THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL

THE INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

VOL. 12
PART 2

JULY
1919

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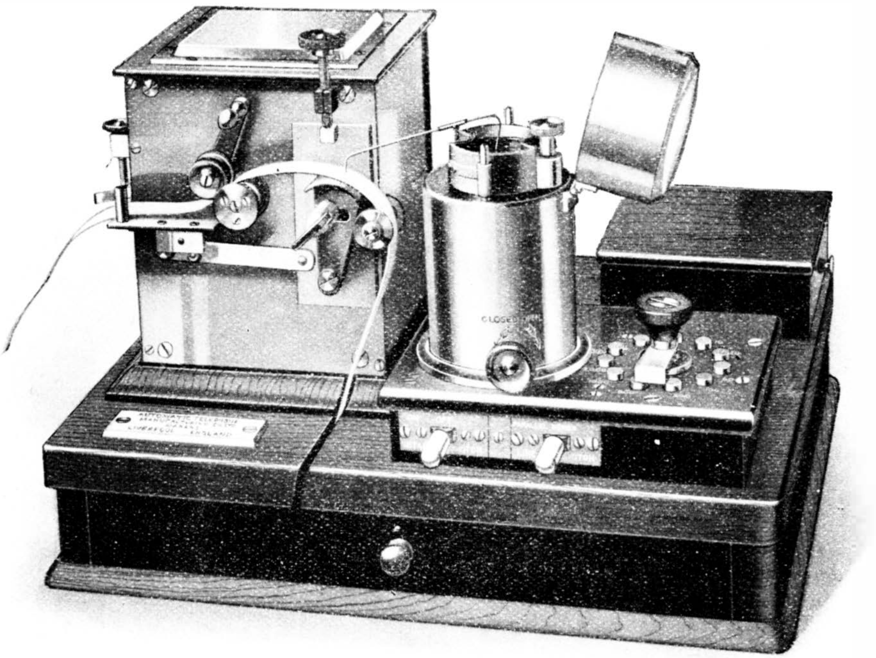

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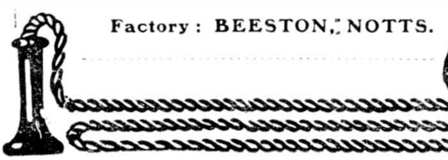
CONTENTS FOR JULY, 1919.

PUBLISHERS:

THE ELECTRICAL REVIEW, LTD., 4, LUDGATE HILL, E.C.

Price 1/- net, post free, 1/3. | **Annual Subscription, postage inclusive, 5/-, payable in advance.**

Editorial Communications see page 128.

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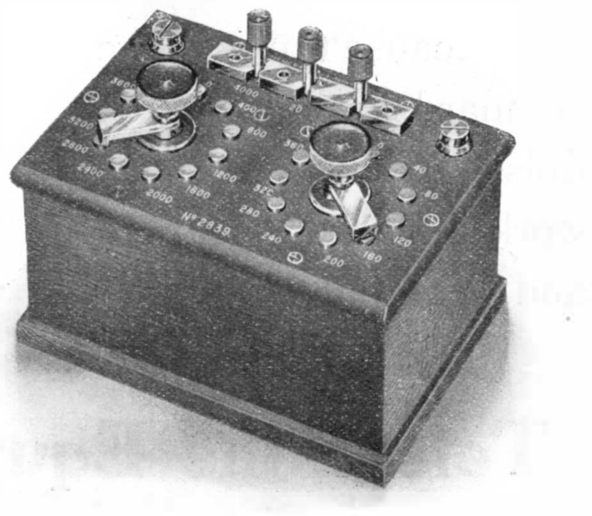

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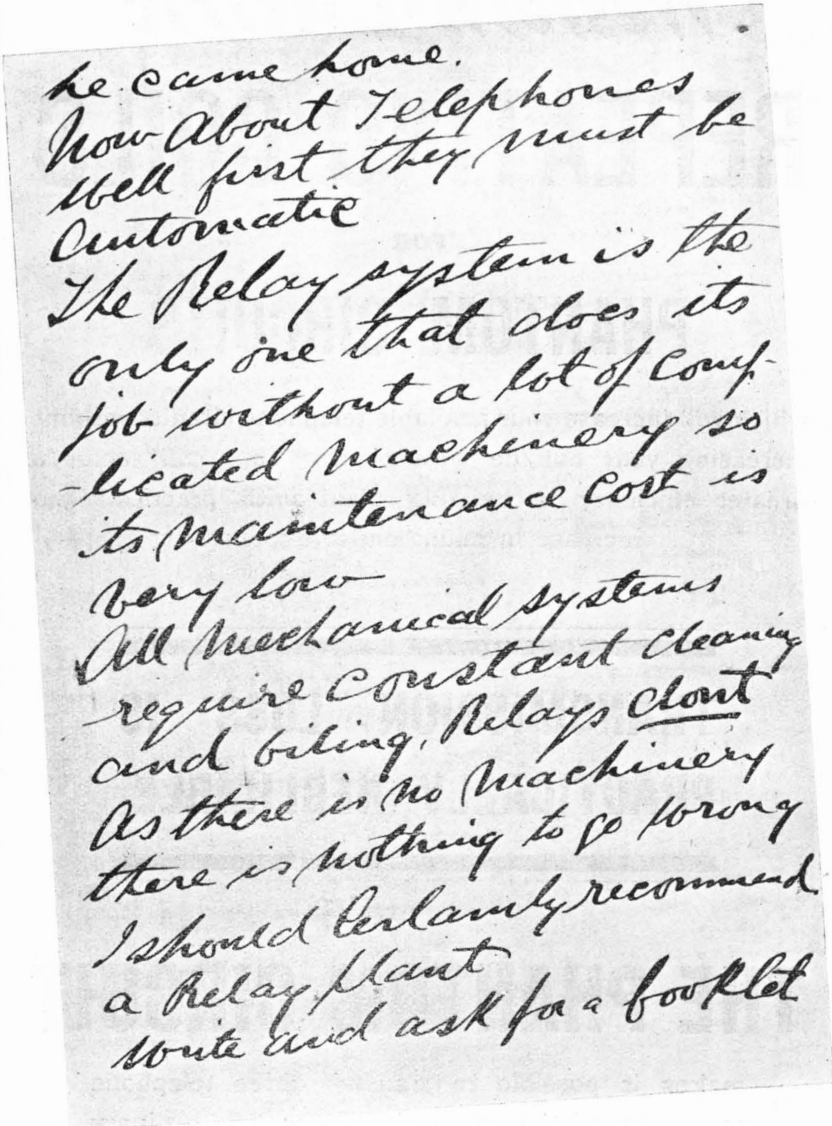

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Mr. William Noble, the New Engineer-in-Chief.

THE
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NEW ENGINEER-IN-CHIEF AT THE G.P.O.

THE announcement that Mr. William Noble has been appointed to the high position of Engineer-in-Chief at the General Post Office in succession to Sir William Slingo has been received with great satisfaction.

Mr. Noble, as Assistant Superintending Engineer and then Superintending Engineer of the London District, is well known to a large section of Londoners as a progressive engineer, and as an individual who keeps abreast of modern developments in relation to commercial needs ; and it may confidently be anticipated, therefore, that with the return of peace conditions and the consequent resumption of telegraph and telephone construction activities, the requirements of the public have been placed in excellent hands.

The appointment is popular with the Post Office staff, as Mr. Noble has risen from the ranks, and in every grade in which he has served he has shown such consideration towards his colleagues and subordinates that, while retaining their great respect, he has made them feel all the happier for representing their views to him. Success in the control of a great department such as the Engineering Department of the Post Office with its 25,000 officers and men, posted throughout the British Islands, depends to a large extent on the existence of a contented staff, and it is indeed gratifying that the new Engineer-in-Chief possesses in a marked degree the characteristics necessary for inducing contentment among the various grades of workers.

Mr. Noble entered the service of the Post Office in 1877 and was a telegraphist in the Aberdeen Office during the earlier years of his career. His interest in the technical side of his work was early evidenced. After achieving a double-medal success in telegraphy and telephony, he was for some years lecturer in telegraphy and telephony and later also in magnetism and electricity. The strenuous type of student for which the northern city is famed, well accorded with the strenuous character of the teacher, for during his period as teacher no year passed without one or more of his students obtaining that coveted honour of all science students—a medal award. It has, moreover, been a source of unalloyed gratification to him to witness the steady progress which many of his early students have made in the Engineering Department of the British Post Office. Technical education and training, whether of messengers, fitters, linemen or others, still claims his attention, and for some years past Mr. Noble has been one of the examiners of the City and Guilds of London Institute.

In 1893 Mr. Noble was appointed a second-class engineer at Aberdeen, and in 1897 received promotion to a first-class engineership in the Engineer-in-Chief's Office. Here his native ability and organising power were soon recognised and were afforded fuller scope. The period was one of rapid transition and development. The purchase of the trunk telephone lines from the National Telephone Company had been completed shortly before this, and the necessary reconstruction of many of these and the abnormal growth of the system which followed furnished problems well calculated to engage Mr. Noble's active mind. Larger developments, too, were pending. The active entry of the State into competition with the National Telephone Company was already foreshadowed and was shortly afterwards decided upon, and in the earliest preparations for that momentous undertaking Mr. Noble bore no small part. It was desirable for the success of the work that the fullest possible information should be obtained as to the Company's ways and methods, both for the purpose of emulating what was good and avoiding what was bad in the Company's system. Many of these important preliminary investigations were carried out by Mr. Noble.

In 1900 he was made a technical officer, and in the following year was made an Assistant Superintending Engineer in the Central Metropolitan District. This was the district in which both the earliest and fiercest telephone competition was anticipated and experienced. As second in command Mr. Noble was responsible for a large share of the work which is now popularly known as the "Telephoning of London." The work was vast and ceaseless, with potentialities of worry to correspond! But it was during the four years when the heat and dust of labour was greatest that the energy and resource of the subject of our sketch was most conspicuous; and when promotion to a first-class staff engineership came in 1905 no man could say that the recipient had not fought and won his way by vigorous achievement to the higher post.

Mr. Noble's next task was to take charge of the Telegraph Section at Headquarters. For prominent among the foundations of belief upon which the policy of the Department rests is Shakespeare's dictum that on the stage of life "one man in his time plays many parts." Incidentally it argues a remarkable versatility on the part not only of Mr. Noble, but of many of the Department's administrative officers, that they can at a moment's notice completely change in direction the current of their energies, and adapt themselves to any and every one of the complex duties which go to comprise Telegraph and Telephone Engineering. In this case heavy construction work and the installation of telephone equipments were suddenly left behind, and intricate and delicate problems of telegraph apparatus resolutely tackled. As chief of the Telegraph Section, Mr. Noble was responsible for much experimental work designed to determine the relative merits and spheres of usefulness of the different telegraphic systems then clamouring for recognition and adoption. Exhaustive experiments and many practical tests with multiplex and typewriting telegraph apparatus were carried out under Mr. Noble's direction, and, aided by a loyal and industrious staff, much useful work was done. During this period also the different types of C.B. telegraphs were first introduced and largely developed.

In 1907 Mr. Noble was appointed Superintending Engineer of the Central Metropolitan District, and his earliest efforts were directed to the improvement and consolidation of its organisation. As an administrator his zeal and energy speedily compelled recognition, and shortly after taking up duty in the Central Metropolitan District he was appointed a member of the Superintending Engineers' Committee. His wide practical experience and sound judgment have indeed been of peculiar value to the Department in its committee work. The committees upon which Mr. Noble has served are many and important. He was Chairman for about five years of the Factory Works Committee. In conjunction with Mr. Sinnott he reported on the factory repair work, and as a result of the recommendations which were made the present system of joint examination was set up. The arrangement has proved a highly satisfactory one, and has resulted in considerable economy. In 1909 a committee of three, known as the Advisory Board, was appointed, and it is safe to say that never in the history of the Engineering Department were the operations of any Committee the object of such vigilant and assiduous attention by the staff. Mr. Noble, together with Messrs. J. W. Woods and A. J. Stubbs, Assistant Engineers-in-Chief, were selected to compose this committee, and entrusted with the task of selecting, for promotion to first-class engineerships, the more promising amongst the senior second-class engineers. Mr. Noble also acted as one of the board of selection for second-class clerkships.

In 1910 Mr. Noble was appointed by the Postmaster-General as member of a committee to consider and report upon the question of underground mail transmission in London, and in company with the Controller of the London Postal Service (Sir R. Bruce, C.B.) visited Berlin, Vienna and Paris, to investigate proposed continental systems. More recently Mr. Noble was appointed by the Postmaster-General to serve on the Factories Committee charged with the labour of investigating the subject of factory work and costs and the conditions under which the Department's work might economically be produced. For his work on these important committees he received the special thanks of the Postmaster-General. Mr. Noble was also the only engineering member of the Staff Transfer Committee created for the purpose of grading into existing Post Office classes the members of the late Company's staff—the heaviest staff task ever undertaken by any Government Department.

With such heavy and important Committee work added to the labours of chiefship of a heavily worked district Mr. Noble's energies were taxed to the utmost. But recognition alike from the Department and the Staff was won. From the former an allowance of £100 per annum for special services; from the latter a loyalty that counted for much more than gold.

In March, 1912, Mr. Noble's ability and energy were further recognised by his promotion to the position of Assistant Engineer-in-Chief. In this capacity, both before and during the war, Sir William Slingo had a stout supporter. Much of the work done in the Engineering Department of the Post Office since 1912 has been of a confidential nature relating to Military and Naval communications and the time is not yet ripe for publishing details. It may, however, be assumed that such administrative responsibilities and duties as were entrusted to Mr. Noble were carried out with such judgment and zeal as have justified the Postmaster-General in placing the reins of the Engineering Department in his hands.

Recently the King of the Belgians honoured Mr. Noble by creating him a "Chevalier de l'Ordre de la Couronne" for "constant and generous help" during the war.

MAJOR T. F. PURVES, O.B.E., ASSISTANT ENGINEER-IN-CHIEF.

THERE can be no doubt that the selection of Major Purves for promotion is popular throughout the Engineering Department. He entered the Department in 1892, and I godfathered him to Headquarters between then and 1894—if so papist a term may be used in regard to a Scot! I often have wondered what became of the other aspirants whose ambition was frustrated by my selection of T. F. P. If this should meet their eye I trust that their present position is such as to enable them to view with not too serious regret the fact that they "failed to satisfy the examiner" of their drawings in the long ago!

Mr. Purves passed successively through the grades of Second Class Clerk (1898); Second Class Technical Officer (1900); Assistant Superintending Engineer (1905); Staff Engineer (1907); and now at forty-seven shares the second position in our great Department. As regards his work, I still recall with what satisfaction I realised that he had "made good" when in 1901 he produced the device of the rotary switch for secondary cells—thus putting a finishing touch to the system that previously had been all my own! Then it fell to him to develop the telegraph intercommunication system (1902), and when I went to Mount Pleasant in that same year he was the power behind the throne of "Designs," first under Mr. Slingo and then under Mr. Catley until 1905. Later he ascended the throne (1907)! Then came the war and his great opportunity. It did not look great at first, but it became great in his hands through sheer patriotism, and he has made a lasting impression on the military telegraphy and telephony of the world. The O.B.E. bestowed by His Majesty the King is an honour well earned in his case. All his colleagues realise that his advancement is due to solid merit, and recognise that in his upward progress he has never had any use for "back stairs." The fact that since 1914 he has been Chairman of the Board of Editors of the JOURNAL prevents this appreciation from posing as an "editorial" paragraph! We all congratulate the Department as well as Major Purves.

A. J. STUBBS.

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THE TELEPHONE REPEATER.

(*Continued from p.* 11.)

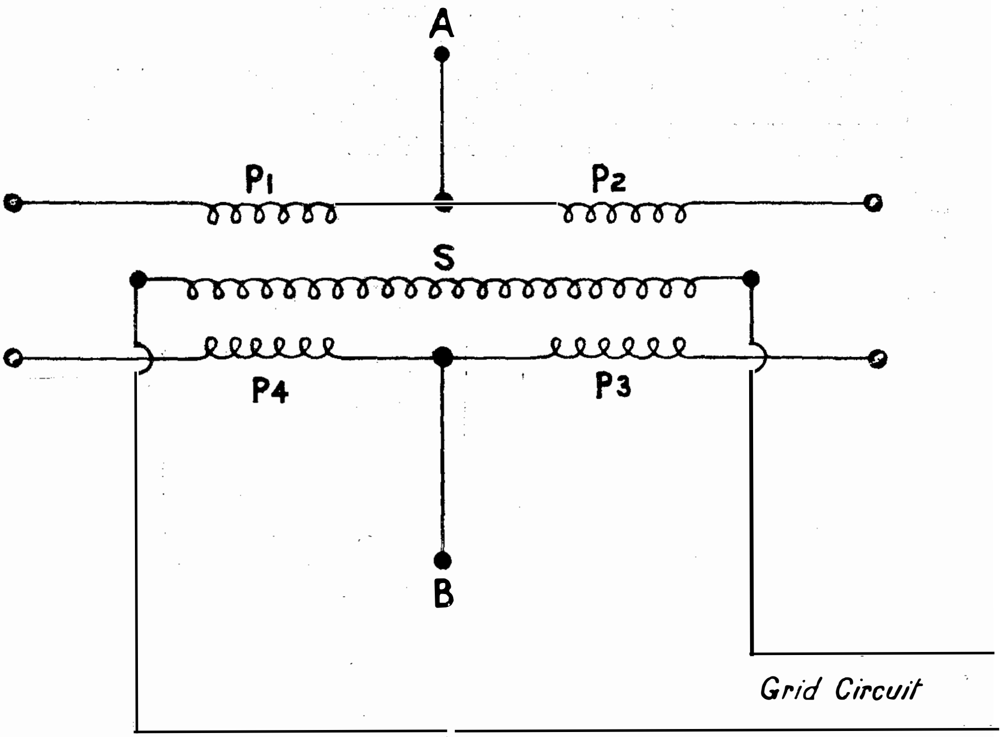
THE input transformer shown in the line circuit (**10**) is of special construction, and will be described in detail later.

The primary (line) winding is disposed on two bobbins, each bobbin being wound with 250 turns of twin wire, so that the half-windings P_1 and P_2 and similarly P_3 and P_4 are accurately differential (**13**).

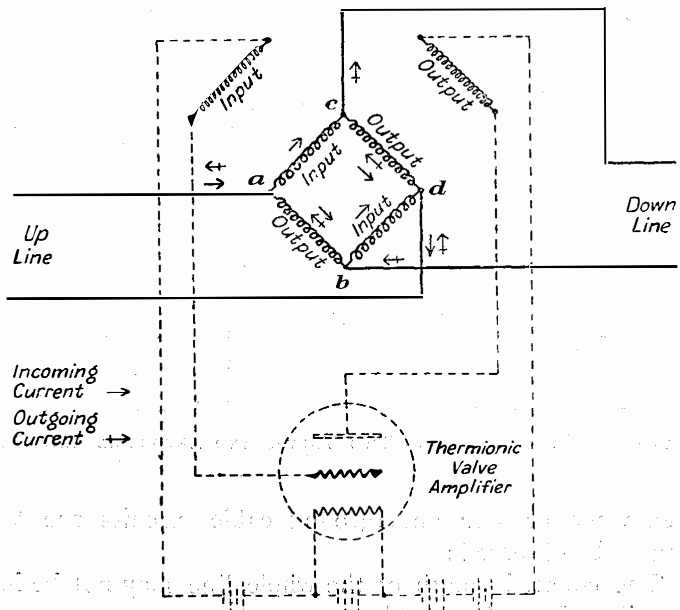
These windings are inductive when joined in series in the order named, and consequently when inserted in a line circuit, as shown in **10**, produce a magnetic flux in the iron core when traversed by a current passing around the line loop. If this current is alternating a corresponding alternating current is induced in the secondary S (16,000 turns), which is connected to the grid circuit of the valve. On the other hand, if a potential, continuous or alternating, be applied to the centre points A and B of the primary winding, no magnetic flux in the iron core will result, and there will be no induced current in the secondary.

It follows of course that the lines on either side of the transformer must be electrically identical, and the difficulty of ensuring this condition under all circumstances constitutes the chief objection to the use of this circuit in practice.

Consider for a moment that the line on the east side is of lower impedance than the line on the west, and that a potential is applied to the points A and B (**13**); the effect on the secondary due current in the primaries P_2 and P_3 will not be cancelled by the current in P_4 and P_1; consequently an out-of-balance current will flow in the grid circuit connected to S, and the whole valve circuit becomes reactive. Under this condition the repeater cannot amplify speech between the ends of the line.

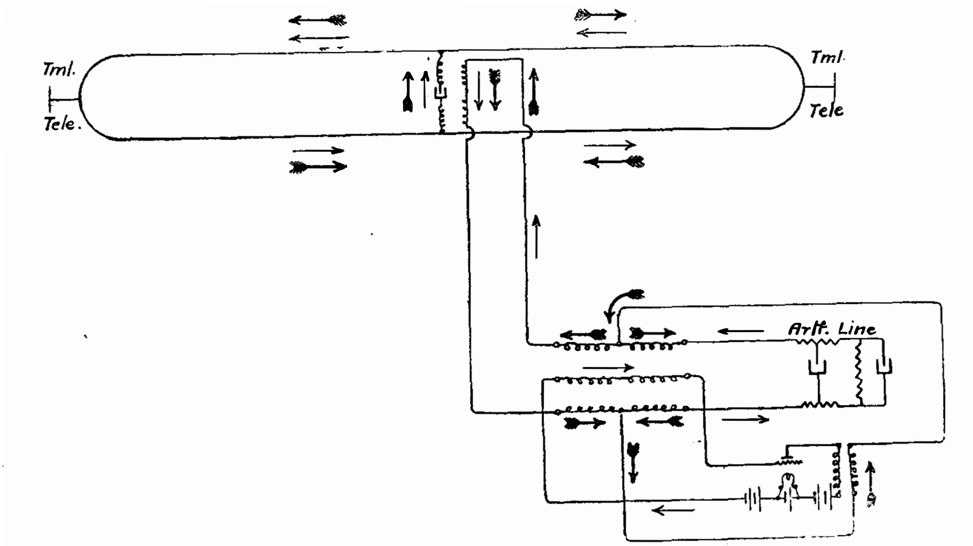


13.—INPUT TRANSFORMER. DIFEERENTIAL PRIMARY WINDINGS.

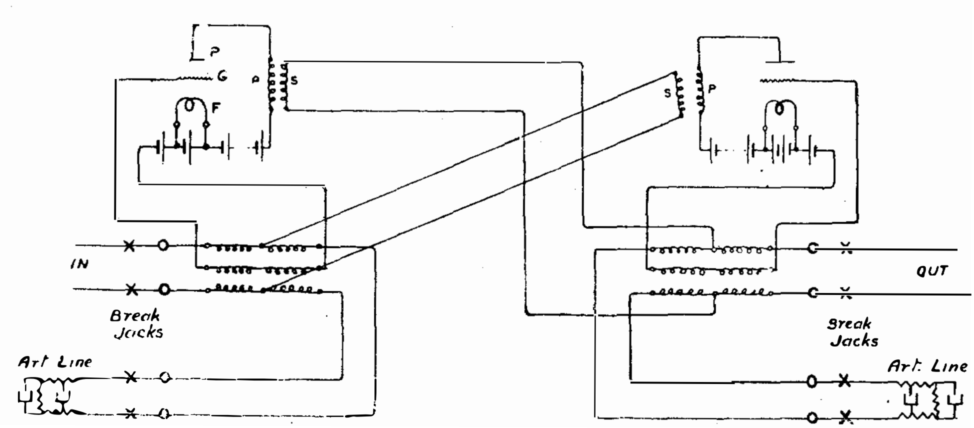


14.—THE TELEPHONE REPEATER. BALANCED POTENTIAL CIRCUIT.

It may be possible in some cases to adjust the balance between the lines by the insertion of adjustable artificial cable, but the remedy is not always effective. In practice therefore the use of this repeater circuit is limited to underground cables, the characteristics of which do not vary under normal conditions.



15.—THE TELEPHONE REPEATER. "TEED" SYSTEM.



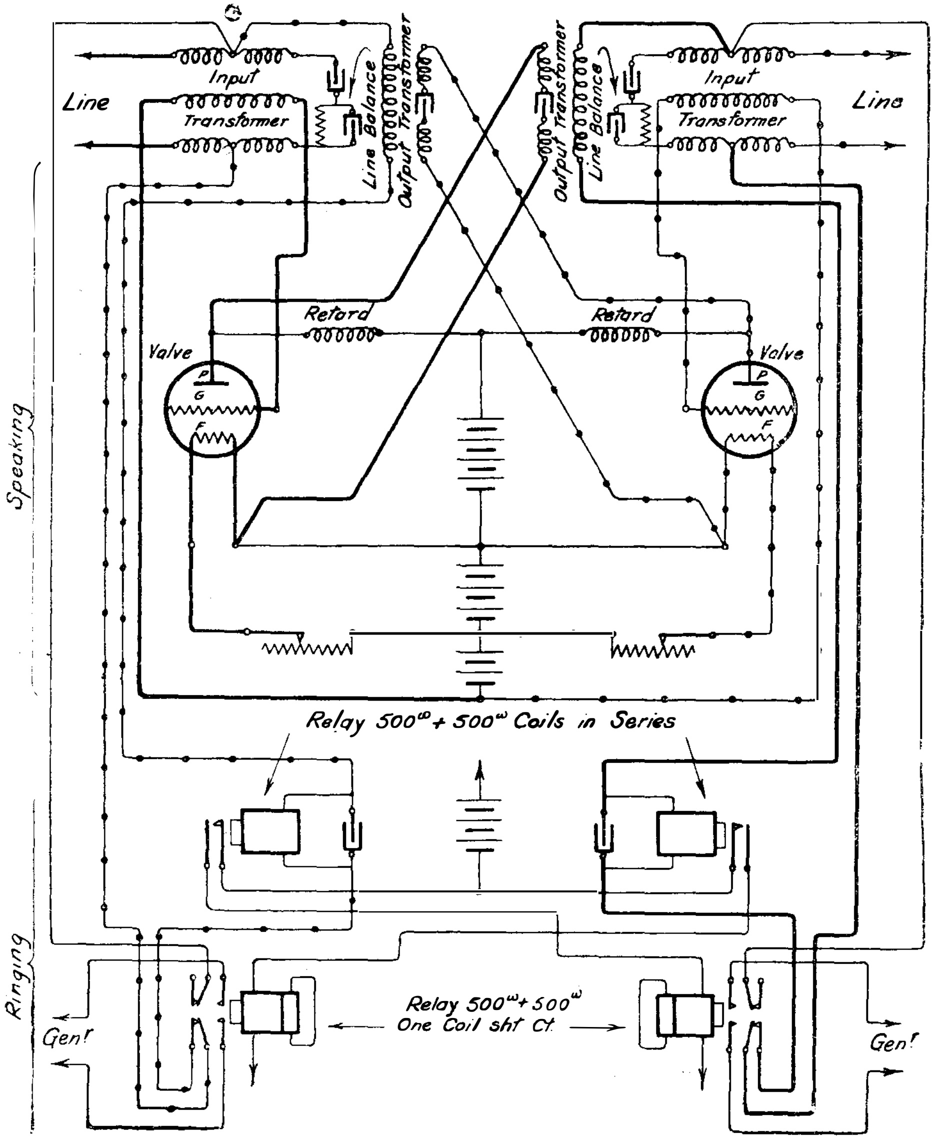
16.—TELEPHONE REPEATER, USING TWO VALVES AND ARTIFICIAL LINE BALANCES.

Even when used in underground cable circuits the following limits must be observed :

(*a*) The equated length of the whole line may not be less than twenty miles of standard cable.

(*b*) The lines on either side must have the same constants.

(*c*) The electrical distance between either end and the repeater may not be less than the equated value of the improvement due to the repeater.

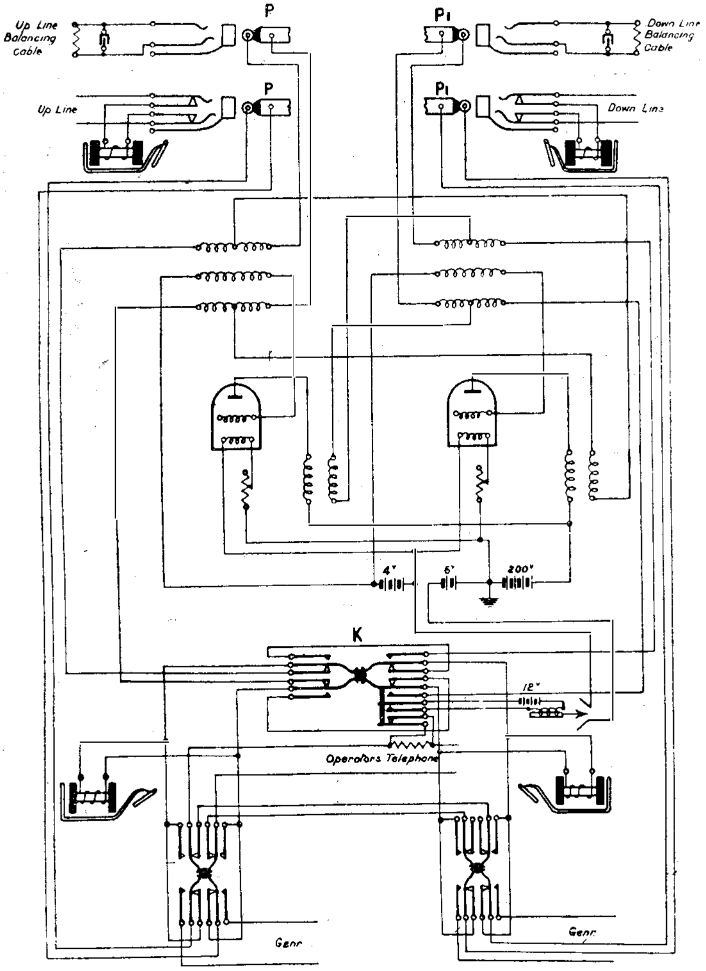


17.—Telephonic Repeater with Ringing Repeater.

A variation of the Edison differential circuit known as the equal potential system has been used with success in some cases where the former was found unstable. This system is fully described in an article by Statters & Lonnon in the 'Electrician' for January 31st, 1919.

A diagram of the circuit is given in 14.

When the lines on either side of the repeater have widely different characteristics neither of the foregoing systems is applicable. The simplest method of dealing with these conditions is to couple



18.—Telephone Exchange Cord Circuit Repeater.

the repeater inductively to the line and to balance the whole line by an artificial circuit.

15 is a sketch of the repeater arrangement.

"*T*" may be a transformer of the standard toroidal type, having four equal windings, two being joined in series across the line as primary, the other two acting as secondary being connected to the repeater. The wiring of the repeater circuit itself may be either of the systems described previously. The artificial balancing line is an arrangement of resistances and condensers representing as accurately as possible the mean characteristics of the lines as measured from the terminals of the line transformer.

This repeater system may be arranged for insertion in the cord circuit of a trunk-line exchange, and the equipment may include special keys for closing the heating battery circuit and for bringing in artificial line balances.

The second method of dealing with the condition of unequal lines is that of the double repeater, which is the standard arrangement.

It is shown in outline in **16**. It consists of two differential repeaters with separate artificial line balances. It will be seen that the valve output transformer on each side is connected to the middle points of the input transformer on the opposite side, where the outgoing current divides between the line and the balance circuits. As the two line circuits are completely separated it is necessary to provide means for passing through ringing signals between terminal stations.

The valve transformers are not suitable for repeating signals of ordinary ringing frequency—that is, about seventeen cycles per second, and a separate ringing repeater is usually provided.

17 illustrates a standard ringing repeater.

18 illustrates a scheme for introducing the double repeater into an exchange cord circuit.

The lines terminate on jacks in the usual manner, and above these jacks are placed special jacks, to which are connected the corresponding artificial line balances. The repeaters are terminated on two pairs of two-way plugs, each pair of which may conveniently be combined in a four-way plug.

In addition to the usual speaking and ringing keys the operator is provided with a special two-position key "*K*," which throws the repeater into or out of circuit as required. In the former position the valve-heating battery circuit is closed, and in the latter position it is opened by the special relay "*R*."

It may be necessary to provide additional means for controlling the magnification of the repeater and for adjusting the artificial line balances. These matters will be referred to later. A. B. H.

(*To be continued.*)

ELEMENTARY CONSIDERATIONS OF THE INDUCTANCE OF LOADING COILS AND THEIR INSERTION IN CABLES.

By E. S. RITTER, A.M.I.E.E., and A. MORRIS, A.M.I.E.E.

SYNOPSIS.—General method of treatment of windings of iron-core coils in series and in parallel, assisting and opposing.

Measurements on 508 and 535 type coils.

General requirements of loading coil design. Direction of latest progress.

The inductance of phantom circuit coils for submarine and for underground cables.

Jointing loading coils into cables. Faults met with.

Tests during and after construction.

THE SELF-INDUCTION OF A WINDING.—1 represents in diagrammatic form the type of coil which is used for loading the pairs of twin cables or the side circuits of the two-pair cores of multiple twin cables. The winding AA' is jointed into the A wire and the winding BB' into the B wire, AB being the "up" side and $A'B'$ the "down" side of the circuit. AA' and BB' are wound over a specially built core of magnetic material, the direction of the winding being from A to A' to B' to B.

If a current of varying strength is passed through the AA' winding, the magnetic flux thereby set up in the iron core will produce in the winding a voltage which tends to prevent the variation in the strength of the current. If the current changes at the rate of one ampère in one second, the voltage (say L) produced by this change is the measure of the SELF-INDUCTION OF THE WINDING.

Of the total flux set up by the current in the AA' winding, part is carried by the core only and part by the core and air jointly. The part which is carried by the core will link both the AA' and BB' windings, and will be referred to as the "interlinked flux"; whilst the part which is carried by the core and the air jointly will link only the AA' winding, and will be referred to as the "leakage flux." In a similar manner for the flux set up by a current in BB', part will link both the AA' and BB' windings, whilst part will link only the BB' winding. Assuming unit rate of change of the current, let the voltage produced in the AA' winding by the change of the interlinked flux be M and let S be the voltage produced by the change of the leakage flux. Then the value of L for the winding AA' will be equal to $(M + S)$. The inductance L' of the winding BB' will be equal to $(M' + S')$, where M' and S' respectively have the same significance for the BB' winding as M and S have for the AA' winding. If the winding BB' is exactly similar to the winding AA', then M' will be equal to M. Further, if the leakage flux-path of the BB' winding is exactly similar to the leakage flux-path of the AA' winding, then S' will be equal to S. Thus L', M' and S' will be equal respectively to L, M and S. This is substantially the case for well-balanced coils of the 535 and 545 types, and will be assumed to hold when computing the inductance of a loading coil under the various conditions of connection of the windings. It will also be assumed for this purpose that the flux produced in a magnetic core by the flow of current in a winding is proportional to the magnitude of that current, *i.e.* that the permeability of the magnetic core is constant.

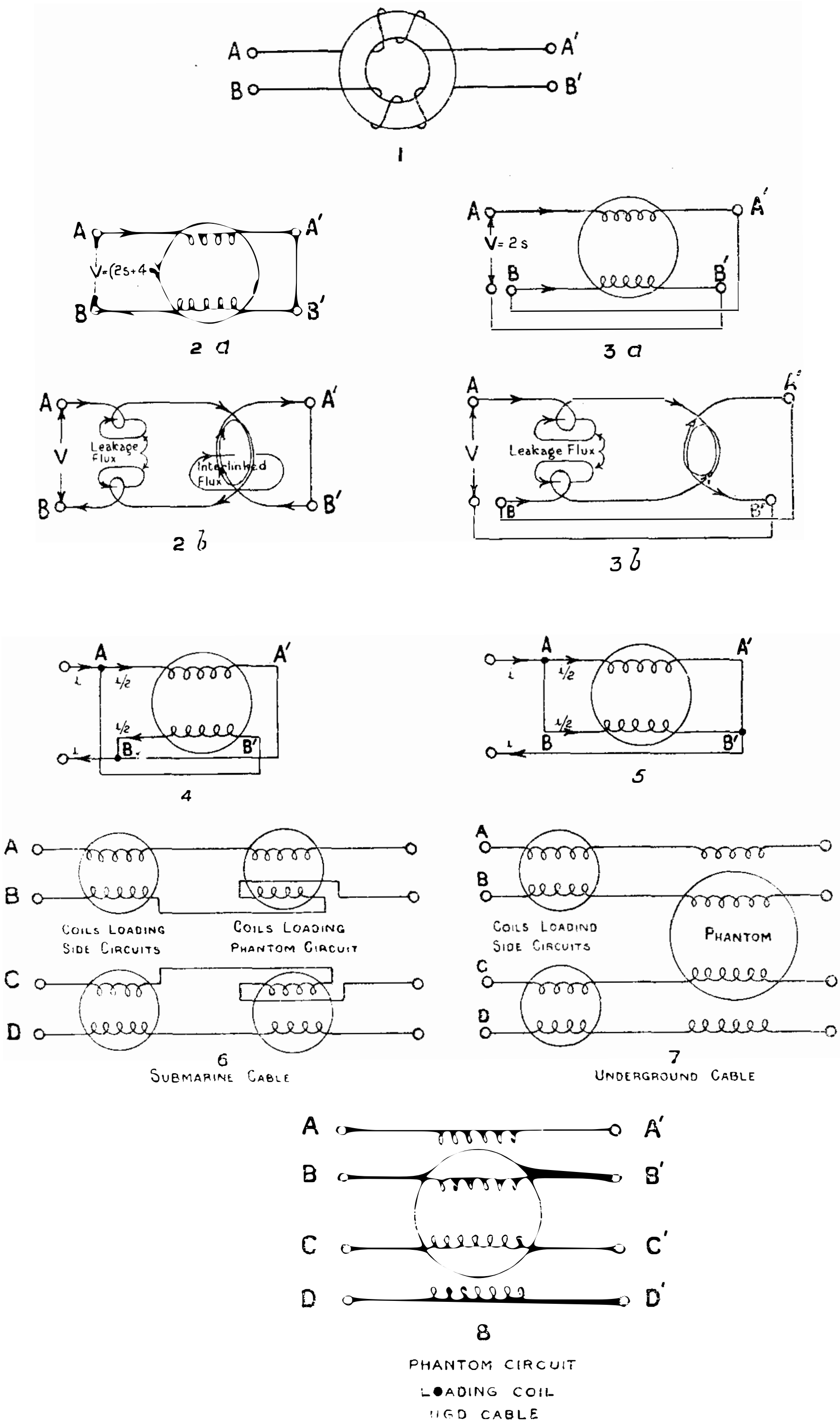
SERIES CONNECTION OF THE WINDINGS.—If AA' and BB' are connected in series, the back E.M.F. produced by unit rate of change of current through the circuit will be the resultant of the back E.M.F.'s produced in AA' and BB' respectively. If the connection of the windings is such as to cause the flow of the current to be in the direction A to A' to B' to B, the interlinked flux set up will be twice that set up by one winding (see **2**B), and therefore the voltage induced in the winding AA' by the change of this flux will be $2M$, whilst if A to A' to B to B' is the direction of flow there will be no induced voltage due to the the interlinked flux, since the resultant interlinked flux in this case is zero (see **3**B).

The back E.M.F. produced in AA' will therefore be $(S + 2M)$, or S, according to the connection of the windings. Similarly the back E.M.F. produced in BB' will be $(S + 2M)$, or S.

The resultant of the back E.M.F.'s produced in AA' and BB' will therefore be $(2S + 4M)$, or $2S$, according as $AA'B'B$ or $AA'BB'$ is the direction of flow of the current (see **2**A and **3**A). The manner in which the fluxes operate to produce the back E.M.F. across the coil for the two methods of connection is represented in **2**B and **3**B.

PARALLEL CONNECTION OF THE WINDINGS.—**4** and **5** show the two windings connected in parallel. Let the current flowing in each winding be $i/2$ ampères, the total current from the source being i ampères. Then if the parallel connection is as shown in **4**, A being connected to B' and A' to B, *i.e.* "parallel assisting," the E.M.F. induced in each winding by a change of current in the external circuit of i ampères in unit time will be $(S + 2M)i/2$, since the interlinked flux and therefore the E.M.F. due to it is double that produced by one winding only.

Since the windings are connected at their ends, this will be the E.M.F. across the compound circuit. The E.M.F. induced across the circuit by unit rate of change of the current will be $(S/2 + M)$, which is therefore, by definition, the self-induction of the circuit.



1.—Loop Circuit Loading Coil. **2A.**—Coil Windings, Series assisting. **2B.**—Flux Paths, Series assisting. **3A.**—Coil Windings, Series opposing. **3B.**—Flux Paths, Series opposing. **4.**—Coil Windings, Parallel assisting. **5.**—Coil Windings, Parallel opposing.

If the parallel connection is as shown in 5, A being connected to B and A' to B', *i.e.* "parallel opposing," the E.M.F. induced in each winding by a change of current in the external circuit of i ampères in unit time will be i S/2, since the resultant interlinked flux, and therefore the E.M.F. due to it, is *zero*. As the windings are connected at their ends this will be the E.M.F. across the compound circuit. The E.M.F. induced across the circuit by unit rate of change of the current will therefore be $S/2$, which is therefore, by definition, the self-induction of the circuit.

Table I gives a summary of the equations derived.

TABLE I.

Circuit (see 2A, 3A, 4 and 5).	Self-induction.	Self-induction if S is neglected.
One winding only (the other winding being disconnected)	$S + M$	M
Two windings in series, assisting	$2S + 4M$	$4M$
,, ,, series, opposing	$2S$	*nil*
,, ,, parallel, assisting	$S/2 + M$	M
,, ,, parallel, opposing	$S/2$	*nil*

TESTS ON 508 AND 535 TYPE COILS.—The results of tests on two types of coil, namely, the 508 and 535 types, are given in Table II, in illustration of the above formulæ.

TABLE II.

Circuit (see 2A, 3A, 4 and 5.)	Inductance.		
	General expression (Table I).	Coil-type 508 (millihenries).	Coil-type 535 (millihenries).
Inductance measured on AA'	$S + M$	48	31·5
,, ,, BB'	$S + M$	48·05	31·7
,, ,, $AA'\ B'B$	$2S + 4M$	172·4	128·4
,, ,, $AA'\ BB'$	$2S$	20·8	0·3
Values calculated from the above measurements:	S	10·4	0·15
	M	37·9	32·0
	$S + M$	48·3	32·15

The calculated values given in the lower part of the table agree fairly well with the measured values. It will be observed that in the 535 type coil the value of S is very small, being only 0·47 per cent. of the value of M. This is due to the fact that in this type of coil each winding is wound completely round the ring forming the core. The effect of this is to confine practically the whole of the flux set up by the passage of the current in the winding to the iron core. In the 507 and 508 type coils each winding occupies only one half of the core, and when carrying currents in series or in parallel opposition a fairly large flux circulates through the air external to the coil. If this leakage flux cuts the windings of other coils in its vicinity currents will be set up in them, and there will be electromagnetic cross-talk between those phantom circuits which are formed on side circuits containing coils of such a type. It is for this reason that the 507 type of coil is never used in cables designed for phantom circuit working. It will be noticed also that when ringing over a circuit loaded with this type of coil, or when ringing over one line of such a circuit and earth, ringing induction in other loops will be set up.

Several patents have been taken out for combined side and phantom circuit loading coils in which the loading of the phantom circuit is provided for by utilising the leakage flux, for which a special iron circuit is arranged. Generally speaking, the magnetic circuit of such a coil is of a complex character, and particular care is required in designing the reluctances of the various associated magnetic paths and the magneto-motive forces of the windings in regard to the constitution of points of equal or of zero magnetic potential. The electrostatic and electro-magnetic out-of-balance also requires careful consideration, in order that cross-talk between the side circuits and between the side circuits and the phantom circuit may be prevented. Further, the values of the inductances of the windings should be such that the side and phantom circuits are loaded to the same degree. So far as the authors are aware, no such coil has yet been brought into use, although the matter is being actively pursued by a few workers.

General Requirements of Loading Coil Design.—The design of a loading coil should be along such lines as to ensure, consistent with reasonable cost:

(1) A small value for the direct current resistance of the windings.

(2) A small value for the effective resistance (R) of the windings to alternating current of telephonic frequency. This value should not change appreciably with variation of current strength or of frequency. The value of R/L for modern iron-core coils varies from 25 to to 60 ohms per henry at a frequency of 800 periods per second, according to the purposes for which the coils are required. (*Note:* The effective resistance of the windings at any particular frequency is equal to their direct current resistance plus a resistance which is dependent upon the eddy current losses in the windings, the eddy current and hysteresis losses in the iron core, and also any losses caused by the external magnetic field of the coil.)

(3) A small value for the variation of the inductance (L) of the windings with variation of current strength or of frequency.

(4) A small value for the electrostatic capacity between the windings.

(5) A high value for the insulation resistance between the windings and between the windings and their containing case.

(6) A high value for the breakdown pressure of the insulation of the coil, *e.g.* the coil should not be liable to break down with voltages up to, say, 600 volts.

(7) A good electrical balance of the windings in order that there shall be no cross-talk introduced when the coil is inserted into a line. To effect this all the windings should be of equal inductance, effective resistance, capacity and leakance.

(8) That no external magnetic or electrostatic fields are set up by the coil.

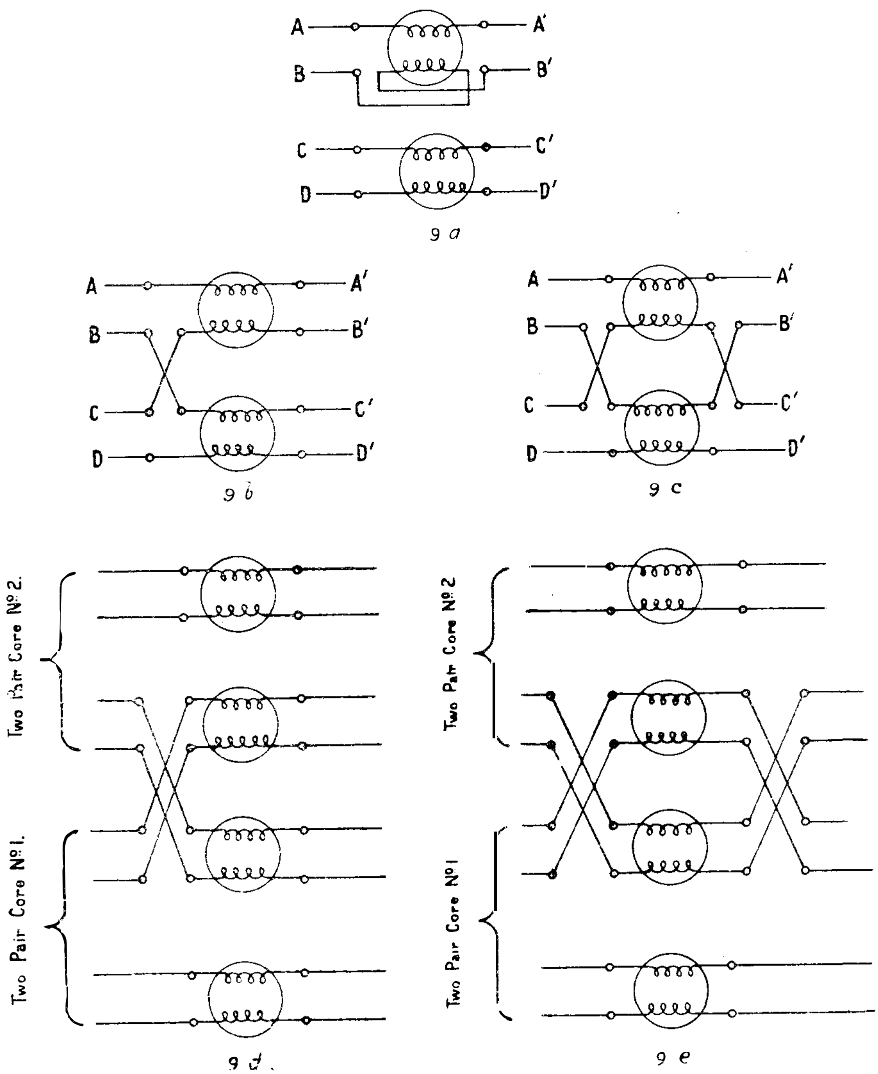
(9) The impossibility of the permanent magnetisation of the iron core through the flow of any working or testing currents.

(10) Compactness and complete protection from mechanical injury.

(11) Suitability of design for manufacture in quantity.

The original Post Office air-core coils did not satisfactorily fulfil conditions (5), (8) and (10), and were inferior to the modern iron-core coils in respect of (1) and (2). The modern iron-core coils only partially fulfil conditions (2), (3), (6), (8) and (9), and future progress in design and construction will tend towards a more complete attainment of these conditions. The design of the magnetic core directly influences conditions (2), (3), (8) and (9), and much research work has been carried out during recent years in this connection. Loading coil cores have hitherto been built up of thin iron plates or of fine iron wire. The specific resistance of such cores is fairly high, but it cannot be increased beyond a certain point because of the difficulty of a higher degree of lamination. Attempts at increasing the permeability of the material of the cores have generally been negatived by an excessive increase of the hysteresis and eddy-current losses, and in an impairment of the magnetic stability. Patents have been taken out from time with a view to overcoming some of these difficulties, the most recent of which describes a method of forming loading-coil cores from specially treated finely divided magnetic material, which is moulded into suitable form under high pressure. Air-gaps have also been introduced in order that the permeability of the core to telephone currents will be essentially the same under varying degrees of residual magnetism. The authors are not at present in a position to say to what extent improvements have been effected by the modifications described above.

PRECAUTIONS WHEN TESTING LOADING COILS OR LOADED LINES.—In order to guard against permanent magnetisation of the core, owing to the passage of large currents through the coils and



9.—FAULTS IN JOINTING LOADING COILS INTO CABLES. (A) ONE WINDING REVERSED. (B) SPLIT PAIR. (C) DOUBLE SPLIT PAIR. (D) SPLIT CORE. (E) DOUBLE SPLIT CORE.

the accidental production of excessive voltages which might result in a breakdown of the insulation of the coils, certain precautions are adopted when testing loading coils or loaded lines. A current of more than 100 milliampères is liable to permanently magnetise the iron core, and so in making direct-current tests on the coils the testing current should never exceed about 25 milliampères. Further, in making megger tests, the charge in the line should always be allowed to discharge through the megger after the latter instrument has been brought to rest, in order that the discharge current may be limited in amount by the resistance of the instrument. For insulation tests a voltage greater than 250 volts should only be used in exceptional circumstances on account of the danger of insulation breakdown.

THE LOADING OF SUBMARINE CABLES.—Up to the present the phantom circuits of submarine cables have been loaded by two separate coils, one of which is inserted in each loop circuit at the same point as the side circuit coils, to which they are exactly similar, as shown in **6**. If $(2S + 4M)$ is the inductance of the two windings in series assisting, then $(\frac{1}{2}S + M)$ is their inductance in parallel assisting, which is therefore the inductance in one leg of the phantom circuit. If it is assumed that S is small, as is the case in practice, it follows that the inductance of a loading coil used to load the phantom circuit is one quarter of the inductance which it would have if used to load a loop circuit.

The total inductance of the phantom circuit due to two coils is therefore $(S + 2M)$, which is just one-half of the inductance of either loop coil. As the electrostatic capacity per unit length of the phantom circuit is double the electrostatic capacity of either loop circuit this arrangement of coils will load the phantom circuit to the same degree as the side circuits.

THE PHANTOM CIRCUIT COIL FOR UNDERGROUND CABLES.—The coil used for loading the phantom circuits of underground cables has four windings wound over a single core. One winding is joined into each line of the two pairs forming the phantom circuit. The coils are generally in the same case with the side circuit loading coils, and are joined to their respective side circuit loading coils in the works of the manufacturer (see **7**).

Consider a coil with four windings (see **8**), AA', BB', CC' and DD'. Let the inductance of each winding be $(S + M)$; S and M having the same meanings as in the coil previously dealt with. The windings are to be considered inductive in the same direction, AA', BB', $C'C$ and $D'D$. The inductance of any two windings may be obtained from Table I. The inductance of the four windings can be obtained from this table by regarding two windings joined together as one and applying the formulæ. The results are shown in Table III. Generally S is so small that it may be neglected. Caution should, however, be used when referring to the table, as it does not necessarily follow that S and M are the same for each pair of windings, although this is usually the case in practice.

TABLE III.

Circuit (see 8).	Self-induction.	Self-induction, neglecting S.
One winding	$S + M$	M
Two windings, series assisting	$2S + 4M$	$4M$
,, ,, series opposing	$2S$	*nil*
,, ,, parallel assisting	$\frac{1}{2}S + M$	M
,, ,, parallel opposing	$\frac{1}{2}S$	*nil*
Four windings, series assisting	$4S + 16M$	$16M$
,, ,, series opposing	$4S$	*nil*
,, ,, series parallel assisting (as used in the phantom circuit of underground cables)	$S + 4M$	$4M$
Four windings, series parallel opposing	S	*nil*
,, ,, parallel assisting	$\frac{1}{4}S + M$	M
,, ,, parallel opposing	$\frac{1}{4}S$	*nil*

The coils, Type 536, used for loading the phantom circuits in the London–Birmingham–Liverpool cable have an inductance of about 82 millihenries; assuming S is small, each winding will have an inductance of about 20 millihenries.

THE JOINTING OF SIDE-CIRCUIT LOADING COILS INTO CABLES. —It will be readily realised that a coil may be joined into a cable incorrectly, as far as its designed inductive effect is concerned, and yet the circuit may appear satisfactory to continuity tests. A few of the most general mistakes of this kind, their effects on the circuit and the method of detecting them are given below:

(1) A winding may be reversed in either leg of the circuit (see 9A). This causes the inductance in the loop to be $2S$ instead of $(2S + 4M)$, which means that the loop is practically unloaded since S is small. An inductance of $(\frac{1}{2}S + M)$ appears in the leg of the phantom circuit, of which this pair forms a part. This mistake can only occur when there is one cable stub to the loading coil case. When an "up" and a "down" stub are fitted this reversal of one winding is hardly possible. It will be noticed that if both windings are completely reversed the circuit will be correctly loaded.

(2) One winding may be joined into a wire of one pair, whilst the other winding of the same coil may be joined to a wire of another pair, as illustrated in 9B and 9C. This causes the inductance in each wire to be $(S + M)$ and the inductance of the loop to be $(2S + 2M)$ instead of $(2S + 4M)$—*i. e.* the effective inductance of the loop is practically one-half of what it should be were the coil correctly inserted. In addition to this, loud cross-talk is set up between the pairs concerned and also between the pairs and the phantom circuits on these pairs. It will be noticed that the faulty

jointing represented in 9B will give rise to two "split pairs" in the cable, whilst the two jointing errors (one on either side of the coil) represented in 9C counteract each other as far as the splitting of the pairs of the core or cores is concerned, but not in respect of the inductance of the circuits.

(3) In the case of those cables in which a proportion only of the total number of circuits are to be loaded, some of the coils may be joined by inadvertence into what should be unloaded loops and omitted from those intended to be loaded. This may sometimes be detected by variations from the normal loop resistance as well as by an inductance test.

(4) One pair of a two-pair core may be jointed at a loading point in such a manner as to be associated with a pair from a different two-pair core ("split core"), (see 9D and 9E). The fault represented in 9D will be discovered on tapping-out during the constructional tests, since pairs which are associated in any faulty two-pair core at one end of the cable will appear in separate two-pair cores at the other end. The faults represented in 9E will counteract each other as far as the splitting of cores is concerned, but will cause trouble subsequently when loaded phantom circuits are superposed on the loops concerned. In such a case cross-talk between the two phantom circuits would be experienced.

Each of the above types of fault has been met with in practice, and serves to indicate the necessity for the systematic laying out of the work, the provision of clear and lucid instructions to the jointers and the careful and regular carrying out of electrical tests during the construction period, especially in those cases of balanced and loaded cables where portions of the whole work are carried out by different Engineering Districts. In such cases, and particularly when only a proportion of the circuits are to be loaded, or when some circuits are to be loaded with a different type of coil from the other circuits, the jointing of the coils should be carried out in accordance with a definite numbering scheme. The circuits are numbered in a definite order from one end (*e.g.* the "up end") of each loading coil section; numbers are then placed on the wires of corresponding circuits at the other end (*e.g.* the "down end"). Each of the loading coil stubs is correspondingly numbered in accordance with the pre-arranged scheme. Circuits bearing the same numbers at either side of the loading coil are joined together *viâ* the similarly numbered wires of the loading coil stubs.

Besides promoting uniformity of method and greatly reducing the chances of jointing errors, such a numbering scheme provides a rapid and certain method for the identification of the circuits at any of the loading points at any time subsequent to the jointing operations. It also greatly reduces the chance of disturbing working circuits when the cable is being opened for maintenance purposes and a given circuit is required to be picked up for testing or any other purpose.

THE JOINTING OF PHANTOM CIRCUIT LOADING COILS INTO CABLES.—When the phantom circuit coils are contained in the same case as the side-circuit coils, the method adopted is similar to that for jointing side-circuit coils. Any mistakes made in jointing these coils into a cable are more difficult to locate, however, as the considerations of the inductance effects are more complex, although the detection of such errors may be as easy as when only loop coils are present.

Auxiliary cable stubs have been provided at the loading points in the London–Birmingham–Liverpool cable for the purpose of loading the phantom circuits of the 200-lb. conductors, should it be deemed desirable in future to do so. Each two-pair core is led in and out of the stub by two associated two-pair cores forming an eight-wire core. The phantom circuit loading coil is intended to be joined between the associated "up" and "down" two-pair cores in the stub, and it will therefore be of interest to notice the effect on the working of the circuits of a two-pair cable core, resulting from the following reversals of the "up" and "down" wires of the stub.

It will be assumed that each phantom coil is joined into its own circuit, *i.e.* its own eight-wire core. (See **8** for diagram of the coil.)

(1) One wire of a pair reversed. Result: Cross-talk between this pair and the phantom circuit. This pair is partly loaded by the phantom coil. One leg of the phantom only is loaded, namely, that leg which is made up of the other pair of the core.

(2) One wire of each pair reversed. Result: Cross-talk between the two loop circuits. Each loop circuit is partly loaded by the phantom coil. The phantom is not loaded.

(3) Both wires of one pair reversed. No cross-talk, but the phantom will not be loaded.

(4) Both wires of one pair and one wire of the other pair reversed. This is equivalent to (1) as regards the pair with the one wire reversed.

(5) All four wires reversed. The phantom will be correctly loaded.

It will be noticed that cross-talk results from all these mistakes except those indicated under (3) and (5).

THE TESTING OF LOADED CABLES.—It is considered that during the period of construction, electrical tests should be made on every three loading coil sections which have been joined together through the coils, in order to check the accuracy of the jointing, to detect damage to the coils through magnetisation of the cores, and to determine the advisability of inserting suitable crosses between such groups of sections for the purpose of preventing the building-up of cross-talk. When these sections are thus tested any faults which exist can very often be located quite definitely to the correct coil. If more sections are dealt with in any one test, it may only be possible to detect the fault and not locate definitely its position without incurring the expenditure of considerable time, trouble and expense.

Complete final tests of the finished cable should always be made between the terminal exchanges before the cable is brought into use.

NOTES ON FRENCH TELEGRAPH CONSTRUCTION.

By CAPT. P. DUNSHEATH, O.B.E.

IN the early part of 1918 the writer was responsible for the installation of a system of communications for the Independent Air Force operating between Nancy and Epinal for the purpose of bombing the various military objectives along the Rhine Valley. In the course of this work, owing to the wide area over which the aerodromes and parks were spread, and to the urgency with which the circuits were required, it was found necessary to co-operate very closely with the French Department of Posts and Telegraphs, using their permanent routes by picking up spare wires, diverting circuits, and running additional wires. With a view to retaining the circuits on the cessation of hostilities, the French authorities were anxious that only standard French fittings should be used in erecting new circuits, and in this way an excellent opportunity offered of comparing French with British methods.

In the simplest form of French open-line construction the wires are supported on *consoles* consisting of glass or porcelain insulators cemented on to iron brackets with plaster of Paris. The fittings are fixed to the pole by means of coach-screws—two to each—and are arranged in pairs, one long and one short, on opposite sides of the pole. By staggering alternate pairs as shown in **I**, the span clearance between wires is improved.

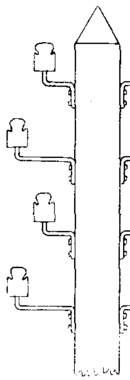
As it is not the practice in France to bind in line wires at every pole, the insulators are shaped with horns below the groove and these support the wire.

Two sizes of insulators are in general use corresponding with our large and small types, and are known as the G.M. (Grande Modèle) and P.M. (Petit Modèle) respectively. The large type is adopted for wires heavier than about 200 lb. a mile.

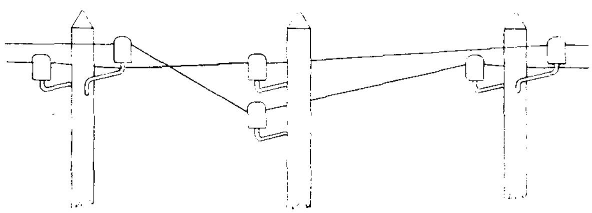
The system of crossing these flat pairs against induction is indicated in the following table:

	Distances in km. from beginning of line.										
Top pair crosses at . .	—	1	—	2	—	3	—	4	—	5	etc.
Second ,, ,, ,, . .	½	—	1½	—	2½	—	3½	—	4½	—	,,
Third ,, ,, ,, . .	½	1	1½	2	2½	3	3½	4	4½	5	,,
Fourth ,, ,, ,, . .		1	—	2	—	3	—	4	—	5	,,
Fifth ,, ,, ,, . .	½	—	1½	—	2½	—	3½	—	4½	—	,,

It will be seen that after the first three pairs the sequence recommences. The sixth pair would be crossed at the same points as the third, and so on.



1.—Arrangement of Long and Short *Consoles*.



2.—Method of inserting a cross in a Flat Pair.

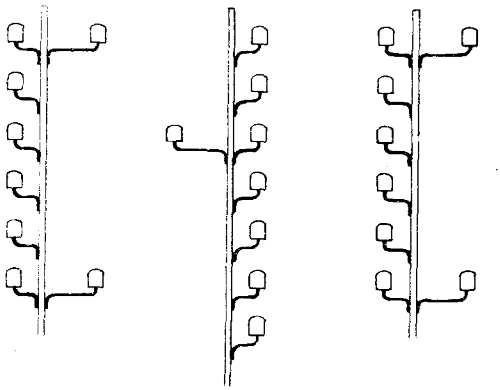
To insert a cross in a pair two short *consoles* are fixed on one side of the pole and the wire from the other side is brought round as illustrated in **2**.

3 shows the necessary fittings for four pairs of wires at the ½-km., 1-km., and 1½-km. points.

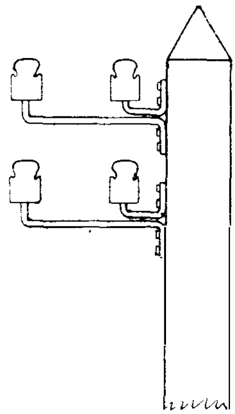
Telegraph wires are usually separated from telephone pairs by being run in a group by themselves low down the pole.

To obtain squares of wires for phantom circuits the French usually employ arms as described below; but, in several cases met with, the combination of *consoles* shown in 4 had been adopted The twisting of the pairs in these cases is not carried out in every span, but, at intervals of a kilometre or so, a quarter twist is inserted in the span. On heavy rail routes an eighth of a turn is given in each of two consecutive spans, the centre pole having special fittings to throw the diagonal pair vertical.

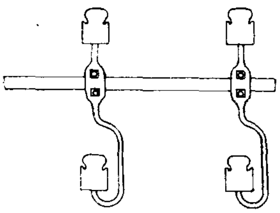
The type of construction described above is used on lines up to ten or twelve pairs and sometimes more ; but for heavy routes iron arms are employed. These are made of square tube clamped to the pole with a metal saddle and carrying double fittings, as shown in 5, which are secured to the arms by means of small U-shaped



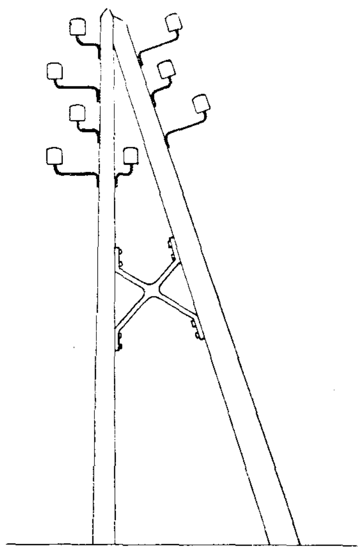
3.—Arrangement of Fittings at ½ km., 1 km., and 1½ km. Poles for crossing Four Flat Pairs.



4.—One Method of obtaining Wires in "Square" Formation.



5.—Construction with Tubular Iron Arms.

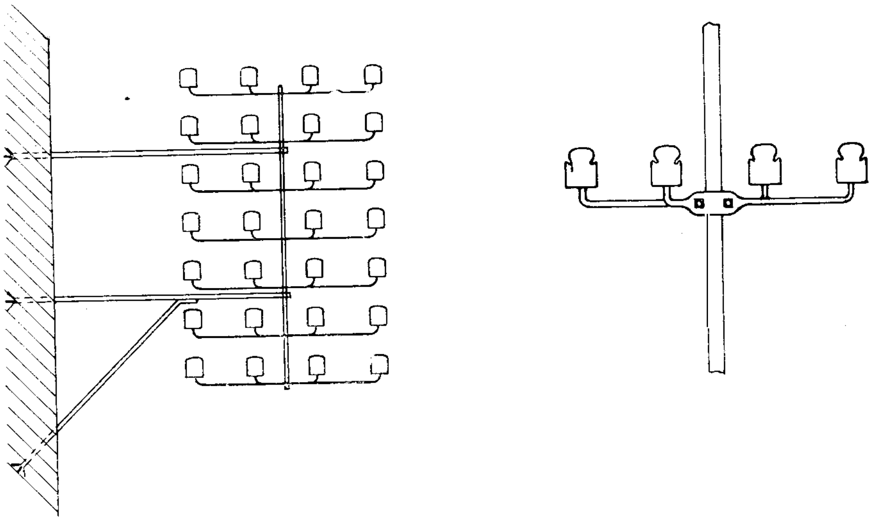


6.—Common Type of Strutted Pole.

bolts and nuts. This is the standard construction on the very heavy State routes running along the railways.

The French rarely use stays on pole lines. Poles are sunk very deep and given considerable "set" at angles, while wires are not pulled up to a very high tension. No external support is given at small angles, but the spans are considerably reduced. At sharp angles and on heavy routes struts are used almost exclusively, an **X**-shaped forging being fitted, as shown in **6**, with coach-screws into the poles. In these cases some of the *consoles* are usually fixed down the strut in the manner indicated.

French line wires are designated, not by their weight, but by their diameter in millimetres. For instance, three types of bronze wire are used having diameters of 1, 1½, and 2 mm. The "*quinze-dixième*" (1½ mm.), slightly heavier than 40 lb. bronze, is largely used for subscribers' circuits. Copper wires vary in half millimetres from 2 to 5. The "*fil de deux*" (2 mm.) is largely used where we

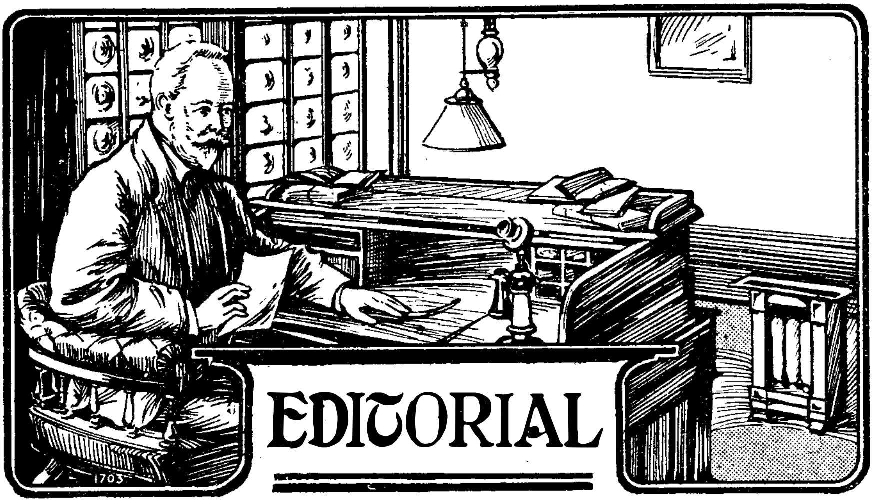


7.—*Potelet Lorain.* General Arrangement and in Detail.

should run 100-lb. copper, and the "*trois*" (3 mm.) for 200-lb. copper.

House fittings are much more popular with the French telegraph engineer than over here. In large towns quite heavy routes are run on the face of buildings along main thoroughfares. The fitting used for this purpose is known as the *Potelet Lorain*, and consists of a vertical square section iron tube, in various lengths up to about 8 ft., to which are clamped double horizontal *consoles*, as illustrated in **7**. The upright tube is clamped to two horizontal tubes of similar material, the ends of which are splayed and cemented into the wall of the building, the lower one being strutted from a point further down the wall. With this fitting, again, the insulators are cemented on to the iron shanks.

As a result of pre-war holidays spent on the Continent, the writer had formed the impression that continental telegraph construction was of an elementary nature and very much inferior to British construction. More intimate knowledge of the methods, gained during the war, has, however, modified that view. There are many points where British methods score, such as the more perfect symmetry obtained with machine-bored arms than with *consoles*—an important point where phantom circuits are concerned—and the ease with which British insulators are replaced when broken. At the same time it must be admitted that certain of the French methods have much to commend them. The unpopularity of stays helps in the wayleave problem and the simplicity of the road lines keeps down the number of different items which need to be carried. A heavy French route, with its many struts and cross braces, certainly makes a sound mechanical job, and the good regulation which one finds on these lines tends to confirm this view.



RETIREMENT OF SIR WILLIAM SLINGO.

AN official career, short of fifty years by a few months only, was brought to a close on May 31st last by the retirement of Sir William Slingo, who, since March 1st, 1912, has occupied the onerous position of Engineer-in-Chief to the Post Office.

To engineering readers it is hardly necessary to say that a member of any branch of their profession who succeeds in keeping pace with its ever-advancing requirements must needs devote himself whole-heartedly to his work, and so it was with Sir William. Like many other eminent men in the world of action he left the schoolroom at an age when, according to most modern authorities, the time is far from ripe for closing, in the ledger of life, the account under the name of "Education." But, whether the said authorities are right or wrong, Sir William started his life's work with assets which are of greater importance than any store of acquired knowledge—native ability, energy, and, not least, a marked sense of humour; these early set him on the road which after some twenty years caused his name, in association with that of his colleague, the late Mr. A. Brooker, to be as well known among students of electrical engineering as that of Todhunter among aspiring mathematicians, and there can be no doubt that the feeling of gratitude on the part of the electrical students was more pronounced than among the would-be Wranglers!

Subsequent to his appointment as Engineer-in-Chief Sir William has served on the Council of the Institution of Electrical Engineers, and also on a number of Committees set up by that Institution and also by the British Engineering Standards Association to deal with technical problems in the domain of electrical engineering, and it is worthy of note that he has recently been appointed by the Sectional Electrical Committee of the latter body to the position of Chairman of the Sub-Committee on Telegraphs and Telephones in succession to Sir John Gavey.

The extent of the advantage which has accrued to the British Post Office and to our Colonial administrations as a result of Sir William Slingo's work during the years 1876 onwards cannot be estimated, but there is no doubt that it resulted in the study of telegraph and telephone engineering being placed on a truly scientific basis at a much earlier date than otherwise would have been the case, and in view of the extent to which, in the development of telegraphy, British practice has been followed in other countries, it is not overstating the case to say that his pioneer efforts exercised an influence which was world-wide.

It is seldom within the power of the staff of a Government Department—or, indeed, of any undertaking—when their Chief retires to take any action of continuing force which may be regarded as conferring honour on both parties; and it is very pleasant, therefore, to be able to record that on the eve of his retirement Sir William Slingo was elected an Honorary Member of the Institution of Post Office Electrical Engineers, of which, it need hardly be said, he has always been a cordial supporter.

Sir William, in one respect, may reasonably feel that Fate was hardly kind to him when, after his attainment of the blue ribbon of the British Post Office Engineering Department, it decreed that out of a period of seven years' further service nearly six years were mainly absorbed in attending to problems arising out of the valuation of the National Telephone Company's undertaking and then out of the great war. To critics, if such there be, who may be inclined to suggest that the present organisation of the Engineering Department shows relatively small evidence of his personality, it may fairly be suggested that he showed wisdom in refraining from the attempt to introduce "reforms" under the conditions that have prevailed since August, 1914.

It is not surprising to know that Sir William has no intention of leading a life of ease now that he is, in a stricter sense than hitherto, free to shape his own actions, and we feel that we do no more than give expression to the thought in the minds of all our colleagues when we wish him many years of activity in those spheres of interest to which his knowledge and experience direct him.

THE EDITORS.

"W.S.": AN APPRECIATION

WHEN the writer first met him in 1882, "W.S." had already become an outstanding personality in that great forcing house of character—for good or ill—TS.

With characteristic acumen and pre-vision "W.S." had realised as far back as the 'seventies that the progress of the nascent but rapidly developing art of telegraph engineering must result in a clamant demand for the acquisition of a higher technical efficiency—as distinct from manipulative skill—on the part of the operating force. In preparation for this, he first made himself proficient in the art, as well as in other recondite subjects having to the superficial eye but little connection therewith—no mean task in those days of non-existent or misleading text-books—and, this done, he commenced, and for many years carried on single-handed, the pioneer work of training the telegraph engineers of the future.

The yield from the efforts of those early years was more substantial to the pupils than to the teacher; but, though for some years the results were not sensational, the consistent spade-work eventually told, and, as the roots of his carefully-nurtured plant struck ever deeper, the fruit became more plentiful and the work of cultivation less arduous, but only those who know the conditions under which "Slingo's Classes" had to be carried on during their first lustrum can adequately appreciate the tremendous amount of dynamic energy expended before success—indubitable and sweeping—was achieved.

Looking back to the 'eighties and thence onwards, the writer's recollections of "W.S." are of a man always at work, always energetic, always optimistic, always enthusiastic: indeed "*Toujours l'audace*" might well have been his motto, though a measure of shrewd caution was ever mingled with his audacity.

In illustration it may be pertinent to quote the notable oblique attack on current overhead line construction made by "W.S." and his brilliant lieutenant, the late Arthur Brooker, in their series of articles, "Storms and Telegrams," published by the 'Electrical Review' in January and February, 1891, dealing primarily with the great breakdown of Christmas, 1886. Foreseeing perhaps that one day, as Engineer-in-Chief, he might have to justify his words—though at that time he was not even on the Engineering Staff—"W.S." wrote: "It is only on such occasions as storms of snow, hail, wind or rain that outsiders are made aware of the difficulties which result from causes that no amount of engineering skill could entirely provide against, although, as will be shown, much may be done to minimise disastrous consequences." It was therefore fully in accordance with the eternal fitness of things that the record storm in all British telegraph engineering experience should have occurred while Sir William Slingo occupied the post of Engineer-in-Chief; probably no one was more thankful than he for the existence, in 1916, of the underground routes, for which in 1891 he so convincingly pleaded, urging that the cost, great though it might appear, should be looked upon as merely the premium necessary to be paid for insurance against interruption of communication.

Glancing round the large company gathered in the Postmaster-General's Deputation Room on May 30th last, to make a formal presentation to him on his retirement from the highest position in the world of telegraph engineering, the memorial to Sir Christopher Wren in the Cathedral hard by—

"LECTOR, SI MONUMENTUM REQUIRIS, CIRCUMSPICE"

leapt to the mind, for, save for the N.T.C. men who had also foregathered to do him honour, the vast majority of the telegraph engineers there present were men in whose training "W.S." had played a prominent part.

Asked for the secret of his success, he might well answer, "Work, and payment by results"; certainly the policy he followed himself he instilled into those who worked for him. He appreciated good work, and acknowledged it in a way of his own, rarely in words, but ever by the kindly and genial smile that spoke just as eloquently to those who knew him.

The writer knows no more fitting conclusion than that which he quoted, as applicable to their honoured guest, at the dinner given in 1912 to "W.S." by his old students on his preferment to the title and dignity of Engineer-in-Chief to the Post Office:

"If you can fill the unforgiving minute
With sixty seconds' worth of distance run,
Yours is the Earth and everything that's in it,
And—which is more—you'll be a Man, my son."

G. F. M.

COMPLIMENTARY DINNER TO SIR WILLIAM SLINGO.

THE Annual Dinner of the Post Office Engineering Department, which had been suspended during the period of the war, was resumed this year in the form of a complimentary dinner to Sir William Slingo on his retirement from the service. The gathering was held at the Connaught Rooms on May 31st—a date which, although rather late in the year for such a function, was chosen intentionally because it was the last day of Sir William's service in the Post Office.

The chair was taken by Mr. W. NOBLE, who, before calling upon Mr. M. F. Roberts to propose the toast of the evening, read several letters of regret from gentlemen who were unable to be present; notably among these was one from Sir John Gavey, who was not well enough to attend.

Mr. M. F. ROBERTS, in proposing the toast of the evening, referred in very eulogistic terms to the career of Sir William, mentioning that they both joined the Post Office service in the same month of the same year, viz. June, 1870. In the course of his remarks he referred to the fact that of the 25,000 members of the Engineering Department some 13,000 joined the colours, and of these some 1000 have given their lives for their country. He also pointed out that great difficulties had existed in the early days in obtaining technical information, and even then it was not always accurate. It was this great need that led Sir William to establish his "Telegraphists' School of Science." This institution proved wonderfully successful, and resulted in many of the students obtaining very high positions in the Post Office service. It was no doubt a fact that many of those present that evening were indebted to the Telegraphists' School of Science for the progress they had made. The school was eventually closed, not because it was not a success, but because it was too great a success and drew too many students from other technical institutes.

A few interesting dates in Sir William's career were quoted, viz.:

1898. First Class Technical Officer.
1903. Superintending Engineer, North Wales District.
1911. Assistant Engineer-in-Chief.
1912. Engineer-in-Chief.
1915. Knighted.
1918. Chevalier pour l'Ordre de Léopold.

The speech was punctuated by frequent bursts of applause.

Mr. MOIR, Superintending Engineer of the London District, supported the toast in an admirable speech, which his audience thoroughly appreciated.

Sir WILLIAM SLINGO, in replying, expressed his due appreciation of the kindness extended to him, and referred to the very great difficulty he experienced in suitably responding to the eloquent speeches that had been made on his behalf. He referred particularly to his love for the work of the Engineering Department, and that the secret of every success is "work." Work among colleagues, all working for the common good, cannot fail to be successful, and he enjoined his hearers to bear this always in mind. He paid willing tribute to the unfailing support he had received from his staff, and he felt that he had the confidence of the staff, just as much as he had felt confidence in them.

The reply was followed by loud and prolonged applause and by the singing of "For he's a jolly good fellow."

The toast of the Chairman was ably given by Mr. NEWLANDS, Controller of the C.T.O., and was well supported by Mr. MORGAN, late Controller of the Stores Department.

In reply, Mr. NOBLE expressed his great desire to give satisfaction in his new position, although he recognised that complete satisfaction was practically an impossibility. He would, however, do his utmost to attain that end, and in this respect his door would always be open, so that he might act as guide, philosopher and friend to any of his colleagues who had need of his assistance.

Mr. A. J. STUBBS proposed a vote of thanks to the Dinner Committee for the hard work they had done in providing such an excellent repast and for the splendid musical entertainment that had been given.

The meeting closed by the singing of "Auld Lang Syne."

It is understood that Sir William Slingo is proceeding shortly to the United States in connection with proposals for submarine cable work in America. He has thus relinquished office in the Post Office only to take up a similar kind of work elsewhere. During the war Sir William undertook, as personal work, the provision of the numerous submarine cables required for naval and military purposes, including the cutting of enemy cables and the provision of new telegraph and telephone cables between England, France, Russia and Canada.

* * * * *

Many members of the staffs of the Engineer-in-Chief's and other Departments met in the Deputation Room, G.P.O. North, on the afternoon of May 30th, 1919, to bid adieu to Sir William Slingo on his retirement from the service the following day and to present gifts.

Sir William was accompanied by Lady Slingo.

Mr. W. Noble presided, and the speakers included Mr. C. E. Sparkes, who spoke first as representing the Stores Department and secondly as an old Slingo boy, "who felt his advancement in the service had been made possible by Sir William's efforts and faith of years gone by."

Mr. A. Moir addressed the meeting on behalf of the Superintending Engineers and Mr. E. H. Shaughnessy for the "old Slingo-ites."

The presentation consisted of a Persian carpet, an illuminated address, an album containing the names of the subscribers to the testimonial for Sir William and a gold chain to Lady Slingo. The gifts were presented by Mr. Noble with many a kindly word of good cheer for their future happiness and welfare.

Sir William Slingo in acknowledgment said: " Mr. Noble, Ladies and Gentlemen,—I have had a few difficult positions to fill in my life at one time or another, but I do not know that any one of them was more difficult than this. The parting of the ways has come. I do not know what the future has in store for me, as to which you have been good enough to express kindly feelings, but I am confident of this, that no man ever served in a department for nearly fifty years with greater calmness, greater happiness and greater comradeship than has fallen to my good fortune. So far as this testimonial and these records of good feeling are concerned, I can assure you I appreciate them in the spirit and the fact to the full.

" As regards the carpet this was thought to be something exceptional, and, as one of the committee remarked, had a Slingo touch about it. I can only hope it will support us when we tread on it as faithfully as I have been supported by my students and staff during the past.

" The testimonial shall have its sphere of influence too. It will be hung where I hope it will be an inspiration to the young Slingos who will happen to see it in the future. I think it will be an inspiration to them.

" On behalf of my wife I have to thank you very cordially indeed for your kindly thoughtfulness in remembering her. To her I owe very much: first because she is my wife, and secondly because that without her I could not have done what I have done.

" In conclusion I again thank you very heartily and very feelingly for your goodness, and I hope you may all have long life and a good time."

THE DECIMAL ASSOCIATION.

MR. A. J. STUBBS, Assistant Engineer-in-Chief, whose work in advocating the advantages of the metric system is well known, has been appointed a member of the Executive Committee of the Decimal Association.

POST OFFICE STORES DEPARTMENT.

RETIREMENT OF MR. G. MORGAN, C.B.E., I.S.O., AND APPOINTMENT OF MR. W. H. ALLEN, O.B.E., AS CONTROLLER.

THE retirement on April 13th last of Mr. G. Morgan, C.B.E., I.S.O., Chevalier of the Order of Leopold, from the Controllership of the Stores Department closed a long and honourable career in the service of the Post Office.

Mr. Morgan entered the Service on September 1st, 1871, at the age of eighteen under the first Engineer-in-Chief of the Post Office, Mr. R. S. Culley, to whom, as well as to Mr. W. H. Winter, the Assistant Engineer-in-Chief, he acted from the first as personal clerk. He brought with him three years' experience of a large commercial business—an experience that undoubtedly stood him in good stead throughout his forty-seven and a-half years of public service in what may be claimed to be the most progressive Department of the State. On the retirement of Mr. Culley in 1874 Mr. Graves was appointed Engineer-in-Chief and Mr. W. H. Preece (afterwards Sir William Preece) Assistant Engineer-in-Chief. The occasion was taken to form, out of the Engineer-in-Chief's office, a new Department known as the Telegraph Stores Department, the first control of which was placed in the hands of Mr. Winter and later in those of Mr. C. E. Stuart, each of whom in turn retained Mr. Morgan as his personal assistant. Both Mr. Graves and Mr. Preece were desirous of securing the return of Mr. Morgan to the Engineer-in-Chief's Office and on more than one occasion requisitioned his services, but eventually Mr. Morgan elected to remain in the Stores Department.

On the retirement of Mr. A. F. Varley, soon after the amalgamation of the Postal and Telegraph Stores Departments in 1902, Mr. Morgan became Assistant Controller, and in 1908, on the retirement of Mr. S. C. Hooley, I.S.O., the first Controller of the combined Department, he was appointed to the Controllership.

The reign of the new Controller was full of incident and hard work, section after section of new work being added to the Department. The transfer of the National Telephone Company's Store and Factory work and staff and the re-transfer to the Stores Department of the Post Office Factories both maturing on the same day (January 1st, 1912) doubled the staff of the Department, which was still further increased by the addition on April 1st, 1914, of the Stamps Section, which for many years had been administered by the Board of Inland Revenue, so that before his retirement Mr. Morgan's staff numbered nearly 3,500. Then came the war, which made special calls upon the Department, involving much additional work which had to be performed under very trying conditions. All these tasks the Controller faced with equanimity; responsibility sat lightly on him, and years passed without adding a wrinkle to his brow or a grey hair to his head. He tackled his work with zest, but without hustle. He was never flurried, and his quiet confidence in his own and his Department's powers to tackle any job that might come along was a tremendous asset to a Department whose work was constantly increasing. His never-failing tact and courtesy, his broad-mindedness, and above all his human sympathy endeared him to all with whom he came in contact. The cordial relations between the Engineering and Stores Departments, without which the work of neither could be successfully accomplished, owe much to his personal influence.

Besides being a member of the Fair Wages Advisory Committee, Mr. Morgan, on the outbreak of war, was appointed an Official Adviser to the Central Committee on Women's Employment, a committee set up by the Local Government Board.

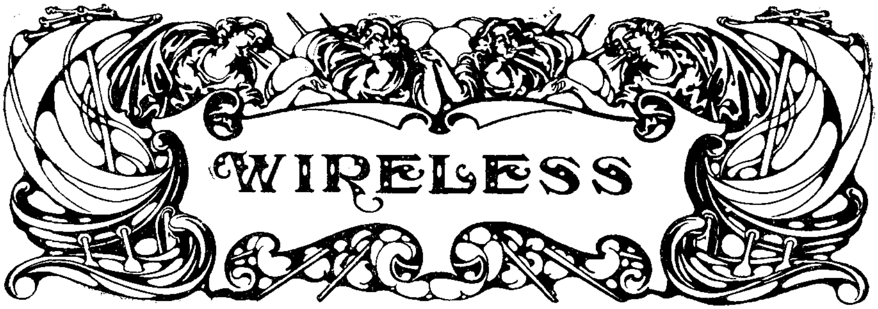
Mr. Morgan was the guest of the more senior members of his staff at a dinner at the Holborn Restaurant on April 10th, and on April 11th he was the recipient of a testimonial from his staff and from a few old Engineering friends who insisted on coming in.

All join in wishing him a thoroughly good time in his well-earned retirement and a long continuance of that excellent health which we have come to look upon as inseparable from him.

It seemed inevitable that Mr. Morgan should be succeeded by his able chief Assistant, Mr. W. H. Allen, O.B.E., who for so many years had been associated with him in the conduct of the work of the Department, but it is very satisfactory to see the announcement of his appointment in the 'Post Office Circular' of April 15th.

Mr. Allen, although never a member of the Engineering Department, was a candidate for the technical officership obtained by Mr. A. J. Stubbs in 1887. Mr. Allen entered the Stores Department in 1882, became an Examiner in 1888, and an Assistant Superintending Examiner in 1900. After the amalgamation of the Postal and Telegraph Stores Departments his organising abilities and his exceptional powers of working out detailed schemes soon brought him to the front and his promotion was rapid. He became a Staff Officer in 1905, Assistant Controller in 1908, and Vice-Controller in 1914. He was a member of the "Section Stock" Committee (1909), the Engineering Accounts Committee (1910), and Capt. Norton's Committee on the Post Office Factories (1910–11).

The extensive Engineering programme will impose a heavy burden on the Engineering and Stores Departments, and it is pleasing to know that the control of the two Departments has not been weakened by the changes, and that the cordial relations between them are sure to be fully maintained.



WIRELESS TELEPHONY AND DIRECTION-FINDING DEMONSTRATIONS.

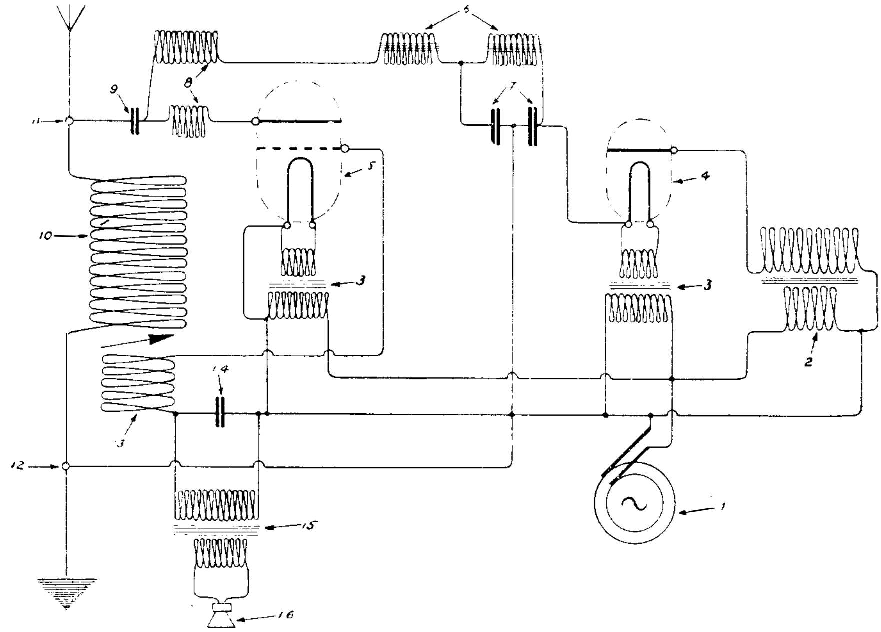
THROUGH the courtesy of the directors of the Marconi Wireless Telegraph Company, Limited, members of the Board of Editors were invited to attend a series of wireless demonstrations at Chelmsford on May 28th.

Advantage was also taken to make a comprehensive tour of the works and to examine the different processes of manufacture of wireless equipment. The works are thoroughly up-to-date in every respect, making such small items as the screws and terminals for instruments, using for these purposes automatic lathes. Several machines for engraving purposes were at work cutting the scales on condensers and other pieces of apparatus. The Company has undertaken important contracts for Admiralty and Army wireless apparatus throughout the war, in addition to the enormous demands of the mercantile marine, whilst the wireless stations belonging to the Marconi and subsidiary companies in all parts of the world have obtained the bulk of their supplies from the Chelmsford works. The inspection included visits to the store-rooms for raw materials and spare parts, the wood-working and wiring sections, also the assembly and erecting shops.

Visits to the testing and research departments were interesting features in the tour of the works and visitors found these sections among the most fascinating items in an enjoyable programme.

Approximately 800 employees are engaged at the Chelmsford works and a good proportion of the staff consists of women and girls. The whole of the employees work under favourable conditions, and it was interesting to observe that canteens, also a social club, with billiard tables, etc., have been provided for the welfare of the staff. A fully-equipped surgical ward has also been established in order to deal, on the spot, with any cases of accident to, or illness among, the workers.

During the morning demonstrations of wireless telephony were carried out between the Chelmsford works and a small station at Broomfield, about two miles distant. This experience enabled visitors to test the scope and value of the latest development in wireless telephony. The articulation was distinctly good, and the reduced amount of distortion was a noticeable feature in the trial. **1** gives details of the wiring of the wireless telephony transmitting station, whilst **2** illustrates the wiring of the apparatus at the

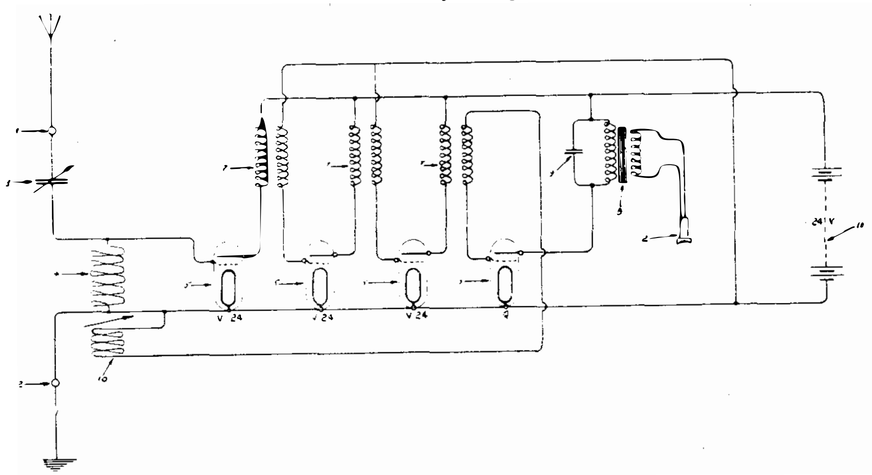


1.—WIRING DIAGRAM OF WIRELESS TELEPHONY TRANSMITTER CIRCUIT. 1, ALTERNATOR. 2, POWER TRANSFORMER. 3, FILAMENT TRANSFORMERS. 4, RECTIFYING VALVE. 5, POWER VALVE. 6, IRON CORE CHOKES. 7, CONDENSERS. 8, AIR CHOKES. 9, BLOCKING CONDENSER. 10, AËRIAL INDUCTANCE. 11, AËRIAL TERMINAL. 12, EARTH TERMINAL. 13, REACTION COIL. 14, GRID CONDENSER. 15, MICROPHONE TRANSFORMER. 16, MICROPHONE.

receiving station. Several different types of wireless telegraphy and telephony installations were inspected, one of the most interesting being a portable combination wireless telephone and telegraph set for pack-horse or wheeled transport, which is of great value for Army or other mobile operations. This set can be erected within ten minutes, and the range of speech across level ground is approximately 60 miles for telephony, whilst for telegraph transmission a range of 200 miles is claimed.

A working 5 kilowatt high-speed transmission set, giving wireless telegraphy signals at the rate of 100 words per minute, was inspected, and other interesting items included a 2-kilowatt Army set, a 100-watt aeroplane transmitter and a 30-watt portable set fitted with a hand-driven generator.

In the afternoon an opportunity was given to investigate the progress made in connection with direction-finding. This operation may be effected either by means of frames which are capable of rotation, or by a fixed aërial on the Bellini-Tosi principle, using coils which are rotatable. The last-named arrangement is the more accurate of the two and is usually adopted for land stations where sufficient room is available. Direction-finding apparatus was fitted for the trials at Braintree and Heybridge. A motor-'bus was used



2.—Wiring Diagram of Wireless Telephony Receiver Circuit. 1, Aërial Terminal. 2, Earth Terminal. 3, Aërial Tuning Condenser. 4, Aërial Inductance. 5, H.F. Amplifying Valve. 6, Rectifying Valve. 7, High-frequency Transformer. 8, Telephone Transformer. 9, Condenser. 10, Reaction Coil. 11, H.T. Battery. 12, Telephone.

for the conveyance of members of the party, and the 'bus was accompanied by a motor-lorry for transporting the portable wireless station. The motor-'bus was fitted with a frame aërial and ordinary wireless receiving apparatus, the passengers being provided with head-gear receivers. The party started out with sealed instructions which had been drawn up by a gentleman interested in the subject of wireless, but who was in no way connected with the Marconi Company. After travelling about five miles along the Chelmsford–Colchester road the instructions were opened and the site for the portable station ascertained. This proved to be about one mile south-west of Colchester. The station was opened up in quick time and communication established with the stations at Braintree and

Heybridge, which were asked to indicate the position of the temporary station by means of their direction-finders. Braintree gave the position as 78·5° and Heybridge 32°, and from these angles the locality of the portable station was determined. The calculated position as worked out by the direction-finders was correct to within 250 yards, reckoned from a distance of 13½ miles from Braintree and 12½ miles from Heybridge.

Whilst the motor-'bus was travelling between Chelmsford and Colchester, at a rate of 12 miles an hour, conversations by wireless telephone between London and Broomfield were plainly overheard, as well as wireless telegraphy messages from Horsea, near Portsmouth, and from vessels in the North Sea. By way of diversion the visitors were enabled to enjoy a series of gramophone selections transmitted by wireless from the Chelmsford works. A. O. G.

BOOK REVIEW.

'The Principles Underlying Radio-Communication.' (Issued by the Signal Corps, U.S. Army, 1919.)

This little book, beautifully printed on white glazed paper, treats of the principles underlying radio-communication in language which is essentially non-technical.

About half the book is devoted to elementary electricity and dynamo-electric machinery, more especially as applied to radio work, whilst the rest is devoted to what may be termed "radio matters proper." As befits its importance in the realm of radio-communication, a special section is devoted to the subject of vacuum tubes, or valves as they are more generally known, and their use in radio-telegraphy and telephony.

As the title implies, the book is not intended for one desiring a knowledge of present-day apparatus or practice, but rather for the inquirer, handicapped by lack of mathematical knowledge, desirous of acquiring a fundamental knowledge of radio matters.

The subject-matter throughout is treated simply and directly, and the reader is neither side-tracked nor bored.

The book can be recommended to those desirous of assimilating the fundamentals of radio working, and should provide both useful and easy reading. E. H. S.

[Owing to lack of space, several reviews are unavoidably held over.]

A SYSTEM OF RAILWAY TRAFFIC CONTROL BY TELEPHONE.

By T. F. Lee, A.C.G.I., A.M.I.E.E.

Railway traffic consists roughly of two classes: the passenger service, run to a definite pre-arranged time-table, and the freight or goods service, which is run as required. With the former the control is comparatively simple, as passenger trains are timed for all points on the route and travel repeatedly the same journey under similar conditions. On the other hand the freight service is very irregular, as varying quantities and classes of goods are arriving at all times all along the route, and the handling of these goods is a very different matter from loading and unloading passenger trains.

The quantity and class of goods, many of which are perishable and have to be dealt with immediately, vary enormously from day to day. These difficulties make it impossible to deal with goods traffic on a set time-table basis, and the problem of using the available locomotives, wagons, shunting facilities, etc., to the best advantage, at the same time obtaining rapid service, is a particularly difficult one and of the greatest importance to railway companies, as it can readily be imagined that the difference in cost between efficient and inefficient handling is very great.

It is a system for controlling this goods traffic and not the passenger traffic which is considered in this article. Since telegraph working is in such common use on railways it is not surprising that telegraph control was at one time almost universally employed, but this has been steadily giving way to various control systems depending on telephones, and with the increased use of telephony specially efficient instruments and various forms of signalling from one instrument to another have been developed. Generally this control is obtained by linking up the various points on the line by means of a single pair of wires, looping telephones across the wires at the required intervals, and arranging some form of call whereby one telephone can ring up another either by code or preferably by a selective system enabling one instrument to ring another without disturbing the remaining telephones.

There are in use several ingenious methods of effecting this selective call, the most obvious being by means of polarised relays or bells arranged, some across the line, and some between the wires and earth. This scheme has given quite good results, but is open to objection in that it is so easily affected by the line faults which are unavoidable in open line construction—such faults, for example, as intermittent and accidental "earths."

Unfortunately these faults are very prevalent during snowstorms, heavy rainstorms and generally during bad weather, and it is just at these times that the control is most urgently wanted.

The system hereafter described is one which was developed jointly by telephone and railway engineers in order that efficient apparatus should be combined with a practical scheme of control, and it is independent of "earth" connections, and therefore not to any considerable extent affected by "earth" faults.

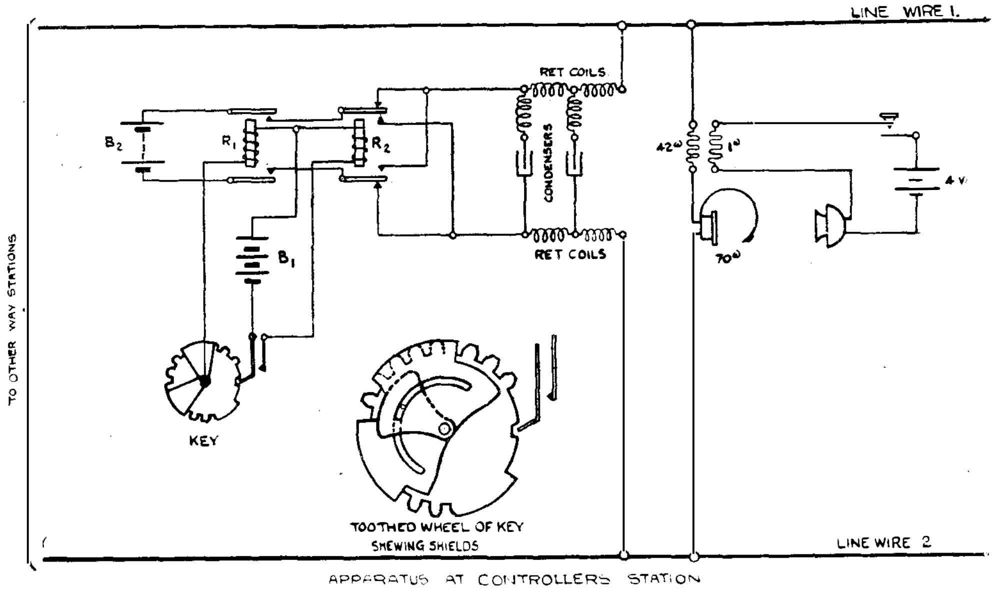
The actual method of handling traffic naturally varies with different railway companies, but the system in use with one of the largest English companies will serve to illustrate the general principle. The line is divided into suitable sections and a controller is appointed for each section. This controller has complete charge of the goods traffic on his section ; no movement of trains, locomotives, wagons, etc., may be made without his knowledge, and in any case of doubt as to the best method of procedure his decision is final. In front of his desk is a large-scale map of the section mounted vertically on a board and showing the position and wagon capacity of all sidings, goods stations and so on. By means of clips, pin-flags or similar devices, representing trains, locomotives, etc., he can show the position of all the traffic on his section and can follow up the movements from time to time.

The telephone line on which his instrument is connected runs completely round the section, and at various signal-boxes, shunting-yards, and such other points as are necessary, other telephones known as way station telephones are located. The controller himself is always connected to the line by means of his head receiver and chest transmitter and has before him a cabinet of keys, each key being associated with one way-station telephone. By giving any key a quarter turn and then releasing it the bell at the way station controlled by that key and no other bell rings. There is no reason for the way-station man to ring up the controller, as he has only to listen to ascertain if the line is free and then to speak to the controller.

In order to follow out the movements, imagine that a signalman has noted a goods train passing his box. He passes on the train, noting its number or other necessary details, removes his receiver, listens to ascertain that the line is free, and, if so, reports to the controller, who moves a flag on the map and logs the movement. Possibly further down the line there are trucks to be added to this train, and by operating one key the controller can advise the man in charge of the trucks that a train will be calling there at a certain time, while the operation of a second key will put him in communication with another point where the train guard can be advised of the number of trucks waiting for him to pick up ; in fact, it can readily be seen that the controller literally controls his section. In order to make his authority complete no means of calling from one way station to another is provided, and way-station men are not allowed to use the line for intercommunication.

It is usually arranged that when the controller is away from his desk he removes his telephone, and the action of withdrawing his instrument plug throws into circuit a bell, lamp or loud-speaking receiver, so that a way-station man can give a visual or audible signal indicating that the controller is required.

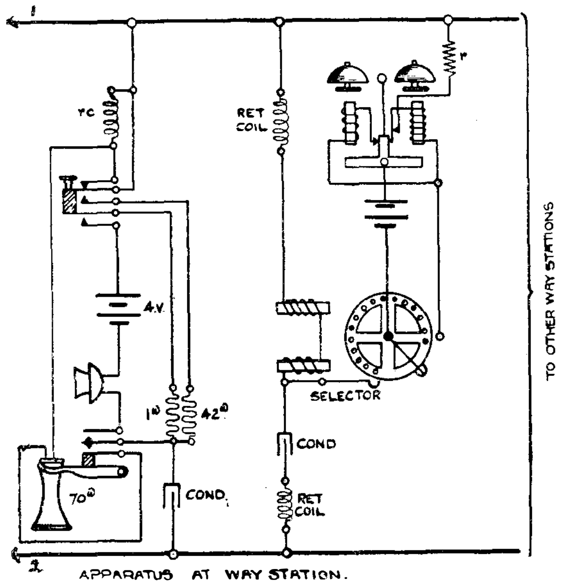
Referring now to the actual apparatus and circuits by which these results are obtained, the controller's selector keys may first



I.—Circuit of Traffic Control System.

be considered. Each key consists essentially of a toothed wheel and two contact springs, one of which presses against the teeth so that as the wheel rotates contact between the two springs is made and broken. The rotation of the toothed wheel is controlled by a train of gear wheels, a clock spring and a small governor, and the "winding up" is effected by giving the handle a quarter turn. On being released the wheel rotates a full revolution at a constant speed, the contact springs controlling two circuits, one a local relay circuit, and the other a circuit formed by connecting a fairly high voltage battery across the line.

Reference to I will show that relay *R*1 is operated for the whole revolution of the key, since the long spring is making contact with the body of the toothed wheel, either through the tops or roots of the teeth, except when the key comes to rest and the spring slips into the gap *a*. This relay places the battery *B2* across the line, through the contacts of *R2*, the circuit of which is broken as the long and short springs on the key are brought together, or separated, by riding over the teeth. From this it will be seen that as the key rotates the polarity of the line wires is reversed as each tooth is passed. In order to simplify the explanation, this reversal of polarity will be referred to as "sending positive and negative impulses to line." The description is perhaps a rather loose one, but will be readily understood. An examination of the circuit will show that actually these impulses of current are converted into alternating current of low frequency.



2.—Mechanism of Selector fitted at "Way" Stations.

In order to see the effect produced at the way stations by the operation of a key, it will be best to consider first the action of the selector—that is, the apparatus which responds to the current impulses. 2 shows diagrammatically the essential working portion of this selector. The armature is polarised, but to simplify the diagram the polarising magnet is omitted. The driving pawl *p1*, it will be noted, presses the toothed wheel forward, whether the armature is attracted to the right or left coil of the electro-magnet, driving pin *d1*, actuating the pawl in the former case and driving pin *d2* in the latter. Pawl *p2* is only a holding pawl, resting under one of the teeth of the wheel, preventing it from returning once it has been advanced by *p1*, and only leaving the wheel free when the armature is in its zero position, which is parallel to the magnet-pole faces. In this zero or normal position $p2$ is held off the toothed wheel by $d4$, but as soon as $p1$ moves forward $p2$ is freed, moves forward, and engages with the teeth of the wheel. When a positive current impulse is received on one line wire the armature will be attracted to the left-hand magnet coil and the toothed wheel will be advanced one tooth, carrying with it ring *R*, which will advance one hole. The toothed wheel and ring *R* are rotated against the tension of the coil spring, which tends to return them to the zero position. The positive impulse will be followed by a negative impulse which will attract the armature to the right-hand coil, and during the reversal from the positive to the negative impulse the armature will pass its zero position, at which position $p1$ and $p2$ will release the toothed wheel, catching it again and advancing it another tooth as the negative impulse attracts the armature to the right-hand coil. The wheel will be released by $p2$ for such a short period that it will not have time to fall back, as it would do under the action of the coil spring if free, but will be caught again by $p1$. If the positive and negative impulses are continued, the wheel, and with it the ring *R*, can be rotated for a complete revolution, but if at any time the impulses are stopped, either by cutting off the battery, or by stopping the movement of the armature of relay $R2$ (1), the selector armature will remain in its zero position sufficiently long for the toothed wheel to be freed from the two pawls, and the coil spring will bring it back to zero unless it is stopped by some mechanical brake.

$S1$, $S2$ and $S3$ are three pins in the ring *R*, and *b* is a brake spring pressing against $d3$, and therefore moving backwards and forwards with the current impulses. It will be noted that $S1$ is in the 5th hole, $S2$ in the 5th + 8th = 13th hole, and $S3$ in the 5th + 8th + 4th = 17th hole in the ring. Pins $S1$ and $S2$ can be set in any holes, but $S3$ is fixed.

Now if five impulses are sent out to line the ring *R* advances five holes, and if the impulses are then stopped the ring would return to zero, but as $d3$ falls back, brake *b* also falls back and catches stop $S1$, holding the ring and toothed wheel in place. If eight more impulses are sent out the same thing happens again and *b* catches $S2$, and when four more impulses are sent brake *b* catches stop $S3$, and at the same time contacts $C1$ and $C2$ come together and close a local bell circuit. One or two more impulses after the bell has rung long enough, will advance the ring again, and when the impulses cease, as there is no stop for the brake to catch, the ring will return to zero.

This selecting action will perhaps be made clearer by considering the effect of the group of impulses mentioned above, viz. 5 + 8 + 4, on another selector with stops set differently, for it must be remembered that all selectors are in parallel and respond to the impulses.

Consider a selector with pins in holes 4, 13 and 17, giving impulse groups of 4 + 9 + 4, and call this selector No. 2, designating the one already considered as No. 1. On sending five impulses and stopping, both No. 1 and No. 2 will advance five holes, and then attempt to return. No. 1 will be held because brake *b* catches the stop in hole No. 5, but No. 2 has no stop in hole No. 5, and is therefore free to return to zero. If now eight more impulses are sent out, the brake of No. 1 catches stop *S2*, but No. 2 has started again from zero, and having no stop in the eighth hole it again falls back to zero. Now four more impulses are sent, and, as already seen, No. 1 is caught at *S3* and the bell is rung through contacts *C1* and *C2*. No. 2 has started from zero, and having a stop in the fourth hole it will be caught by the brake, but as *C1* and *C2* are not brought together its bell will not ring, and the extra one or two release impulses sent out will release both No. 1 and No. 2 selectors.

With each call a total of seventeen impulses is used to ring the bell, and by dividing these impulses into three groups, seventy-eight separate selections can be made, as will be seen from the following table:

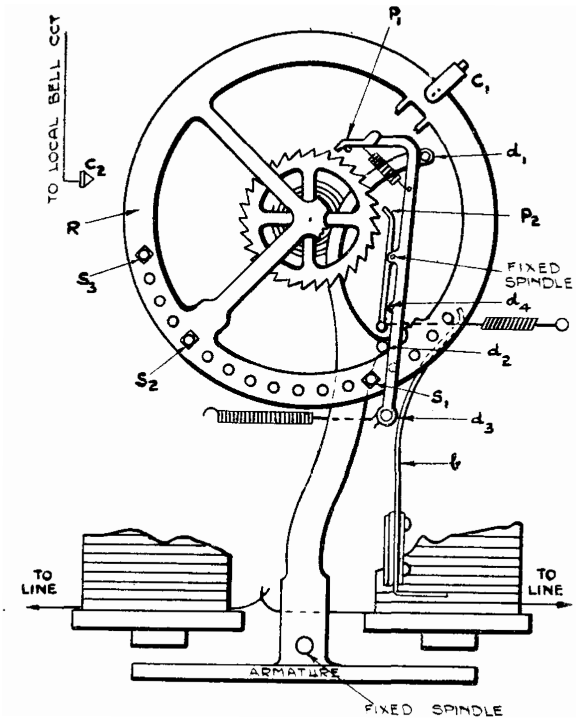
TABLE OF CODE SETTINGS.

Total Steps in Each Code—17. *Total Code Settings*—78

2-2-13							
2-3-12	3-2-12						
2-4-11	3-3-11	4-2-11					
2-5-10	3-4-10	4-3-10	5-2-10				
2-6-9	3-5-9	4-4-9	5-3-9	6-2-9			
2-7-8	3-6-8	4-5-8	5-4-8	6-3-8	7-2-8		
2-8-7	3-7-7	4-6-7	5-5-7	6-4-7	7-3-7	8-2-7	
2-9-6	3-8-6	4-7-6	5-6-6	6-5-6	7-4-6	8-3-6	9-2-6
2-10-5	3-9-5	4-8-5	5-7-5	6-6-5	7-5-5	8-4-5	9-3-5
2-11-4	3-10-4	4-9-4	5-8-4	6-7-4	7-6-4	8-5-4	9-4-4
2-12-3	3-11-3	4-10-3	5-9-3	6-8-3	7-7-3	8-6-3	9-5-3
2-13-2	3-12-2	4-11-2	5-10-2	6-9-2	7-8-2	8-7-2	9-6-2
10-2-5							
10-3-4		11-2-4					
10-4-3		11-3-3		12-2-3			
10-5-2		11-4-2		12-3-2		13-2-2	

In order to control these impulses and send them out in the groups required, each selector key is fitted with narrow adjustable metal segments or shields, affixed to the side of the toothed wheel, and reaching to the circumference formed by the tops of the teeth, so that the spring, when passing over a shield, cannot ride up and down over the teeth, but keeps the contacts closed. During this closed contact period, of course, no impulses go to the line.

Reference to 3 showing the enlarged sketch of the face of the toothed wheel of the key will make clear the action of the selection keys and selectors. When the key is operated the long spring first makes contact on leaving slot *a*, thereby completing the circuit through relay *R*1, so placing the battery *B*2 across the line, as already explained. The long spring then rides over the first group of teeth operating relay *R*2, and sending alternately positive and negative impulses to the selectors, which all operate as already explained. The key springs then pass over the first shield, during which time no



3.—ENLARGED SKETCH OF TEETH AND SHIELDS ON CONTROLLER'S SELECTOR KEY.

impulses are sent out, and the selectors return to zero, except the few that are caught by suitably arranged stops. The second group of impulses then passes out, and the selectors move forward again, some only to fall back to zero once more as the second shield is passed over. Finally the third group of impulses is sent, and by the time these are finished the selection of the instrument required will have completed its local bell circuit, and the bell will ring while the key springs pass over from *C* to *D*.

After this, the impulses sent by the spring passing from *D* to slot *a* will release the chosen selector, and this will return to its normal position.

Batteries $B1$ and $B2$ both consist of dry cells, the voltage of $B1$ being about 8 and that of $B2$ varying from 100 to 200 according to the length of the line and number of stations fitted.

In the description no mention has been made of the condenser in series with the selectors. Their function is an important one, as it is the charging of these, first positively and then negatively, which gives the impulses of current operating the selectors. As current is only taken from $B2$ at certain intervals while $R2$ is operating, the actual amount of current used is very small, due to the stoppage of all direct current by the condensers, and the battery lasts for several months. The selectors have an ohmic resistance of about 15,000 ohms. The impedance of a selector and condenser at selective frequency, which is $3\frac{1}{2}$ periods per second, is about 25,000 ohms, and at talking frequency over 1 megohm.

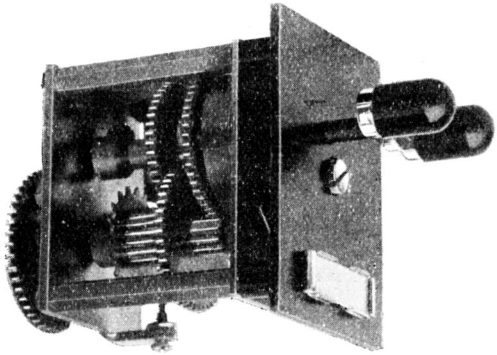
4.—Controller's Selector Key Cabinet.

So far only the selective apparatus and circuits have been considered, but this portion of the system is, of course, of very little use without an efficient telephone scheme.

The arrangements shown on 1 and 2 are almost self-explanatory as regards the telephone circuit, the main feature of which is the provision of a separate speaking and listening circuit at the way stations. The controller's circuit is practically a regular local battery circuit. The way-station man presses the button on his telephone when speaking and releases it when listening, but it will be seen that the retardation coil (*r.c.*) prevents an absolute break in the listening circuit, when the transmitter circuit is in use, and the user can just hear if the controller wishes to break in on his conversation.

The telephone apparatus used, and the circuit described above, give exceedingly clear speaking with entire freedom from side noises, and the length of standard cable over which conversation can be carried on is rather longer than in the case of ordinary telephones, but the main improvement is in the direction of clearness and the absence of extraneous noises.

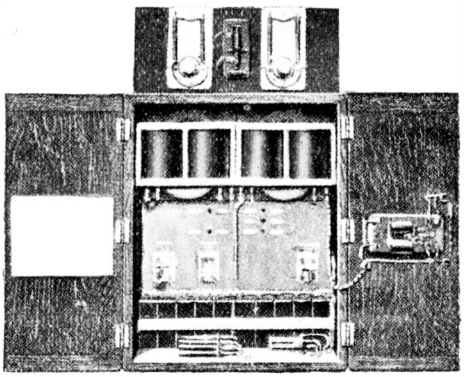
One interesting feature is seen by referring to the resistance *r* in **2** in connection with the way-station bell. While the bell is ringing.



5.—Controller's Selector Keys.

there is a change in the potential of the line sufficient to cause a low buzzing in the controller's receiver, and by this means he can hear quite plainly when the bell of the selected station rings.

1 and **2** show only the essential features of the system, but in practice protectors are fitted at each telephone, a small circuit-



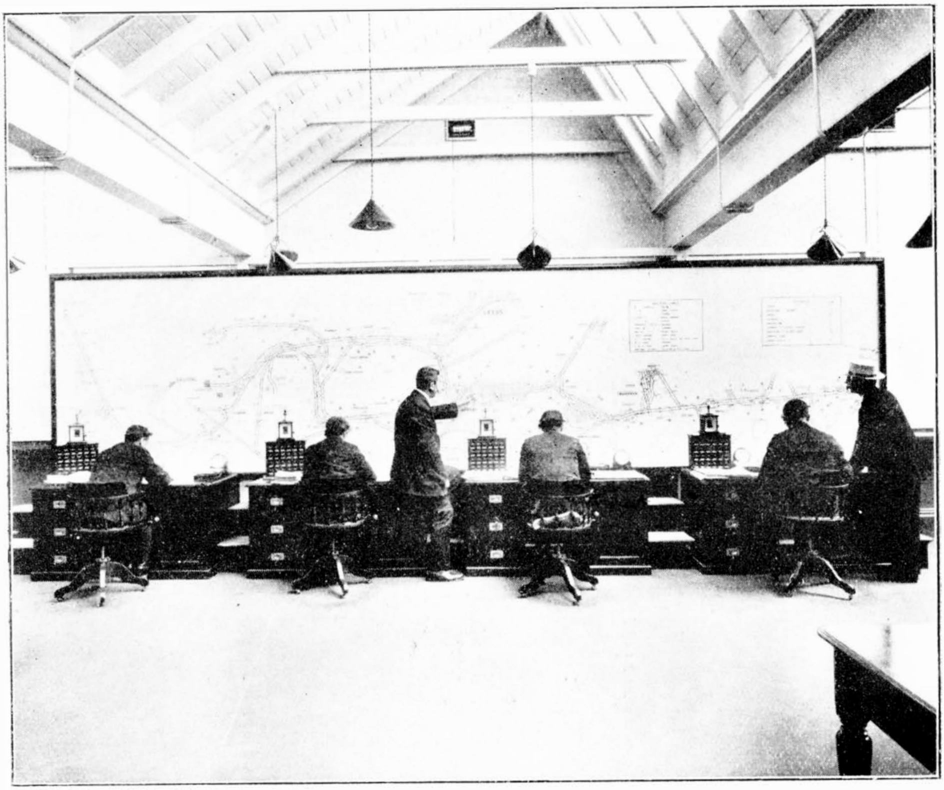
6.—Controller's Selector Apparatus Case. (This Case contains all the Controller's Apparatus shown in **1**, except Selector Keys and Telephone.)

breaker cuts off the main battery in case of a short circuit on the line, and double pole switches are so placed that any faulty way-station outfit can be cut out, leaving the line and the remaining telephones working.

The following brief facts will give an idea of the wide limits permissible and the flexibility of the system.

Any selector can be set so as to be selected by any one of 78 groups of impulses when the ordinary standard selector and selector keys are used, and as in this country more than 35 way stations are seldom under the care of one controller, practical requirements are more than met.

By a slight alteration to the selector and key, however, as many as 253 selectors are possible.



7.—Great Northern Railway Company's Control Office at Leeds (showing Four Controllers, each with Selector Key Cabinet on Left).

On a line of 150 lb. copper 80 miles long with a battery of 100 volts about 20 stations can be fitted, and if the voltage is raised to 200 volts 50 stations can be fitted.

On an average line, on which a 100-volt battery is suitable, from 10 to 20 stations can be equipped, and will be working under economical conditions.

The number can be reduced to 5, and still the operation will be quite satisfactory, although the voltage will be too high for economical working.

Referring back to the table on p. 110, it will be seen that every group is made up of 17 impulses, and if 17 impulses are sent out without a break, all the selectors will be brought to the ringing position, so that a controller, by means of a 17-impulse key, can call at all stations at once to give general instructions.

The quality of transmission with all stations on the line at one time will of course depend on the length of line and number of stations, but no difficulty has been experienced in using this service on the English railways, where the number of stations seldom exceeds 35 and the length of line (open wire) does not exceed 100 loop miles.

4 shows a controller's selector key cabinet ; 5 gives a view of the mechanism of the controller's selector key; whilst 6 indicates the assembly of working parts in the controller's selector apparatus case.

In 7 a comprehensive view of the Great Northern Railway Company's control office at Leeds is given.

While it is not possible to detail the various minor purposes which the apparatus is made to serve on a train-control equipment, it will be realised that the possibilities are considerable, and although the system was originally devised for railway working, it has already found a field in two other directions, namely, in the linking up of electrical sub-stations on power-supply systems, and in the control of the service of cars on tramway systems, and in both these directions there seems to be considerable scope for extension.

In conclusion the writer has to thank the Western Electric Company for supplying the blocks and drawings illustrating this article.

A MODIFIED COMMON BATTERY SIGNALLING TELEPHONE SYSTEM.

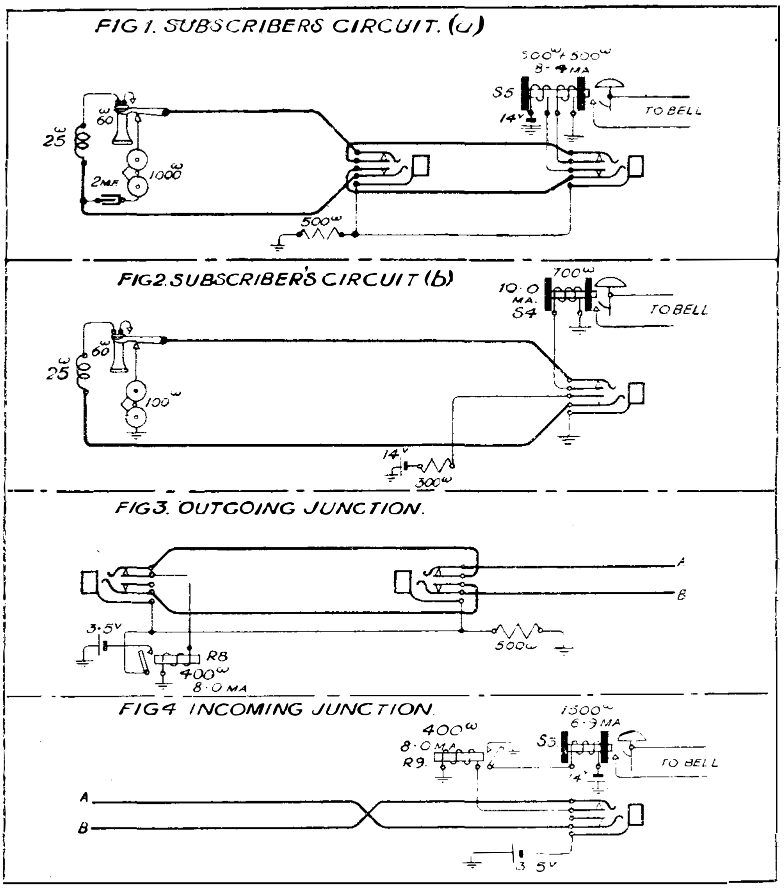
By H. W. White,

Engineer-in-Chief's Office.

The system about to be described is suggested for use at centres where a suitable power supply for charging secondary cells does not exist, and it therefore becomes necessary to instal primary cells or use small portable secondary cells, or where the conditions are such as to make the conservation of electrical energy a matter of first importance. A feature of the system is that it provides for the minimum transmission loss over the junctions, having regard to (1) the signalling requirements, and (2) the prevention of noises due to local inductive disturbances, which are augmented when the lines are extended.

The *subscriber's circuit* is shown in **1**. The subscriber's telephone is of the local battery speaking type. The subscriber calls the exchange by looping the lines through his receiver, thus causing the signal *S*5 to operate. The exchange calls the subscriber by applying an earthed generator to one line and earthing the other line.

The *outgoing junction circuit* is shown in **3**. The relay *R*8 is operated from the time the clearing signal is given until the plug of

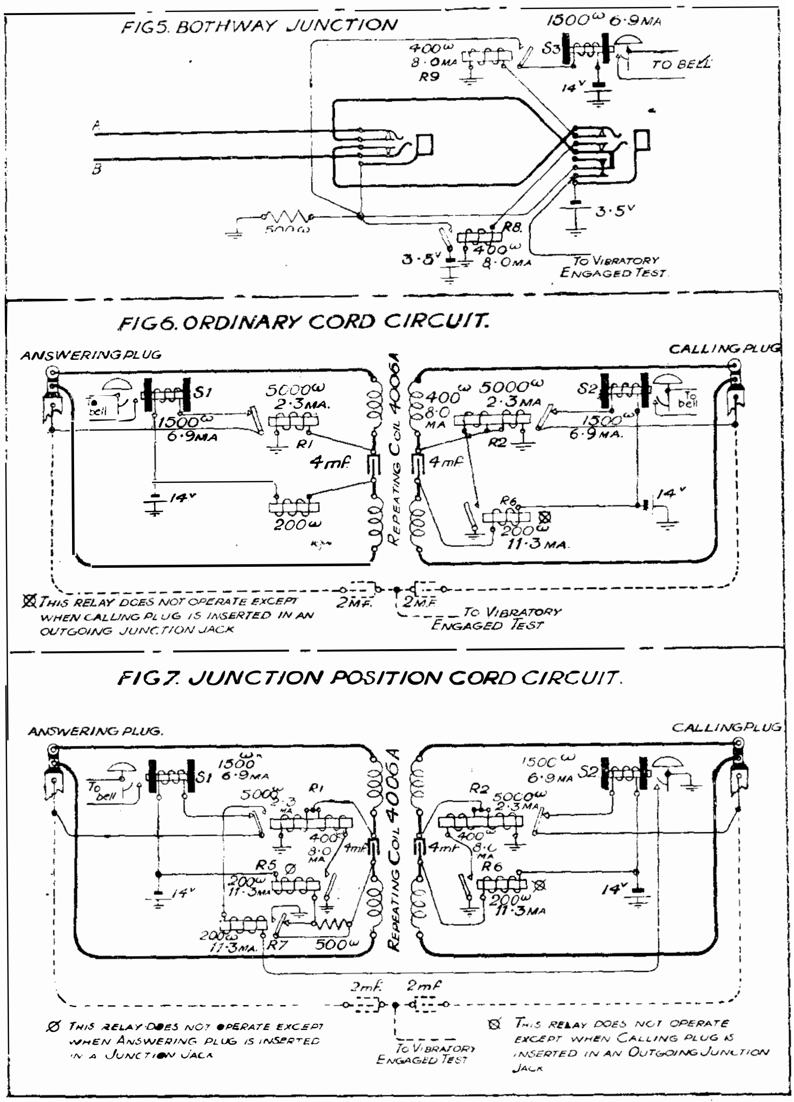


the cord circuit in the jack at the distant end of the circuit is withdrawn. The connection of 3·5 volts to the bushes of the jacks provides a distinctive "engaged test" to inform the operator as to the actual condition of the line.

The *incoming junction circuit* is shown in **4**. On short lines the relay *R*9 and signal *S*3 could be replaced by a signal, operated direct.

The *both-way junction circuit* shown in 5 combines the features of the circuits shown in 3 and 4.

The *ordinary cord circuit* is shown in **6.** It is suitable for establishing the following connections:



(*a*) Subscriber to subscriber.

(*b*) Subscriber to outgoing junction.

The *junction position cord circuit* shown in 7 is of the universal type and is suitable for establishing connections as follows:

(*a*) Subscriber to subscriber.
(*b*) Subscriber to outgoing junction.
(*c*) Incoming junction to subscriber.
(*d*) Incoming junction to outgoing junction.
(*e*) Outgoing junction to outgoing junction.

Relays *R*5 and *R*6 do not operate when the plugs with which they are associated are inserted in a subscriber's circuit, because the current, in flowing through the subscriber's receiver under talking conditions, can only reach earth *viâ* the 5000-ohm. winding of relay *R*1 or *R*2, as the case may be. Relay *R*7, which gives the "through" signal, will only operate when the answering plug is in the "incoming" jack of a junction and signal *S*2 is energised.

LONDON DISTRICT NOTES.

Internal Construction.

Telephone Lines and Stations.—During the thirteen weeks ended April 22nd, 1919, 2738 exchange lines, 3766 internal extensions and 405 external extensions were provided. During the same period 875 exchange lines, 1756 internal extensions and 340 external extensions were recovered, making net increases of 1863 exchange lines, 2010 internal extensions and 65 external extensions.

External Construction.

For the three months ended April 30th, 1919, a net decrease of 2368 miles occurred in telephone exchange wire mileage within the London Engineering District, the decrease under the heading of underground being 263 miles; open wire (bare wire), 41 miles; and aërial cable, 2064 miles.

Telephone trunk wire mileage remains unaltered. Telegraphs (underground) increased by 30 miles. Telegraphs (aërial) unaltered.

Pole line mileage increased by 7 miles, whilst pipe line mileage remains unaltered.

The aggregate mileages in the District at the end of April were as follows:

Line Mileage.

Pole line	2574 miles.
Pipe line	3575 ,,

Single Wire Mileage.

Telegraphs	17,950 miles	Exclusive of wires on railways maintained by railway companies.
Telephone exchange	1,010,477 ,,	
,, trunks	17,409 ,,	
Spare wires	18,247 ,,	

The total length of underground cable is 7164 miles.

Snowstorm Damage.

The snowstorm of April 27th played havoc with the overhead wires throughout the London District. On the morning of April 28th approximately 10,000 subscribers' telephones were reported "out of order" due to storm faults. The worst effects were manifested in the Northern and Eastern suburbs, where pole damage was extensive. In one instance six spans of wires with poles complete disappeared below the surface of an adjacent reservoir. In two cases roof standards carrying 128 and 88 wires respectively were completely buckled up, the wires festooning the surrounding neighbourhood. The "casualty" list included the following items :

Poles broken, 46.
Poles deflected, 778.
Stays drawn or broken, 565.
Spans of wire affected, 25,000 (approx.).
Roofs, walls and chimney-stacks damaged, 511.

COUNCIL NOTES.

Will Foreign and Colonial corresponding members please note that subscriptions are now due for the current year, ending March 31st, 1920, and remit to the Secretary, Room 50A, G.P.O. West, London, E.C. 1, as soon as possible.

It is probable that some Colonial members have temporarily lost touch with the Institution owing to their absence on military duties. These members may have resumed their former stations and the Secretary will be glad to hear from them.

The Council is glad to report that new members have recently been recruited from India and Egypt, whilst Colonial engineers on leave in England prior to demobilisation have also availed themselves of the opportunity of joining the Institution. It is hoped that the Institution of Post Office Electrical Engineers will, more than ever, serve to link the Colonial telegraph and telephone administrations with the home country and help to strengthen the ties which the great war has called into being.

T. Smerdon,
Secretary.

LOCAL CENTRE NOTES.

EASTERN CENTRE.

THE first meeting of the 1918–19 Session—the first since before the war—was held at Cambridge on March 13th, 1919, when there was read a paper by Mr. A. J. Stubbs entitled "Notes on Accidents in the P.O. Engineering Department." There was a large attendance, every Section being well represented. The audience included by special invitation a number of the foremen of working parties.

The Chairman (Mr. J. F. Lamb), in opening the meeting, referred to the absence of some who had passed away in the service of their country. He welcomed back to the Eastern Centre meetings the representatives of the St. Albans Section, and expressed his pleasure at the presence of the Assistant Engineer-in-Chief (Mr. Stubbs), whom he called upon to read his paper.

Mr. Stubbs commenced with a general review of the subject of accidents, and then proceeded to deal with their causes and their prevention. After remarks on present-day educational methods and what is known as "safety first" organisation, Mr. Stubbs referred very fully to accidents in the Post Office Engineering Department and gave some interesting statistics, from which it appeared that the Eastern District compared favourably with other districts in the matter of accidents to its staff. The paper concluded with some lantern-slides illustrating methods adopted in the United States to educate workmen on the subject of the avoidance of accidents.

The discussion was opened by Mr. J. Whitehead, and was continued by Messrs. Wise, Taylor, D. M. Smith, Gardner, Cain, Lakey, Lamb and others, including some of the foremen present. Emphasis was laid by several speakers on the importance of the general health factor.

Mr. Stubbs replied very fully, and the meeting closed with a hearty vote of thanks to him for his interesting paper.

The second meeting of the Session was held at Cambridge on April 15th, 1919, when about fifty members attended to hear a paper read by Mr. J. E. Taylor on "Atmospheric Electricity."

Mr. Taylor dwelt at some length on the question of the normal electric field existing in the atmosphere and on the degrees of conductivity exhibited under conditions of ionisation, laying stress on the consideration that the two features are antagonistic, and cannot both be fully developed and maintained at the same time. The subject of ionisation of gases was also specially treated, emphasis being placed on the distinction between true ionisation, in which ionic fields of force or electric linkages exist throughout the ionised space, and spurious ionisation in the shape of electrification of gaseous particles or aggregations of molecules (so-called "heavy ions"). In the former case there is true conductivity in the gas; in the latter case only convective transference of charges is involved.

Considerations of the mode of action of the hydro-electric machine, which was fully explained, led to a special theory of thunderstorms based on a fundamental assumption of the decomposition of water vapour by the solar rays. The objections to existing theories were fully explained. Modern methods of lightning protection were discussed briefly and rather severely criticised in some of their aspects.

In an addendum, whilst reiterating his antagonism to the electronic theory of currents, Mr. Taylor drew attention to the great potentialities with which the new science of molecular physics was fraught. Vistas not only of new fields of research but of new realms of power as yet undreamt of were opened out. The suggestion was thrown out that in this direction the germ of life itself might well be found. The indications were that it would be through the gateway of the carbon atom that it would be rendered accessible, as all organisms contain this element in combination with hydrogen in some form or other.

The paper was illustrated by numerous lantern-slides. The optical lantern was kindly lent for the occasion by the Superintending Engineer, Mr. J. F. Lamb.

A discussion followed the reading of the paper, and was taken part in by Messrs. Titterington, Calveley, Lamb, Scarr and other members. The meeting closed with a hearty vote of thanks to Mr. Taylor on the proposition of Mr. Titterington, seconded by Mr. McCullagh.

NORTHERN CENTRE.

Chairman, Mr. J. R. M. ELLIOTT.—The paper of the evening on "Notes on Accidents in the Post Office Engineering Department" was read by Mr. A. J. Stubbs, M.Inst.C.E., M.I.E.E., Assistant Engineer-in-Chief, and proved to be of more than ordinary interest.

Upon his introduction by the Chairman, Mr. Stubbs proceeded to outline the reasons for investigating this subject. Available statistics were obtained from the various districts, and it was considered advisable to at once place some of the information gained before those concerned, rather than accumulate further evidence, which would have caused delay. In order to solicit the co-operation of those affected many illustrations were presented, together with details of prime importance for the prevention of accidents wherever possible. Mr. Stubbs also pointed out as a recorded fact that recently—thanks to the education of industrial opinion—considerable progress had been made in respect of this important matter. The information thus placed before the members was thoroughly appreciated.

During the discussion which followed many details were brought forward by the members, and a lively interest was evinced by the foremen who had been specially invited to the proceedings.

A hearty vote of thanks was accorded to Mr. Stubbs for his illuminating paper, on the proposition of the Chairman and seconded by the Hon. Secretary.

A record attendance was registered.

SIR G. E. P. MURRAY, K.C.B.

THE Board of Editors begs to tender its hearty congratulations to the Secretary of the General Post Office on the great honour bestowed by His Majesty the King in the recent Birthday Honours List.

MILITARY HONOURS.

THE Board of Editors has great pleasure in publishing the further list of honours awarded to members of the Engineering Department:

Major T. F. Purves, R.E. (Assistant Engineer-in-Chief), Major H. Brown, R.E. (Assistant Staff-Engineer), and Major J. Cameron (Executive Engineer) have been awarded the M.B.E. (Military Section).

Mr. H. C. Gunton (Principal Power Engineer) has been awarded the M.B.E. (Military Section).

Lieutenant-Colonel A. Evans, R.E. Signal Service (Assistant Engineer, North Midland District). Mentioned in Despatches.

Lieutenant G. Bishop, R.E. (Third Class Clerk, South-Eastern District). Awarded the Military Cross and the Croix de Guerre avec Étoile (French).

Second Lieutenant W. Griffiths, Royal Air Force (Inspector, North Wales District). Mentioned in Despatches.

Corporal H. D. Bear, London Regiment (Labourer, London Engineering District). Awarded the Military Medal.

Sapper W. G. Cadwallader, R.E. Signal Service (Unestablished Skilled Workman, North Wales District) (died of wounds). Awarded the Croix de Guerre (Belgian).

Sergeant E. Eden, London Regiment (Skilled Workman, Class II, London Engineering District). Awarded the Military Medal.

Chief Mechanic T. W. Evans, Royal Air Force (Skilled Workman, Class I, London Engineering District). Awarded the Meritorious Service Medal.

Sergeant T. H. Giblett, R.F.A. (Unestablished Skilled Workman, London Engineering District). Awarded the Distinguished Conduct Medal and the Military Medal.

Sergeant H. Gilbert, The Buffs (Assistant Clerk, London Engineering District). Mentioned in Despatches.

Sapper S. H. Gisby, R.E. Signal Service (Unestablished Skilled Workman, North Wales District). Awarded the Military Medal.

Sapper A. G. Lawrence, R.E. Signal Service (Skilled Workman, Class II, South Midland District). Mentioned in Despatches.

Sergeant A. J. Shotter, R.E. Signal Service (Skilled Workman, Class II, South Western District). Awarded the Meritorious Service Medal.

Company Sergeant-Major H. Wilcock, R.E. Signal Service (3rd Class, Clerk, South Lancashire District). Awarded the Distinguished Conduct Medal.

Sergeant T. W. Williams, R.E. Signal Service (Skilled Workman, Class II, North Wales District). Awarded the Military Medal and the Croix de Guerre avec Etoile en Bronze (French).

Lance-Corporal W. Carrick, R.E. Signal Service (Skilled Workman, Class II, Scotland West District). Awarded the Meritorious Service Medal.

Sergeant T. Cripps, R.E. Signal Service (Unestablished Skilled Workman, London Engineering District). Mentioned in Despatches.

Sergeant A. MacRae, R.E. Signal Service (Unestablished Skilled Workman, Scotland West District). Awarded the Military Medal.

Lance-Corporal C. E. Wearn, Civil Service Rifles (Clerical Assistant, Eastern District). Awarded the Military Medal.

Pioneer P. C. Clegg, R.E. Signal Service (Labourer, Metropolitan Power District). Awarded the Military Medal.

Sergeant-Major H. Morris, Royal Air Force (Inspector, North-Eastern District). Brought to the notice of the Secretary of State for War.

Company Sergeant-Major A. C. S. Akast, R.E. (Chief Inspector, Metropolitan Power District). Awarded the Meritorious Service Medal and Mentioned in Despatches.

Sergeant J. B. Ball, R.E. Signal Service (Unestablished Skilled Workman, South Lancashire District). Mentioned in Despatches.

Sergeant R. D. Bennett, Royal Berkshire Regiment (Clerical Assistant, South Midland District). Mentioned in Despatches.

Second Corporal A. Ramsey, R.E. Signal Service (Unestablished Skilled Workman, Scotland West District). Awarded the Meritorious Service Medal.

Sapper H. Easterbrook, R.E. Signal Service (Labourer, South-Western District). Awarded the Military Medal.

Sapper G. Powell, R.E. Signal Service (Labourer, South Midland District). Awarded the Military Medal.

Sapper F. T. Wells, R.E. Signal Service (Labourer, South-Eastern District). Awarded the Military Medal.

Lance-Corporal J. Clark, London Regiment (Assistant Clerk, Engineer-in-Chief's Office). Awarded the Military Medal.

Sapper P. H. Hassell, R.E. Signal Service (Skilled Workman Class II, Ireland). Awarded the Croix de Guerre (Italian).

Sergeant H. E. Hawkins, R.E. Signal Service (Unestablished Skilled Workman, South Wales District). Awarded the Distinguished Conduct Medal.

Corporal H. A. Jefferies, R.E. Signal Service (Unestablished Skilled Workman, London Engineering District). Awarded the Military Medal.

Lance-Corporal (acting Sergeant) J. S. Smythe, R.E. Signal Service (Unestablished Draughtsman, North Wales District). Awarded the Croix de Guerre avec Etoile en Bronze (French) and Mentioned in Despatches.

Sergeant G. R. Sykes, Royal Air Force (Skilled Workman Class II, London Engineering District). Awarded the Croix de Guerre (Belgian).

Sapper G. Wilson, R.E. Signal Service (Skilled Workman Class II, Scotland West District). Awarded the Meritorious Service Medal.

Sergeant E. T. Goodwin, R.E. Signal Service (Skilled Workman Class II, Eastern District). Awarded the Cross of St. George (Russian) and Mentioned in Despatches.

Lance-Corporal M. Kinsella, Machine Gun Corps (Assistant Clerk, London Engineering District). Awarded the Military Medal.

Lance-Corporal A. P. Ware, R.E. Signal Service (Unestablished Skilled Workman, South Midland District). Awarded the Meritorious Service Medal.

Corporal J. H. Chubbock, R.E. Signal Service (Third Class Clerk, London Engineering District). Mentioned in Despatches.

Sapper F. Curtis, R.E. Signal Service (Skilled Workman, Class II, North-Eastern District). Mentioned in Despatches.

Chief Mechanic F. W. Dixon, Royal Air Force (Skilled Workman, Class II, London Engineering District). Mentioned in Despatches.

Sapper C. W. Impett, R.E. Signal Service (Third Class Clerk, London Engineering District). Mentioned in Despatches.

Sapper (Acting Sergeant) B. Lister, R.E. Signal Service (Inspector, South Lancashire District). Mentioned in Despatches.

Sergeant T. F. Reeves, Hampshire Regiment (Inspector, South Midland District). Mentioned in Despatches.

Petty Officer A. H. Veale, Royal Naval Air Service (Inspector, London Engineering District). Mentioned in Despatches.

Company Quartermaster-Sergeant R. W. Holliday, R.E. Signal Service (Inspector, London Engineering District). Brought to the notice of the Secretary of State for War.

Chief Mechanic E. H. McCarthy, Royal Air Force (Tradesman, London Engineering District). Awarded the Meritorious Service Medal and brought to the notice of the Secretary of State for War.

Staff-Sergeant A. E. Smith, R.E. Signal Service (Skilled Workman, Class I, South Midland District). Awarded the Military Medal.

Lieutenant and Quartermaster B. Pooley, Cambridgeshire Regiment (Chief Inspector, Eastern District). Awarded the Military Cross.

Corporal J. Lindley, Royal Army Service Corps (Clerical Assistant, North-Eastern District). Awarded the Meritorious Service Medal.

Sergeant D. Thomson, Argyll and Sutherland Highlanders (Clerical Assistant, Scotland West District). Awarded the Distinguished Conduct Medal.

Corporal J. Dalgleish, R.E. Signal Service (Skilled Workman, Class I, North-Eastern District). Awarded the Meritorious Service Medal.

Sapper G. S. Furrie, R.E. Signal Service (Unestablished Skilled Workman, Scotland West District). Awarded the Military Medal.

ROLL OF HONOUR.

THE Board of Editors sincerely regrets the deaths on active service of the undermentioned members of the Engineering Department. Nineteenth List.

Name.	Rank.	District.
F. W. Beere	Unest. Skilled Workman	E.
G. F. Burrell	Labourer	,,
W. Donaldson	,,	Scot. E.
C. C. Elliott	Unest. Skilled Workman	S. Wales.
E. Goddard	Labourer	S.W.
J. H. Hatt	Unest. Skilled Workman	N. Mid.
J. W. Haycock	Skilled Workman, Cl. II	London.
G. S. Heath	Youth	S.E.
J. E. Kingston	Unest. Skilled Workman	N.
A. Lynes	,, ,, ,,	,,
P. McMahon	,, ,, ,,	Scot. E.
J. McPhillips	,, ,, ,,	S. Wales.
P. H. Massey	Assistant Clerk	London.
J. T. Moran	Unest. Skilled Workman	N.W.
C. Parkes	Labourer	N. Wales.
A. Prior	,,	S. Mid.
E. H. Reaney	Unest. Skilled Workman	N. Wales.
T. Robinson	Labourer	Ireland.
G. Ross	Skilled Workman, Cl. II	Scot. E.
N. S. Smith	Assistant Engineer	E. in C.O.
D. J. Taylor	Labourer	S. Wales.

STAFF CHANGES.

POST OFFICE ENGINEERING DEPARTMENT.

PROMOTIONS.

Name.	District.	From.	To.	Date.
Noble, W.	E. in C.O.	Asst. E. in C.	E. in C.	1 : 6 : 19
Purves, Major T. F. O.B.E.	,,	Staff Engr.	Asst. E. in C.	1 : 6 : 19
Henley, F. L.	,,	Asst. Staff Engr.	Staff Engr.	1 : 5 : 19
Herbert, T. E.	Scot. W.	Exec. Engr.	Asst. Suptg. Engr.	10 : 5 : 19
Wood, A. H.	London.	Asst. Engr.	Exec. Engr.	1 : 5 : 19
Burton, G. M.	N.E.	,,	,,	26 : 3 : 19
Roche, T.	Ireland.	,,	,,	10 : 4 : 19
Patrick, J.	N. Mid.	,,	,,	7 : 4 : 19
Scott, A.	Scot. W.	,,	,,	,,
Roberts, A. H.	E. in C.O.	,,	,,	24 : 3 : 19
McNicol, A. J.	S.E.	,,	,,	19 : 4 : 19
Markwick, J. J.	E. in C.O.	,,	,,	24 : 3 : 19
Cockshott, W. J.	S.W.	,,	,,	7 : 4 : 19
Simmance, J. H.	E. in C.O.	,,	,,	24 : 3 : 19

PROMOTIONS (*continued*).

Name.	District.	From.	To.	Date.
Turner, E.	Ireland.	Asst. Suptg. Engr.	Suptg. Engr.	1 : 7 : 19
Dwyer, J. J.	To be fixed later.	2nd Cl. Engr.	Asst. Engr.	To be fixed later.
Stevenson, W.		,,	,,	
Smith, W. W.		,,	,,	
Hammond, E. J.		,,	,,	
Wiggins, F.		,,	,,	
Harper, E.		Chief Insp.	,,	
Paterson, J. S.		,,	,,	
Jarrett, E. J.		,,	,,	
McLeod, N.		Junior Engr.	,,	
Stiles, O. S.		,,	,,	

RETIREMENTS AND RESIGNATIONS.

Name.	District.	Rank.	Date of retirement or resignation.
Slingo, Sir W.	E. in C.O.	E. in C.	31 : 5 : 19
Shorrock, L.	S. Lancs.	Asst. Engr.	26 : 4 : 19
Mackenzie, J.	S. Wales	2nd Cl. Engr.	2 : 5 : 19
Smyth, R. S.	,,	,,	22 : 4 : 19
Dear, R. E. B.	London	3rd Cl. Clerk	4 : 5 : 19 (resigned)

DEATHS.

Name.	District.	Rank.	Date.
Smith, N. S.	E. in C.O.	Asst. Engr.	1 : 2 : 19
O'Keefe, J.	Ireland	3rd Cl. Clerk	7 : 4 : 19

TRANSFERS.

Name.	Rank.	Transferred.		Date.
		From	To	
Wilby, E. J.	Exec. Engr.	Ireland	E. in C.O.	22 : 4 : 19
Baker-Cresswell, H. G.	Asst. Engr.	Scot. W.	Met. Power S.W.	11 : 5 : 19
Cottle, P. J.	,,	E. in C.O.	S.W.	15 : 4 : 19
Ellson, F. A.	,,	S. Wales	E. in C.O.	7 : 4 : 19
Todd, E. W. J.	2nd Cl. Clerk	London	Ministry of Pensions	15 : 5 : 19
Shadforth, F. J.	,,	Scot. W.	N.	26 : 2 : 19
Turner, P. W.	3rd Cl. Clerk	E. in C.O.	Ministry of Pensions	15 : 5 : 19
Withers, C. A.	,,	N. Wales	N. Mid.	12 : 2 : 19
France, W. M.	Suptg. Engr.	N. Mid.	E. in C.O.	1 : 7 : 19
Gomersall, E., O.B.E.	,,	Ireland	N. Mid.	,,
Taylor, J. E.	Asst. Suptg. Engr.	E.	London	,,
Batchelor, Major W. M., D.S.O., M.C.	,,	N.	E.	,,

COMMUNICATIONS.

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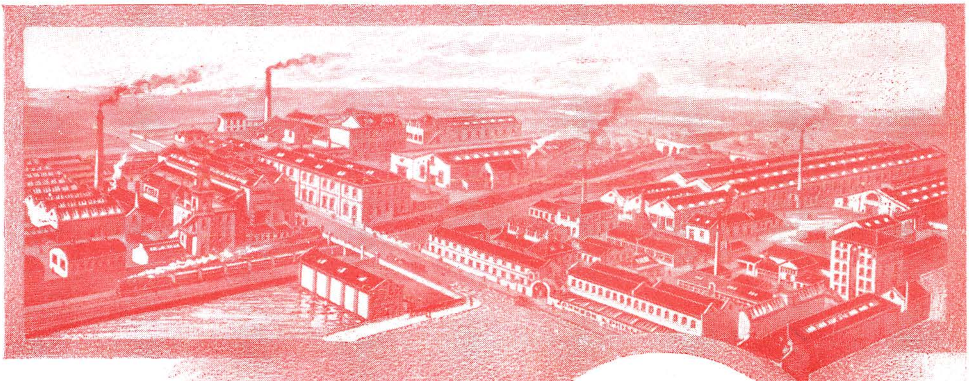

Printed and Published by THE ELECTRICAL REVIEW, LIMITED, at 4, Ludgate Hill, London, E.C. 4.