc. (Eng.). From the N.P. Lab. Construction of a yoke to give values of H = 3000 on straight samples 20 to 25 cm. long and up to 5000 on samples 8 to 10 cm. long is described and also the methods of measuring. The effect of stress in the specimen is considered.

Journal of the American Institution of Electrical Engineers.

September, 1929.

Application of Induction Regulators to Distribution Networks. E. R. Wolfert and T. J. Brosnan.

Annual Report of Committee on Protective Devices, including report of Sub-Committee on Relays.

Annual Report of Committee on Education.

Radio Interference from Line Insulators. Ellis Van Atta and E. L. White. A discussion of the causes of radio interference from insulators on high voltage equipment; the present methods of eliminating disturbance and future designs.

High-Voltage Low-Current Fuses and Switches. Roy Wilkins.

The Interconnected Integraph. Robert E. Glover and Henry H. Plumb. A machine for solving differential equations in two variables.

Annual Report of Committee on Instruments and Measurements.

October, 1929.

Travelling Waves due to Lightning. L. V. Bewley. The purpose is to describe and analyse the origin and formation of waves on a transmission line induced by lightning discharges.

Annual Report of Committee on Communication. Report covers Telephone Transmission, Telephone Service Improvements, Dial Telephony, Carrier Systems, Telephone Plant, Telephone Equipment, Developments in Materials, Airways Communications, Wire Line Systems for Broadcasting, Frequency Control in Radio, Railroad Train, Radio Equipment, Trans-Atlantic Telephony, Trans-Atlantic Telegraphy, Printing Telegraphy, Facsimile Transmission, Television, Sound Pictures, and Municipal and Protective Signalling.

Annual Report of Committee on Research.

The Electrical Engineering of Sound Picture Systems. K. F. Morgan and T. E. Shea. Paper describes the technique and apparatus of sound picture recording and reproduction.

Magnetic Shielding. S. L. Gokhale. The shielding of magnetic instruments from steady stray fields.

November, 1929.

The Theory of Electrical Conductivity. Recent developments. William V. Houston.

Dial Telephone System serving small communities. F. O. Wheelock.

Annual Report of Committee on Transmission and Distribution, Power.

Impulse Insulation Characteristics of Wood Pole Lines. H. L. Melvin. Results of a comprehensive series of tests on power lines.

Annual Report of Committee on Electrical Machinery.

Effect of Surges on Transformer Windings. J. K. Hodnette. Power.

Annal Report of Electrophysics Committee.

STAFF CHANGES.

POST OFFICE ENGINEERING DEPARTMENT.

PROMOTIONS.

Name.	Grade.	Promoted to	Date.
Kingston, J. H.	Acting Assistant Staff Engineer, E.-in-C.O.	Assistant Staff Engineer, E.-in-C.O.	5-11-29
Tattershall, J. T.	Executive Engineer, Exeter Section, S.W. District.	Assistant Superintending Engineer, Scot. E. District.	12-10-29
Shea, J.	Executive Engineer, Leeds Extl. Section, N.E. District.	Assistant Superintending Engineer, N.W. District.	1-1-30
Cameron, J.	Executive Engineer, Glasgow South Section, Scot. West District.	Assistant Superintending Engineer, Scot. West District.	24-9-29
Beeton, H. G.	Acting Exec. Engineer, London District.	Executive Engineer, London District.	16-9-29
Smith, D. Mc.E.	Assistant Engineer, Norwich Section, E. District.	Acting Executive Engineer, Norwich Section, E. District.	16-9-29
	Acting Executive Engineer, E. District	Executive Engineer, E. District.	
Warnock, J. W.	Assistant Engineer, Glasgow Extl. Section, Scot. West District.	Executive Engineer, Glasgow South Section, Scot. West District.	25-11-29
Crompton, W. W. B.	Assistant Engineer, Lines Section. E.-in-C.O.	Executive Engineer, Leeds Extl. Section, N. Eastern District.	1-1-30
Smith, H. A.	Assistant Engineer, Technical Section, London District.	Executive Engineer, West Extl. Section, London District.	1-12-29
Ritter, E. S.	Assist. Engineer, Telegraph Section. E.-in-C.O.	Executive Engineer, Telegraph Section, E.-in-C.O.	1-4-30
Hill, H.	Assist. Engineer Equipment Section, E.-in-C.O.	Executive Engineer, (location to be fixed later).	1-4-30
Morgan, J.	Assist. Engineer, Lines Section, E.-in-C.O.	Executive Engineer, Exeter Section, S.W. District.	15-12-29
Hannaford, F. S.	Asst. Engineer, S. East District.	Executive Engineer, N. Wales Dist.	
Innes, J.	Asst. Engineer, Scot. East Dist.	Executive Engineer, Scot. West Dist.	
Tite, W. G.	Chief Inspector, London District.	Assist. Engineer, Telephone Section, E.-in-C.O.	18-9-29
Frost, J.	Chief Inspector, N. Wales District.	Assistant Engineer, Nottingham Section, N.Mid. District.	1-10-29
Sinclair, R.	Chief Inspector, London District.	Assistant Engineer, London District.	12-12-29
Wilkie, E. D.	Chief Inspector, Northern District.	Assistant Engineer, London District.	1-1-30
Smith, R. P.	Chief Inspector, E.-in-C.O.	Assistant Engineer, E.-in-C.O.	12-12-29
Powell, H. W.	Chief Inspector, N. Wales District.	Assist. Engineer, S. Lancs. District.	To be fixed later.
Leithead, W.	Chief Inspector, Scot. East District.	Assistant Engineer, Scot. E. District.	1-1-30
Graham, R. S.	Chief Inspector, Northern District.	Assist. Engineer, S. Lancs. District.	To be fixed later.
Smith, H. G.	Chief Inspector, Eastern District.	Assistant Engineer, Eastern District.	To be fixed later.
Parker, N. W.	Chief Inspector, London District.	Assistant Engineer, E.-in-C.O.	12-12-29
Satchwell, W. A.	Chief Inspector, S. Lancs. District.	Assist. Engineer, S. Lancs. District.	12-12-29

PROMOTIONS (*continued*).

Name.	Grade.	Promoted to	Date.
Judd, F. J.	Chief Inspector, London District.	Assistant Engineer, E.-in-C.O.	To be fixed later.
Baker, T. W.	Chief Inspector, S.W. District.	Assistant Engineer, E.-in-C.O.	To be fixed later.
Naylor, G.	Inspector, S.W. District.	Chief Inspector, S.W. District.	28-4-29
Stokes, G. W.	Inspector, S.E. District.	Chief Inspector, S.E. District.	18-12-27
Browning, W. H.	Inspector, London District.	Chief Inspector, London District.	19-12-28
Law, C. V.	Inspector, N. Wales District.	,, ,,	29-3-29
McIntosh, J.	Inspector, Scot. East District.	Chief Inspector, Scot. East District.	26-1-29
Vernon, R. J.	Inspector, S. Lancs. District.	Chief Inspector, E.-in-C.O.	10-4-29
Mayman, A. C.	Inspector, N. East District.	Chief Inspector, E.-in-C.O.	21-4-29
Arnold, A.	Inspector, Scot. West District.	Chief Inspector, E.-in-C.O.	11-4-29
Lynn, B.	Inspector, E.-in-C.O.	Chief Inspector, E.-in-C.O.	21-11-28
Howrigan, H. F.	Inspector, Testing Branch.	Chief Inspector, Testing Branch.	21-2-29
Davies, H. S.	Skilled Workmen, Cl. I., N. Wales District.	Inspector, N. Wales District.	
Moores, H. J.	Skilled Workmen, Cl. I., S. Lancs. District.	Inspector, S. Lancs. District.	
Devereux, S. F. W.	Skilled Workmen, Cl. I., London District.	Inspectors, London District.	To be fixed later.
Header, S. O.			
Stowell, A. C. St. J.			
Byrne, W. G.			
Sanger, C.			
Gooch, J. V. L.			
Nightingale, W. H.			
Lockie, R. A.			
Brown, W. J.			
Hicks, C. J.			
Burrows, C. T.	Skilled Workmen, Cl. I., S. E. District.	Inspector, S.E. District.	

RETIREMENTS.

Name.	Rank.	Districts.	Date.
Comport, Major G. H., M.C.	Assistant Superintending Engineer.	N. Ireland.	30-9-29
Wallace, G. S.	,,	N.E.	31-12-29
Cowie, J.	Executive Engineer.	London.	30-11-29
Hetherington, T.	,,	Scot. West.	31-12-29
Gwyer, J. H.	Assistant Engineer.	London.	31-12-29
Walby, W. F.	,,	,,	30-11-29
Ives, G. T.	Inspector.	,,	31-8-29
Harris, W. R.	,,	,,	31-1-29
Price, H. G.	,,	S. Wales.	13-10-29
Comport, T.	,,	London.	20-11-29

DEATHS.

Name.	Rank.	District.	Date.
Hansford, Dr. R. V.	Assistant Staff Engineer.	E.-in-C.O.	5-10-29
Evers, J. H.	Inspector.	S. Wales.	31-8-29
Graves, K. G. R.	,,	London.	4-9-29

TRANSFERS

Name.	Rank.	From	To	Date.
Horner, F. H.	Executive Engineer	N. Wales District.	E.-in-C.O.	17-11-29
De Wardt, R. G.	,,	Grimsby Radio.	E.-in-C.O.	29-9-29
Faulkner, H.	,,	Rugby Radio.	E.-in-C.O.	8-10-29
Struthers, G. A.	,,	Bodmin Radio.	Rugby Radio.	29-9-29
Lock, F.	,,	E.-in-C.O.	S. Mid. District.	1-10-29
Hanford, S.	Assistant Engineer	E.-in-C.O.	S.E. District.	3-11-29
King, A. G.	Chief Inspector	Bridgwater.	S. Mid. District.	29-9-29
Wain, S. W.	,,	Bodmin Radio.	Rugby Radio.	29-9-29
Robinson, R. P.	,,	Grimsby Radio.	E.-in-C.O.	29-9-29
Kennard, T. G.	,,	E.-in-C.O.	London District.	24-10-29
Hinton, H.	Repeater Officer, Cl. I.	Harbour Grace. Newfoundland.	Communications Coy.	29-9-29
Hutchison, D. C.	Acting Inspector.	Grimsby Radio.	Communications Coy.	29-9-29
Richardson, A. E.		Grimsby Skegness Radio.	Colney Heath Radio.	29-9-29
Bateson, E. L. H.		Grimsby Skegness Radio.	Baldock Radio.	29-9-29
Macqueen, J. J.		Grimsby Skegness Radio.	Rugby Radio.	29-9-29
Wade, W.		Bodmin Bridgwater Radio.	Portishead Radio.	29-9-29
Woodhead, H. C.	Inspectors.	Bodmin Bridgwater Radio.	Rugby Radio.	29-9-29
Stewart, T.		Bodmin Bridgwater Radio.	Baldock Radio.	29-9-29
Thomsett, H.		Bodmin Bridgwater Radio.	Rugby Radio.	29-9-29
Lynes, F. A.		Grimsby-Skegness Radio.	Leafield Radio.	29-9-29
Shephard, A. C.		Leafield Radio.	Rugby Radio.	29-9-29
Cooper, W. D.	Inspector.	Rugby Radio	E.-in-C.O.	10-11-29
Law, C. V.	Chief Inspector.	London District.	N. Wales District.	6-10-29

CLERICAL ESTABLISHMENT.

RETIREMENTS.

Name.	Grade.	District.	Date.
Miller, W	Higher Clerical Officer.	Scot. East.	29-6-29

TRANSFERS.

Name.	Rank.	From	To	Date.
Norman, R. D. S.	Higher Clerical Officer.	Northern District.	Scot. East.	10-11-19

COMMUNICATIONS.

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

Binding covers and copies of the Contents for Vol. 3 to 21 are available, and may be obtained from the local agents for 1*s.* 6*d.* and 3*d.* respectively. Subscribers can have their copies of Vol. 21 bound, with index included, at a cost of 3*s.* by sending the JOURNALS to the local agents. Orders for bindings, Vols. 1—19, should indicate whether the original binding with black lettering, or the later pattern in gold, is required. Covers with gold lettering will be the only type stocked from Vol. 20 onwards

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