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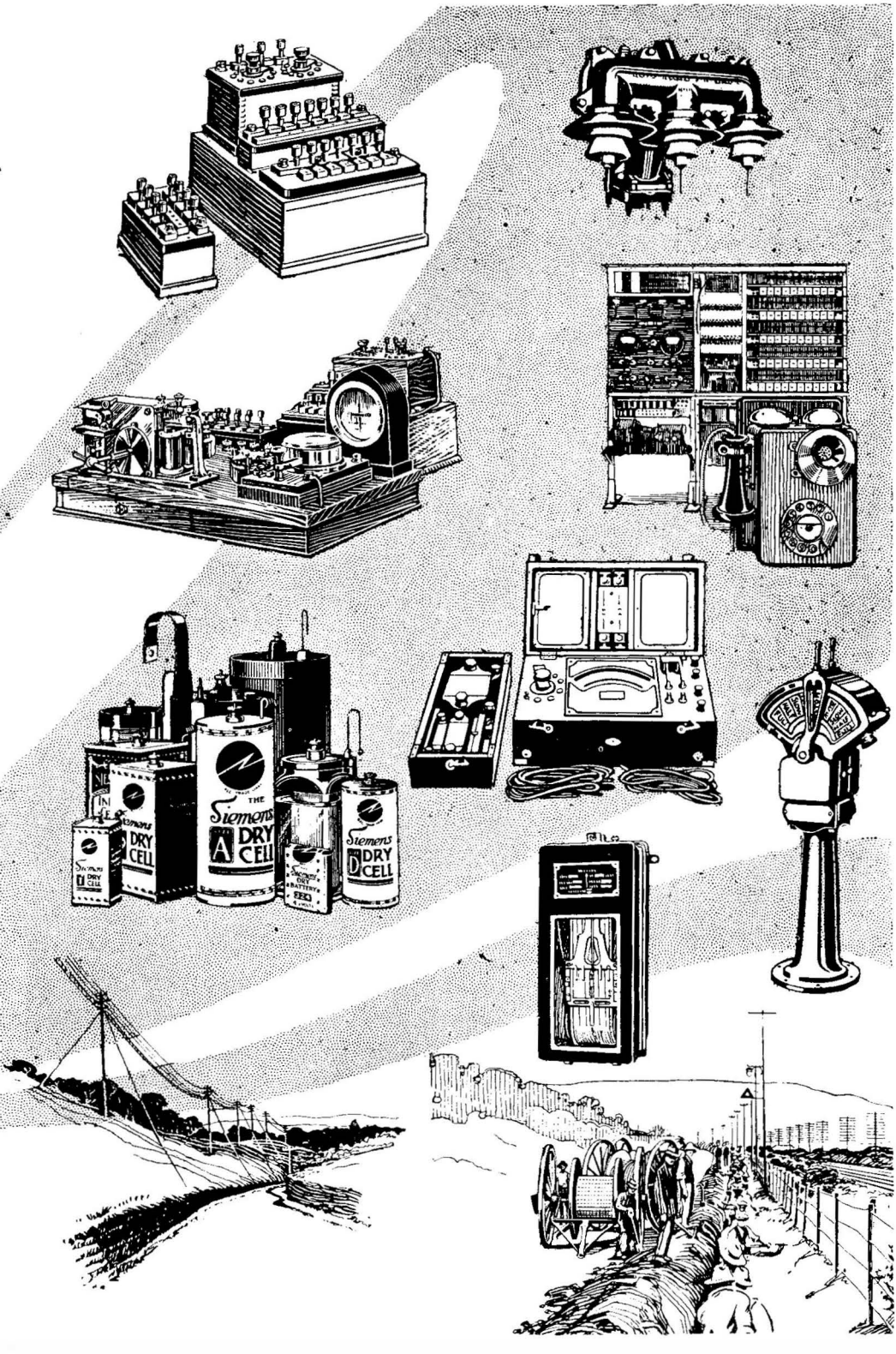
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Annales des Postes, Telegraphes et Telephones.

The French Administration of Posts and Telegraphs publishes a technical journal entitled "Annales des Postes, Telegraphes et Telephones."

This publication, which appears every two months, is edited under the control of a commission nominated by the Ministry; it includes amongst its contributors writers of the highest authority; it publishes regularly also extracts from the current technical literature on telegraphy and telephony from all countries.

The "Annales des Postes, Telegraphs and Telephones" forms per year a volume running to about 1,200 pages, which constitutes a technical record of the first order on all progress in the realm of telegraphs, telephones and postal work and also current work and research in French laboratories and those abroad.

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THE
Post Office Electrical Engineers' Journal

AN INTERNATIONAL 5-UNIT TELEGRAPH CODE.

WE have much pleasure in publishing the following letter from Mr. Donald Murray on the above subject in response to our appeal for a discussion which appeared in our last issue:—

To the Editors, POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

Gentlemen,

I have read with great interest Colonel Booth's article about an International 5-unit Telegraph Code in your issue for October, 1922. Theoretically, it would be desirable to have one universal code; but there are serious practical difficulties in the way, and I doubt if the practical advantages would make a universal code worth while.

In a paper that I read before the British Institution of Electrical Engineers in 1911, under the title of "Practical Aspects of Printing Telegraphy," I outlined a proposal for a universal standard keyboard. Not only was there complete apathy in regard to it, but there was also the practical obstacle of special characters which could not be provided except on the primary positions. For instance, Sweden has special requirements and so also has France. The French typewriter keyboard does not correspond exactly with the Remington standard universal keyboard. It is true that these are questions of keyboard and not of the 5-unit code, but the same difficulties present themselves in both cases. Only an approximation to a universal 5-unit code is practicable, and I doubt if an approximation is worth while. International communication is comparatively small, and has to be provided for by special keyboards and characters in any case.

It is also true that the International Telegraph Convention

provides for an International Morse Code and an International Hughes Alphabet, but modern printing telegraph conditions necessitates departures from the International Convention arrangements, and the extreme particularism which has arisen in various European countries, especially in the new States, as a result of the war, will render any agreement very difficult.

If it has proved so hard to secure a universal International Morse Code where there are no machines to be scrapped, how much more difficult will it be to secure a universal 5-unit code which will involve extensive alteration of a large quantity of telegraph machinery? For instance, the Western Union Telegraph Company in America has some 3,000 keyboard perforators and printers in use, in which the Murray arrangement of the 5-unit code is employed. The Murray code is also used in Canada, and the Morkrum Company has adopted it for their printing telegraph machinery, including the Teletype. The Teletype has already come into quite considerable use in various countries throughout the world, and it will be extremely difficult to induce the users of the Teletype to change the Teletype alphabet, particularly as there is no advantage in the change. The operators on the Teletype keyboards have no knowledge of the alphabet that the machine uses.

As Colonel Booth has pointed out, the allocation of the signals to the various characters in the Baudot, Murray, and Siemens codes was made, in all three cases, on a sound practical basis. It may be interesting to mention the reasons in the case of the Murray code. I allocated the most frequently used letters in the English language to the signals represented by the fewest holes in the perforated tape, and so on in proportion. The objects were to have the perforated tape as strong as possible by having as few holes as possible, and to impose the least wear on the perforating mechanism. I also arranged the 5 marking impulse signal (5 holes in the tape) as the Erase signal instead of the letter "P" as in the Baudot code. In the original Murray code I also arranged for a separate space signal. The economy in the use of the European Figure-Space, Letter-Space plan, however, is so considerable that I have reverted to the European practice in this respect, though in the case of any Administration desiring a separate Space key, I can provide it so long as the Baudot code is not made universal.

The most important change, however, that I made was the re-allotment of the numerals so as to arrange them in a straight line on the top row of keys:—

Q W E R T Y U I O P
1 2 3 4 5 6 7 8 9 0

The Baudot code was arranged before the days of typewriter keyboards, and the numerals with the Baudot code are scattered all over the keyboard, an impossible arrangement. It is true that by providing an extra fourth row of keys for the numerals, this difficulty can be overcome; but this is a clumsy expedient and entails extra cost of construction. The simplicity of the three-row keyboard is too valuable to be sacrificed for the sake of making the Baudot code universal. I regard this argument as decisive. Colonel Booth argues that this basis of allocation is destroyed by the large number of code words now used in business telegrams in which the ratio of frequency of occurrence of letters in the English language does not hold good. This is true in the case of a certain limited amount of telegraph traffic, such, for instance, as that which is handled by the Cable Companies (who, by the way, use Morse, and not the 5-unit alphabet); but it certainly does not apply to a large proportion of the ordinary telegraph traffic of the world, and especially it does not apply to newspaper telegraph traffic.

Also, Colonel Booth's argument that my basis of allocation is destroyed by the large number of code words now in use does not apply to the numerical difficulty with the Baudot code, and unquestionably this is the most serious objection of all.

The Murray alphabet is only used with machine telegraphy, and it is therefore not necessary for the operators to learn it at all. I have never learned it, and I cannot read tape perforated with the Murray code. It is only a question of time before all Printing Telegraphs using the 5-unit code will be operated by Typewriter keyboards, and the nature of the code employed will then be of small importance.

Hence, the problem of a universal 5-unit code will solve itself by the slow but inevitable extension of the use of typewriter keyboards in place of the 5-key Baudot transmitter. In the whole of America there is not a single 5-key transmitter. This manual method of transmitting 5-unit signals is an anachronism and the 5-key transmitter should have been replaced long ago by keyboard perforators or by direct keyboard transmitters of the Teletype class. The advantage of the typewriter keyboard machine is the greatly increased speed at which they can be operated with comfort to the users compared with the 5-key transmitters. It is ridiculous to crawl along at 30 words a minute when 40 and 50 words a minute are within easy reach, with great economy of lines and labour and telegraph machinery. Indeed the Western Union is working a number of circuits now at 60 words a minute per channel.

If the Baudot 5-unit code could be made completely universal, it would certainly be desirable, but some alterations are inevitable.

For instance, the 5 marking unit signal must be used for invisible correction of errors in modern machine telegraphy, and therefore another signal must be substituted for the Baudot "P" signal. France also requires an accented E. We do not. Sweden requires other changes. The Russian alphabet involves a complete departure from the Baudot code; so do the Chinese and Japanese alphabets.

The new Chinese alphabet especially, is going to be of great practical importance within the next ten or fifteen years to hundreds of millions of human beings. Australia, New Zealand and South Africa have already adopted the Murray code for the Multiplex, by the purchase of Multiplex machinery employing the Murray code; and the Indian Telegraph Administration already has 60 Murray Keyboard Perforators in use with the Murray code and a corresponding number of Baudot Printers fitted with type-wheels to suit the Murray code. To adapt Baudot printers for use on circuits employing the Murray code, all that is necessary is to fit on type-wheels and inversion wheels to suit. This is what has been done in India. Altering a Baudot Printer for one code or the other only takes a few minutes.

In North America the adoption of the Baudot code is impossible. The Murray code is established there on a very large scale, and the Americans will insist on the use of the Murray code on ocean cables, when the new cables with a speed of 300 or 400 words a minute enable the Multiplex to be used across the Atlantic and Pacific and other oceans.

In passing, I may mention that it is a matter of astonishment to me that so little notice is being taken either in the technical or the general press, about the great revolution that is taking place in cable telegraphy as the result of the new distortionless cable. If all the expectations about this new form of cable are realised, it is of enormous importance to mankind; and it also has a great bearing upon the relative importance of long-distance wired and wireless telegraphy. Clearly, if ocean cables by-and-bye are going to have a carrying capacity of 300 or 400 words a minute, so that they will be worked by Multiplex installations, the question of an international 5-unit telegraph code deserves serious consideration and discussion. It is for this reason as well as others that I welcome the opportunity of placing before your readers such facts and arguments as are known to me.

As a final word, I might point out that a universal standard typewriter keyboard for telegraph use is highly desirable within each Administration or country, and I think Colonel Booth has done valuable work in pushing this matter forward. It is significant in this connection that the basis of the standard keyboard

which Colonel Booth has done so much to materialise, is essentially the standard keyboard in use on all the American printing telegraph machinery; and I venture to prophesy that the standard 5-unit code, as well as the standard keyboard, will be determined by American practice, especially when that practice coincides with the Canadian, South African, Australian and New Zealand practice. It is well to bear in mind that the future destinies of mankind are going to be determined by the giant world nations, and not by petty European States like England and France.

DONALD MURRAY.

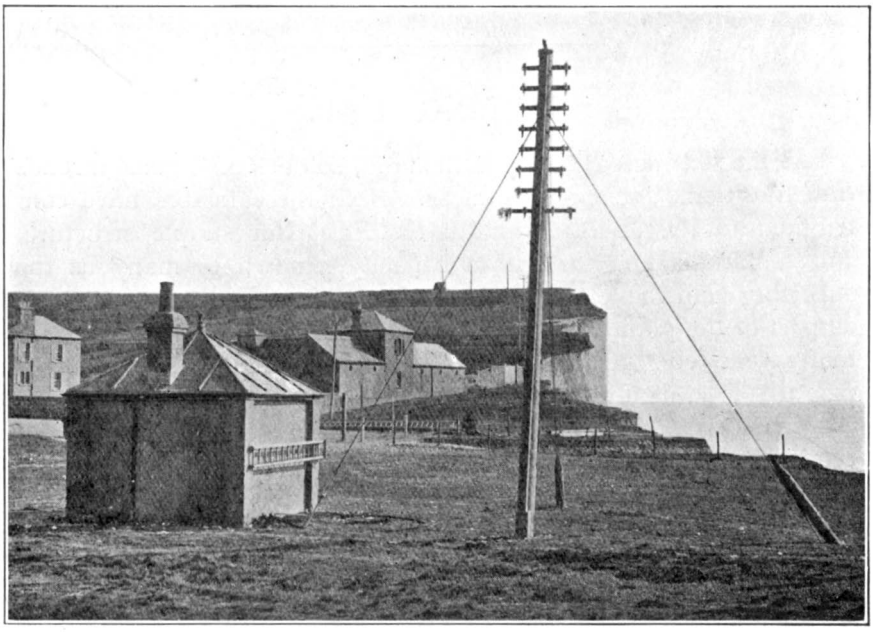
BIRLING GAP.

As the sea encroaches upon the land, so does time make inroads into traditions and circumstances. Both these factors have contributed to the abolition of an historical but simple structure, unostentatious and limited in capacity, known to many as the "Birling Gap Cable Hut." It was handed over to the Post Office as part of the plant of the Submarine Cable Company and has for many years continued to be used for its original functions. It is true it served as a domicile for an isolated officer during virtually the whole period of the war, when by the apprehensive it was regarded as a possible target for submarines, but this was of course only a trifling incident in its career. It is now a relic. Fragments of the early Dieppe Cable with solid core—but nevertheless with excellent gutta-percha—still remain in the locality, and run suspended and now neglected from the chalk cliff. The latter has been subject to erosion for years past and the old hut has become perilously near the edge. The hut is probably known to many of the Submarine Cable Branch and has probably been cursed by others who attended there in inclement weather. It has also been, I have no doubt, an objective of pleasureable interest for others from time to time.

Foresight and other compelling necessities have, however, led to the need for an alternative site to which the plant has been transferred. Consideration of questions involving amenities and objections have led to the construction of a building which, although of the same utilitarian value, is of a more artistic and pleasant appearance than the old hut it supersedes.

A comparison of the two views accompanying this note shows that a design has been created which is probably unique so far as regards Post Office buildings of a working character. Although with an exterior apparently suggestive of cubist ideas the interior

is just as drab as may be expected. The surroundings, however, are such that the ordinary design of a Post Office building would not have been in harmony, and artistic ideas were allowed to prevail. The hut stands on grounds that have been laid out as Pleasure Gardens, and other buildings have been erected of almost a classic character with which it must conform. One must now approach the building with the reverence which would be appropriate to the occasion of a sacrifice to the Goddess Electra.



The Old Cable Hut at Birling Gap.

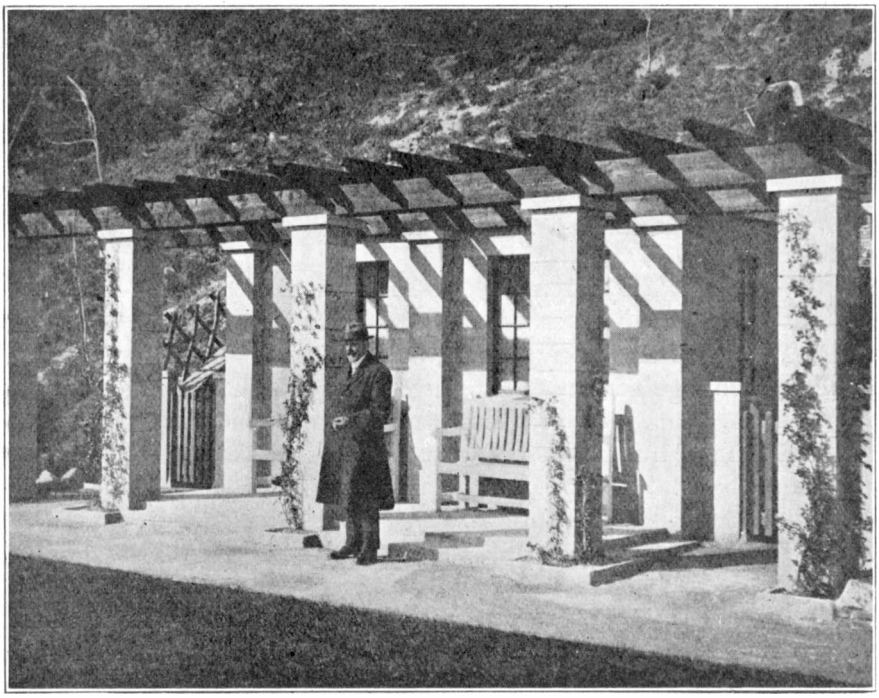
The abolition of the old hut as a matter of sequence practically severs the tie between East Dean—the earlier repeater station—and the sea. It sweeps away the remaining landmarks connecting time with some of the older members of the Engineering Service. It recalls the historic days when cables were much more delicate from a working point of view—although, strictly speaking, more robust because of the better materials employed—and for many years after the Submarine Cables were transferred to the Post Office, there was at East Dean a framework containing a series of six galvanometers which were incidentally employed for maintaining the working of the cables. When a cable broke down, it was quite usual to seal up the fault temporarily by the application of a

positive current through these galvanometers, so that communication could be restored and work proceed for a further short period.

It is only fair to the Submarine Department to say that such an item does not form a part of the equipment of the new hut.

It is satisfactory to find that an artistic spirit still prevails in the Service and the work of the Engineering Branch is not wholly confined to the erection of plant in open spaces calculated to disturb and distress the normal feeling and characteristics of mankind.

F.T.



The New Hut at Holywell, Eastbourne.
Mr. J. Bourdeaux in front.

AUTOMATIC TELEPHONY.
PROGRESS AND DEVELOPMENT.

J. RADFORD, A.M.I.E.E.

AUTOMATIC telephony was introduced into this country for the public exchange service at Epsom in May, 1912. It may be of interest to review the progress which has taken place since the introduction of this method of working and to give some indication of the probable lines of development.

In reviewing past progress it will not be forgotten that the period covered, except for the first two or three years, was almost wholly governed by war or post-war conditions, and readers of these pages are well acquainted with these conditions and of their effects on the telephone industry.

The particulars given in Tables 1-5 show, however, that in spite of the adverse conditions obtaining during the period under review, some very material progress has been achieved and that accelerated progress is now assured.

Statistics do not fully disclose all that has been accomplished, and a few details will be given in order that a better appreciation may be gained of the lines along which development has taken place and the object to which endeavour has been directed.

Automatic telephony did not make its appearance in a perfected state, and, although the fundamental principles of the various systems remain practically unchanged, numerous improvements in design and circuit arrangements have been effected and the facilities now available more nearly approach such standardisation as may be desirable from economic and service considerations but do not

preclude the possibility of further improvements, as and when they become necessary.

The development of automatic telephony in this country has been closely associated with general administrative considerations, and the uncertainties which formerly attended these considerations were not conducive to a comprehensive and well ordered development.

The possibilities of the new medium of communication, with its almost unlimited scope for inventon and design, gave a decided impetus to the electrical industry. This is reflected in Table 1, in which five different systems are represented. One other system will shortly be added to the list, and numerous others, each embodying novel and interesting features, have been submitted for consideration. It has been one of the tasks of the Department's engineers to make a thorough study of the claims of each of the systems from the standpoint of capital and maintenance costs, circuit principles and arrangements, mechanical design and the possibility of co-ordinating the features of their operation with the requirements of the public service.

Up to within about a year ago, proposals for automatic working were subjected to a very searching investigation on a comparative cost basis to determine whether manual working should be continued, or whether it should be substituted by automatic working. These comparisons occupied a considerable amount of time and it was only when extensive enquiry indicated that automatic working would be economical from all points of view that a decision in its favour would be given.

In December, 1921, it was decided as a policy to introduce automatic working in all cases where such a course was undoubtedly economical, and to call for statements of comparative costs only in those cases where this method of working was not obviously economical. Sufficient data of a financial, engineering and traffic character are now available to enable a decision to be arrived at with a minimum of delay, and these data indicate that the ultimate conversion to automatic working of the exchange system of the whole country is probably only a matter of time.

Multi-Office Area Working. It has been decided to constitute automatic areas on the same basis as was adopted in connection with the revision of telephone rates. Each area, which embraces the territory enclosed by a circle whose centre is the telephone centre of the town giving its name to the area, and whose circumference is drawn at a radius of 5 miles, will be known as a multi-office area, and all suitable exchanges within the area will be converted to automatic working. There will be one manual board

associated with the main automatic exchange to deal with all the manual traffic of the area, and arrangements are also being made for centralised testing.

It is not intended to imply that all areas as a matter of course will be treated in this manner, but the exceptions will probably comprise only very large cities and those areas where, amongst other things, the unexhausted effective capacity of the exchange concerned would render such a course uneconomical. As regards the very large cities, including London, it will be realised that the problems involved are extremely complex, and in addition to the solution of the Department's own building, engineering and traffic problems, the claims of any particular system to preference as regards design of equipment, trunking facilities and capital and maintenance costs will need to be minutely examined and favourably reported upon before the responsible authorities can arrive at a decision in the matter.

In view of the extension of automatic working, a few particulars of the preparatory work undertaken in dealing with a multi-office area conversation may be of interest generally, and perhaps specically, to those who will become more intimately associated with such a project. Assuming that the preliminaries regarding sites and buildings have been dealt with and that full traffic data for each exchange in the area are available, the first step in the design of the plant is to calculate the amount of equipment required for the various periods of development under consideration.

In order to effect economies in the cost of the initial equipment, but at the same time to provide sufficient equipment for development needs, the specification for the equipment of an automatic installation for public exchange service provides for five years development as regards the manual board, frames, racks, cabling and multiple banks, and for three years development as regards switches. Towards the end of the first and each subsequent year, steps will be taken to ascertain the following two years' anticipated development of subscribers' and junction lines. The amount of equipment necessary to provide for this development will then be installed so that the equipment at any exchange will thus always meet at least one year's development. The nature and extent of the switching equipment is calculated in terms of the units and types of plant peculiar to the various contractors' systems in order that competitive tenders may be invited.

At this stage also it becomes necessary, both as regards present requirements and future development, to settle the most suitable and economical numbering, and trunking schemes and some of the factors which have a material bearing in this connection are appended:—

(1) The general design must comply with the appropriate transmission standards.

(2) The switching scheme as a whole must afford unrestricted intercommunication between all the exchanges in the area entitled to service on a non-fee junction basis and must provide for segregation of the traffic between exchanges not so entitled, *i.e.*, those exchanges separated by a distance of more than 5 miles from each other, in order that fee traffic from those exchanges may be diverted to the manual board, for accounting purposes.

(3) The scheme must afford facilities for dialling out to those exchanges within the area which will continue to be worked manually and for the automatic operation of the calling subscriber's meter when the called subscriber replies.

(4) Facilities must be provided to enable Trunk or "O" level traffic, phonogram, enquiry, service telephone-telegram and test desk traffic to be segregated and dealt with in accordance with the traffic requirements.

(5) Provision of facilities for exchanges outside the multi-office area to dial-in to the main exchange for terminated traffic, and *via* the main exchange for through traffic to the other automatic and manual exchanges in the area.

It must be determined also whether the sub-exchanges in the area, as distinct from the main or parent exchange, shall be provided on a "self-contained" or "satellite" basis, the former term being applied to those automatic sub-exchanges whose local traffic is completed without passing over junctions to the parent exchange, while the latter term applies to those automatic sub-exchanges which utilise the equipment in the parent exchange for completing their local traffic. In the case of satellite exchanges it is possible, by means of special selective devices which function either as selectors or repeaters, depending on the particular digit or digits dialled, to effect a reduction in the number of junction lines to the parent exchange.

In order that the scheme finally decided upon may incorporate the most up-to-date features of design and layout, and to ensure that provision has been made to cater for the traffic and engineering requirements of all the exchanges concerned, close co-operation is of necessity maintained between the various engineering groups, and between these groups and other branches of the telephone service.

Village Exchanges.—Side by side with the development of the telephone system on a multi-office basis the need will arise for certain places to be specially catered for by reason of administrative or geographical considerations. These cases will be generally confined to those small towns or villages where multi-office working would not be applicable, or where, although the exchange is situated in an area into which automatic working will ultimately be introduced, it is necessary for the particular exchange to be specially dealt with on an automatic basis in advance of the general conversion.

These exchanges are usually situated in more or less isolated localities and are generally described as Rural, Village or Community automatic exchanges. The requirements to be met comprise continuous day and night service, direct and party-line working and junction working to one or more exchanges in the locality.

The most important conditions in connection with the design of the equipment for this type of exchange are that the plant shall be relatively inexpensive and simple in operation and that it shall need the minimum amount of accommodation and attention. Much work has already been carried out in order to develop a type of equipment for village exchanges to meet these conditions.

Automatic P.B.X.'s. One other type of automatic exchange which is now in the early stage of development is the Private Automatic Branch Exchange which, as its name implies, is an exchange located on the premises of a subscriber where it functions entirely as an automatic exchange as far as local calls are concerned and affords facilities, by means of an associated manual board, for dealing with the public exchange traffic.

Objections have been advanced to a Private Automatic Branch Exchange having direct access to a public exchange either for originating or incoming exchange traffic, on account of administrative and operating difficulties, but the retention of the manual board is not an engineering necessity.

Special tariff rates for these exchanges are in operation, and at present the switching equipment, including the manual board and the power plant, is provided and installed by the contractors.

In conclusion, only a passing reference can be made to the particulars shown in Tables 2-5, and it will no doubt be conceded that the information furnished therein represents a healthy state of affairs as regards present activities and holds some promise of a very considerable development in the immediate future.

AUTOMATIC TELEPHONY. PROGRESS AND DEVELOPMENT.

(1) AUTOMATIC EXCHANGES WORKING AT 31-10-22.

Name.	Type.	System.	Capacity.		Date opened.	Remarks.
			Present.	Ultimate.		
Epsom ...	Public	A.T.M.	600	1,500	18-5-12	Extension of 500 lines in hand.
Official ...	P.A.B.X.	,,	700	1,500	13-7-12	
Hereford ...	Public	Lorimer	500	900	1-8-14	
Darlington ...	,,	W.E.	800	2,260	10-10-14	Extension of 300 lines in hand.
Accrington ...	,,	A.T.M.	700	1,500	13-3-15	Extension of 400 lines in hand.
Chepstow ...	,,	,,	90	100	7-7-15	Rural. Extension of 100 lines in hand.
Newport ...	,,	,,	2,000	3,500	14-8-15	Extension of 600 lines in hand.
Crombie ...	P.A.B.X.	,,	55	90	4-10-15	Admiralty.
Portsmouth ...	Public	,,	5,200	7,000	29-4-16	
Paisley ...	,,	,,	1,700	2,150	15-7-16	
Dudley ...	,,	W.E.	500	1,600	9-9-16	
Blackburn ...	,,	A.T.M.	2,400	4,400	14-10-16	
Wylies* ...	P.A.B.X.	,,	100	150	31-5-17	War Office.
Rosyth ...	,,	,,	500	500	23-6-17	Admiralty.
Blackbank* ...	,,	,,	175	250	4-10-17	War Office.
Port Edgar ...	,,	,,	200	200	1-4-18	Admiralty.
Leeds	Public	,,	9,600	15,000	18-5-18	
Grimsby ...	,,	Siemens	1,860	4,000	14-9-18	
Polmaise ...	P.A.B.X.	A.T.M.	25	100	21-6-19	Admiralty.
Turnbridge ...	,,	,,	150	200	28-6-19	British Dyes Co.
Stockport ...	Public	Siemens	1,300	2,260	23-8-19	
Dalton ...	P.A.B.X	A.T.M.	100	400	4-10-19	British Dyes Co.
Wallasey Corporation	P.A.X.	,,	25	50	31-5-21	No exchange facilities.
Ramsey (Hunts) ...	Public	Siemens	40	80	24-10-21	Village.
Hurley ...	,,	,,	40	80	20-12-21	Village.
Liverpool Courier ...	P.A.B.X.	Relay	50	80	16-1-22	
N.E. Marine Eng. Co. ...	,,	,,	70	180	27-4-22	
Fleetwood ...	Public	,,	480	800	15-7-22	
Dunlops ...	P.A.B.X.	W.E.	300	800	19-8-22	
Total ...			30,260	51,630		Extensions of 1,900 lines in hand.

* Since closed.

(2) AUTOMATIC EXCHANGES UNDER CONSTRUCTION ON SITE AT 31-10-22.

Name.	Type.	System.	Capacity.		Remarks.
			Initial.	Ultimate.	
Southampton ...	Public	Siemens	3,200	5,500	—

(3) AUTOMATIC EXCHANGES FOR WHICH ORDERS HAVE BEEN PLACED.

(Including Exchanges which will be ordered in the immediate future).

Name.	Type.	System.	Capacity.		Remarks.
			Initial.	Ultimate	
J. R. Dale & Co.	P.A.B.X.	Relay	40	50	Installation commenced 13-11-22.
Swansea ...	Public	Siemens	3,200	5,800	
Sketty	,,	,,	300	500	Satellite on Swansea.
Dundee	,,	North Electric	3,500	4,500	
Broughty Ferry ...	,,	,,	600	1,000	
Marton	,,	A.T.M.	80	230	Village (Middlesboro' M.O. area).
London County Council ...	P.A.B.X.	,,	600	900	New County Hall.
Ormerod's ...	,,	Relay	25	30	Rochdale.
Pocock's	,,	,,	30	50	London.
U.K. Provident Institution ...	,,	,,	25	30	,,
Basil St. Hotel ...	,,	,,	100	120	,,
Bank of England	,,	,,	90	90	,,
Phillips	,,	,,	100	130	Manchester.
Babcock & Wilcox	,,	,,	170	200	London.
Debenham's ...	,,	,,	400	1,270	,,
Woolland's ...	,,	*	40	50	,,
Total			9,300	14,050	

* System not yet decided.

(4) AUTOMATIC EXCHANGES IN SPECIFICATION STAGE.

Multi-Office Areas.	No. of Exchanges.	Total Capacity.		Remarks.
		Initial.	Ultimate.	
Brighton ...	6	8,380	10,730	Including Hove.
Sheffield ...	9	12,090	17,370	
Shrewsbury ...	1	870	1,670	
Torquay ...	3	1,680	2,460	
Gloucester ...	4	1,240	2,160	
Cheltenham ...	2	1,170	1,970	
York	1	1,530	1,980	
Kirkcaldy ...	5	940	1,470	
Rochdale ...	8	3,700	7,000	
Newport (Mon.)...	1	—	600	Newport Extension.
,, ...	1	60	100	*Risca.
,, ...	1	60	100	*Caerleon.
,, ...	1	60	100	*Cwmbran.
Swansea ...	1	400	500	Morriston.
Halifax ...	9	3,710	6,560	
Total		35,890	54,770	

* Satellites on Newport.

(5) AUTOMATIC EXCHANGES IN PRE-SPECIFICATION STAGE.

Multi-Office Area.	No. of Exchanges.	Remarks.
Leeds	Chapeltown	Main Exchange existing.
,, ...	Stanningley	,, ,, ,,
,, ...	Headingley	,, ,, ,,
,, ...	Roundhay	
Dudley	Brierley Hill	Main Exchange existing.
Portsmouth	Gosport	,, ,, ,,
West Hartlepool ...	3	
Harrogate	4	
Bedford	2	
Oxford	3	
Ipswich	1	
Exeter	2	
Southport	5	
Burnley	3	
Leicester	12	
Newcastle	16	
Colwyn Bay	8	Including Llandudno.
Folkestone	4	
Chesterfield	4	
Preston	6	
Edinburgh	10	
Hanley	10	
Nottingham	10	
Bath	7	
Middlesbrough	9	Including Marton.
Macclesfield	4	
Keighley	6	
Coventry	4	
Plymouth	8	

AUTOMATICS.

THE INFLUENCE OF LINE CONDITIONS ON IMPULSING RELAYS DURING DIALLING.

By C. W. BROWN, A.M.I.E.E.

THE Telephone and Research Sections of the Engineer-in-Chief's Department of the British Post Office recently collaborated to ascertain the relationship between the theoretical and practical ratios of "make" and "break" of dial springs during impulsing, and the extent to which line conditions influence the impulsing circuit. The following notes and illustrations on the results of the investigations may prove interesting to readers of the Journal.

The dials used during the tests were the A.T.M. Company's pattern, in which interrupting cams operate springs to disconnect the calling subscriber's looped lines a prescribed number of times dependent upon the digit dialled. The cam producing the impulse is cut to give a "break" sector of 110° in a semi-circle, leaving a

70° sector for the "make"; this proportion should give a ratio of 61.1% "break" to total impulse. Tests were carried out on 12 dials taken from stock and the average mean "break" was found to be 66.4%.

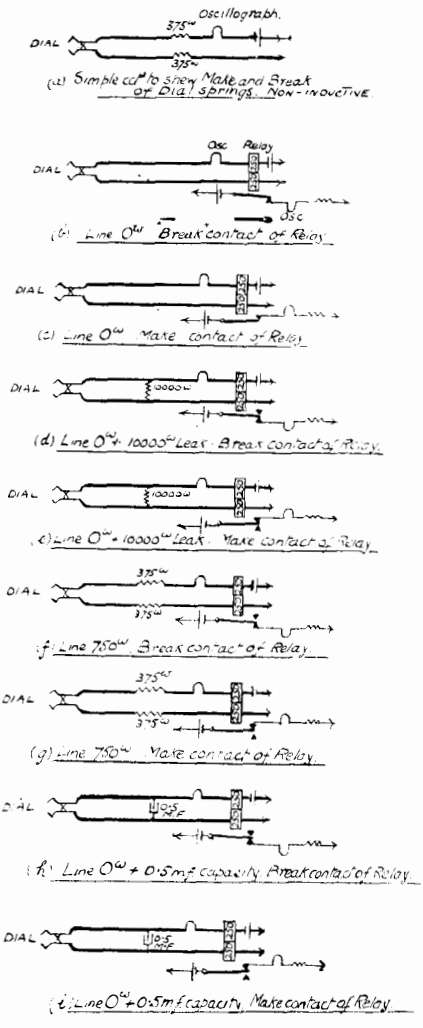


FIG. 1. CIRCUIT CONDITIONS.

In order to ascertain the effect of line conditions upon the operation of a 250ω + 250ω impulsing relay having standard adjustment, oscillograms were taken to show the relationship between the rise and fall of line current in response to dial impulses, and the lag of the impulsing relay as recorded by the

passage of current over its " make " and " break " contacts. The circuit conditions obtaining during the tests are shown in the following diagrams :—

The results are shown in Fig. 2. In order to permit of comparison under the different line conditions, the oscillograms were corrected to one scale of time, seen at the top in Fig. 2. The normal line current does not appear on the oscillograms, and to enable the reader to compare the values of the line current normally in the circuit and that during dialling as shown by the peaks in the

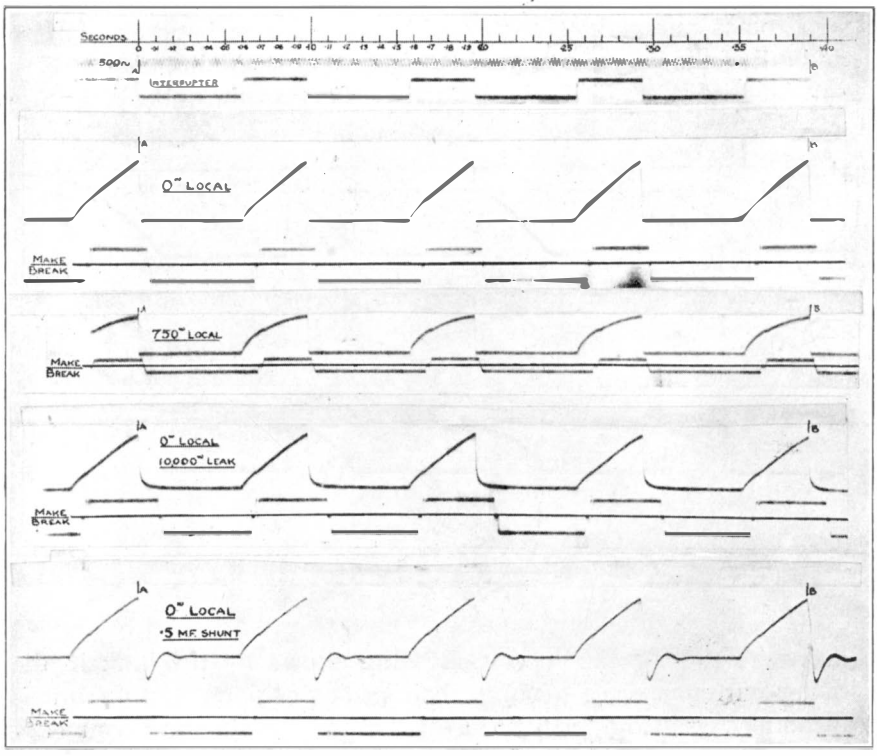


FIG. 2.

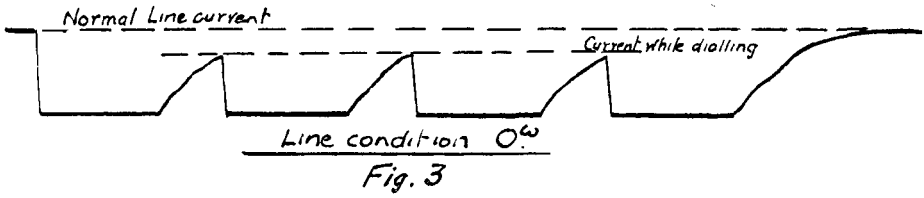
oscillograms, the following diagrams—taken from observed results —will be useful :—

From the tests it was found that in the zero loop circuit the current reaches approximately 77%, in the 750$^{\omega}$ circuit 90%, in the zero loop with 10,000$^{\omega}$ leak circuit 80%, and in the zero loop shunted with 0.5 mf. circuit 72%. The excess normal current under zero loop conditions has no benefit in practice. Although the percentages differ, the actual peak currents at the end of the

" make " period are the important values and these must be considered carefully in designing routine testers.

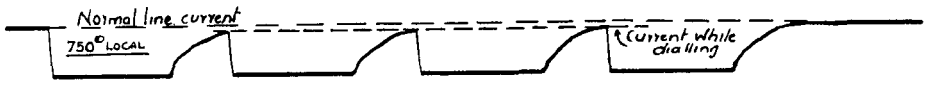
The oscillograms show clearly the information sought and indicate that the line conditions influence the impulsing relay in a very definite way. The contacts of this relay transmit the necessary current impulses to the magnet apparatus associated with the switches, and sluggish or premature operation of the impulsing relay beyond definite limits will result in misoperation of the switches; routine tests therefore must impose conditions which will ensure the correct operation of the impulsing relay under extreme line conditions.

From a reference to Fig. 2, the time relation between the rise and fall of the line current and the operation of the impulsing relay can be readily studied, the inductive effect as the relay armature



Line condition 0^{ω}

Fig. 3



Line condition 750^{W}

Fig. 4

moves to the " make " position being shown by the kink in the rising current curves towards their peak position; a pronounced " chatter " is also noticeable at the " make " of the local contact.

The effect of the $10{,}000^{\omega}$ leak in retarding and slowing down the fall of current and prolonging the " make " is interesting, the leak also has the effect of causing the relay to make more promptly, thus shortening the effective " make." The influence of line leakage, therefore, is important.

The effect of simple line resistance is to shorten the " make " and lengthen the " break " of the relay armature.

The effect of localised capacity is to bring about coincidence of the rise and fall of line current and the operation of the relay. It is interesting to note the effect of capacity in producing an oscillatory current and a pronounced " chatter " of the relay armature in the " break " position.

AUTOMATIC TELEPHONY IN AUSTRALIA.

WE have received a copy of a paper on the above subject with special reference to the Sydney Exchanges, read before the Sydney Division, Institution of Engineers, Australia, by Mr. J. M. Crawford (formerly of the British P.O. Engineering Department and one time Secretary to the I.P.O.E.E.), on the 13th July last.

The paper deals largely with a description of the Strowger system, which has been described already very fully in our pages, but there are several points of interest worthy of quotation.

Mr. Crawford says with regard to semi-automatic exchanges: "The only semi-auto systems in the Commonwealth are those of the Western Electric Co. at Unley and Underwood, and Siemens Bros. at Port Adelaide, but in view of the wide range of my subject, no description of these systems will be attempted. Indeed they are generally claimed as half-way houses to full automatic, and it is significant that one of them (the Clement Auto. Manual system) is being tried out by the British Post Office in Dundee as a full automatic. The experience in Australia also indicates that the full automatic is better than semi-automatic systems." Semi-automatic exchanges have not been adopted by the British P.O. The investigations made by this Department with regard to annual charges indicated without doubt that wherever semi-automatic proves economical, full automatic will be still more beneficial.

With regard to switching in a multi-office network, Mr. Crawford states that "Means are taken to relay the dial impulses from office to office by means of repeaters. These repeaters also enable the third wire of the trunk between selector and selector to be dispensed with between the offices, supply talking current, and provide means of supervision on the calling line. A different form combines the functions of repeater and selector. This latter form is a particularly ingenious device called a 'switching repeater,' and which can best be understood by following the progress of an actual call. A subscriber, say, at Homebush, which is a sub-office having Ashfield Exchange as its main office, wishes to call another Homebush subscriber (say U 6234). Upon lifting his receiver, his line is automatically connected through the line switch individual to his line to a switching repeater in the Homebush Exchange. This, in turn, extends his line to Ashfield Main Exchange, where all switching operations for Homebush calls intended for other exchanges are done. The caller now operates his calling device and pulls U (which is really 7), and which simultaneously operates both the switching repeater and the first selectors at Ashfield. Then he pulls 6, which similarly extends the line to and operates the second selector at Ashfield. The switching repeater is fitted

with a special switch bank, so connected that whenever the wipers come to a stop on the second selector U 6 positions the repeater switches the calling line over to a local third selector, *i.e.*, a selector in the Homebush office. The call is then completed at Homebush. It also, however, disconnects and releases the outgoing trunk to the Ashfield first selector, and the incoming trunk leading back from the second selector at Ashfield to the Homebush third selector, that is to say, it throws free for use the two trunks between the two offices. It is thus the function of the switching repeater at Homebush first to relay the impulses on to Ashfield and upon the operation of the incoming trunk from Ashfield to release two long and valuable trunks. Therefore, besides other advantages, the provision of a trunk line is saved between the two offices." The use of selectors of the switching repeater type is embodied in the British P.O. Department's specification when the annual saving for line plant under such conditions is more than the annual cost of the additional internal equipment required.

"A remarkable feature about the Sydney telephone network and one that adds greatly to the transmission problems, is the fact that it includes exchanges like Parramatta and Liverpool, 15 and 12 miles respectively from the centre of the network. In no other State in Australia, and indeed in no other telephone network in the world, are exchanges so far distant from the centre and allowed to have communication with all other exchanges in the network at the network rates. This fact, added to the peculiar configuration of Sydney with its harbour, bays and inlets, makes the problem of satisfactory lay-out for telephone purposes both difficult and relatively costly."

PRIVATE AUTOMATIC BRANCH EXCHANGES.

By A. B. Eason, A.M.I.C.E., A.M.I.E.E.

This article mentions some features of automatic telephone working which are to be found in P.A.B. exchanges. The term "P.A.B.X." may not be the best possible, but is adopted because it is the term laid down by the British Engineering Standards Association for a private exchange, with automatic plant from which connections may be made to the public telephone system. P.B.X. is a private (manual) branch exchange, associated with the public system. P.A.B.X. is a private (automatic) branch exchange associated with the public system. P.A.X. is a private exchange worked automatically, which has no communication with the public system.

The year 1922 was the first one in which P.A.B.X.'s were generally introduced. The "Official" P.A.B.X. has been in use since 1912, but it was in the nature of an experiment when first installed and the war hindered further developments of P.A.B.X.'s. The schedule below gives particulars of plants, some of which have recently been put into operation and others are on order.

Particulars of some P.A.B.X.'s:—

	Equipment of lines.		Manual Sections.		Battery capacity Ampere hours.	
	Now.	Ultimate.	Now.	Ultimate.	Now.	Ultimate.
Fort Dunlop	300	800	3	6	193	386
London County Council	600	900	7	11	282	352
N.E. Marine Engineering Co.	65	90	1	1	58	66
Liverpool Courier ...	45	80	1	2	58	66
Bank of England ...	90	100	2	2	48	48
Basil Street Hotel ...	100	120	1	1	40	40
Magasin de Louvre ...	40	50	1	1	40	40
Pocock Brothers ...	30	50	1	1	40	40
Ormerod and Sons ...	30	50	1	1	40	40
United Kingdom Prov. Inst.	25	30	1	1	32	32

There are two main types of P.A.B.X.; one is the small type with one or two manual switchboard sections, having cord circuits similar to those shown on diagram C.B. 887, with "sixpenny" indicators and negative supervision. The other type is the large P.A.B.X, with three or more manual switchboard sections, having cord circuits as in C.B. exchanges with supervisory lamps and positive supervision. The exchange lines on small boards terminate upon 5 point jacks, with indicators, and current for exchange calls is fed from the main exchange over the line to feed the extension. On large boards the exchange lines terminate upon 3 point jacks with lamps, and current for exchange calls is fed from accumulators at the P.A.B.X.

Traffic Features.

Local calls are completed automatically, as in a public exchange.

Incoming calls from the public exchange. On P.A.B.X.'s a jack is provided on the manual board for every line, so that incoming calls may be completed by the operator inserting a plug in the jack of the extension line, instead of providing both outgoing junction multiple jacks associated with automatic plant and dialling facilities for the operator, so that she would complete calls by plug-

ging in the junction multiple and dialling the requisite number. Therefore on the manual board one finds as many multiple jacks as there are extension lines for dealing with incoming calls.

Outgoing calls to public exchanges. The above mentioned jacks may also be used for outgoing calls from extensions to the public exchange, by wiring the automatic plant so that when "0" is dialled the calls arrive upon a lamp associated with the multiple jack. On small P.A.B.X.'s this jack then becomes the answering jack, and either term could be used for the jack. On the large P.A.B.X.'s, such as the L.C.C., there will be both answering and multiple jacks.

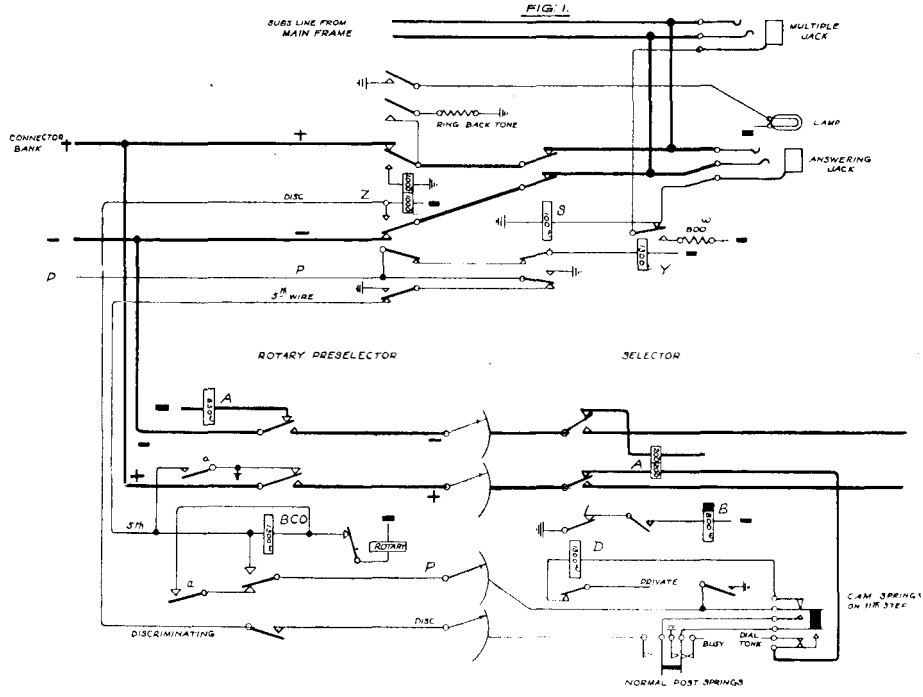


FIG. 1. L.C.C. HALL. MANUAL BOARD CIRCUIT. A.T.M. COMPANY.

As this multipling of the extension lines upon the manual board has not been used so far in public exchanges, the circuits will be mentioned. Many different types of arrangements could be made, depending upon how the selectors or AB feeds are to be utilised during the "0" level calls. After the calling extension has picked up a selector and dialled "0," the selector may be in use (*a*) during the whole period of the call, or in use (*b*) until the operator answers, or in use (*c*) only for the short dialling period, *i.e.*, until the calling lamp glows at the manual board. This last method is now being specified. The number of selectors, the pro-

vision of which can be avoided if method (*c*) is adopted instead of method (*b*), depends upon how long the operator takes to answer the calling lamp. The manual board circuit for the L.C.C. exchange is shown in Fig. 1. When the selector is taken possession of, relay B puts earth on the release trunk, and this operates Y and puts the engaged test on the multiple jacks. After "o" is dialled, the selector moves over the ten O level junctions—which are made to test busy—and lands on the 11th. In this position both the normal post springs and the cam springs operate and relay Z operates; the loop to the automatic apparatus is broken and the selector releases. When the operator answers, sleeve relay S operates, which earths the private of the automatic apparatus and releases Z.

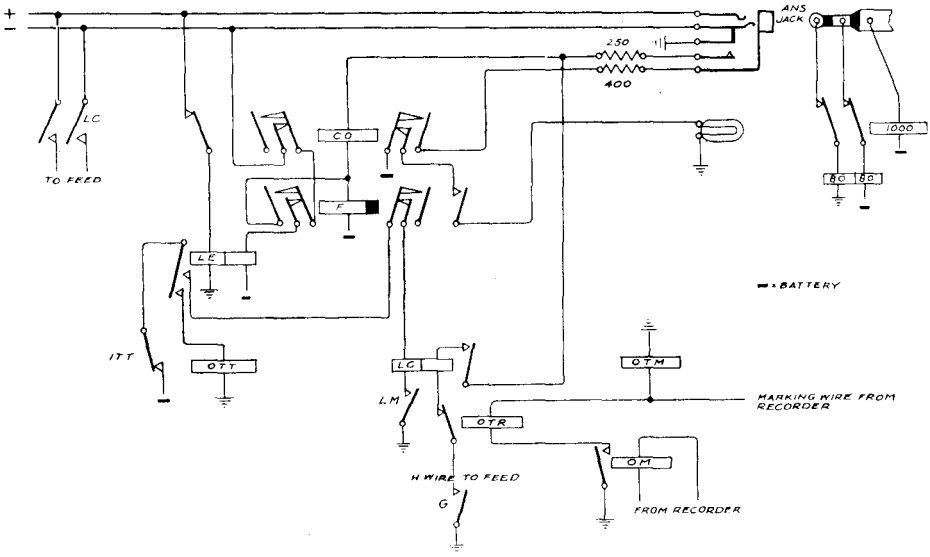


FIG. 2. MANUAL BOARD CIRCUIT. RELAY AUTOMATIC COMPANY.

Fig. 2 shows the method adopted by the Relay Automatic Company. They can provide for the release of the feed and lighting of the calling lamp without much additional equipment, owing to the fact that every line has a "Fault" relay, in addition to the line and cut-off relays which every system has. The operation of the circuit includes the following steps: the extension makes a call; LE operates; the link and feed are chosen, so that LM (not shown) operates; then LC operates. This joins the A and B lines to the feed. The G relay in the feed (not shown) puts earth on the holding wire and CO and F operate and LC is held. When the extension finished dialling "o," the recorder sends out impulses which operate OM and then OTR. OTR cuts the holding wire and causes the release of LC and CO; the release of CO puts F

across the A and B wires; F puts battery on the calling lamp *via* CO. When the operator plugs in, the earth on the third spring of the jack is put on CO, and CO operates.

At Fort Dunlop the method of working outgoing junction calls is different. The calling line having dialled "0," picks up an idle junction line in the "0" level and lights the calling lamp of that line; when the operator answers the selector and junction line are held; the selector is kept in use during the whole of the conversation. There are 15 such "0" level lines to the manual board to carry the outgoing traffic. The circuit is practically the same as on a public exchange.

Tones and Ringing Currents.

Busy. On P.A.X.'s—which are not connected to the public exchange system—the type of tone given to the caller if he finds the line he wants is busy does not matter much. But when a private exchange is connected to the public exchange, it is desirable that the tones given on the local plant should be the same as the tones given on the public system. Therefore on the P.A.B.X.'s the busy tone is of the standard period.

Faulty lines. In manual exchanges, if a subscriber asks for another subscriber whose line is faulty, the operator will tell the caller that the line is "out-of-order"; the fact of its being out of order is known by a tone upon the bush of the multiple jack. On a public automatic exchange, a subscriber who dials the number of a line which is faulty is given a continuous tone to indicate that the line is not available. In some P.A.B.X.'s a busy tone is given in such cases; on other P.A.B.X.'s the standard "number unobtainable" tone is given.

Dead levels. Some provision has to be made to indicate to a caller his own fault; for instance, if the caller dials a dead level—say he dials 84 on a 40 line board when the only numbers in use are from 20 to 59. In this case he may either get the N.U. tone, or be put through to the operator. Obviously, when there are only a few lines, it is better to connect the man who dialled wrongly to the operator, who can tell him of his fault, seeing that the load put on the operator is negligible. In a large exchange, where the number of people dialling dead levels becomes appreciable, it is better to connect the calling line to the N.U. tone, and thus relieve the operators of the necessity of answering the false calls.

The necessity of providing the above mentioned tones makes it desirable to provide standard ringing machines. These machines at the same time provide standard ringing current. Pole-changers and vibrators do not provide all the necessary facilities for tones and interruptions.

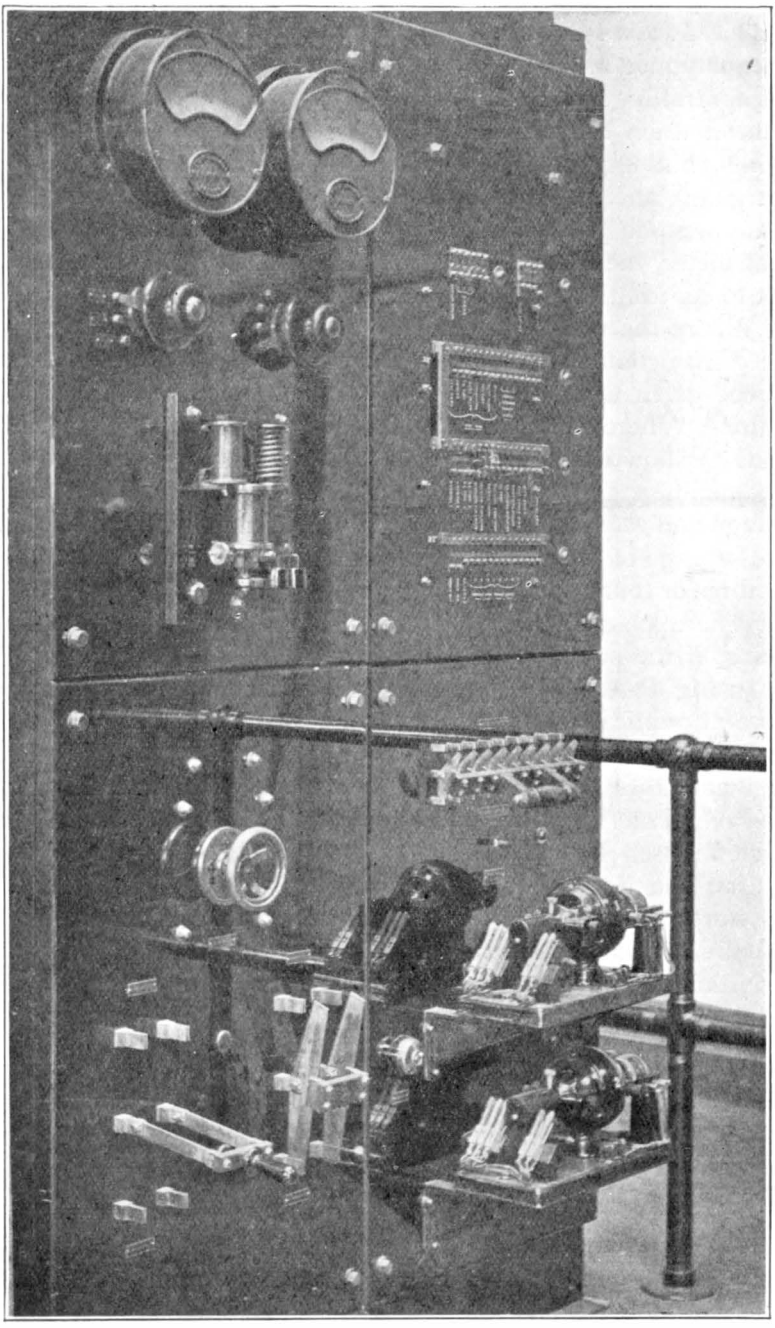


FIG. 3. POWER BOARD. RELAY AUTOMATIC COMPANY.

POWER PLANT.

The power plant includes batteries of 32, 40, or 72 ampere-hour capacity, when supplied by the Department, and of other capacities when supplied by the outside contractors, and a small power board for controlling the charge and discharge. The charge is commenced when the maintenance man comes round and closes the switch, but is cut off automatically when the batteries are fully charged. The determination of the fully charged condition is made in some places by a voltmeter and in others by an ampere-hour meter, the instruments being provided with an electrical contact to control the cut-off switch.

Where the voltage control is in use, the voltage relay is provided with contacts to show both high and low voltages; an alarm can be given when the battery voltage drops to a predetermined figure. Where the ampere-hour meter is used, no provision is made to show automatically the state of discharge of the battery. The maintenance attendant will go round periodically to the exchange and set the charge going independently of the precise state of discharge of the battery, which has a capacity to carry the load for three or four days.

Where possible the batteries are charged from the supply mains, if the supply be Direct Current.

In big P.A.B.X.'s the charging arrangements are similar to those at public automatic exchanges.

Ringing machines are usually of the small 5-watt type, similar to dynamotors Nos. 3 and 4, which were described in *P.O.E.E. Journal*, Vol. 13, p. 286, year 1920. Fig. **3** shows the type of machine used by the Relay Automatic Company at *Liverpool Courier* and North Eastern Marine Engineering Co. P.A.B.X.'s. No starters are needed, and the ringers only run when they are actually needed. When a call is made the machine starts up to give dialling tone, busy tone, N.U. tone, ringing current and the various interruptions, until the called subscriber answers, or the caller hangs up his receiver.

THE RELAY AUTOMATIC TELEPHONE SYSTEM. FUNDAMENTAL PRINCIPLES AND FEATURES.

By G. H. BRYANT, A.M.I.E.E.,
Chief Engineer of the Company.

THE application of the Relay system is extending in various parts of the world, and as there is a demand for an exposition of the fundamental principles this article is written with a view to bringing out those principles in their true simplicity.

The first Relay plant was installed in London in 1910, and it has been said from time to time that the system would be limited to small switchboards on account of cost and maintenance difficulties. In this connection, however, the tracing of calls and fault locating on the largest plants installed to date is being carried out successfully, and is not proving a handicap.

Successively larger plants are being designed and installed, and the details of large Public Multi-Exchange networks are now being completed.

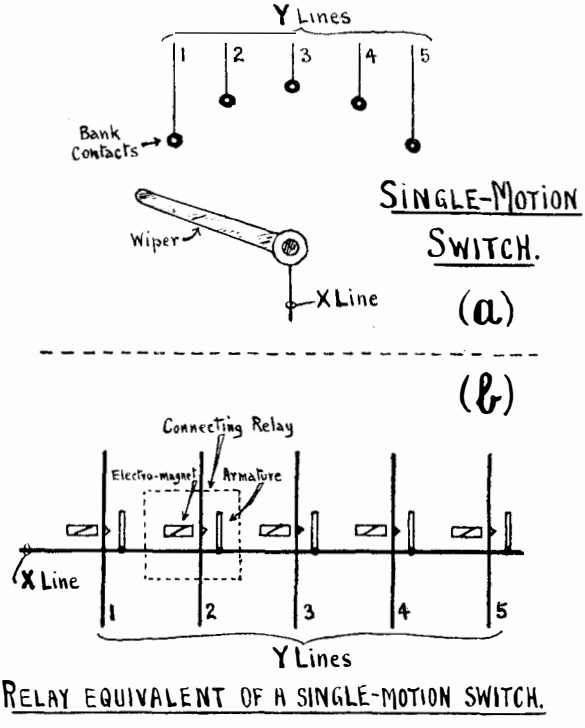


FIG. 1.

The large number of private installations fitted in Offices, Works, Institutions, etc., during the last six years has enabled much valuable practical experience to be obtained. These plants are in some cases working as single P.A.X.'s, in others as Multi-P.A.X.'s with inter-dialling; also connection is now being given to the Public Exchanges from Private Automatic Branch Exchanges. (P.A.B.X.'s).

RELAY TRUNKING SCHEME.

As most readers of this article have some knowledge of Switch systems, and will use it as a starting point for studying the Relay

system, we will first consider how a number of relays can be arranged to do the work of a switch.

Fig. **1**(*a*) shows a typical single-motion switch arranged so that the wiper can connect with any one of the bank contacts; while

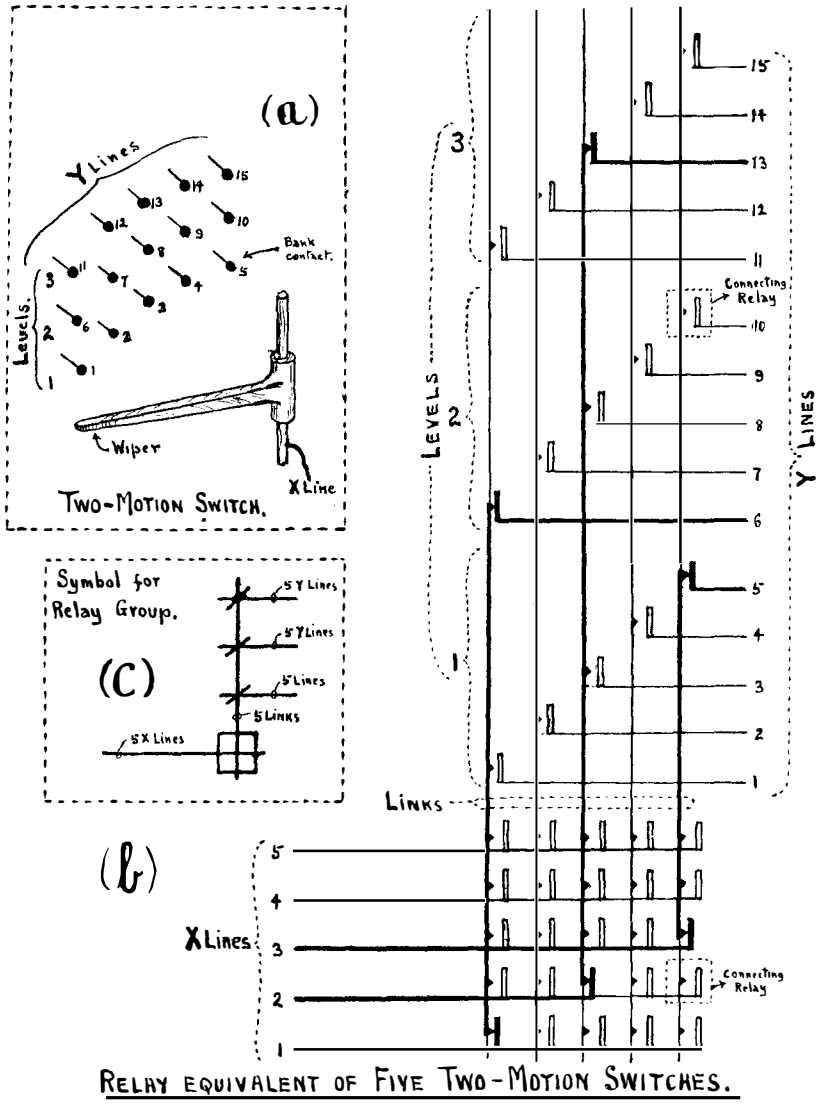


Fig. 2.

Fig. **1**(*b*) shows how a number of relays can be arranged to do similar work. In each case the circuit X can connect with any one of the circuits Y.

Fig. **2**(*b*) indicates how a group of relays can be arranged to do

the work of a number of two-motion switches. Assuming that five 15-point (*i.e.*, 3 levels of five) switches with their bank contacts in multiple are being compared, then in the equivalent relay group we shall require, as shown in Fig. **2**(*b*), 5 X lines each provided with 5 relays giving access to 5 links. At the various intersecting points connecting relays are provided so as to give access to 15 Y lines.

In the case of five switches of the type shown in Fig **2**(*a*), although each switch has 15 bank contacts, the total number of connections that can be set up at any one time is one per wiper, *i.e.*, a total of five. In the same way, in the relay equivalent, 5 connections can be set up at one time from the 5 X lines to any 5 of the 15 Y lines; three connections are shown in thick lines, X1 to Y6, X2 to Y13, and X3 to Y5.

It is convenient to indicate a group of relays as shown in Fig. **2**(*b*) by means of a symbol, Fig. **2**(*c*). (*Fleetwood Trunking Scheme* (*P.O.E.E. Journal*, *Vol.* 15, *Part* 2, *p.* 199) *illustrates the use of the symbol.*)

Whereas in a step-by-step switch (Figs. **1**(*a*) & **2**(*a*) an appreciable time is taken for the switch to pass over a number of intervening bank contacts, this is not the case with a relay group in which a search is being made for an idle circuit, for it takes no longer to connect to the last circuit than it does to the first.

It should be borne in mind that in a telephone exchange the number of conversations proceeding at any one time is usually only about 5 to 15% of the total number of working telephones, and the problem in an automatic telephone exchange is to provide the minimum of apparatus that will carry the busy-hour load without undue loss of calls.

We will now consider a simplified relay exchange, as shown in Fig. **3**, which will indicate clearly the function of the various groups in a larger plant. The subscribers' lines are provided with a number of OTC (Out Trunk Connecting) relays giving access to A and B Feeds, which are the equivalent of a number of cord circuits.

The *A and B Feeds* are provided with RC (Recorder Connector) relays, which connect the Feeds with one of two Recorders.

The *Recorder Connectors* function somewhat similarly to the listening keys of a manual board, for while the caller is giving the required number, by dialling, they temporarily connect a Recorder to his line to record his demand.

The subscribers' lines are also provided with a number of ITC (In Trunk Connecting) relays, which are energised as required by a Recorder in order to complete the connection between a Calling and Called line.

When a Caller, for instance No. 3, removes his receiver from the hook, his loop starts a searching operation for an idle Out Trunk, and assuming that No. 2ABF is free, then the OTC relay at the point of intersection between sub. No. 3 and Out Trunk No. 2 would be energised in a manner to be described later.

The Caller is now connected to ABF2 and on dialling for sub. No. 6 the six short breaks (*i.e.*, impulses) he gives to his loop, result in firstly a Recorder, for instance, No. 1, being taken into

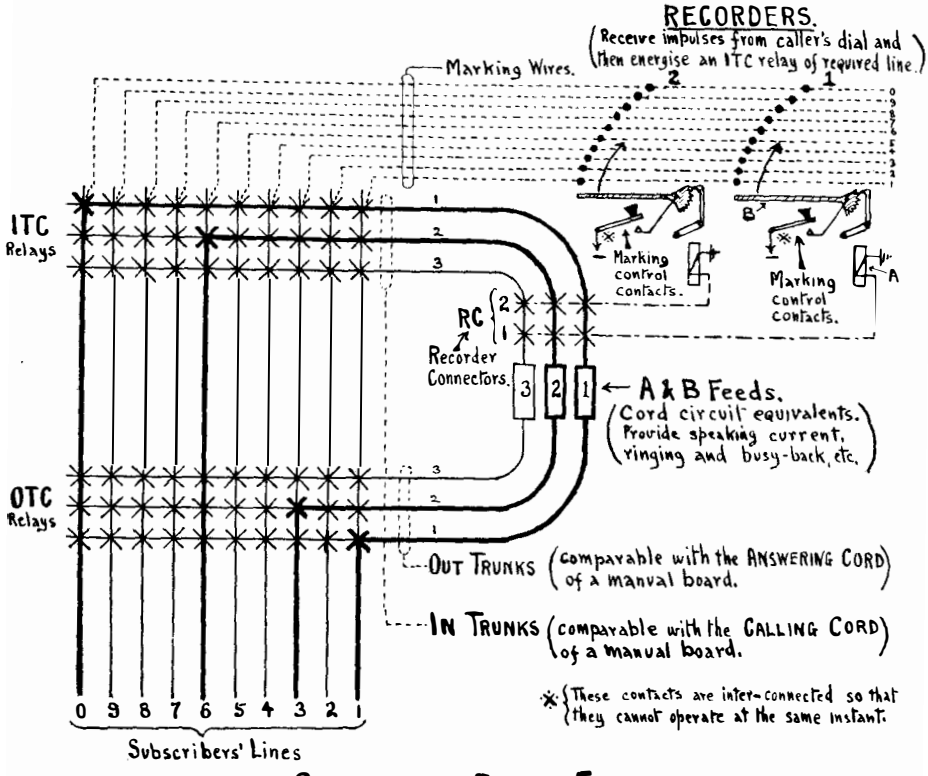
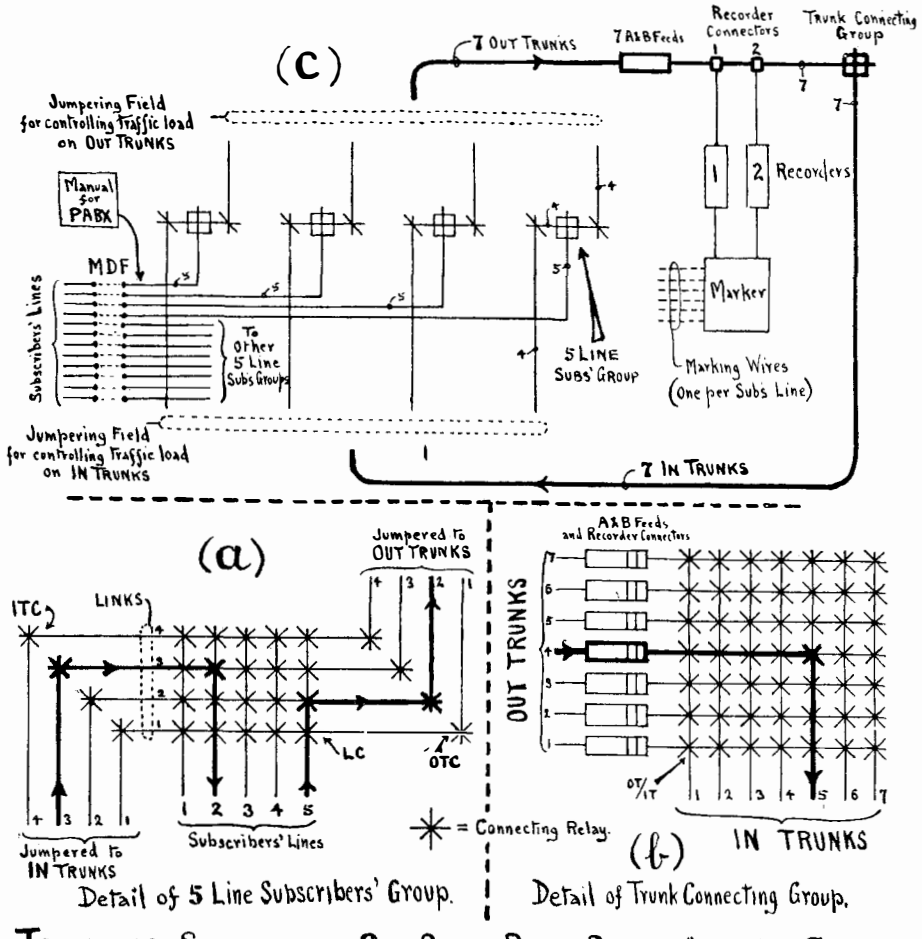


FIG. 3.

engagement with ABF2, *viâ* RC1, and, secondly, in the impulses being counted and stored in the Recorder on sets of relays. In Fig. 3 these relays are shown as a switch, the magnet A doing the counting and the wiper B the storing. The six impulses from the calling dial having ceased, the wiper will be at rest on Marking Wire No. 6. Then, provided that at that instant the other Recorder is not using the Marking Wires, the marking control contacts of Recorder No. 1 will automatically close and thus

energise the ITC relay of ABF2 which affords connection with sub. No. 6. When ITC has operated, it remains locked in a holding circuit and the Recorder instantly releases and resets ready for another call. Ringing is then applied to the called line from the ABF and ceases when the called party answers; the speaking circuit is then established.



TRUNKING SCHEME OF A 2 OR 3 DIGIT RELAY PRIVATE AUTOMATIC EXCHANGE.

FIG. 4.

If the called line is engaged the Recorder sends a signal to the ABF, which results in busyback being given to the caller.

It should be noted that although both Recorders can be receiving impulses from different callers at the same time, they can only send current over the marking wires one at a time.

The trunking scheme shown in Fig. 3 is extravagant of connecting relays except in very small exchanges.

A typical trunking scheme as employed for P.A.X. and P.A.B.X. plants is shown in Fig. **4**(*c*). The subscribers are divided into groups of five, see Fig. **4**(*a*), with 3 to 5 links which have access to both *Out* and *In* Trunks. It is important to note that each 5 line Subs. Group has its own set of links which are used for both outward and inward calls.

Fig **4**(*c*) is used for plants of from 20 to about 300 lines. The Subs. Group are shown in symbol form and the detail of one group is given in Fig. **4**(*a*).

As each Subs. Group has access to only a portion of the *Out* and *In* Trunks the Trunk Connecting Group (TCG) is provided so that *any Out Trunk can connect to any In Trunk.*

A comparison with the simpler scheme of Fig. **3** will show that the additional features are the Subs. Group Links and the TCG; also that the number of relays individual to a subscriber's line does not increase with the size of the exchange (they are dependent upon the busy-hour load per average subscriber's line).

The sequence of operations for making a call is as follows: When the Caller removes his receiver from the hook his loop starts a search for both an idle Link and an Out Trunk. The LC (Link Connecting) relay of the first idle link energises and extends the line to the link, see Fig. **4**(*a*), at the same time the OTC (Out Trunk Connecting) relay energises to extend the link to an Out Trunk and thence to an ABF, as shown in the same Fig., where sub. No. 5 is connected *via* OTC2 by the thickened line.

The foregoing occurs prior to dialling, and assuming that the dialling and marking have been completed in a similar manner to that previously described, also that OTC is jumpered to Out Trunk 4, then at the time the Recorder sent marking current to the Called sub.'s relays, say No. 2 in Fig. **4**(*a*), it also sent a marking current to energise an OT/IT (Out Trunk/In Trunk) relay in the Trunk Connecting Group so as to connect Out Trunk 4 to an idle In Trunk 5, see Fig. **4**(*b*); this In Trunk having access to the Subs. Group containing the wanted line then connects with a free link and thence to the desired line, as shown in Fig. **4**(*a*), where ITC3 is connected to sub. No. 2.

The Caller having been connected to the Called line, the Recorder and Marker are disconnected and are free for other calls.

Subs. Groups of the same size are used for exchanges of various sizes provided that the busy-hour calling rates are approximately equal.

The *Out and In Trunks* are, however, provided in sufficient number to meet the total busy-hour load without undue loss.

A *Recorder* is only in circuit with a calling line from the time the first dialling impulse is sent until the connecting relays have

been energised on the In Trunk and Called line, a matter of a few seconds. The *total number of Recorders* required is therefore dependent upon the busy-hour calling rate and is usually 1 to 3% of the subscribers' lines.

The *Marker* is only in circuit with a Recorder for the very short time that the connecting relays take to energise.

The *Trunk Connecting Group* shown in Fig 4 is only employed

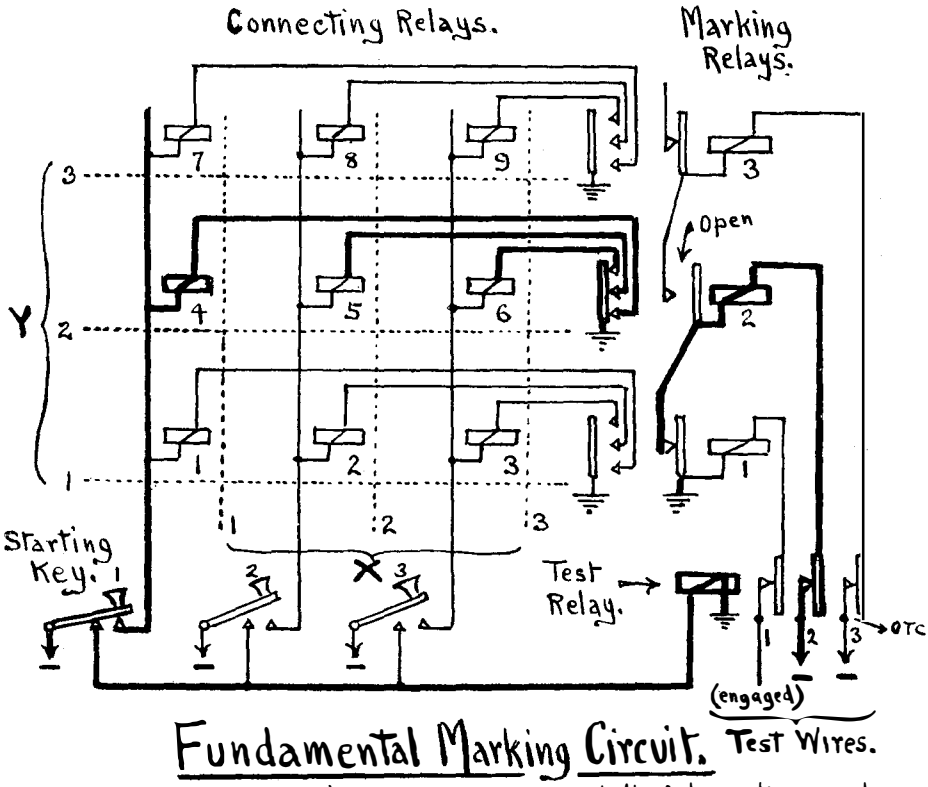


FIG. 5.

when the number of trunks does not exceed 30. When larger groups of trunks are used trunk-links, which will be explained later, are employed to keep the number of connecting relays at an economical figure.

FUNDAMENTAL MARKING CIRCUIT.

Fig. 5 illustrates the method employed to energise a connecting relay at an intersecting point. Three vertical X lines and three horizontal Y lines are shown; the speaking circuit contacts are omitted in order to simplify the circuit.

Connecting relays 1 to 9 are fitted at the intersecting points. Assume that X1 is a calling line, and that Y1, 2 and 3 are links with the first one engaged. Then if starting key 1 be depressed a circuit is completed for the test relay and it will energise. The three test wires are thereby extended to Marking relays 1, 2 and 3. As Y1 is assumed to be engaged, No. 1 test wire is disconnected from the negative pole of the battery.

The negative pole of the battery on Test wires 2 and 3 causes Marking relays 2 and 3 to commence to energise, but as soon as the armature of Marking relay 2 gets on the move it disconnects the coil circuit of Marking relay 3 and the latter does not have time to energise.

Marking relay 2 connects the positive pole of the battery to one side of connecting relays 4, 5 and 6.

It will be seen that only one connecting relay, No. 4, gets both positive and negative on its coil and accordingly energises and completes the speaking circuit from X1 to Y2 (contacts not shown).

At this stage the holding circuit of connecting relay 4 is completed through a second winding (not shown), and the starting key is released, thus de-energising the test relay and marking relay 2. The negative is at the same time removed from test wire 2 in order to make the circuit test engaged.

This *Marking Principle* is applicable to any sized group and is used extensively in the Relay system. For example, in the case of the 5 line Subs. Group shown in Fig. **4** (*a*), the Subs.' lines 1 to 3 are the X lines 1 to 3, and the links 1 to 3 are the Y lines 1 to 3, while the line relay contacts, not shown, constitute the starting keys. The marking windings of the OTC relays are inserted in the test wires at the points indicated. A second test relay serves, in a similar manner, to switch in the ITC test wires and relays for inward calls.

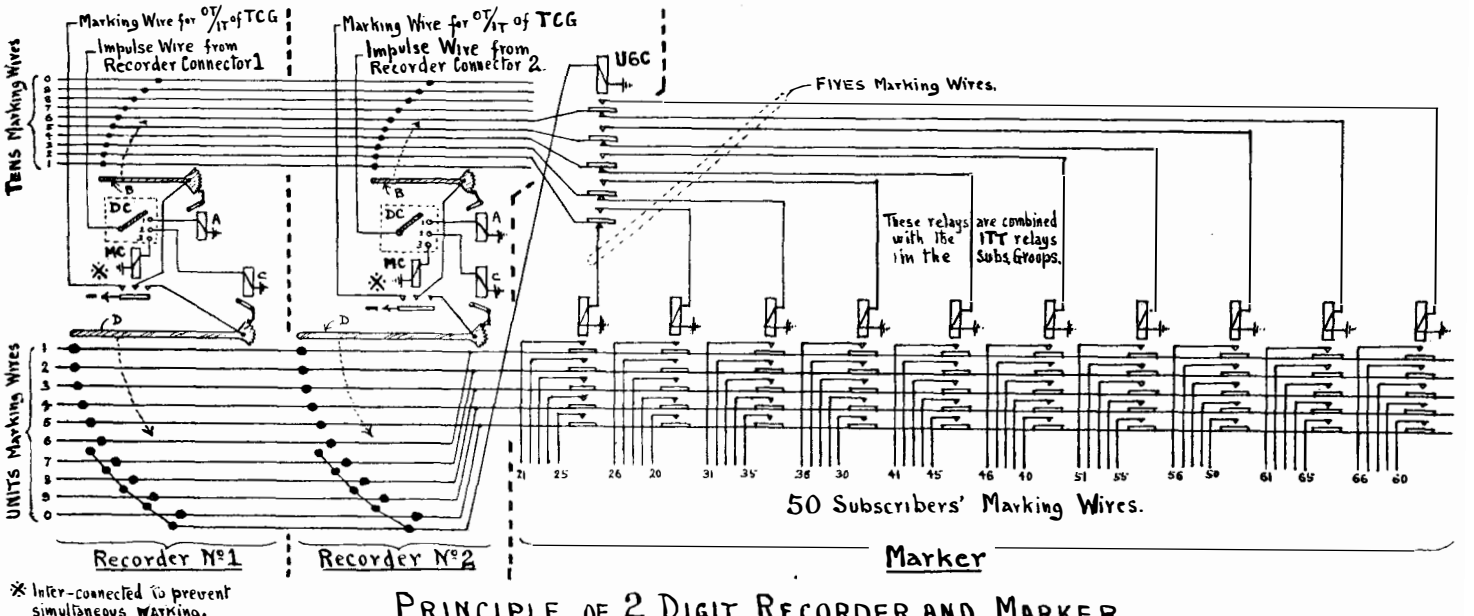
It should be noted that the searching time for connecting to the first link is the same as for connecting to the last, irrespective of the number of links.

Principle of Recorder and Marker.

Fig. **6** shows two Recorders and a Marker for 50 subscribers' lines. Switches are shown in the Recorder, instead of relays, in order to make the principle clear.

When a Calling subscriber has obtained connection with an ABF and commences to dial, impulses will be sent *via* the Recorder Connector and the Impulse Wire to the Recorder DC (Digit Control) switch which will be in pos. 1.

The Tens Impulses will actuate the counting magnet A which will step round the wiper B and thereby store the tens impulses.



PRINCIPLE OF 2 DIGIT RECORDER AND MARKER.

The Recorder Counting, Storing, and Digit Control relays are shown as switches in order to indicate their functions clearly.

FIG. 6.

When the tens impulses have ceased the DC switch moves to pos. 2.

Magnet C now counts the Units Impulses, steps round the wiper D, and thus stores the Units Impulses.

The impulses having ceased, the DC switch moves into pos. 3.

Provided that the Marker is not at that instant in engagement with another Recorder, the MC (Marking Control) relay energises and connects marking negative to a *Tens* and a *Units Marking Wire* which will result, as can be seen, in the *Called Sub.'s Marking Wire being connected to Negative*

The MC relay, at the same time, sends marking negative to energise the requisite OT/IT relay of the TCG.

These marking currents only flow for a very short time, and when the necessary connecting relays OT/IT, ITC, and LC have been energised the Recorder and Marker are released and immediately reset for another call.

It can be seen from Fig. **6** that a number of Recorders can receive impulses at the same time, and that they are arranged to wait on one another for the service of the Marker.

Sets of relays are arranged to do the work of the switches DC, AB and CD, which will be explained later.

In the case of a 3 Digit Recorder and Marker, extra storing relays are required in the Recorder for the hundreds digit, also one relay for each fifty subs. lines is added to the Marker.

The foregoing notes refer to 5 line subs. groups for P.A.X and P.A.B.X. exchanges. For Public Exchanges (excepting Village) 10 line Sub.'s Groups are used, and the Recorder and Marker are modified accordingly, although the principle remains unaltered.

Private Automatic Branch Exchanges.

The Trunking Scheme shown in Fig. **4** is employed for sizes up to about 300 lines.

When the manual board for dealing with the Public Exchange calls is located in the same building as the automatic board, extension jacks (one per line) are teed to the Sub.'s lines at the point shown in Fig. **4** (*c*). Line lamps are arranged, one per jack, and when an extension wishes to make an exchange call he dials "0"; the Recorder does not wait for other digits, but marks and lights the corresponding extension line lamp on the manual board, and in so doing releases the Out Trunk and Sub.s' Group link which were used to make the call. The call is then dealt with on the manual board in the standard way.

The Public Exchange lines terminate on the manual board, and inward calls are received by the telephonist and connected

direct to the extension jacks, without employing the automatic switchboard.

Private Automatic Branch Exchanges without local manual boards have been supplied to Administrations abroad, in which case the Public Exchange telephonist obtains the extensions by dialling over the exchange lines. The extensions call the Exchange direct by dialling "●."

[*In the foregoing, Mr. Bryant describes the principles of the Relay system with particular reference to its application to P.A.X.'s and P.A.B.X.'s; in our next issue the larger public exchanges will be dealt with.*—EDS. P.O.E.E. JOURNAL.]

PRESS VISIT TO FLEETWOOD AUTOMATIC EXCHANGE.

ON Saturday, the 28th October, Fleetwood Exchange, which was opened on the 15th July, was inspected by a body of technical press men, the guests of the Relay Automatic Telephone Company who had installed the equipment. Representatives of the following papers were present:—*Electrical Review, Engineer, Engineering Electrical Industries, Electrical Times, Electrician, Electricity, The Times, P.O. Electrical Engineers' Journal, Liverpool Courier, Fleetwood Chronicle, Blackpool Times, Blackpool Gazette and Herald, Lancashire Daily Post.* The Department was represented by Mr. J. Sinclair Terras, Assistant Superintending Engineer of the N.W. District, and Mr. W. Beattie on the engineering side, while Lieut.-Col. Warren, Postmaster of Blackpool, and Captain G. H. Cole, Postmaster of Fleetwood, attended on behalf of the local administration. Captain H. Riall Sankey, C.B., C.B.E., R.E., a director of the installing Company, F. Morley Ward, Manager, G. H. Bryant, Chief Engineer, Major Burningham White, Publicity Manager, and G. A. Hollings travelled north with the company. Lieut.-Col. C. B. Clay, Managing Director, was unable to accompany the party owing to illness.

Mr. Bryant described the lay-out of the equipment and explained the working in general terms, and afterwards the party split into groups, each under the charge of a skilled representative of the Company, who carried them through the details of the system and demonstrated how the calls are made and completed. As full descriptions of the exchange have already appeared in our columns and in a professional paper of the Institution—Vol. XV., Part 2, July, '22, and the "Relay Automatic Telephone Company's System," by Mr. H. W. Dipple—a further account of the equip-

ment is not necessary at this late stage, especially as the weekly journals represented have already described the plant very fully in their columns. It is sufficient to state that the silent and efficient working of the system, which has been remarkably free from faults since its inauguration, made a great impression upon the visitors, who were keenly alive to the intricacies of the electrical circuits, and the problems set the Company and solved satisfactorily.

Fleetwood is unique amongst automatic exchanges in this country, as manual operation is entirely dispensed with. All traffic outside is handled at Blackpool, some nine miles distant, where there is a C.B. manual exchange of the No. 10 type. To complete the inspection, the company travelled to Blackpool and through the courtesy of Lieut.-Col. Warren the party was enabled to witness the operation of the trunk traffic to and from Fleetwood.

The installing Company afterwards entertained the visitors to luncheon in the Hotel Metropole, Blackpool, Capt. Sankey occupying the chair. In replying to the toast of the Post Office, Mr. Terras stated that he would say nothing regarding the policy of the Department on the subject of automatic exchange working. He could give, however, his own opinion with regard to the results of the Fleetwood equipment. Since its opening on the 15th July, the apparatus had met all requirements in a most satisfactory manner, the public were very pleased with the system, and the number of faults had been very small. The exchange was young yet, however, and the trying conditions of a Lancashire seaside town would prove an excellent test of the ability of the equipment to stand up to its job. He apologised for the absence of the Superintending Engineer of the District, Mr. Stretche, and thanked the Company for the hospitality they had extended to himself and to the Department's officers who were closely associated with the erection and maintenance of the exchange.

AUTOMATICS IN INDIA.

PRIVATE ENTERPRISE FOLLOWS GOVERNMENT'S LEAD.

FOLLOWING the example set by the Post & Telegraph Administration of the Indian Government in installing Automatic Telephone equipment at Simla, Lahore, Amritzar, Ootacmund and Conoor, and the highly successful results obtained thereby, the Bombay Telephone Company has decided to give its subscribers the benefits of Automatic service also, and will shortly proceed with

the installation of equipment to serve a total of eleven thousand lines in the City of Bombay.

The contract for this equipment has been secured by the Automatic Telephone Manufacturing Co. Ltd., in whose Liverpool factory the whole of the apparatus will be manufactured. It is anticipated that installation will be completed and the new system ready for the cut-over early in 1924.

Bombay is particularly well adapted for the successful exploitation of an automatic system, no less than sixty-two different languages and dialects being in common use among its population of approximately one million.

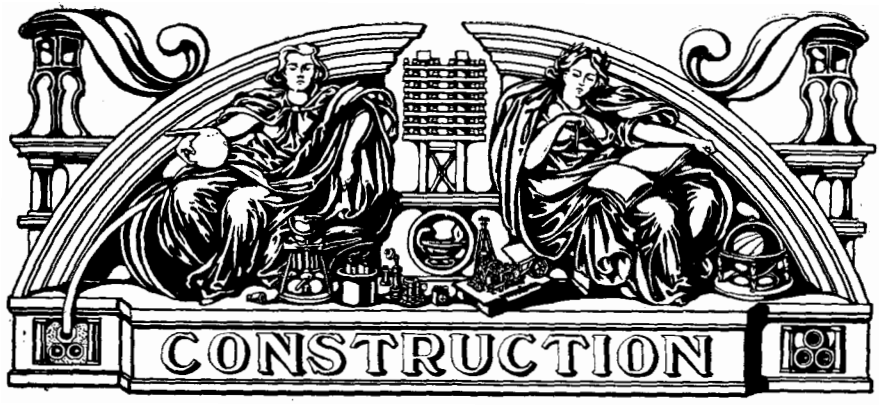
The city is built on the Southern end of Bombay Island, which is 11 miles long and 4 miles across at its widest point. The Island communicates with the larger island of Salsette by means of road and rail bridges at its Northern end. Bombay is the great cotton market of Western India, a large percentage of the population being employed in this industry. It is also the terminus of the Great Indian Peninsula and of the Bombay-Baroda & Central India Railways. The annual value of the freight trade of Bombay exceeds eighty-five million pounds sterling.

The proposed total of 11,000 line equipment will be housed in two exchanges, one, the present "Central," accommodating immediate equipment for 6,500 lines and making provision for an ultimate capacity of 15,000; the other Automatic exchange to be known as "Gell Street" will replace a temporary Manual Telephone exchange which has just been completed at the Northern end of the city and equipment will be provided there for immediate requirements on 4,500 lines and an ultimate capacity of 15,000.

The 5 digit system will be adopted for Bombay and provision made for connecting to all long distance toll lines entering the city. The scheme embraces line switches of the latest Rotary type, together with covered type Selectors and Connectors.

Considerable economies in floor space and cabling will be secured by the adoption of the "Unit" type intermediate distributing frame for the line circuits. Under this arrangement, cross-connecting frames are mounted on top of the individual units, and, whilst affording exactly the same facilities, dispense with the necessity for a separate intermediate distributing frame.

Standard Selector and Repeater trunk boards will be installed, together with power equipment designed to carry the ultimate load except for the batteries which, at the outset, will only be fitted with sufficient plates to provide ampere-hour capacity for immediate requirements.



THE LOWERING OF MULTIPLE-WAY DUCTS ON ACCOUNT OF ROAD WIDENING OPERATIONS.

By ALFRED MAGNALL,
Sectional Engineer, Manchester.

[*In our last issue a method of lowering ducts along old Watling Street, between Gravesend and Strood, where they were exposed on one side was described; the following article gives an account of the methods adopted on the Manchester-Liverpool road where the ducts and pipes had to be lowered vertically.*—EDS. P.O.E.E. JOURNAL.]

The roads at the present time are being used to a greater extent than in the period just prior to the introduction of railways; indeed, the enormous increase in motor traction has made it imperative to improve the main arteries of communication.

Work on the improvement of roadways has been taken in hand energetically in order to afford some measure of relief to the very serious unemployment problems which are facing the country. In connection with these operations many cases have arisen where the road levels have been re-arranged, and it has, therefore, been necessary either to divert main cable routes or to lower them in situ. In these days of balanced and loaded cables, however, the diversion of a cable route presents formidable difficulties since the re-balancing of a complete loading coil section would be involved; and it is believed that the readers of the *Journal* will be interested in the details of a method of lowering which was recently adopted on the widened roads between Manchester and Liverpool.

The work was carried out under particularly difficult conditions due to the unstable nature of the ground, its water-logged character

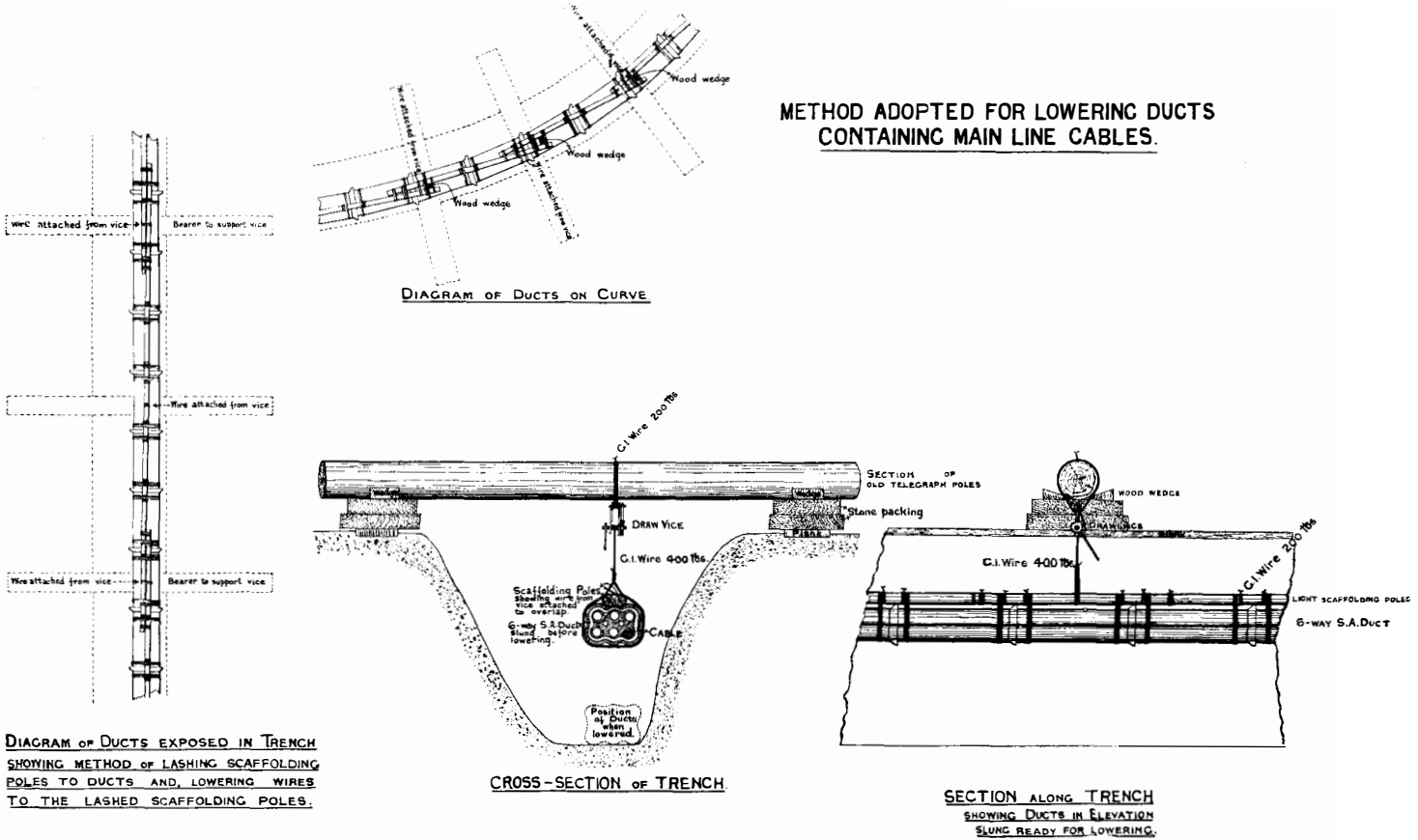

METHOD ADOPTED FOR LOWERING DUCTS
CONTAINING MAIN LINE CABLES.
Wood wedge
Wood wedge
Wood wedge
DIAGRAM OF DUCTS ON CURVE
Wire attached from vice
Bearer to support vice
Wire attached from vice
Wire attached from vice
Bearer to support vice
DIAGRAM OF DUCTS EXPOSED IN TRENCH SHOWING METHOD OF LASHING SCAFFOLDING POLES TO DUCTS AND, LOWERING WIRES TO THE LASHED SCAFFOLDING POLES.
G.I. Wire 200 lbs.
SECTION OF OLD TELEGRAPH POLES
Stone packing
DRAW VICE
G.I. Wire 400 lbs.
Scaffolding Poles attached to vice attached to overlap
6-way S.A. Duct slung before lowering.
CABLE
Position of Ducts when lowered.
CROSS-SECTION OF TRENCH
WOOD WEDGE
DRAW VICE
G.I. Wire 400 lbs.
G.I. Wire 200 lbs.
LIGHT SCAFFOLDING POLES
6-WAY S.A. DUCT
SECTION ALONG TRENCH SHOWING DUCTS IN ELEVATION SLUNG READY FOR LOWERING.

FIG. **1.**

and the heavy traffic which it normally carries. To add to the difficulties, continuous rain was encountered, but even with these adverse circumstances the lowering of the multiple ducts proved to be economical and practical, the cost of the operations amounting to little more than 30% of that involved in providing a new track.

The plant affected consisted of a 6-way duct and three 3″ C.I. pipes, the pipes being uppermost, and to one side of the ducts, except at the manholes, where the pipes entered directly above the ducts. The section of route to be lowered measured about 250 yards, and carried four main line cables. The problem to be solved was to drop the ducts about two feet.

FIG. 2. TIMBER BAULKS ACROSS TRENCH SHOWING PACKING UNDER ENDS TO OBTAIN HEADROOM.

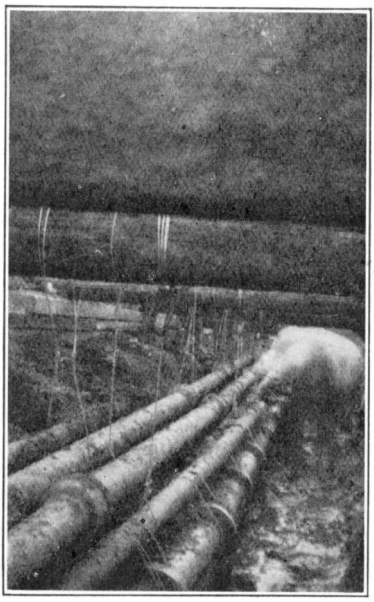


FIG. 3. DUCT LINE EXPOSED, SCAFFOLD POLES AND SUSPENDING GEAR IN POSITION.

The ground was first of all opened, and the ducts exposed on the top and on one side; the other side could not be exposed owing to the position of the C.I. pipes, and a large gas main. The width of the trench was made sufficient to allow working room for the subsequent deepening and removal of the soil from beneath the ducts.

Light scaffold poles from 2½″ to 3″ diameter and 18′ to 20′ long (hired locally) were placed along the top of the ducts so that the ends of adjacent poles overlapped two duct joints, the poles being bound together near the ends by a few turns of 200 lb. G.I. wire.

Short scaffold poles, 8′ to 10′ long, were used on curves and bound together in a similar manner, the overlap in this case necessarily covering one duct joint only owing to the curvature of the duct line.

The scaffold poles were then lashed to the ducts, two lashings of three turns of 200 lb. G.I. wire being placed at each duct socket, one on each side of every socket.

Timber baulks consisting of 10′ lengths of old telegraph poles were then placed across the trench, being spaced about 7′ 6″ apart on straight sections, and 5′ 0″ apart on curved sections. Owing to the very sandy and treacherous character of the surface soil, 9″ ×

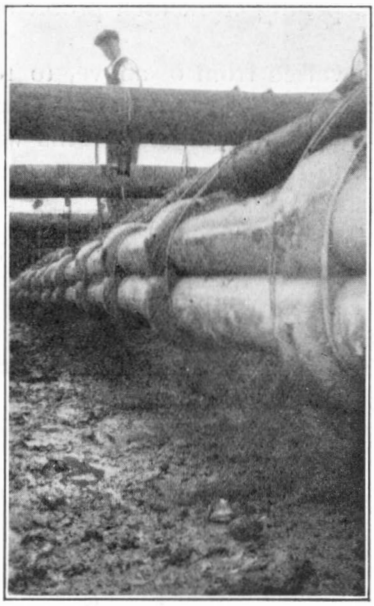


FIG. 4. DUCTS SUSPENDED AND TRENCH DEEPENED ALONGSIDE AND UNDER DUCTS ON STRAIGHT SECTION.

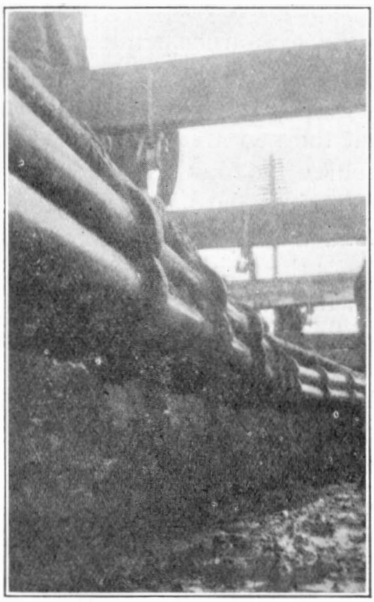


FIG. 5. DUCTS SUSPENDED ON CURVED SECTION. PLANKS ON EDGE USED FOR CROSS-TIMBERS INSTEAD OF OLD POLES.

3″ planks, 4′ to 6′ long, were placed under the ends of the baulks on either side of the trench so as to distribute the weight as much as possible, and thus to avoid the risk of the trench falling in; where they rested on the planks the baulks were packed up at each end with pieces of stone flag, which fortunately were available on the spot: a headroom or clearance of about 18″ was thus obtained between the top of the ducts and the lower side of the baulks, this space being required for fixing and operating the suspending and lowering mechanism described later.

At points directly over the centre of the duct line, Draw Vices No. 2 were fixed to each baulk by a lashing of four turns of 200 lb. G.I. wire, a length of 400 lb. G.I. wire being fixed on the vice drum in readiness, the free end of the 400 lb. wire being made off by taking two turns around the scaffold poles. This 400 lb. wire was used for suspending the ducts during trench deepening operations, and for the subsequent lowering of the ducts into their final positions. When 20 vices had been placed in position—covering a length of approximately 50 yards of duct line—just sufficient tension was applied by vice keys at each suspension to take the weight of the ducts.

The 3 C.I. pipes at the side having been secured to each baulk by ropes of G.I. wire, the trench deepening work then proceeded in the section suspended.

As the level of the new roadway varied from 6″ above, to 10″ below, the old level, special arrangements were necessary to ensure that the new trench was deepened the correct amount. This was ensured by fixing wood stakes close to the trench to indicate the levels at 50 yard intervals, the requisite data being supplied by the Road Surveyor. At these points "sight boards" were erected across the trench at a height of 2′ 0″ above the new roadway level, and the correct depth of trench obtained by the use of a "boning rod" of the requisite length and "sighting" along the top of two adjacent "sight boards." When the deepened trench was completed, with the requisite depressions excavated in the trench bottom at the points where the duct sockets would rest, the brickwork around and below the ducts was removed in the manhole selected as the starting point. This operation completed the preparatory work prior to the actual duct lowering in the prepared section.

Lowering was carried out by placing a man with a vice key at each of the 20 points suspended. These points were numbered 1 to 20, starting from the manhole end. At a given signal all the men lowered their draw vice ratchets one tooth. At the second signal vices Nos. 1 to 19 were lowered a second tooth; at the third signal Nos. 1 to 18 were dropped a third tooth; and so on, one vice less being lowered at every signal.

On completion of the first cycle of lowering operations it was repeated, if necessary, until draw vices Nos. 1, 2, 3 & 4 were out of action owing to the ducts having reached their ultimate position on the bottom of the trench at the four points. The 4 spare vices were then transferred to positions Nos. 21, 22, 23 and 24, and the same cycle of deepening and lowering operations was repeated until the 180 yard section between the manholes was completed.

Filling-in and the preparation of a suitable bed for the 3 C.I.

pipes on top and at the side of the ducts was then proceeded with, the pipes being lowered in sections by hand into their final position. The timber baulks and all gear were then cleared and the filling-in completed.

The remaining 70 yard section on one side of the manhole was lowered in an exactly similar manner to the main section.

The reconstruction of the manholes to suit the altered conditions was then put in hand and in this connection it may be mentioned that the only case of damage to the ducts occurred at the manhole ends, this being due to the removal of the brickwork around the ducts and the cohesion of the duct to the brickwork where it was

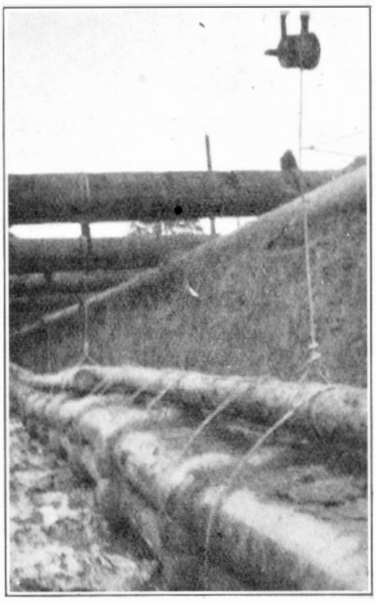


FIG. 6. DUCTS LOWERED INTO FINAL POSITION. C.I. PIPES ON RIGHT IN ORIGINAL POSITION.

FIG. 7. CONDITIONS UNDER WHICH 75% OF WORK CARRIED OUT. RAIN AND DRAINAGE WATER ACCUMULATED IN TRENCH.

built in with cement mortar. The damage was made good by trimming off the broken edge of duct and recessing the new manhole wall to accommodate the shortened duct.

Fig. **1** shows the position of the scaffold poles, and details of the various lashings and suspending gear. The C.I. pipes have been omitted as these are clearly to be seen in the photographs.

The whole of these operations were accomplished without damage either to the ducts or to the cables. The difficulties encountered were accentuated by wretched weather conditions

which persisted throughout the whole time the work was in progress, which, with the soft and yielding nature of the sandy surface soil with a subsoil of stiff clay, and the configuration of the adjoining land, resulted in the trench work being water-logged practically the whole time. This, added to the absence of surface water drains, etc., which were out of commission in consequence of the road widening work, had the effect of converting the trench into an open drain and rendered necessary the use of four Floodgate pumps to keep the trench moderately clear.

A GAS EXPLOSION.

By J. Cleaver, A.M.I.E.E.,
South Lancashire District.

At 8.30 a.m. on July 8th last, a gas explosion of exceptional violence occurred in a newly constructed duct route in Wellington Road South, Stockport.

A 7-way duct line in the usual formation, *i.e.*, 3 ways over 4 ways, had recently been laid under the carriageway in connection

Fig. 1. Roadway above Manhole Roof.

with the Manchester-Birmingham balanced and loaded cable now in course of construction. The jointing chambers in this Section of the route are Manholes C.F.6, of internal dimensions 7′ 0″ × 4′ 0″ × 6′ 0″.

On the date in question the cable contractor's workmen were engaged at the north end of Wellington Road South. They had opened the two first manholes of the section for drawing-in pur-

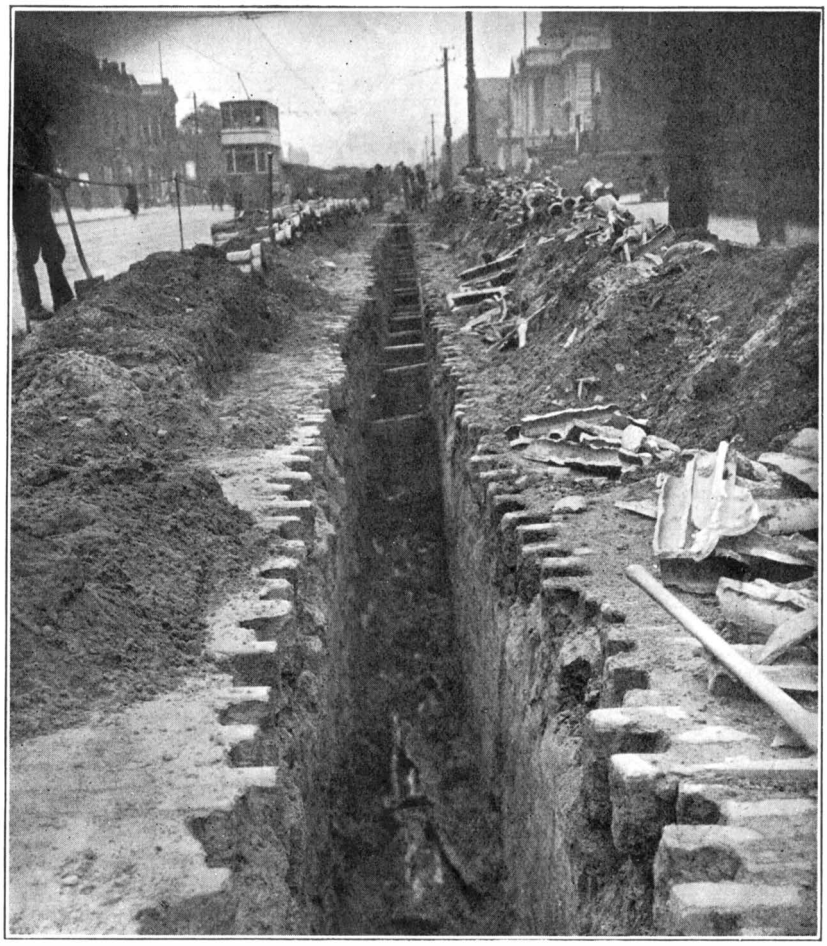


FIG. 2. CONDITION OF DUCT LINE AFTER EXPLOSION.

poses, and, a strong smell of coal gas being observed, they also removed the cover of the third manhole, and were proceeding with their preliminary operations when the explosion occurred.

It is evident that a large volume of gas had accumulated in the fourth manhole of the affected section, at which point the centre of

the explosion was located, but this manhole was closed until the moment of the occurrence.

The effects of the explosion were startling. The cover of the fourth manhole was thrown high into the air, and the concrete roof slab, which, together with the overlying road material, weighed probably about 2 tons, was displaced bodily. (Fig. **1**). The "set" paving around the manhole was entirely broken up for some feet in all directions. The 14" brick walls of the manhole were badly split and bulged, and the duct ends were smashed. At a first inspection this appeared to be the extent of the damage, but on testing the ducts it became evident that these also had suffered. The duct trench was, therefore, re-opened, and it was found that for about 160 yards in both directions, as far, in fact, as the adjacent manholes, the lines was entirely wrecked. The ducts were dug out and as each was uncovered and lifted it fell to pieces. Throughout the 320 yards of the two lengths scarcely a single unbroken duct was found. Fig. **2** gives a good idea of the condition of the duct line. The fourth manhole had, of course, to be entirely rebuilt.

In view of the violence of the explosion, and of the fact that it occurred in the daytime in one of the busiest streets in Stockport, it must be accounted more than fortunate that no one was actually injured. One passer-by complained of shock to the system, and considerable alarm was caused in the surrounding area.

TELEGRAPH AND TELEPHONE PLANT IN THE UNITED KINGDOM.

MILEAGES AND TELEPHONE STATIONS FOR EACH ENGINEERING DISTRICT AS AT 30TH SEPTEMBER, 1922.

Telephone Stations.	Overhead Wires: Mileages.				Engineering District.	Underground Wires: Mileages.				Submarine (Land miles).
	Telegraph.	Trunk.	Exchange.	Spare.		Telegraph.	Trunk.	Exchange.	Spare.	
332,625	559	2,292	52,009	327	London	17,541	18,823	1,188,423	25,165	Returns made annually.
52,575	2,058	18,684	47,716	2,023	S.E.	2,195	9,850	145,917	15,407	
43,096	4,813	20,527	36,006	1,578	S.W.	11,864	1,979	76,245	2,090	
33,906	9,344	26,047	34,065	4,056	E.	12,267	15,355	38,939	10,427	
58,605	9,399	36,772	41,126	2,825	N. Mid.	8,464	14,005	96,001	62,811	
46,841	5,326	24,791	46,393	4,386	S. Mid.	6,682	8,245	117,858	82,402	
39,718	5,454	24,769	36,391	2,749	S. Wales	5,112	10,377	62,875	17,517	
56,672	9,019	21,606	36,014	5,321	N. Wales	11,448	17,453	97,135	9,604	
99,836	3,103	16,223	45,275	3,253	S. Lancs.	10,161	38,226	236,312	22,126	
49,875	6,530	24,715	35,013	2,257	N.E.	5,459	13,437	106,304	22,409	
50,674	4,315	26,364	40,230	2,688	N.W.	9,079	16,006	100,728	14,043	
31,989	3,007	14,149	21,611	2,122	N.	2,540	5,042	51,861	5,750	
13,921	5,547	5,593	10,151	221	Ireland	120	57	27,060	235	
41,792	5,926	19,353	28,650	1,612	Scot. E.	1,404	5,065	75,183	3,336	
63,796	7,338	22,248	39,799	308	Scot. W.	11,417	13,008	169,114	18,718	
1,015,921	81,738	304,133	550,449	35,726	Total.	115,753	186,928	2,589,955	312,040	
995,483	82,399	301,535	546,440	35,652	Figures on 30th June, 1922.	114,993	181,521	2,580,547	317,119	

BROADCASTING.

E. H. SHAUGHNESSY, O.B.E., M.I.E.E.

BELOW are printed the conditions which Broadcast receivers should fulfil to obtain the Postmaster General's approval and registration. It will be seen that there are some departures from the earlier proposals, these departures being in the direction of extending the facilities offered to holders of Broadcast Receiving licenses whilst restricting the possibility of the receiving sets causing intolerable interference with each other.

It is well known that there is difficulty in using high frequency multi-valve amplifiers on low waves without the amplifier self oscillating, even without the use of any designed reaction, and it will be seen that although the unit system is permitted to some extent, no combination allowing the addition of an indeterminate number of high frequency amplifying units to a set is permissible. Each unit containing any high frequency amplification or any tuner must also contain the rectifier. Even under these conditions it has been found that sets embodying high frequency amplifiers when put on the Test aerials have oscillated and thrown good signals across a distance of about 100 feet to another aerial. Such sets have not been approved, but the makers by altering the design have been able to prevent this.

It will also be observed that there is no restriction on the wave-length range over which Broadcast Receivers may be used, and under clause 6 of the conditions it will be possible to use reaction on a valve beyond that attached to the aerial and cause local oscillations to be set up round that valve, thus making it possible to receive continuous wave signals on an approved Broadcast receiver. Where such arrangements of reaction on to the anode of

the first valve have been provided the sets have been tested for radiation between two aerials about 100 feet apart, and whilst some have given no trace of aerial radiation others have been distinctly disturbing and some quite as bad as a single valve receiving set with reaction direct on to the aerial tuning coil. The results obtained have all been checked by changing over the instruments on to the two aerials used and by comparison with an auto-heterodyne receiving set.

Up to the end of November, about 700 different instruments had been submitted for testing and a large number of these had been approved as satisfactory. It should be noted that the approval only implies that the sets cover the broadcast range of wave-length (350 to 425 metres) on a 30 ft. and on a 100 ft. aerial, and that the sets will not cause interference. The approval does not carry any guarantee of quality, etc., and one may readily see from the numerous types on the market that there is no attempt at standardisation of either design or quality.

The British Broadcasting Co. has not been definitely formed, when this is being written, but Broadcasting transmissions in the name of the Company are being regularly maintained each evening in the following places: London (Marconi Co. Station, 369 metres), Birmingham (Western Electric Co. Station, 425 metres), and Manchester (Metropolitan Vickers Station, 385 metres).

CONDITIONS WHICH BROADCAST RECEIVERS SHOULD FULFIL TO OBTAIN POST OFFICE APPROVAL.

1. That all types of Broadcast Receivers may be constructed for the reception of signals of any wave-length.

2. That the apparatus shall be so constructed that it is difficult to change the arrangement of the circuits embodied in the design by means of external connections.

3. The following units, each of which must consist of apparatus assembled, connected and mounted in a single container, shall be approved:

a. Combined Tuner and Rectifier.

b. Combined Tuner, High Frequency Amplifier and Rectifier.

c. Audio Frequency Amplifier (of Valve or other type),

d. Tuner, Rectifier and Audio Frequency Amplifiers.

e. Tuner, High Frequency Amplifiers, Rectifier and Audio Frequency Amplifiers.

In particular, it is intended that each panel must contain all the High Frequency Circuits and the High Frequency Amplifiers in association with the Rectifier, but there is no limit to the number of High Frequency or Audio Frequency Amplifiers that may be included in any unit or set provided the other conditions set forth herein are complied with. Audio Frequency Amplifiers may be added in single, double or multiple units to (*a*) and (*b*).

4. No receiving apparatus for general broadcast purposes shall contain a valve or valves so connected as to be capable of causing the aerial to oscillate.

5. Where reaction is used on to the first receiving circuit it must not be adjustable but must be fixed and incapable of causing oscillation.

6. Where reaction is used between a second or subsequent valve on to the anode circuit of a valve connected to the aerial, either directly or inductively, and no specific coupling tending to produce oscillations in the aerial is provided between the first receiving circuit and the first anode circuit, the reaction may be adjustable.

7. Tests of sets will be made on two aerials, one 30 feet long and the other 100 feet long. On these aerials the sets should be capable of receiving on wave-lengths covered by the "Broadcast" band, viz., 350 to 425 metres.

8. The sets will be tested for the production of oscillations in the aerial, and for interference properties with a factor of safety, *i.e.*, increasing the high tension battery by about 30%, changing valves, etc., but not by altering any soldered connections.

9. The Postmaster-General must be satisfied that sets containing reaction can be reasonably repeated with consistent conditions.

10. After approval, the type will be given a Post Office Registered Number and makers must see that the sets fulfil the non-interfering conditions before they are sold. All sets sold for use under the Broadcast Receiving licence shall bear the registered trade mark of the British Broadcasting Company and the Post Office Registered Number.

11. The unit or set approved as the pattern instrument of a type shall be retained without alteration by the maker. The Postmaster-General shall have the right at any time to select any set of an approved type for test to see that the set is reasonably similar to the approved pattern. In the case of sets of an approved type employing reaction being found to oscillate the aerial, the Post Office may cancel the authorisation of the future sale of that type. No change

in the design of any set or unit may be made after approval without the previous sanction of the Postmaster-General.

Note.—The approval of the Postmaster-General does not carry any implied guarantee of the quality, workmanship or sensitivity of the apparatus.

Firms desiring to submit Sets for approval and registration should send a sample set of each type, together with relative wiring diagrams, to the Engineer-in-Chief, Wireless Section, General Post Office West, London, E.C.1. After tests the firms will be notified of the result and advised that the sets are ready for collection.

WIRE: WIRED WIRELESS: AND WIRELESS.

THE majority of the students attending telegraph and telephone classes in the various technical institutes of the country are members of the Department's staff, and an account of the recent activity of one of these institutes may not be thought out of place in this Journal.

It is the practice at the Polytechnic, Regent Street, London, to set apart one evening in each session for a lecture by an eminent authority on some phase of communication engineering. Last session, Mr. F. Gill, now President of the Institution of Electrical Engineers, honoured the Poly with a lecture on the Western Electric Co.'s "Panel" Telephone Switching System, and an exhibition of instructional cinematograph films. This session, or more precisely on the 3rd November last, the institute had the good fortune to secure Mr. E. H. Shaughnessy, O.B.E., M.I.E.E., M.I.R.E., head of the Engineer-in-Chief's Wireless Section, as lecturer, and Mr. F. J. Brown, C.B., C.B.E., M.A., B.Sc. (Lond.), an Assistant Secretary of the G.P.O., as chairman. The Fyvie Hall was crowded—indeed had the hall been three times as large it could easily have been filled. Mr. Shaughnessy's subject was, "Recent developments in Radio Telegraphy and Telephony," and his resumé of recent progress and masterly exposition of the wireless station at Leafield were enjoyed by all. Having in view the prominence which "broadcasting" has recently attained, Mr. Shaughnessy thought it fitting that the lecture should terminate with a demonstration of broadcasting, and, thanks to the co-operation of the staffs of the Post Office and Marconi Coy., the Polytechnic was able to provide a demonstration worthy of the occasion, and, so far as the writer is aware, one not hitherto attempted in this country.

For over a year an extra trunk circuit has been in use between

London and Bristol, made up, in the underground cables of the cities, of ordinary physical circuits and, between the cities, of a circuit superimposed on one of the pairs of the all-aerial route. The superimposed, or "wired wireless," circuit is obtained by using a current of 23,000 frequency to carry speech from Bristol to London, and one of 16,000 frequency to carry that in the reverse direction. [A description of this system was given in a paper contributed to the Institution of Post Office Electrical Engineers by Messrs. C. A. Taylor and R. Bradfield on the 8th March last.] It seemed feasible, therefore, that the demonstration could be one of telephony transmitted from Bristol to the Polytechnic by wire, wired wireless, and wireless in series. The interest and co-operation of Mr. Eldridge and his staff at Bristol, and of the Marconi Coy. in London, were enlisted. A preliminary trial proving successful, Mr. Eldridge approached the Lord Mayor of Bristol and obtained his Lordship's promise to participate in the demonstration by giving an address of ten minutes duration from the Council House, Bristol. The address was a brief, though intensely interesting account of the history of Bristol City, from the seizure of the British camp on Clifton Hill by the Romans to the founding of the Bristol University. The following extract from His Lordship's address will be of interest to all in the Telephone profession:—

"Forty-five years ago, when I was a young man, I had the honour of explaining the telephone to the citizens of Bristol, with my friend Graham Bell. Later on, I took part in some experiments made in Montreal, using the telephone as a means of locating the presence of a bullet in a wounded man. These experiments were eminently successful, but of course were immediately replaced by the Rontgen discovery. . . "

Every word of the address was heard in the receivers at the Polytechnic (280 pairs had been provided). The speech was not only received at the Polytechnic, however, but by all "listeners-in" having wireless apparatus within range of the 1½ K.W. transmission from Marconi House, provided, of course, that their apparatus was tuned to the 360 metre wave radiated on this occasion. A report has reached the writer that a wireless amateur in Newport received the whole of the Lord Mayor of Bristol's speech, also the concert broadcasted from Marconi House later. The volume obtained with a four valve set was such that he could hear fairly well with the receivers on the table. It is believed that the speech was heard also at a station in the south of Italy.

The Lord Mayor of Bristol was introduced to the unseen wireless audience by Sir William Noble, chairman of the committee responsible for the formation of the British Broadcasting Coy.

Sir William's speech came through with great clarity, his pleasing and characteristic Scottish accent being quite plainly distinguishable.

The next item in the demonstration was a broadcasted address by Alderman E. C. Moore, Lord Mayor Elect of London. The address was delivered before a transmitter in the aldermen's chamber of the Guildhall. The transmitter—which by the way was the same as that used by H.R.H. the Prince of Wales at St. James' Palace to speak by wireless to Boy Scouts—was connected by wire to Marconi House, where it was brought into modulative relationship with the main oscillator. In a remarkably clear speech he expressed the hope that his year of office would be marked by an improvement in trade and a reduction in unemployment—a hope in which we all heartily join.

Major T. Worswick, the Director of Education at the Polytechnic, then broadcasted an able and clear address of thanks and the first wireless concert contributed by Polytechnic artistes followed.

Grateful acknowledgement is here given to all who contributed to make the demonstration possible—amongst whom were:—

Mr. F. J. Brown, Assistant Secretary, and Mr. J. W. Wissenden, of the Secretary's Office.

Major T. F. Purves, Engineer-in-Chief, Messrs. E. H. Shaughnessy, J. R. Gall, M. Ramsay, H. Wilson, B. S. Cohen, W. J. Bailey, A. B. Hart, C. H. Chapman, I. H. Jenkins, C. A. Taylor, G. M. Maddock, F. Reid, A. Fraser, J. H. Bell, A. J. Aldridge, F. E. Nancarrow, H. Faulkner, and Miss T. Clements, of the Engineer-in-Chief's Office.

Mr. R. McIlroy, Superintending Engineer, and Messrs. G. F. Greenham, P. T. Wood, C. E. Tattersall, R. Wilson, P. J. Ridd, R. A. Wells, C. W. Phillips, E. H. Milne, W. A. Stradling, C. W. Messenger, G. Smith, G. P. Milton, G. F. Greenwood, F. E. Tetlow, C. P. Searle, H. Hill, G. A. Ward, H. Trussler, F. J. W. Lidstone, of the London Engineering District.

Mr. E. J. Eldridge, Superintending Engineer, and Messrs. A. E. Chapman, E. A. Pink, E. E. Aickin, A. Rattue, W. E. Walton, and A. E. Hayward, of the South-Western Engineering District.

J.W.T.

[*To Mr. J. W. Turner, Head of the Telegraph and Telephone Section of the Regent Street Polytechnic, is due the credit of organising this demonstration. He, further, on the same evening, gave two lectures to appreciative audiences in North London and successfully associated with each lecture a demonstration similar to that provided at the Polytechnic.*—EDS. P.O.E.E. JOURNAL.]

RADIATION FROM AERIAL TUNING INDUCTANCES.

THE use of frame aerials for transmission and reception is well known, and the radiation properties of square frames have been fully investigated by Dellinger. It may, however, be of some interest to give the following simple observations on the radiation from the aerial tuning coils at Stonehaven and Northolt. At Stonehaven a tuning inductance circular coil, axis vertical, 36 turns and diameter 18¼ inches, when excited with 35 amperes of high frequency current—the aerial circuit being completely disconnected—produced good signals 14 miles away. At Northolt a circular tuning coil, axis vertical, 42 turns and diameter of 6 feet, when excited with a high frequency current of 36 amperes, the aerial circuit being completely disconnected, produced signals at a distance of 10 miles loud enough to be heard all over the room.

ALLOY STEELS FOR PERMANENT MAGNETS.

By F. O. BARRALET, A.M.I.E.E., M.Inst.Mets., and W. G. RADLEY, B.Sc.

THE permanent magnet has for centuries been a subject for speculation by scientific men; its unique properties have suggested that here we have a manifestation of the forces concerned in the constitution of matter which, if explained, would give some indication of the ultimate nature of material substances.

It is not only as a subject of purely scientific research, however, that the permanent magnet has its interest, and an enormous amount of patient investigation on what may be termed the technological study of the magnet has been carried out.

In this work the production of superior magnets has been the object, and the process has involved the development of methods of testing and the thorough investigation of the magnetic properties of steel of various compositions, the study of the effects of thermal treatment and ageing.

The electrical engineer accepting as a matter of course the permanency of calibration of his moving coil measuring instruments, his electricity meters, etc., probably does not fully appreciate that this accuracy has only been attained as a result of years of laborious investigation.

In this article a short account is given of tests carried out on some of the special steels in which the magnetic properties are developed to the highest degree so far attained.

A discussion of the properties of the permanent magnet, based

on the conception of current rings arising out of the modern theory of the atom, is also included. This conception is considered very fully in a paper by Mr. S. Evershed* before the Institution of Electrical Engineers in 1920, to which reference may be made for a detailed treatment of the subject. The views on permanent magnets expressed therein have been generally adopted by the writers as forming a useful working hypothesis, which enables the predetermination of the dimensions of magnets for particular purposes to be carried out with considerable accuracy.

In general, when a permanent magnet forms part of a piece of Post Office apparatus, it is made from a steel containing from 5% to 6% of tungsten, together with about 0.6% carbon. Such tungsten steel magnets, when properly hardened and designed, give satisfactory results; but, in order that it may maintain the required magnetic field, it is often necessary to make the magnet of considerable proportions. In addition to tungsten steels use is made, especially in America, of chromium steels, which, although not quite equal to tungsten, give results considerably better than plain carbon steels. These steels were used in Germany during the war, when tungsten was unobtainable in that country.

During recent years, following the researches of Weiss and of Professor Honda, the properties of iron-cobalt-carbon alloys have been investigated, and the range of steels available for permanent magnets has been enormously increased by the introduction, by certain manufacturers, of grades of steels containing cobalt. These steels contain cobalt alloyed with iron in certain proportions in addition to other elements such as chromium, and are magnetically superior to the tungsten steels. Certain of these cobalt steels have been brought to the notice of the Post Office Research Section, which has carried out magnetic tests on these and also on samples of tungsten steel.

In order to obtain the best results from a permanent magnet, the steel must be suitably hardened. Specimens are usually submitted for test ready hardened, but in some cases the specimens have been hardened in the Research Section. In order to harden tungsten steel magnets, after slow and even heating they must be quenched in water or oil. The risks of cracking and distortion attached to this process are such that, even in the best practice, a proportion of cracked or badly deformed magnets are obtained. Certain of the cobalt steels do not require quenching in a liquid medium, and magnets of such steel and of the largest size are satisfactorily hardened after cooling in air.

The magnetic testing of magnet steels involves primarily the determination of the Hysterisis loop, with especial reference to

* *Journal I.E.E.*, Vol. 58, pp. 780—825.

that portion lying between the Remanence value of the flux and the Coercive Force.

The experimental magnetic circuit used consisted of a single straight test rod, firmly held in a double soft-iron yoke of ample proportions, and making good magnetic joints with the test rod. The minimum length of test piece required was 8". All test pieces were $\frac{3}{8}$" in diameter.

Both the Coercive Force and the Remanence depend on the previous magnetising force, and only reach a maximum after the specimen has been fully magnetised. In the case of tungsten steel magnets a magnetising force of from 500 to 700 C.G.S. units is sufficiently high to produce complete saturation, but cobalt steel magnets were found to require an initial magnetising force of at least 1,500 C.G.S. units in order to obtain the best results.

In order to apply such an intense magnetising force to the specimen, it was necessary to wind a magnetising coil on the test rod containing more than one layer of wire. Only a fraction of the total turns forming the inner layer of the coil was used to apply a negative magneto-motive-force when measuring points on the negative portion of the B/H curve. When testing hardened steels it is sufficient to calculate and allow for the magnetising ampere-turns absorbed by the Swedish iron yokes and by the junctions between test piece and yokes, as the sum of these is only a very small percentage of the total ampere-turns involved.

The flux measurements were made by means of a Sullivan Ballistic galvanometer. The galvanometer was calibrated by means of a Campbell variable mutual inductance, the secondary of which was always in the galvanometer circuit, and in series with the main search coil, wound over the middle of the test piece. The calibration was made by reversing a known current in the primary of the mutual inductance and noting the throw. With a galvanometer of high sensitivity a flux measurement could be made by reducing the magnetising current and at the same time reversing a predetermined current in the primary of the mutual inductance. The value of the mutual inductance should be such that the deflection is small, and in a direction due to the search coil; the change of induction is then obtained by adding the value corresponding to the current in the mutual inductance primary to that indicated by the deflection. This procedure is preferable to a strictly null method, because of the difference in time-constants of the mutual inductance circuit and the circuit encircling the iron. The galvanometer will always show a more or less complex kick, which is difficult to interpret. Since the search coil has an area somewhat greater than that of the test rod, the observed change in induction density is too great. The correction to be subtracted

is $\frac{a-A}{A}\{H_1 - H_2\}$, where a is the area of the search coil, and A the cross section of the specimen.

In the test the specimen was first subjected to the maximum magnetising force chosen for the tip of the loop, and the cyclic state established. The magnetising force was then reversed and at the same time reduced in value. The value of the induction B, corresponding to this new value of the magnetising force H, was the maximum induction minus the change of induction. The maximum induction was determined by reversing the maximum magnetising current. Every point on the demagnetisation curve was taken by a measurement starting from the point of maximum

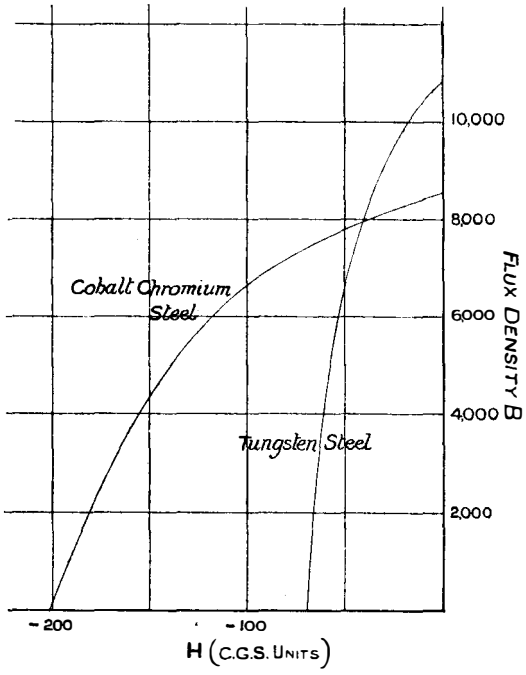


FIG. 1.

induction, so that the demagnetisation curve corresponds to conditions in which the magnet has been fully magnetised. It should be noted that the residual induction can not be obtained exactly by opening the switches, as, in that case, there are indeterminate magnetising forces acting on the test bar, due to differences in retentivity of the different parts of the magnetic circuit.

In Fig. 1 are shown the demagnetisation curves for a test bar of an iron-cobalt-chromium steel, and also for a test bar of a very good tungsten steel. Both these curves were obtained with initial magnetising forces of 1,500 C.G.S. units, but in the case of the

tungsten steel an almost equally good result was obtained after the test bar had been magnetised by a force of only 750 C.G.S. units. From these curves it will be seen that the tungsten steel had a fairly high Remanence of about 10,800 lines per sq. cm., and a Coercive Force of 70 C.G.S. units; while the cobalt steel, although with a lower Remanence of 8,550 lines per sq. cm., had a Coercive Force of slightly over 200 C.G.S. units.

In order to understand why a permanent magnet will maintain a definite amount of magnetic energy in space under certain conditions, it is first necessary to trace back this energy to its source within the magnetic material.

The only known source of what is called magnetic induction, or flux, or field is an electric current. The discovery of the electron by Sir J. J. Thomson, and the modern theory of the atom as a system of electrons moving with very high velocity in orbits round a centre or nucleus have definitely established the current ring, in some form or another, as the magnetic element in all magnetisable substances. We shall therefore imagine a piece of steel as composed of a crowd of atomic current rings, electrical circuits of no resistance, each carrying a permanent current. In the unmagnetised state these current rings are arranged, not exactly at random, but in more or less self-contained groups, so that the resultant magneto-motive force of the whole mass of current rings is zero.

Mr. S. Evershed, in his paper previously referred to, makes the assumption that each current ring possesses a fixed magneto-motive force in a direction perpendicular to its plane. When these rings are partially or entirely oriented under the influence of an externally applied magnetising force, the resultant of all their individual magneto-motive forces, resolved in the direction of the field, will give to the magnetic material an additional inherent magneto-motive force. Underlying this hypothesis is the understanding that the magnetic conducting power of iron is in no way different from that of air, or empty space, and there is, therefore, strict proportionality between the flux induced in the material and the combined motive forces producing it.

Suppose now that we have a ring of steel, of length L and section A, which has been fully magnetised by means of a current in a coil wound uniformly on it. When the current in the magnetising coil is broken the steel will settle down into a condition of equilibrium, in which the flux density has its remanent value (B_{rem}). There being now no extraneous magneto-motive-force in action, the inherent magneto-motive-force in the steel will be self-absorbed in driving the remanent flux round the closed magnetic circuit.

Imagine now that we sever the steel ring at a cross section, and that the severed ends are drawn apart so as to lengthen the magnetic circuit by the addition of an air gap. Since this air gap contains no magneto-motive-force it constitutes an inert reluctance added to the circuit. The instantaneous effect of this increase in reluctance of the magnetic circuit will be to diminish the flux; and the flux will continue to fall, owing to a decrease in the degree of orientation of the current rings, resulting in a decrease of the internally generated magneto-motive-force. When a steady condition is reached the inherent magneto-motive-force will just be sufficient to maintain the new value of the flux against the increased reluctance of the circuit.

Let the final flux density be B, ϕ being the total flux in the steel.

Let H_m be the internally generated magneto-motive-force, reckoned per cm. length of the steel.

Then, if S be the reluctance of the steel ring, and s the reluctance of the air gap

$$\phi = \frac{H_m L}{S + s}$$

$$\therefore \quad H_m L = \phi\,(S + s)$$

We may divide the total generated magneto-motive-force, $H_m L$, into two parts $H_i L$ and $H_e L$; of which $H_i L$ is the magneto-motive-force required to maintain the flux inside the steel, and $H_e L$ the magneto-motive-force expended in maintaining the flux in the external reluctance, s.

Then

$$H_m L = H_i L + H_e L$$

and

$$H_i L = \phi S.$$

Since the magnetic medium inside the steel is assumed to be the universal magnetic medium of space, its reluctance will be the same as that of an air space of the same dimensions, so that

$$S = \frac{L}{A}$$

H_i then becomes numerically equal to B, and we may write as the equation of magneto-motive-force per cm. length of magnetised material—

$$H_m = B + H_e \qquad \text{.....(1)}$$

for the extended circuit.

The quantity H_e is the surplus magneto-motive-force per cm. of the magnetised steel; that is that portion of the internally generated magneto-motive-force, which, not being utilised inside the steel itself, is available for use outside.

Now suppose that, instead of severing the steel ring, we reduce it to the same final state as regards flux density, B, by means of a current in the coil wound on it. The same sequence of changes in the magnetic material ensues, and the orientation and consequent inherent magneto-motive-force in the steel will be the same as in the previous case, H_m per cm. length.

Let H, also reckoned per cm. length of the material, be the value of the uniform extraneous magneto-motive-force applied to the steel in a negative direction.

The flux in the final state is created by the difference between the inherent magneto-motive-force, H_mL, and the extraneous force, HL, so that,

$$\phi = \frac{H_mL - HL}{S}$$

$$\therefore \quad H_mL - HL = \phi S = BL.$$

$$\left(\text{since } S = \frac{L}{A}\right)$$

so that,

$$H_m = B + H \qquad \ldots\ldots(2)$$

in the case of the self-absorbed circuit.

The equations (1) and (2) refer to two different methods by which the same change of magnetic state is effected in the steel, so that the surplus magneto-motive-force H_e in the extended circuit must be numerically equal to the extraneous magneto-motive-force H applied to the self-absorbed circuit.

The positive surplus magneto-motive-force per cm. length of steel which will be available for use outside a magnet working with a given flux is therefore numerically equal to the negative extraneous magneto-motive-force, which will give the same flux density in a closed magnetic circuit; and may therefore be ascertained from the demagnetisation curve obtained from a test of a sample of the material.

Turning now from the consideration of what takes place inside the magnet to the useful effect outside, the function of a permanent magnet is, in general terms, to magnetise some piece of apparatus or to maintain magnetic energy in some particular space where it is desired to have a magnetic flux or field. To do this the magnet is in practice called upon to maintain not only the energy corresponding to the flux we intend to utilise, but also that corresponding to the leakage flux, which unavoidably extends through the surrounding space.

Let us now consider the design of the permanent magnet required in order to produce a field of strength B_o between the two soft iron pole pieces P_1 and P_2 shown in Fig. **2**. If *a* be the area

of the air gap and l its length the total magnetic energy in the air gap will be $\frac{B_o^2}{8\pi} al$ *ergs*. Neglecting the 8π, the energy in the gap may be written $B_o a\ B_o l$. But $B_o a$ is equal to ϕ, the total flux in the gap, and $B_o l$ to the magneto-motive-force, MF, or magnetic potential required to produce it. The magnetic energy in the gap is ϕ.MF., and, apart from leakage fluxes, this is the amount of energy which the magnet will be called upon to maintain. The useful energy output of the permanent magnet is then ϕ.MF, and the magnet must deliver this energy to the pole pieces in the form of a flux ϕ, at a magnetic potential difference MF.

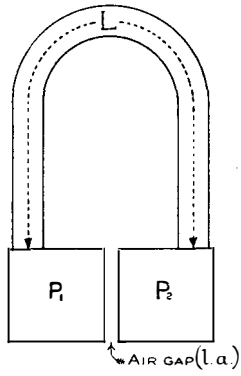


FIG. 2.

Neglecting for the moment the leakage flux passing from one limb to the other, let the flux density in the steel be uniform and equal to B. We have seen that the surplus magneto-motive-force available per cm. length of the magnet is numerically equal to the negative force H, corresponding with the flux density B on the demagnetisation curve. Denoting the length and sectional area of the magnet core by L and A respectively, the total available magneto-motive-force is HL, and the flux BA.

The equations connecting the dimensions of the magnet with the required magnetic energy will be—

$$\phi = BA \quad \ldots\ldots(3)$$

$$MF = HL \quad \ldots\ldots(4)$$

Multiplying these two equations together we get as the Energy Equation for the permanent magnet—

$$\phi.MF = BH.\ AL. \quad \ldots\ldots(5)$$

The product BH is the available, or useful, energy per cubic centimetre of magnetized steel. From inspection of the equation (5) it is evident that, if our object is to use the smallest volume of steel which will provide the given energy requirement, the flux

density must be so chosen as to give BH the maximum possible value. That such a maximum exists is obvious from the shape of the demagnetisation curve; and the economic design of the magnet involves the useful application of this maximum value of the energy content of the material.

In Fig. 3 curves are drawn showing the variation of the product BH with the working flux density B for the two test pieces for which demagnetisation curves are given in Fig. 1. From these it will be seen that, with B equal to 7,500 lines per sq. cm. and a surplus magneto-motive-force of 43.8 per cm. of magnet length, a tungsten steel magnet will give a maximum value for BH of

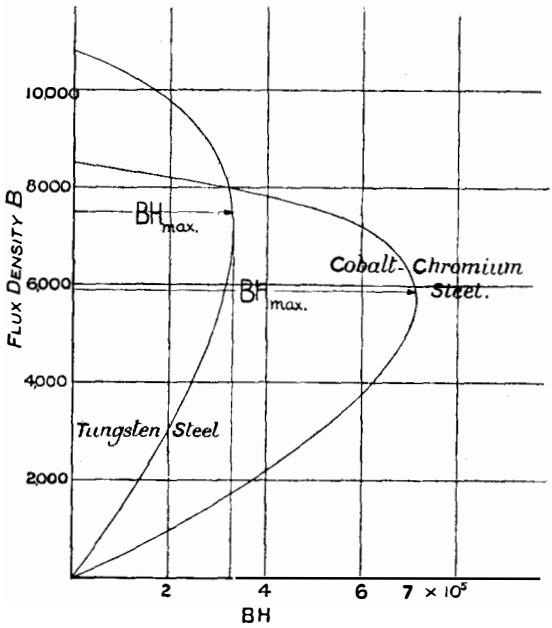


FIG. 3.

329,000 per cubic cm. For the cobalt-chromium steel BH reaches a maximum value of 715,000 per cubic cm., when B is only 5,880 lines per sq. cm., but is associated with a surplus magneto-motive-force of 123 per cm. length.

Present day practice gives to the magnet uniform sectional area. Owing to the unavoidable presence of leakage fluxes, there is a variation of flux density along the length of such a magnet, and the average value of BH must therefore fall short of $(BH)_{max.}$ The total external energy which the magnet will maintain must be obtained by integrating $\int BH\delta V$ along the length of the magnet and, of this total energy, part is wasted in the leakage paths.

With such a range of variation occurring within the magnet,

the only practical criterion of merit for magnet steel is the maximum value of the energy product, $(BH)_{max.}$ As a standard, this value has the advantage of being a precisely defined and easily measurable quantity. It is, moreover, the key to economical design, representing the best that can be done with the steel under the most favourable conditions.

Taking the values given for $(BH)_{max.}$ by the curves of Fig. **3**, we see that since the volume of magnetised steel required to maintain a given useful amount of magnetic energy will be inversely proportional to the maximum value of the available energy content per cubic cm.—

$$\frac{\text{Volume of cobalt-chromium steel magnet required}}{\text{Volume of tungsten steel magnet required}} = \frac{329000}{715000} = \frac{1}{2.18}$$

Thus a saving in weight of 54% is effected by the use of a cobalt-chromium steel magnet in place of the usual tungsten steel. From a consideration of equation (4) it is seen that, on account of the greatly increased surplus motive force of the cobalt-chromium steel, this saving in weight would be made by a reduction in length to less than $\frac{1}{3}$rd of the length of the tungsten steel magnet of the same power, the sectional area of the cobalt chromium steel magnet being slightly the greater.

We see therefore that the use of the new cobalt steels opens up great possibilities in the way of simplification of design of all apparatus employing permanent magnets. This will be due, not so much to the saving of weight, but to the great reduction of magnet length, permitting straight bars to be employed instead of the usual horse-shoe type in such apparatus as magnetos for internal combustion engines, magneto generators, etc.

One firm is now developing an iron-cobalt steel, believed to contain 35% cobalt, for which it is claimed that values of B_{rem} as high as 10,●●0 to 1●,500, together with an H_c of from 200 to 240, can be reached. Such a steel would have a value of $(BH)_{max.}$ of about 900,0●●. A special magnetising coil is being constructed by the Research Section, in order to test this and similar steels after they have been magnetised by forces of 2,000 to 2,500 C.G.S. units. This coil is to be oil immersed. Tests are also being made with cobalt-steel magnets substituted for tungsten-steel magnets in actual Post Office apparatus. The relative ageing of the new cobalt steels is also a matter which requires determining.

The new alloy steels are naturally expensive owing to the high price of cobalt, but, on the other hand, a much smaller amount of the metal is required, and the higher surplus magneto-motive-force with which they work permits in many cases such simplification of design of apparatus that there can be little doubt that there is a wide field open for their economical application.

The following quotation from a paper read by the late Prof. S. P. Thompson on "Permanent Magnets" before the Institution of Electrical Engineers in 1912, emphasises the rapid advance in the production of superior magnetic materials represented by the alloy steels which have been described:—

"The ideal sought for at the present time is a steel of such composition that when properly treated it shall have a Remanence of *800 and a Coercive force of 80. No such steel has been produced, but assuredly it is not unattainable, and with the great modern advance in metallurgical knowledge it is not beyond the bounds of hope that some day a steel may be produced with a Remanence of 1,000 and a Coercive force of 100."

THE "MEG" INSULATION TESTER.

In our April 1916 issue, Mr. J. B. Salmon described in detail the construction of the "Bridge Megger," which has been used in large numbers by the Department and is well known to our readers.

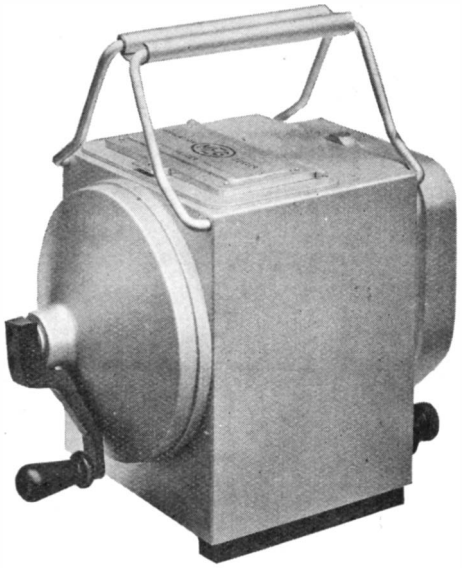


Fig. 1. Instrument Closed.

Messrs. Evershed and Vignoles, the makers of the "Megger" and its extremely useful foster-brother the "Bridge Megger," have now introduced an improved and much lighter form of instrument, which they have called the "Meg" to indicate its purpose and to certify its relationship to their original testing instrument.

The "Meg" apparatus is assembled in a cast aluminium case,

* The Remanence here referred to is the intensity of magnetisation which is equal to $\frac{B_{rem}}{4\pi}$

which is much smaller than the original and is practically water-tight. The case is fitted with a convenient carrying handle, and the weight is only 6⅜ lbs. Separate magnetic systems are used for the generator and moving coil respectively, which are mounted in the opposing ends of the case. The generator is fitted with a novel and extremely light form of free-wheel, which protects the gear from damage and prevents the armature from being turned the wrong way. The steel gears are enclosed in a separate oil-tight casing. The reluctance of the air gap and the resistance of the

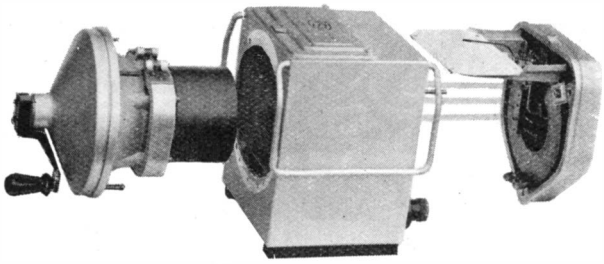


FIG. 2. EXTENDED VIEW OF PARTS.

windings are reduced by flanging the outside laminations. The magnet of the galvanometer side is designed in a circular form, which eliminates the necessity for pole pieces, and the moving coil frame is constructed from one stamping, pressed up into shape. The movement itself is mounted on spring jewels, while the provision of fixed instead of moving ligament drums saves weight, shortens the axle and increases the stiffness.

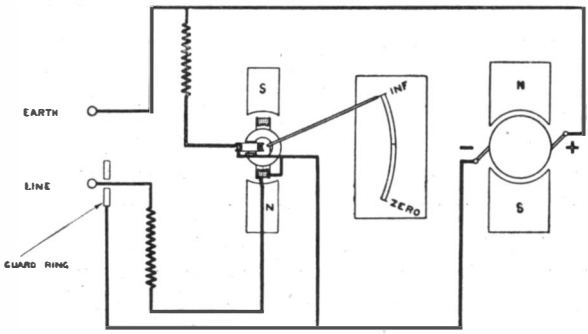


FIG. 3. CONNECTIONS OF APPARATUS.

For the present the instrument is made in one form only, the generator developing a pressure of 500 volts at 100 revs. per minute, and the ohmmeter reading from 0 to 100 megohms. A cover of canvas, fitted with a carrying leather strap for the hand or to be slung over the shoulder, is provided with the instrument. The illustrations show the apparatus and its connections. The terminals and driving handle are protected from damage by the design of the ends of the cast framework.

NOTES AND COMMENTS.

THE present year is noteworthy in electrical circles, from our point of view, because the telegraph and telephone engineer is receiving recognition in several quarters where formerly he was apt to be regarded as a person of small consequence, one who peddled in minute quantities of electricity, a watchmaker in a region of foundries and heavy machinery. It is true that outstanding men like Sir William Preece and Sir John Gavey loomed large enough to be considered worthy of comparison with prominent men engaged on the heavier side of the industry, but the tendency was undoubtedly in the direction of simply ignoring the work of those engaged in the development of signalling and electrical means of communication generally. This attitude was due no doubt in some respect to the fact that our men were the servants of a State department—ever the butt of the self-made individual who has been fortunate enough to deflect a fair amount of the national wealth and credit in his own direction—but largely, we are convinced, because in the past they were content to get on with their job and did not advertise their achievements on the housetops. The growth of the industry, the large amount of capital now sunk in plant and materials and, most of all, the close association between telephony and recent discoveries in the realms of physical science are the factors which have brought the telephone engineer more into prominence than ever he has been before. Mr. Frank Gill's presidential address to the parent Institution was just the sort of paper we were expecting from a man of his technical knowledge, fertile imagination and keen business acumen. It is gratifying to note that his appeal for an attempt to be made to improve the main European trunk routes and thereby help to

smooth the acerbities of international intercourse has not passed without some effort being attempted to carry his ideas into execution. M. Paul Laffont, the French Minister of Posts, Telegraphs and Telephones, proposes to call a conference of the countries interested to consider the question of establishing a practical system of international trunk lines on a sound commercial basis. We wish the conference every success.

We have to congratulate Messrs. F. Tremain and F. C. G. Baldwin on their appointments to the chairs of the South Western Centre and the North Eastern Centre respectively of the Institution of Electrical Engineers. The latter is at present engaged in writing a book on "The history of the telephone in England," a work which will have more than an historical interest to most telephone men. Mr. Tremain has always been full of energy and should prove an excellent chairman.

A regrettable slip crept into Colonel Booth's appeal for an International 5-Unit Telegraph Code, which appeared in our last issue. The third paragraph on Page 209 should have read "The spacing between the elements of letters is of two lengths, the second being the equivalent of a letter space; if made shorter it introduces an additional space unit intermediate between our first and second space signals. In either case . . . ." We welcome the valuable contribution to the discussion by our old friend, Mr. Donald Murray, who treats the subject in his usual trenchant style. Endowed with the spaciousness inherited from his Colonial origin, Mr. Murray is rather apt to underestimate the influence our little "sea-girt isle" has had and will have upon matters telegraphic, and few of our readers will admit that European nations have become "back numbers" on the paths of progress in this direction, even though they have been devastated, torn and stunned by a four years war.

In our last issue we stated that we hoped to be able to describe in this number the new Peel-Conner Automatic Telephone System now being installed in Dundee and Broughty Ferry. Unfortunately, the work of installation has not proceeded far enough, at the moment of writing, for this article to be available, but it will be ready, it is hoped, in time for our April edition. As will be seen from our pages elsewhere, automatic telephony is progressing in this country as fast as it is desirable to go under present economic conditions, and an elaborate programme has been drafted which we commend to the notice of the critics of the administration.

After an extraordinarily checkered career the telephone system of this country in September last reached a million stations, exclusive of the telephone stations in Ireland. An eminent millionaire is said to have made the statement that in the amassing of a fortune

the first £100 is the most difficult part of the task. In a similar way, it is perhaps not inappropriate to say that in the setting up of a telephone system the acquiring of a million stations is the most difficult part. This is perhaps more apt in the case of the telephone system than in the amassing of a fortune, as heritage may play a very important part in acquiring a fortune. There is a very important financial aspect of a million stations that is not to be overlooked. When a telephone system is small, establishment charges, supervision costs and many other overhead expenses must of necessity be comparatively high per station, but the magic number 1,000,000 is symbolical of greatness, and one expects from that achievement onwards overhead charges per station will be reduced, that practices which previously might be regarded as uneconomical may in future be placed within the realm of practical needs. The Board of Editors feel that this moment should not pass without comment in the Journal, and it is hoped that in spite of all the hindrances and difficulties following the European upheaval, trade in this country will gradually recover and that an era of coming prosperity will bring the inevitable concurrent progress of the Government telephone system and that the second million stations will be acquired in record time.

HEADQUARTERS NOTES.

EXCHANGE DEVELOPMENTS.

The following works have been completed:—

Exchange.	Type.	No. of Lines.
Aldershot	Manual C.B.	680
Gerrard Conversion ...	,,	—
Norwich Extension ...	,,	300
Penarth	,,	640
Ilford Extension	,,	620
Jesmond Extension ...	,,	160
Chorlton-cum-Hardy ...	,,	1120
Dewsbury	,,	1300
Fort Dunlop	Automatic P.B.X.	300
Edinburgh Museum ...	Manual C.B.	1400
Gt. Yarmouth Extension...	,,	220
St. Albans	,,	980
Sunderland Extension ...	,,	200
Weymouth	,,	540
Rusholme Extension ...	,,	620
Ramsgate	,,	500
Hop Extension of Incoming Junction Equipment	,,	—

Orders have been placed for new Exchanges as follows:—

Exchange.	Type.	No. of Lines.
Liverpool (Walton) ...	Manual C.B.	640
Birkenhead	,,	3640
Liverpool (Royal) ...	,,	6140
J. R. Dale & Co. ...	Automatic P.B.X.	46
Ormerod & Sons, Ltd. ...	,,	27
Pocock Bros.	,,	38
Basil Street Hotel ...	,,	110
United Kingdom Provident Institution ...	,,	31

ENGINEERING DEPARTMENT ANNUAL DINNER.

We have been asked to announce that the Engineering Department's Annual Dinner has been arranged for Friday, February 9th, at The Connaught Rooms, Great Queen Street, W.C. 2.

The Engineer-in-Chief, Major Thomas F. Purves, will preside. A cordial invitation is extended to all members of the Engineering Staff and also to any visitors who may wish to attend.

H. J. LONEY, *Hon. Sec.*

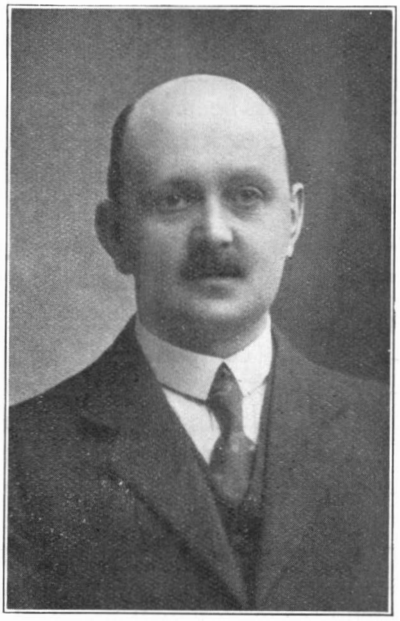
The *Electrician*, in its issue of the 8th December, heralds the inauguration of a series of competitions, accompanied by substantial money prizes, whose object is to discover and crystallise the ideas on many subjects which are floating about in a more or less detached way in the electrical profession and industry. . . . The proprietors are allocating £250 in prize money. The competitions, of which full particulars will be published in due course, will be spread over a year and will be held at about three monthly intervals. That is, there will be four different subjects in series. Eminent engineers who are experts will be asked to judge and will do their best to sort out the really good ideas.

H. P. BROWN, M.B.E., M.I.E.E.

THE many friends of Mr. H. P. Brown, Assistant Staff Engineer of the Engineer-in-Chief's Office, will be interested to learn that he has sailed for Australia on a special mission. Mr. Brown has been loaned to the Australian Government for a period of 12 months to act as adviser to the Postmaster-General on telegraph and telephone matters. He carries with him the good wishes of all his colleagues.

It is perhaps a suitable opportunity to recount the important services that have been undertaken by Mr. Brown at one time and another.

He was employed in the early days of lead-covered cables in replacing the extensive guttapercha covered underground system then in existence, and was also employed in the work of testing and accepting such cables from contractors. At a later stage he was largely responsible for the formulation of plans for main underground routes, including pioneer work in connection with the Northern underground cable from Warrington to Glasgow and the Western underground from Uxbridge to Penzance. In connection with this early work it was necessary to forecast requirements, design the cable, control the financial estimates and



Mr. H. P. Brown, M.B.E., M.I.E.E.

generally deal with the supervision of the work and the final cable tests from a Head Office point of view. This was followed by a period of experimental work on loaded cables and of investigations into the causes of cross-talk and efforts for its elimination on both loaded and unloaded cables.

Later, Mr. Brown took charge of the City, Central and Trunk Exchanges in London, being also responsible for supervising the installation of a new equipment at "Avenue."

In 1911, Mr. Brown returned to Head Office and became responsible for the maintenance of all internal telephone plant and internal construction work carried out by the Department's Staff.

In 1914, he visited India on behalf of the East India Railway

Company and acted as their adviser on telegraph, telephone and railway traffic control matters. During that visit he was called upon to report on the Calcutta Telephone Exchange system, and was also requested by the Calcutta Port Trust Authorities to submit a scheme for the control of railway goods traffic over their extensive system.

On the outbreak of war, he took over the emergency telephone arrangements for home defence purposes. This work embraced the consideration of signalling and communication facilities in co-operation with the military authorities. The matters dealt with covered anti-aircraft gun station and control equipment, Royal Air Force administration and flight station installations, air-raid observation and warning system, coast defence and anti-submarine communications, installations for all Government Departments and comprehensive telegraphic and telephonic area systems for military use in case of invasion. For this service he was awarded the honour of Membership of the Order of the British Empire.

Mr. Brown was also an active R.E. volunteer and was a member of a committee which organised the P.O. Engineers' Volunteer Corps, afterwards known as the County of London Royal Engineers. He was second in command in that Corps with the rank of Captain.

During the post-war period Mr. Brown's activities have been directed towards the carrying out of cost investigation that resulted in the introduction of revised telephone rates in this country. He also took control of the maintenance and operating group responsible for automatic exchanges. Mr. Brown has also been responsible for extensive emergency measures that have been necessary in the Engineering Department for safeguarding telephone and telegraph communication during post-war periods of industrial unrest. B.O.A.

LONDON DISTRICT NOTES.

DURING the quarter ended September 29th, 1922, 5,414 exchange lines, 3,576 internal extensions and 631 external extensions were provided; in the same period 2,156 exchage lines, 2,612 internal extensions and 447 external extensions were recovered, making nett increases of 3,258 exchange lines, 964 internal extensions and 184 external extensions.

INTERNAL CONSTRUCTION.

Telephonists' School, Clerkenwell.—This installation, which consists of twenty-four "A" positions, eight "B" positions and

one of each type of manual P.B.X. used by the Department, has been completed. Every facility is afforded to the students to become proficient in all branches of operating duties and satisfactory results are assured. The thermionic valve which was installed in the Telephonists' School at G.P.O. South, a description of which appeared in the April 1922 issue of the Journal, has been transferred to Clerkenwell.

Exchange Extensions have been completed at East, Hop and Palmers Green, and extensions are in progress at Park and Bartholomew House Exchanges.

New Exchanges of the C.B. 10 type will be commenced shortly at Wanstead, Eltham and Southall. The work in each case will be carried out by the L.E.D. Staff.

Automatic Private Branch Exchanges, to the number of twelve, are either in progress or about to be commenced.

Electrophone Exchange.—The introduction of amplifiers has resulted in a marked improvement in the hearings, and it is satisfactory to note that the number of subscribers has now reached a record, viz., 1,965.

EXTERNAL CONSTRUCTION.

During the three months ended 30th September, 1922, the following changes have occurred:—

Telegraphs.—Nett increase of 1 mile of open wire and an increase of 29 miles in underground.

Telephone Exchange.—Nett increase of 50 miles open wire, decreases of 354 miles and 3,143 miles in aerial and underground cables respectively.

Telephone Trunks.—Nett increases of 47 miles open wire and 187 miles in underground cable.

Pole Line.—Nett increase of 52 miles, making the total to date 3,168 miles.

Pipe Line.—Nett increase of 26 miles, the total to date being 4,095 miles.

The mileage of underground cable to date is 7,954 miles, being an increase of 12 miles during the period under review.

The total single wire mileages, exclusive of wires on Railways maintained by Companies, at the end of the period referred to were:—

Telegraphs	18,099
Telephone Exchange	1,240,432
Telephone Trunks	21,115
Spare wires	25,492

The apparent decrease in Telephone (Exchange) wire mileage results from the lag produced by the change of system and adjust-

ments referred to in the January and April, 1922, issues of the Journal.

The lag tends to diminish as time proceeds, but its effect will not disappear until all works commenced prior to August, 1921, have been completely cleared up.

New Tube Between C.T.O. and Liverpool Street Station.

A 2½-inch pneumatic tube has been completed between the C.T.O. and the Company's telegraph office in the Great Eastern Railway terminus. The lead street tube has been continued inside the station by means of a brass tube suspended from the foot-bridges. Opposite the main booking hall, however, the Company's own brass tube under the rails was utilized. This last length of tube was laid about 40 years ago and has been out of use for many years past. It proved to be in an excellent state of preservation, but it was found necessary to remove two faults which had developed during the last few years. The whole of the work was carried out by the Post Office staff.

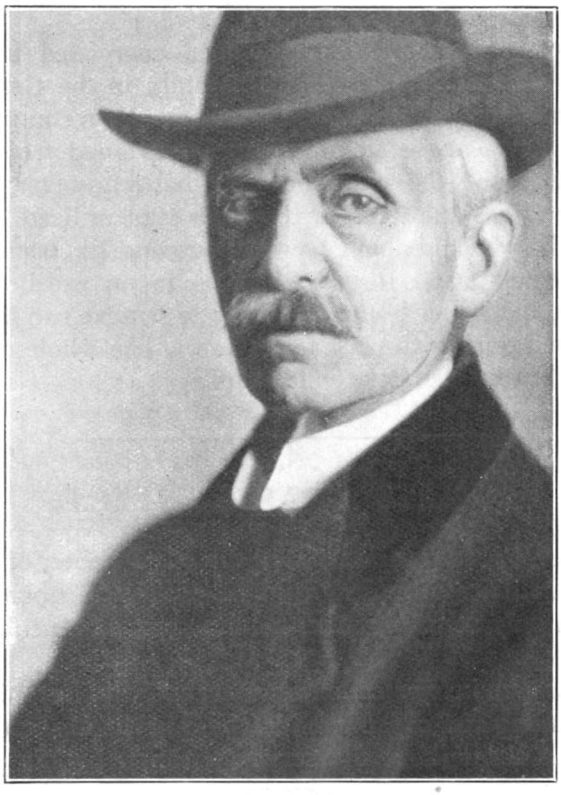
JAMES FRASER, M.I.E.E.

We regret to record the death, on the 4th October, of Mr. James Fraser, M.I.E.E., who retired from his post as Sectional Engineer at Aberdeen only some eighteen months ago, on reaching the age limit.

Jim Fraser, as he was called by everyone who knew him, was a most painstaking and capable officer, held in the highest regard by his associates throughout the service, revered by his pupils and esteemed in a wide circle as a man of sterling worth. He joined the Post Office as a telegraph messenger in Aberdeen over forty years ago, and after service as a telegraphist he was transferred to the engineering department and appointed relay clerk at Nevin. He was promoted to be a Second Class Engineer in the Central Met. District and transferred later to the Designs Section at Headquarters. He was then promoted to the rank of Executive Engineer at Sunderland, but came back again to London as Engineer in charge of the C.T.O. Section, and later returned to the Telegraph Section of the Chief's Office. About four years ago he was transferred to his native town, where he continued to reside after his retirement.

As a teacher of magnetism and electricity and telegraphy, Mr. Fraser was most successful. A triple medallist of the City and

Guilds himself, he inspired his students with the fire of his own zeal and his classes at the Northampton Institute were attended by large numbers of the C.T.O. staff. The writer well remembers the first year of the "double increment" concession when, to meet the request of the C.T.O. men, Mr. Fraser undertook a summer course to enable the telegraphists to sit special examinations in the follow-



Mr. James Fraser, M.I.E.E.

ing October. The largest lecture hall at the Northampton was placed at his disposal, but the accommodation was all too small to take the crowds that assembled. They sat on the stairs, they sat on the edges of the desks and swarmed over the demonstration table almost up to the blackboard. All through the hot summer the lecturer held his large audience silent and attentive, drawing his beautifully neat diagrams with coloured chalks and laying down the principles of the science in his serious, methodical and effective manner. His handwriting was as clear and perfect as the headings in a writing exercise book, and the notes he used to issue to the students were masterpieces of their kind. In his young

days he was fond of drawing pictures of ships under full sail and the care and skill he exercised on those objects of youthful admiration he continued to bestow on his official work right up to the end.

In 1910 Mr. Fraser was awarded the Junior Silver Medal of the I.P.O.E.E. for his paper on "The Theory and Development of Common Battery Telegraphs," and in the October, 1917, issue of the Journal he contributed an extremely valuable article on the Duplex Balance, which investigated mathematically the conditions necessary to secure a balance on long high capacity lines on both differential and bridge systems of duplex. He was chairman for a period of the North-East Scotland Section of the Institution of Electrical Engineers, and when he withdrew from active teaching work he was appointed examiner in Magnetism and Electricity for the City and Guilds of London Institute, a position he held till his death. In September, 1914, he was sent to France to supervise the termination of a cross-channel cable, and for his services he was awarded the 1914 medal, being the only civilian, it is believed, who received that honour.

In his telegraphist days Mr. Fraser was a very fine sprinter and at his own distance, anything from 100 to 200 yards, he had no equal in Scotland. He held the Scottish record for 120 yards for several years, and was well known as a competitor at the numerous Highland gatherings throughout the north. Many tales could be told of his adventures among the running "pros" of those days, of how they walked to the games, cooked the races, manipulated the prize money and ran the local parish men off their feet. It may be that the strenuousness of his life at that time—night duty in the instrument room or delivery and then down to the links for an hour or two's sprints before going to bed was his practice—affected his constitution and impaired his powers in the later years; at any rate, he succumbed suddenly to heart failure, without warning and to the deep regret of everyone that knew him. He lies buried in the beautiful cemetery of Allenvale, not far from the grave of Archibald Forbes, the celebrated war correspondent, who like Robert Louis Stephenson also expressed the desire to lie in the end "at hame among good Scots clods."

Mrs. Fraser and two daughters sorrow his loss. She was also of the telegraphs, and throughout his career took the keenest interest in his work, participated joyfully in all his triumphs and helped him to bear his disappointments. To her and her family and to his brother Andrew we express our sympathy. Tyrrell of T.S.F. spoke but the truth when he said, in the columns of the T. and T. Journal, that James Fraser was one of God's good men.

W.C.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS.

MEDALLISTS OF THE INSTITUTION.

MR. C. ROBINSON.

MR. R. M. CHAMNEY.

Senior Silver Medal for their joint papers: (*a*) "Gas Discharge Relays and their application to Commercial Circuits"; (*b*) "Developments of Telephonic Repeaters since 1917."

MR. A. B. HART.

Senior Bronze Medal for his paper on "Telephone Repeaters."

MR. G. F. ODELL.

Senior Silver Medal for his paper on "The Influence of Traffic on Automatic Exchange Design."

COUNCIL NOTES.

THE Council assembled at Shrewsbury on October 10th and 11th last, for the transaction of business, when arrangements were made for meeting the members of the North Wales Centre.

Mr. A. L. De Lattre, Chairman of the Council, congratulated the Centre on having the second largest membership of Provincial Centres and also in regard to the excellent programme arranged for the Winter Session. Mr. E. H. Shaughnessy (Treasurer) delivered an interesting lecture, entitled, "The Leafield Wireless Station," a description of which is given under North Wales Centre.

Amongst the various items of business dealt with by the Council the more important were the following:—Finance, Equipment, Lanterns, etc., for Local Centres and Printing of Papers.

In connection with the financial situation, which is now satisfactory, the Council discussed fully certain proposals for increasing the efficiency of the Institution as regards its meetings, publications and general service of a professional character.

The Secretary reported that all the Centres had been able to arrange more or less complete programmes of meetings and visits to works, etc.

In connection with the consideration of Papers recommended for printing, the Council appointed a small Selection Committee with a view to expediting the review and printing of papers and reducing the delay which had been hitherto unavoidable.

Membership.—The Secretary reported that the membership was steadily growing and the Council was gratified to note the accession of new Associate Members, although it is hoped that much larger numbers will avail themselves of the opportunity of joining the Institution in the near future.

A vacancy on the Council was created by the promotion of Mr. A. Bates, representing Chief Inspectors, Provincial, and the Secretary was instructed to take the necessary steps for the election of his successor.

T. SMERDON,
Secretary.

LOCAL CENTRE NOTES.

LONDON CENTRE NOTES.

THE Session has opened with renewed vigour like the buds in spring, the interest of the older members having been maintained and supplemented by new members, many of whom are Inspectors.

On July the 18th and 25th respectively, about 60 members,

making 120 in all, visited the Engineer-in-Chief's Research and Wireless Laboratories and workshops at Dollis Hill. The long rows of Army huts carried one's thoughts back to the war and a closer acquaintance with the interiors clearly indicated that the Officers responsible for the lay-out of the Sections had planned war on the *Unknown* in Telegraphy and Telephony.

The limited staff had a very busy two hours in explaining and demonstrating the use of the apparatus. Many of the visitors were heard to express surprise at the scope of the work it was possible to undertake, and hoped that the time would not be far distant when the staff attached to the Research and Wireless Sections would be such that the Engineering Department will not only maintain its present high position but be the pioneer of the world in discovering the secrets which have yet to be revealed.

The Relay Automatic Telephone Company invited the members of the London Centre to attend a Demonstration of their "Relay" Automatic Telephone System on Oct. the 10th, 11th and 12th respectively. About 150 members accepted the invitation.

The practical demonstrations of the working of the "Relay Public Exchanges" and "Relay P.A.X. and P.A.B.X." were preceded by a Lecture on the "General Description of the Relay System," illustrated with lantern slides.

The opportunity is here taken for the Committee to express its thanks to the Managing Director, Lieut.-Col. C. B. Clay, V.D., M.I.E.E., M.I.M.E., and to Mr. F. M. Ward and Major W. B. White and their assistants for a very instructive and pleasant visit.

On October 10th a meeting of the London Centre was held at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. This was the first occasion on which the Engineer-in-Chief, as President of the Institution, occupied the chair. Before calling upon Mr. J. S. Elston to read his paper on "Applied Telephone Transmission," the President remarked on the benefit of the Institution to the Department and promised his whole-hearted support, which was received with acclamation.

Mr. Elston's paper, which was of a highly interesting character, dealt exhaustively with the considerations which have to be borne in mind in planning extensions of line plant and the routing of Trunk and Junction circuits in order that the appropriate standard of Transmission may be secured and maintained. The subsequent discussion was opened by Mr. J. G. Hill and was continued by Messrs. Statters, Ritter, Aldridge, Trayfoot, Barnes, J. R. Hill and Hedley.

Mr. Elston replied to the various points raised and was accorded a hearty vote of thanks.

On the 12th December Mr. S. C. Bartholomew read a paper on "Corrosion of Lead-covered Cables by Electrolytic Action." The paper surveyed the work done in connection with the protection of lead cables from electrolytic action by various administrations throughout the world, and indicated ways in which the leakage of power and lighting currents had been minimised. A long discussion, opened by Mr. Barralet, followed. Mr. Bartholomew replied in his inimitable manner and received a cordial vote of thanks.

Meetings for forward dates are as follows:—

Jan. 9th, 1923. Mr. E. S. Ritter on the "Balancing of Cables."
Feb. 13th, 1923. Mr. A. J. Stubbs on "Standardisation in the Engineering Industries."
March 13th, 1923. Messrs. Cruickshank and McClarence on "Meters and Coin Boxes."

NORTH WALES DISTRICT: BIRMINGHAM EXTERNAL SECTION.

We have recently lost, by death, our senior wayleave officer, Mr. P. J. Hartley, who was transferred from the Company. Officially he was a very efficient, hardworking and successful wayleave officer, and dealt principally with the large estates and also the large property agents in Birmingham. Socially he was of a very retiring and modest disposition.

He was the author of several novels, which had a great sale in America, where they were published. The only two I had the opportunity of reading are "My Lady of Cleeve" and "Lady Diana." They are of the romantic class and provide very enjoyable reading, and I am sure that had he been more pushful in his own private interests he would have achieved good results in England. A third book was published a few months ago, but when I asked for a copy a few weeks back he had not received one from America.

It would come as a surprise to a reader of his books to know that he was *not* a ladies man, except that he worshipped his mother. Mr. Hartley was only 47 years of age, was unmarried, and lived quietly with his brother in Edgbaston.

G.W.B.

NORTH WALES CENTRE.

The Session was opened in this Centre with a visit on 10th October, 1922, from Mr. E. H. Shaughnessy, O.B.E., who delivered an address in the Borough Technical School, Shrewsbury, on "The Imperial Wireless Station at Leafield." Members of

the Shropshire Philosophical Society and the Shrewsbury and District Radio Society were present by invitation and the Council of the Institution, which was meeting in Shrewsbury, also attended. Mr. T. Plummer, Chairman of the Centre, presided.

Mr. Shaughnessy's lecture was listened to with great interest as he described the functions of the Arc and the details of the apparatus which has been installed at Leafield, Northolt, Stonehaven and other places. He gave the history of the erection of the Leafield Station since its inception, and instanced the work it is doing pending completion of other sectons of the Imperial Chain. Mention was made of such services as the Foreign Office Press, Press Transmission to America, Rome commercial service, long distance ship transmission, and the Genoa Conference service. The lecture was illustrated by lantern slides.

A wireless set had been erected in the Lecture Hall by a local amateur, and at an arranged time a message was received from the Leafield Station.

Questions were subsequently raised and replied to by the lecturer, and Mr. De Lattre expressed the pleasure of the Council in being able to be present at the inaugural meeting of the Centre.

The second meeting of the Session was held at Shrewsbury on 28th November, 1922, when Mr. J. Caradoc Jones read a paper on "Linemen's Loads," dealing with the basis on which a lineman's load is computed and the records available for guidance. Some interesting cost particulars were produced which went to show how difficult it is to arrive at a basis which will meet the varying conditions met with in different parts of the country. It was agreed however that an attempt should be made in all cases to arrive at some basis.

Mr. Jones repeated the paper at Birmingham before the members of the staffs located there, on 5th December, 1922.

A.J.W.D.

SOUTH LANCASHIRE CENTRE.

It is very satisfactory to note that the membership of the Institute has considerably increased during the past twelve months, many Inspectors having rejoined.

On October 9th the session was opened with the reading of a paper by the chairman, Mr. W. J Medlyn, on "Progress and Development in the Engineering Department." The paper was supplementary to the one read by the chairman at the opening of the previous session. Facts and figures were presented in a very interesting and helpful form. The hope was expressed that similar papers might be read by the chairman annually.

The second meeting of the session was held in the York Street

Exchange buildings, Manchester, on November 13th, when Mr. E. H. Shaughnessy, of Headquarters, delivered a lecture on the "Imperial Wireless Station at Leafield." An exceptionally large gathering of members was augmented by officials of the Postal and Telephone services, and by representatives of several of the Telephone plant manufacturers in the District. The lecture, which was illustrated by means of a fine collection of lantern slides, was highly instructive and greatly appreciated, whilst the subtle humour of the speaker afforded much pleasure to his audience.

BOOK REVIEWS.

"Mast and Aerial Construction for Amateurs," by F. J. Ainsley, A.M.I.C.E. 82 + vi. pp. London: The Wireless Press. (Price 1*s*. 6*d*.).

One of the chief problems confronting the amateur fitting a wireless set is the provision of an aerial. A good well-elevated aerial is a good investment, as with it satisfactory results can be obtained with simpler and less expensive receiving apparatus. Judging from the type of aerial one usually sees in suburban back gardens, this little book should meet a definite need.

The subject matter is divided into eight chapters. Chapters one and two provide general information regarding types of masts and materials. The succeeding chapters are devoted to detailed instructions for the building of various types of masts. These masts include scaffold pole masts, plank masts, stayed lattice masts, self-supporting lattice towers and tubular steel masts.

The final chapter describes aerial systems suitable for small receiving installations and gives much useful information on roof attachments, leading-in and soldering. The last few pages contain useful hints on frame aerials.

Considering the small size of the masts under consideration, it is doubtful whether from a cost point of view any other type but the scaffold pole is justified. A 22 ft. pole can be obtained for about 6/- at the present time, and most of the built-up types of masts would cost more than this. On the other hand the amateur is not wholly influenced by reasons of first cost in regard to a hobby, and the designs given would provide much interesting work.

Generally the information in this attractive little volume appears to be accurate. The ultimate strength of yellow deal, given on page 13, appears to be lower than usually assumed by engineers, while on page 18 by an obvious slip the breaking strain of iron wire is given as 55 lbs. per sq. in.

The book is well printed and contains 65 clear and useful draw-

ings. It is confidently recommended to all amateurs seeking information on the subject. A.J.G.

"La Telefonia a Grande Distanza ed i Ripetitori Telefonici." By Dott Annibale Craveri and Comm Sisto Demaldè. Published by S. Lattes & C., Torino-Genova, 1922. 416 pp., $6\frac{1}{4}'' \times 4\frac{1}{4}''$, with 124 figures. Price 24 lire.

The first 100 pages of this book deal with the elements of telephonic transmission, including a section (largely historical) on loading. A chapter leading up to telephonic repeaters follows and the remainder of the book deals with the theory and development of the modern telephonic repeater. This section of the book commences with a description of electronic phenomena and the development of thermionic amplifiers, etc. The last 20 pages of the book describe various kinds of telephonic repeater apparatus, systems, and circuits, including description of some of the Western Electric Company's apparatus and systems.

The printing and flexible binding are good. The numerous diagrams are clear, but the paper (of the quality to which one has become accustomed since the war) does not permit of a very satisfactory reproduction of the photographs of apparatus and exchanges equipment which are included in the book. At the present rate of exchange, however, British criticism on this point should be entirely disarmed.

"Traité de Télégraphie," by H. Thomas, Inspecteur General Honoraire des Postes et des Télégraphes.

We have received a copy of this work from the Librairie Polytechnique Ch. Beranger, 15, Rue des Saints-Pères, Paris, published with stiff cover at the price of 100 francs.

The first edition of the work appeared in 1894, since which time the development of Telegraphy has been sufficient to warrant the publication of this second edition, consisting of 1214 pages, with 939 illustrations. After discussing general principles, descriptions are given of apparatus from the early simple sets down to the modern complex Printing Telegraph systems of the Duplex Multiplex type. Aerial and underground Line construction, and also Submarine Cable laying and repairing are very thoroughly covered. Finally, Wireless Telegraphy, from the early Coherer to the Thermionic Valve, is very ably treated.

We can confidently recommend the book, particularly as a work of reference, as it deals equally well with systems developed outside France and includes descriptions of systems which although ingenious and promising have yet failed to satisfy the exacting demands of practical working.

BOOKS AND NOTICES RECEIVED.

"The Wireless Telephone: What it is and how it works," by P. R. Coursey, 2*s*. 6*d*. "Direction and Position Finding by Wireless," by R Keen, 9*s*. The Wireless Press.

An advice has come to hand from M. Dennery, L'Inspecteur Genéral, Directeur de l' Ecole Superieure des Postes et des Télégraphes, Paris, of the publication of a new work by M. Montoriol on "Systems of Telegraphy and Telephony, origins, evolution and practice." The publishers are Messieurs J. B. Baillère et Fils, 19, Rue Hautefeuille, Paris. Price 50 francs. The work forms a complete history of the subjects named from their beginning to the present day.

A catalogue from Messrs. Godbolds Ltd., Chancery Lane, on "Post Office Telephone Progress," notifying the opening of the new telephone exchange at Fleetwood, which was installed by the Relay Automatic Telephone Company.

We have been advised that beginning in January, 1923, "Les Annales des Postes, Telegraphes et Telephones" will appear every month instead of every second month as formerly. Although the material will be considerably augmented the annual subscription will remain at 24 francs for France and 27 francs abroad. "Les Annals" is published by La Librarie de l'Enseignement Technique, 3, Rue Thénard, Paris.

"Nogle Statistishe Meddelelser vedrörende De Koncessionerede Telefonselskaber i Danmark, for years 1919, 1920, 1921." This pamphlet gives statistics of the telephone companies in Denmark, which are private ones operating on the various islands. From 1922 and onwards the Public Committee, which is the body dealing with the Companies on behalf of the State, will publish the statistics.

The tables show total annual payments in 1921 per subscriber, viz., £7 to £11, compared with £3 10s. 0d. to £6 in 1914; number of subscribers; expenses; dividend earned; depreciation; and balance sheets, etc.

STAFF CHANGES.

POST OFFICE ENGINEERING DEPARTMENT.

Appointments.

The following additional officers have been appointed Assistant Engineers on probation from the Open Competition held last April. A previous list was published in the October number:—

Name.	Section, E.-in-C.O.
Harbottle, H. R.	Research
Cohen, I. J.	Wireless

PROMOTIONS.

Name.	Grade.	Promoted to	Date.
Hook, G. H. J. ...	Asst. Engr., Lines Section, E.-in-C.O. ...	Exec. Engr., Lines Section, E.-in-C.O. ...	5 : 12 :22
Reddrop, W. H. ...	Chief Inspector, London District	Asst. Engineer, London District	To be fixed later.
Bates, A. ...	Chief Inspector, Telephone Sec., E.-in-C.O.	Asst. Engr., Telephone Section E.-in-C.O. ...	11 :10 : 22
Hart, W. L. ...	Higher Exec. Officer, S.Lancs. Dist. ...	Principal Clerk, London Dist.	22 : 11 : 22
Rodway, C. H. S.	2nd Cl. Clerk, Ldn. Dist.	Higher Exec. Officer, London Dist. ...	13 : 11 :22
Kimber, J. W. ...	do.	do.	13 : 11 :22
Salter, E. J. ...	3rd Cl. Clerk, Ldn. Dist.	Exec. Officer, Ldn. Dist.	20 : 11 :22
Jenkins, W. A. S.	do.	do.	20 : 11 :22
Everett, A. E. ...	do.	do.	20 : 11 :22
Turner, A. A. ...	do.	do.	20 : 11 :22
Larner, R. H. ...	do.	do.	20 : 11 :22
Griffiths, E. F. ...	do.	do.	20 : 11 :22
Bullard, H. J. ...	do.	do.	20 : 11 :22
Eginton, A. F. ...	do.	Exec. Officer, Met. Power Dist.	21 : 11 : 22
Swansborough, R.	do.	Exec. Officer, Ldn. Dist.	20 : 11 :22
Haves, A. H. ...	do.	do.	20 : 11 :22
Harsum, A. E. ...	do.	do.	20 : 11 :22
Mullens, H. W. ...	do.	do.	20 : 11 :22
Petchey, F. G. ...	do.	do.	20 : 11 :22
Claydon, T. A. ...	do.	do.	20 : 11 :22
Terrill, F. G. A.	do.	do.	20 : 11 :22
Campbell, F. B....	3rd Cl. Clerk, N.E. Dist.	Exec. Officer, N.E. Dist.	23 :10 : 22
Deacon, S. H. ...	3rd Cl. Clerk, E. Dist.	Exec. Officer, E. Dist.	24 :10 : 22
Scott, C. S. ...	3rd Cl. Clerk, N.M. Dist.	Exec. Officer	To be fixed later.
Hoole, G. H. ...	3rd Cl. Clerk, N.E. Dist.	do. N.E. Dist.	23 : 10 : 22
Lean, W. G. ...	do.	do. do.	30 : 10 :22
Ward, H. N. ...	do.	do. N.W. Dist.	1 : 11 :22
Payne, C. W. H.	3rd Cl. Clerk, S.M. Dist.	do. S.M. Dist.	23 : 10 : 22
Bartlett, J. W. ...	do. S.W. Dist.	do. S.W. Dist.	30 :10 : 22
Grant, J. E. ...	do. do.	do. do.	30 :10 : 22
Williams, J. P. ...	do. S.Lcs. Dist.	do. S.Lcs. Dist.	21 :10 : 22
Read, A. M. ...	do. N.Wa. Dist.	do. N.Wa. Dist.	10 : 11 : 22
Heasley, R. A. ...	do. S.W. Dist.	do. S.W. Dist.	30 :10 : 22
McEvoy, J. P. ...	do. N.Wa. Dist.	do. N.Wa. Dist.	22 : 10 : 22
Rowarth, R. A. S.	do. N.M. Dist.	do. N.M. Dist.	23 : 10 :22
McLauchlan, G. R.	do. Sc.E. Dist.	do. Sc.E. Dist.	19 : 6 :22
Vyle, R. S. ...	do. N.M. Dist.	do. N.M. Dist.	23 : 10 : 22
Careless, E. D. ...	do. S.Wa. Dist.	do. S.Wa. Dist.	23 : 10 : 22
Crockett, E. E. ...	do. N.M. Dist.	do. N.M. Dist.	23 : 10 : 22
Crossley, W. C....	do. S.Lcs. Dist.	do. S.Lcs. Dist.	21 :10 : 22
Brown, C. ...	do. S.W. Dist.	do. S.E. Dist.	20 :11 : 22
Morris, F. J. ...	do. S.Wa. Dist.	do. S.Wa. Dist.	23 : 10 : 22
Miller, B. ...	do. N. Dist. ...	do. N. Dist. ...	23 : 10 : 22
Friar, J.	do. N. Dist. ...	do. N. Dist. ...	23 : 10 : 22
Ellis, R. H. ...	do. N.W. Dist.	do. N.W. Dist.	1 : 4 :22
Gibbins, S. ...	do. S.Wa. Dist.	do. S.Wa. Dist.	23 : 10 : 22
Palk, E.	do. S.M. Dist.	do. S.M. Dist.	1 : 4 :22
Gwilliam, A. ...	do. S.M. Dist.	do. S.M. Dist.	23 : 10 : 22
Warburton, W. J.	do. S.W. Dist.	do. S.Lcs. Dist.	20 : 11 :22

PROMOTIONS *(continued)*.

Name.	Grade.	Promoted to	Date.
McBurnie, R. ...	3rd Cl.Clerk, S.Lcs.Dist.	Exec. Offir., S.Lcs.Dist.	23 : 10 : 22
Brown, R. H. ...	do. N.M. Dist.	do. N.W. Dist.	7 : 10 : 22
Martin, H. E. ...	do. S.E. Dist....	do. S.E. Dist.	23 : 10 : 22
Binnington, T. C.	do. N.E. Dist.	do. N. Dist. ...	1 : 11 : 22
Patrick, J. ...	do. Sc.E. Dist.	do. Sc.E. Dist.	20 : 6 : 22
Lane, J.	do. N. Dist. ...	do. N. Dist. ...	1 : 4 : 22
Mawson, J. ...	do. N.M. Dist.	do. S.Lcs. Dist.	30 : 10 : 22
Smith, C. J. ...	do. S.M. Dist.	do. S.M. Dist.	1 : 4 : 22
Gain, P. G. W. ...	do. S.Wa. Dist.	do. Sc.W. Dist.	1 : 11 : 22
Howarth, R. ...	do. S.Lcs. Dist.	do. S.Lcs. Dist.	21 : 10 : 22
Bartlett, A. H. ...	do. S.E. Dist.	do. S.E. Dist.	1 : 4 : 22
Lomax, J. ...	do. Sc.E. Dist.	do. Sc.E. Dist.	23 : 10 : 22
Evered, F. M. ...	do. N.E. Dist.	do. N.W. Dist.	1 : 11 : 22
Hall, G. W. ...	do. N.W. Dist.	do. N.W. Dist.	1 : 11 : 22
Slate, J. F. ...	do. S.E. Dist.	do. S.E. Dist.	1 : 4 : 22
Rowbotham, A. ...	do. N.W. Dist.	do. N.W. Dist.	6 : 11 : 22
Franks, G. ...	do. S.E. Dist.	do. S.E. Dist.	23 : 10 : 22
Eaton, J. C. ...	do. S.M. Dist.	do. E. Dist. ...	1 : 11 : 22
Waller, R. E. ...	do. N.Wa. Dist.	do. N.W. Dist.	3 : 12 : 22
McMullin, T. ...	do. S.W. Dist.	do. Ire.N. Dist.	7 : 11 : 22
Allin, W. W. ...	do. S.Wa. Dist.	do. S.Lcs. Dist.	1 : 12 : 22
Dell, A. H. ...	do. S.M. Dist.	do. S.M. Dist.	23 : 10 : 22
Brown, R. ...	do. Sc.W. Dist.	do. Sc.W. Dist	24 : 10 : 22
Hills, A. M. ...	do. S.W. Dist.	do. Ire.N. Dist.	7 : 11 : 22
Gouldthorp, A. W.	do. N.E. Dist.	do. N.W. Dist.	1 : 11 : 22
MacCallum, H. C.	do. Sc.W. Dist.	do. Sc.W. Dist.	24 : 10 : 22
Nixon, W. ...	do. S.M. Dist.	do. S.E. Dist.	30 : 10 : 22
Mackrill, A. H. ...	do. E. Dist. ...	do. E. Dist. ...	24 : 10 : 22
Lewis, H. E. G....	do. E.-in-C.O.	do. E.-in-C.O.	1 : 4 : 22
Suttle, E. C. ...	do. do.	do. do.	1 : 4 : 22
Johnston, A. E....	Cler. Offir., E.-in-C.O.	Exec. Offir., E.-in-C.O.	12 : 12 : 22
Jones, E. J. ...	do. do.	do. do.	8 : 5 : 22
French, F. S. ...	do. do.	do. do.	12 : 12 : 22
Wager, H. ...	do. do.	do. do.	1 : 4 : 22
Ford, F. C. ...	do. do.	do. do.	18 : 12 : 22

TRANSFERS.

Name.	Grade.	Transferred.		Date.
		From.	To.	
Greenham, G. F.	Asst. Suptg. Engineer ...	London District	Telephone Sect. E.-in-C.O. (Asst. Staff Engineer)	13-11-22
Thow, J. H....	do.	South Mid. Dist.	London District	1-11-22
Brown, H. P.	Asst. Staff Engr.	Loaned to Australian Commonwealth		24-11-22
McGregor, A.	Asst. Engineer ...	South Lcs. Dist.	Telephone Section E.-in-C.O.	12-11-22
Pennington, W.	Exec. Engineer	South Wales Dist.	London District	

COMMUNICATIONS.

RETIREMENTS, Etc.

Name.	Grade.	District, Etc.	Date and Cause.
McMorrough, F.	Exec. Engineer	North Eastern	Illhealth — 27-11-22
Reyner, J. H.	Probationary Asst. Engineer	Wireless Section, E.-in-C.●.	Resigned — 16-9-22
Bradfield, R....	Assistant Engineer	Telephones	,, — 23-9-22
Hannam-Clark, H. C. ...	do.	do.	,, — 1-11-22

DEATH.

Name.	Grade.	District.	Date.
Devey, J. E....	1st Class Clerk	North Midland	6-10-22

COMMUNICATIONS.

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