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he came home.
Now about Telephones
well first they must be
automatic
The Relay system is the
only one that does its
job without a lot of comp-
-licated machinery so
its maintenance cost is
very low
All mechanical systems
require constant cleaning
and oiling. Relays don't
As there is no machinery
there is nothing to go wrong
I should certainly recommend
a Relay plant
write and ask for a booklet

THE
Post Office Electrical Engineers' Journal

THE TELEPHONE REPEATER.

READERS of the JOURNAL have doubtless observed various references in recent numbers to the use of telephone repeaters and will probably endorse the Editors' desire that more definite information be forthcoming. In attempting to satisfy this demand the author desires first to remove any misapprehension that the telephone repeater has been developed behind an official screen of secrecy. The fact is, that development has been so rapid that it would have been impracticable to write any article for the JOURNAL during the past two years which could be said to describe standard practice. Even at this date, when it is evident that the telephone repeater will necessarily bring about radical changes in the whole trunk-line system, there are many unsolved problems to be dealt with. Consequently this article must be confined to a description of general principles and of the problems involved in introducing the repeater into commercial service. It may, however, be said that if the present-day requirement were for the design of a complete new telephone trunk system to replace that now existing, the problem of the telephone repeater would be comparatively straightforward and clear.

The telephone repeater is quite an old theme among telephone engineers, and descriptions of apparatus and circuits may be found in old text-books which do not even mention loading coils or loading in any form. Certainly, long-distance loaded cables had never been dreamed of when telephone repeaters of the microphone type were already in service.

The essential element of any form of telephone repeater is the amplifier, and when it is considered that the energy available in a telephone circuit for operating an amplifier is of the order of a few millionths of a watt at an alternating frequency averaging 800 periods per second it will be realised how difficult was the designing of any form of mechanical amplifier. Nevertheless, the difficulties were surmounted and the mechanical amplifier had reached a high stage of perfection when the advent of the thermionic valve amplifier put it completely in the shade. S. G. Brown's microphone relay is probably the most perfect example of a mechanical amplifier.

The evolution of the thermionic valve is one of the most remarkable developments in modern applied science.* It is quite beyond the scope of this article to describe the scientific discoveries which preceded the introduction in 1904 of the first practical apparatus by Dr. J. A. Fleming. This apparatus is known universally as the Fleming valve. The following is a very brief description of the principles of valves of this type:

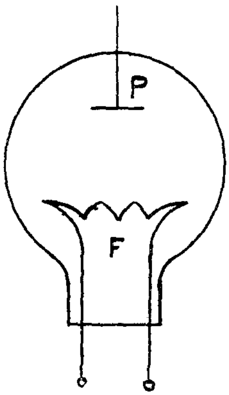


FIG. 1

1 represents a glass bulb which has been exhausted of all air. It encloses a metal or carbon filament *F* which can be heated to incandescence by passing a given current through it, and a metal disc or plate *P*.

When the filament is heated to incandescence it becomes radioactive and emits rays or streams of (negative) electrons from its surface. If now a potential difference be set up (2) between the filament and the plate, in such a direction that the plate is positive to the filament, the streams of electrons will be attracted to the plate. As a stream of electrons constitutes an electric current it may be said that the vacuous space between filament and plate has become conductive, but the flow of electrons is in the reverse direction

* See "The Evolution of the Thermionic Value," by R. L. Smith-Rose, B.Sc., in 'Institute of Electrical Engineers' Journal,' vol. 56, April, 1918.

to the previously accepted direction of the flow of current in an electrical circuit. If the potential difference between plate and filament be reversed, the flow of electrons across the space between

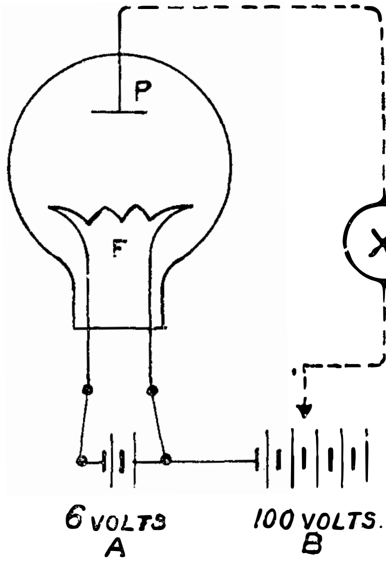
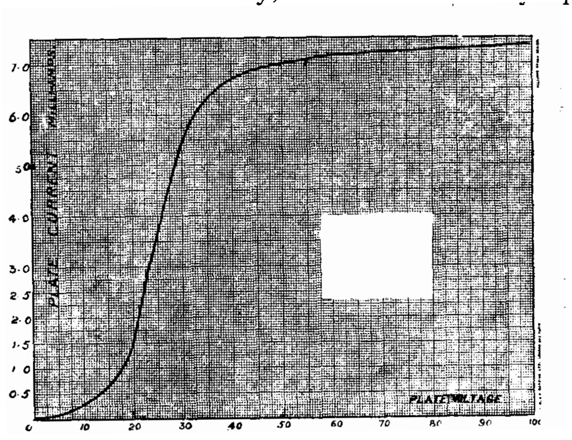


Fig. 2

them will cease and no current will flow in the outer circuit, proving that the apparatus is conductive in one direction only; hence the term "valve." The current through the valve does not, however, follow Ohm's law—that is to say, it is not constantly equal to the



3.—Shows Current Rise with Increase in Plate Voltage.

ratio V/R but follows the law of the curve (3). This curve indicates that for the particular valve under test, and with a given heating current, a change of plate potential from zero to +20 volts causes a very small change in the current; for a change from

+20 to +40 volts there is a very rapid change in current strength; and for potentials above +40 the current ceases to rise. It should be noted that a valve with two electrodes has no amplifying properties and is a rectifier only.

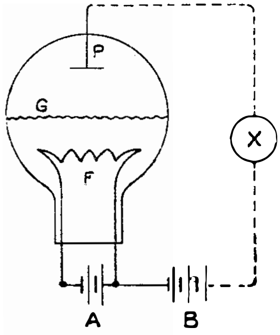


Fig. 4.

Now, if a metal grid or sieve *G* be inserted between plate and filament (4) and insulated from both, the plate potential and heating current being kept constant, the current in the outer circuit through battery *B* will fall almost to zero. The reason is that the grid has interrupted the electron stream and has become negatively charged by it, consequently tending to repel the electrons given off by the filament and prevent them from passing across to the plate.

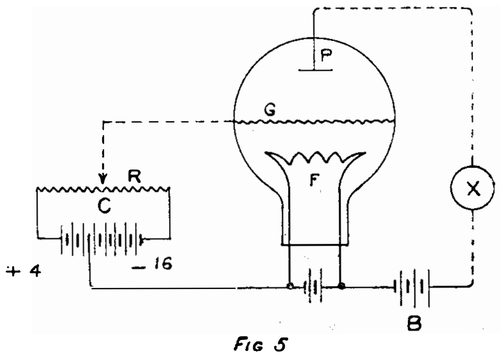
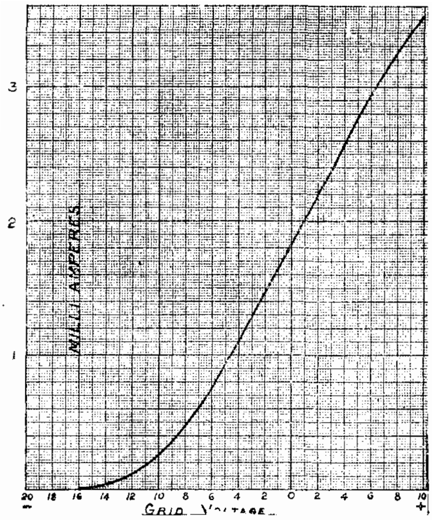


Fig 5

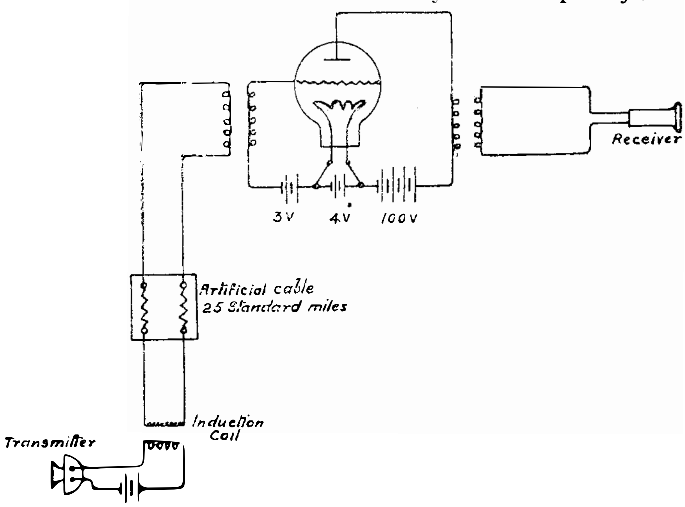
Now, let the potential of the grid with respect to the filament be controlled by means of the battery *C* and potentiometer *R* (5). When the grid is 16 volts negative with respect to the filament the current in the plate-battery circuit is *nil*. When the grid potential is raised to, say, 4 volts positive, a considerable current will flow in the plate circuit; between grid potential values of −16 and +4 the current in the plate circuit varies in value, as shown by curve (6).

It will be seen that between the ordinates — 6 and + 2 there is a rapid change in the strength of the plate current corresponding



6.—SHOWS CURRENT RISE BY INCREASE OF VOLTAGE ON GRID FROM 16 VOLTS — TO 10 VOLTS +.

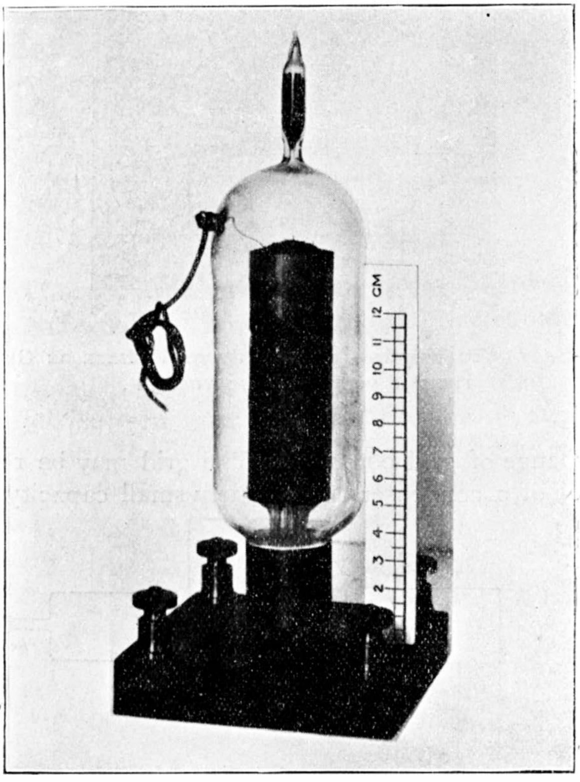
to a given change of grid potential. The grid may be regarded as one electrode of a condenser of extremely small capacity; it there-



7

fore requires only a minute charge to cause an appreciable variation of its potential, and herein lies the essential principle of the thermionic valve as a telephonic amplifier.

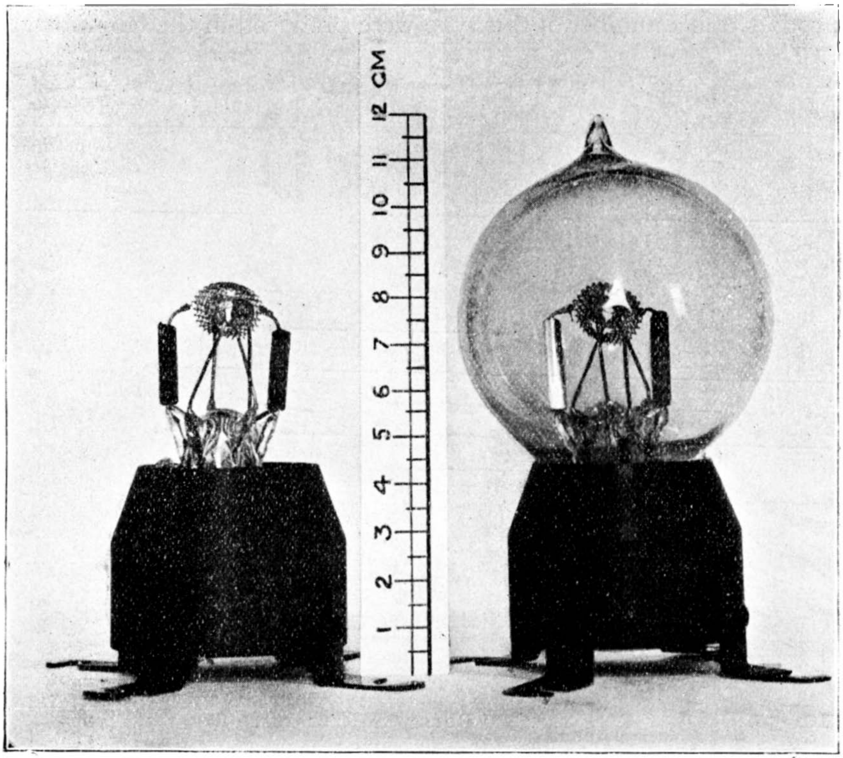
Finally, let the valve be introduced into a circuit made up as shown in **7**, and the arrangement of a telephone amplifier is obtained. Alternating currents impressed on the line by the transmitter and induction coil are attenuated in passing through the artificial cable, and the energy available at the terminals of the input transformer will be of the order of 50 millionths of 1 watt (50 microwatts) at a potential of about 0·2 volts. The voltage alternations will be stepped up about sixteen times by the transformer and added to the steady



8.—Original Post Office Amplifying Valve (Round's Type).

potential of the grid, which will thus vary between $-3 + (-3{\cdot}2) = -6{\cdot}2$ and $-3 + 3{\cdot}2 = +0{\cdot}2$. The corresponding plate current variations, which can be read from the curve (**6**), will generate alternating currents in the line winding of the output transformer. These alternations will be of precisely the same form as those impressed on the input transformer, but magnified about sixteen times. A magnification of this order corresponds to a suppression of about 25 miles of standard cable, so that in the conditions described above the amplifier has reduced the standard cable equivalent of the line to o. An improvement of this magnitude cannot, however, be maintained in actual trunk lines except under unusually favourable conditions, for reasons which will be explained later.

It may be interesting at this point to review briefly the stages of development of the thermionic valve amplifier by the Post Office Engineering Department. In 1908 a little group of workers in the Research Laboratory, who were studying cathode ray phenomena, conceived the idea that a cathode ray tube could be made to act

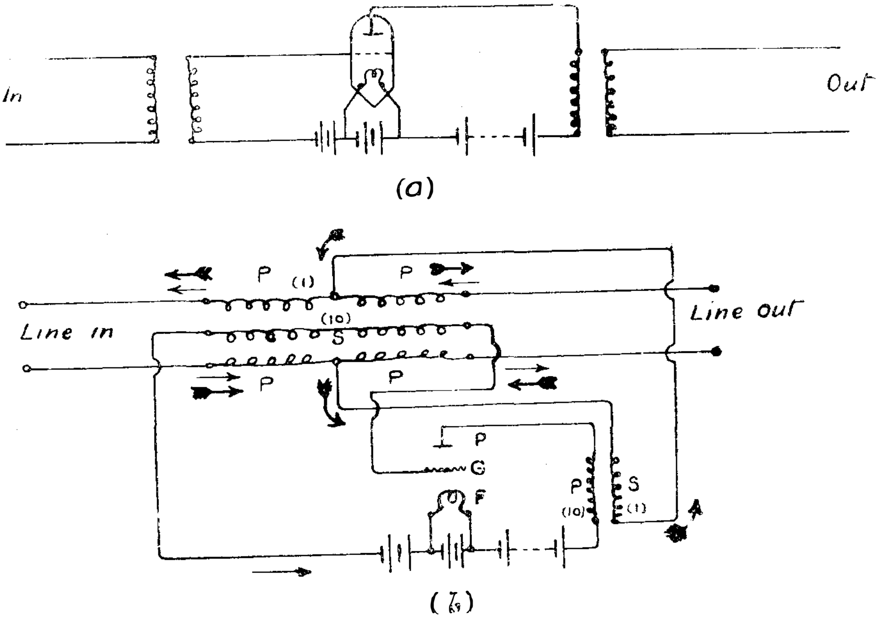


9.—Post Office "Valve, Amplifying, No. 1."

as an amplifier of telephonic speech currents, and the necessary machinery for exhausting vacuum tubes was purchased and installed. Unfortunately, inevitable staff changes dispersed that little band of enthusiasts almost as soon as they had commenced their experiments, and the subject was overshadowed by other matters which appeared at that time to be of greater importance, namely "loading" and the mechanical amplifier, the latter then promising to be of immediate practical use. In 1913, when the inventions of de Forest, Lieben and Reisz, Round and others had brought the thermionic valve amplifier to a high stage of development, the subject was revived.

Fortunately, one of the little band dispersed in 1908 returned to headquarters about this time and restarted the suspended experiments.

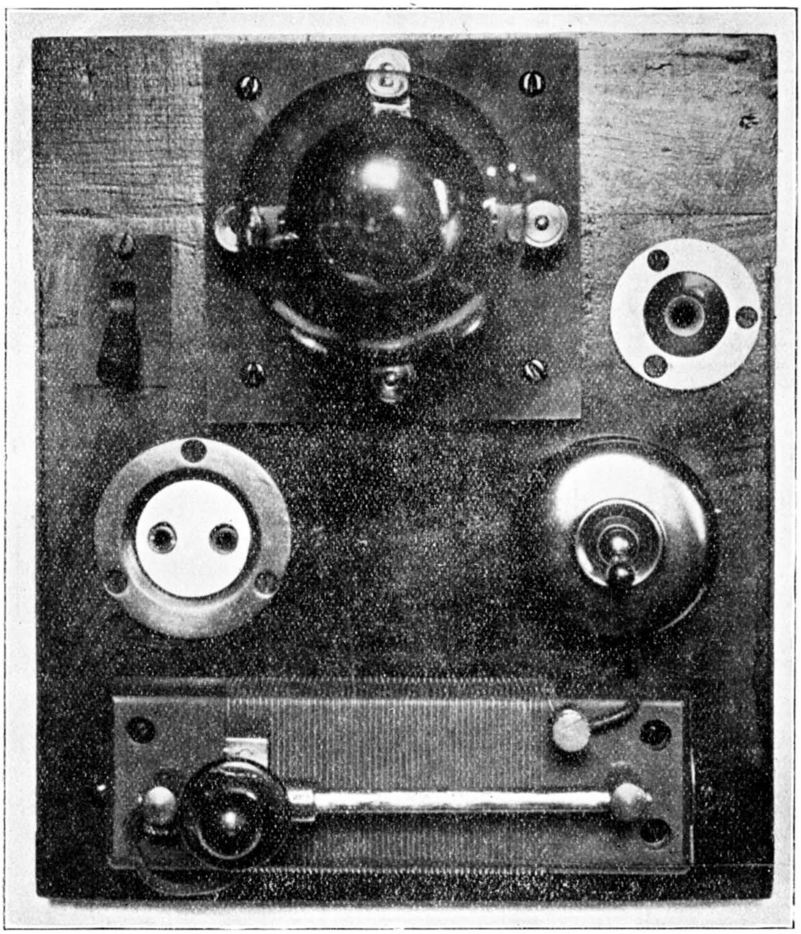
The equipment purchased in 1908 was utilised for the production of new experimental valves, incorporating special features intended to adapt the earlier types to commercial telephone requirements. Samples of valves were obtained from each of the inventors named above, and the characteristics of each were examined in the light of the knowledge of requirements for a telephonic amplifier. Valves of the Round type proved to have the best characteristics for telephonic purposes, and a number of this type were produced in the laboratory



10.—(*a*) One-way Repeater. (*b*) Both-way Repeater. The thin arrow indicates the original current; the thick tailed arrow indicates the amplified current.

8 is a photograph of one of the first valves used in commercial telephone service in this country. It has now been superseded by the type illustrated in 9, which is a photograph of the Post Office standard "Valve, amplifying, No. 1." Valves of this type are known universally as "French valves."

The filament of the standard valve is a fine spiral of tungsten wire. The normal heating current is about 0·85 ampère. The grid is an open spiral of tungsten wire mounted concentrically around the filament at a radial distance of about $\frac{1}{8}$ in. The plate is a spiralled helix of tungsten wire mounted concentrically with filament and grid at a radial distance from the latter of about $\frac{1}{16}$ in. In future issues the plate will be a cylinder of nickel foil. The glass bulb is mounted on a cylindrical red fibre base, which carries the four terminal plates. With a plate potential of 200 volts the standard valve and its transformers have a power magnification factor of about 500. The voltage and current magnification factors are, of course, proportional to $\sqrt{500}$.



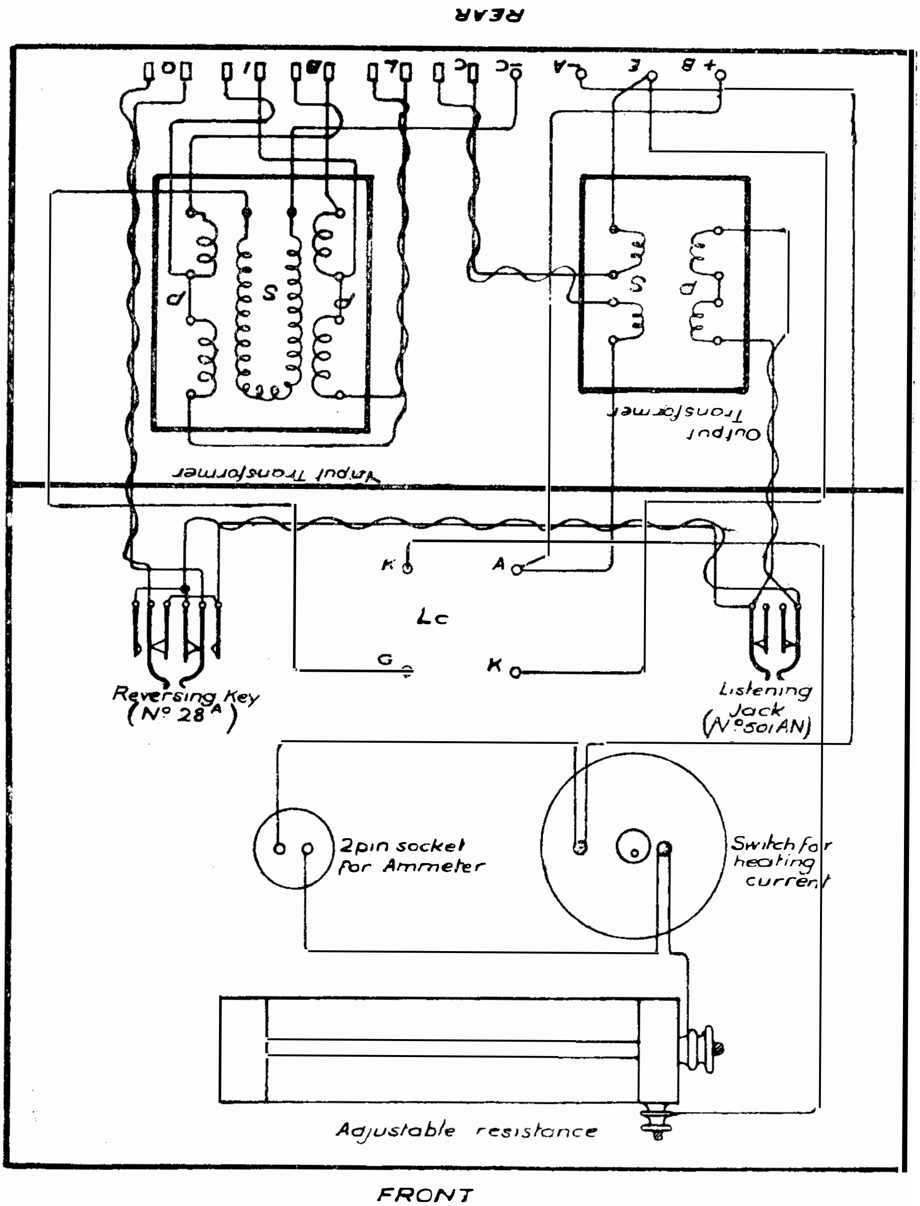
II.—"Repeater, Telephonic, No. 2." Dimensions—8 in. × 9¼ in., 11½ in. deep.

Telephone Repeater Systems.

The arrangement illustrated in 7 constitutes a one-way amplifier only. It will not transmit speech if the positions of the transmitter and receiver are interchanged. In order to act as a telephonic repeater the amplifier must be duplexed.* There are several methods

* See "The Application of Telephone Relays to Commercial Circuits," by C. Robinson, B.A., and R. M. Chamney, A.M.I.C.E., in 'The Electrician,' August 14th, 1914.

of obtaining this facility, and the simplest is illustrated in 10. This arrangement is known generally as the Edison differential system.



12.—"Repeater, Telephonic, No. 2." Wiring Diagram. A is Anode, K the Kathode of Valve.

An explanation of the theory of this circuit and description of other systems will be given in our next issue.

11 is a photograph of a standard amplifier unit (stock list title,

"Repeater, Telephonic, No. 2") comprising: Valve, valve-holder, reversing key (in relay winding of output transformer), listening-in jack, ammeter plug socket, slide resistance (for heating current adjustment), input transformer, output transformer, mounting for rack.

12 is a wiring diagram of this unit.

A. B. H.

(To be continued.)

LINE-TESTING BY MEANS OF DETECTOR No. 2.

THE following description of a testing circuit suitable for use on the test jack panel (fitted on the main distribution frame) of a modern combined Trunk and Local C.B. Exchange may be of interest to those readers of the JOURNAL concerned with the testing of trunk and junction circuits. The usual Weston voltmeter set of the standard C.B. test desk hardly meets the needs in connection with tests of the out-centre junction equipment, and even for ordinary line tests experience seems to show that the Detector No. 2 can be used with advantage in the majority of cases.

The latest type of junction circuit equipment introduces a number of apparatus contact points into the path of the currents transmitted to and from line in the case of exchanges other than C.B., and when it is remembered that equipment of this type has to be maintained at small exchanges where an engineering officer may not be permanently stationed, the need for satisfactory testing facilities to enable the test clerk at the controlling C.B. exchange to ascertain very definite information as to the condition of the distant equipment and battery will be apparent. The full circuit connections are given in **1**, and the arrangement provides the following facilities, all of which have been found to be useful:

(1) The test-set telephone (condensered circuit) is left in bridge across the line when all test-keys are in the normal position, *i.e.* the usual speaking key has been dispensed with.

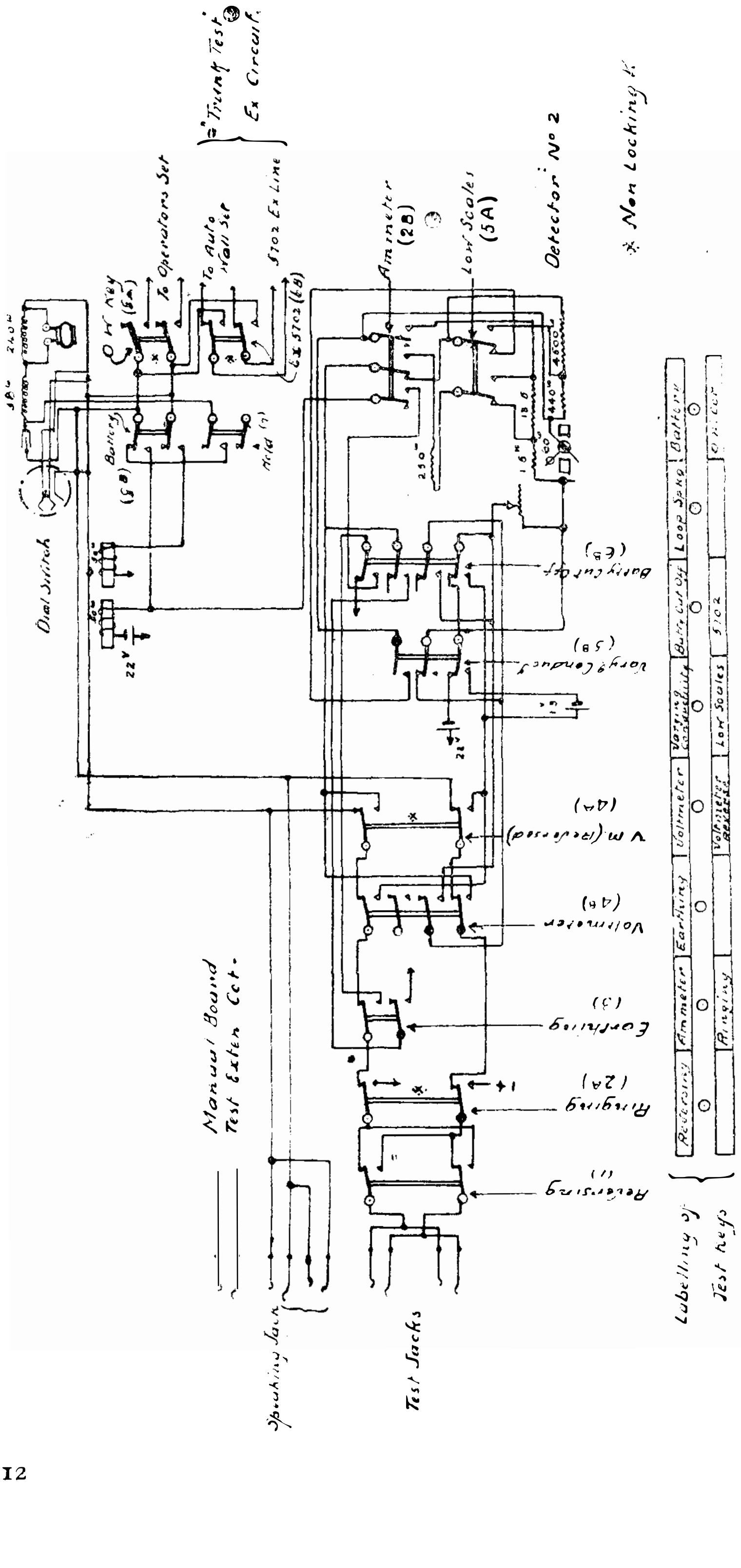
(2) Test-keys enable the test clerk to—

(*a*) Connect up his telephone as a metallic loop.

(*b*) Transmit loop battery to line.

(3) A special jack is provided to enable the test clerk to use a separate circuit as a "speaker" during the progress of tests. This facility has been found most useful.

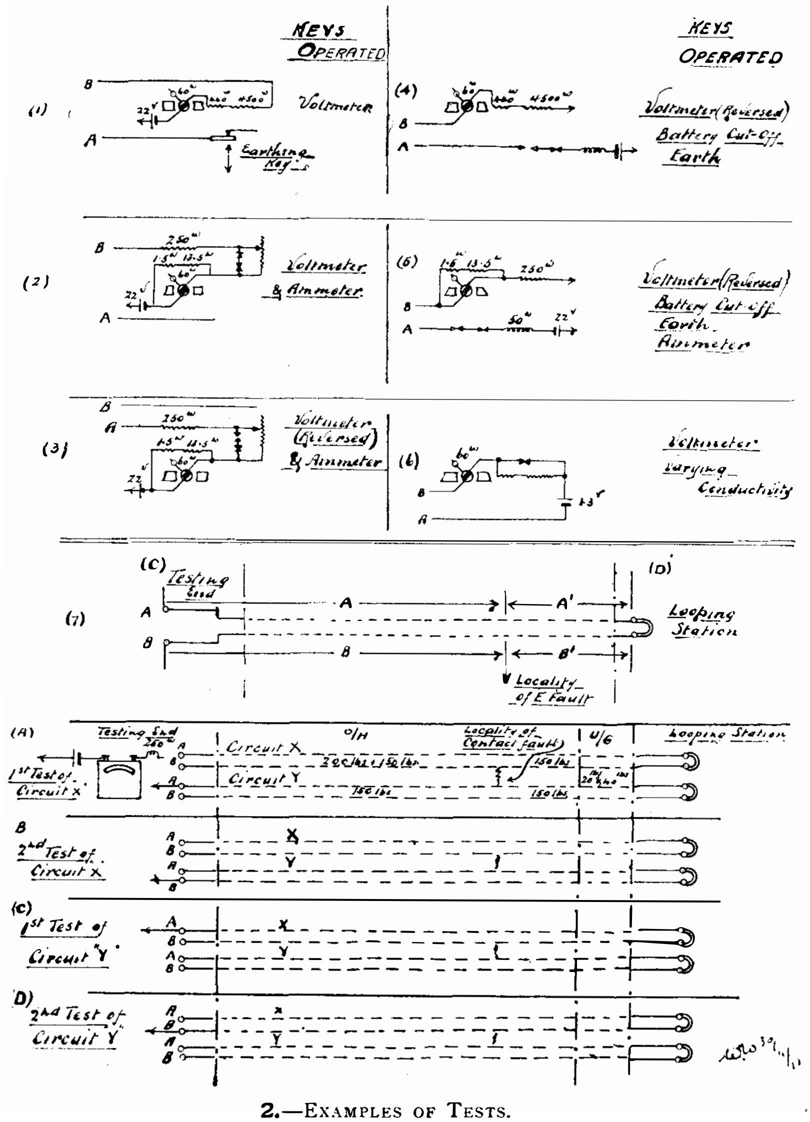
(4) The exchange circuit to which inquirers for "trunk test" are connected is passed through a non-locking key, so that calls can be switched on to the test panel telephone circuit. In the case which is



I.—Diagram of Connections.

the subject of this article the exchange circuit is on an auto system, and the usual dialling facilities have also been provided.

Circuit Continuity and Insulation Tests.—Keys Nos. 4^b, 1 and 3



2.—Examples of Tests.

(the voltmeter, reversing and earthing keys respectively), provide the usual facilities for these tests. The test conditions are shown in **2** (1).

Conductance Tests.—Key No. 2^b connects up the set as a milli-ammeter, and the conductance value of a circuit under test may be obtained by a simple application of Ohm's law. The test conditions are shown in **2** (2). It may be mentioned that measurements of the approximate distance to earth and contact faults on long lines have been made by this method. A few examples of such tests are given at the end of these notes.

Strength of Received Currents.—Keys 2^b, 3, 4^a and 6^b provide this facility, and the test conditions are shown in **2** (5). The test clerk can determine at once whether the transmitted currents are adequate to properly operate the supervisory relays in the C.B. cord circuits. In this connection it will be recognised that the resistance of the testing circuit must have a value equal to that of the supervisory relays, and the 250^{ω} resistance spool shown in the diagram has been provided mainly for this purpose. With reference to this important test, it may be remarked that the test clerk takes the precaution, in the case of local exchanges having small special primary batteries, to request the distant operator to engage a number of junctions, and so load up the battery in order to ensure that his results are reliable.

In some cases the circuit arrangements in the auxiliary equipment at an out-centre make it essential that a "sent" current shall be transmitted in order to complete the path of the received current. The reverse sometimes holds good, *i.e.* when testing the circuit to earth at the distant end the path for a "received" current has first to be completed. The connections on the "earthing" key have been arranged to meet these conditions.

Varying Conductivity Tests.—Keys Nos. 4^b and 5^b are operated. This connects a single dry cell in series with the coil of the Detector No. 2, and eliminates "earth" from the circuit. **2** (6) shows the circuit connections.

The following features may also be of interest:

(*a*) The non-locking side of the voltmeter key (No. 4^a) reverses the instrument connections, and also joins up the line direct. The need for operating two keys is thereby avoided.

(*b*) The "low-scales" key (No. 5^a) increases the sensitiveness of the instrument when reading from both the milliammeter and voltmeter scales.

Reference was made in the paragraph dealing with conductance tests to measurements of the distance of earth and contact faults. The lines are connected up, as shown in **2** (2), and, using the symbols adopted in **2** (8), the following formulæ applied:

$$B^1 = \frac{a-b}{2}.$$

B^1 = Single conductor resistance between "D" and the fault.

a = " " " along the "a" line (*i.e.* $A + A^1 + B^1$ + res. of fault).

b = " " " along the "b" line (*i.e.* B + res. of fault).

The following example is given in order to demonstrate the manner in which the tests are applied.

Circuits X and Y (**2** [9]) were in contact, and four distance tests were made in all, in order to determine the approximate locality of the fault. The values obtained were as follows:

(*a*). "*a*" line-test results were $\dfrac{19''}{\cdot 023}$ or 826^{ω}

"*b*" ,, ,, ,, $\dfrac{19''}{\cdot 02775}$ or 684^{ω}

$$\therefore B^1 = \frac{826 - 684^{\omega}}{2} = 71^{\omega}.$$

(*b*). "*a*" line-test results were $\dfrac{19''}{\cdot 02775}$ or 684^{ω}

"*b*" ,, ,, ,, $\dfrac{19''}{\cdot 035}$ or 542^{ω}

$$\therefore B^1 = \frac{684 - 542^{\omega}}{2} = 71^{\omega}.$$

(*c*). "*a*" line-test results were $\dfrac{21.25''}{\cdot 035}$ or 685^{ω}

"*b*" ,, ,, ,, $\dfrac{21\cdot 25''}{\cdot 040}$ or 531^{π}

$$\therefore B^1 = \frac{685 - 531^{\omega}}{2} = 77^{\omega}.$$

(*d*). "*a*" line-test results were $\dfrac{21\cdot 25''}{\cdot 025}$ or 850^{ω}

"*b*" ,, ,, ,, $\dfrac{21\cdot 25''}{\cdot 03}$ or 708^{ω}

$$\therefore B^1 = \frac{850 - 708^{\omega}}{2} = 71^{\omega}.$$

The above results were obtained on tests over a route about 30 miles in length. Section B^1 measures approximately 7 miles, and each of the four conductors included:

1 heat coil.
Approx. $\frac{1}{4}$ mile of 20-lb. U/G cable.
,, 1 ,, 40-lb. ,, ,,
,, $5\frac{3}{4}$,, 150-lb. O/H wire.

Although the movement of the pointer over one degree of the scale covers a wide range in ohms, localisations to within one mile of the fault are obtainable even on fairly high conductance circuits.

When the testing set is used extensively, a rheostat might be included in the manner indicated in the diagrams, in order to obviate the need for calculations. The use of the "reversed voltmeter" key then throws the rheostat into circuit for the test of one conductor only, so that by suitably adjusting the resistance added to the shorter length of line equal deflections can be obtained over both wires of the circuit. Under these conditions the unplugged resistance has a value equal to twice that of the length of circuit marked "B^1" in **2** (7).

A further use of the set is to prove a faulty line to a lineman at an intermediate point where there are no facilities for disconnecting, etc. The lineman merely gives a full short-circuit, and if the line is clear to him the test clerk gets a balanced reading on both wires of the loop.

Apart from its wide sphere of usefulness as a measuring instrument, the Detector No. 2 appears to serve quite efficiently when used in the place of the horizontal galvanometer formerly used on conductance tests made with the aid of the Wheatstone bridge. When using this galvanometer it happens all too frequently that the pointer is controlled by other influences than those which it is intended should control. On these occasions an instrument such as the No. 2 Detector, which remains unaffected by extraneous fields, is invaluable. The fact that the pointer is placed so that scale-readings are obtainable in one direction only does not present any difficulty, since the flow of a reversed current can generally be detected.

Blackburn. W. WHEELER.

THE TRAINING OF PERMANENT LINEMEN IN THE ARMY SIGNAL SERVICE.

By Capt. J. G. Hines, R.E.

As so many men of the Post Office Engineering Department have been employed in the Army Signal Service, it is thought that it will be of interest to give a brief description of the scheme of training in a depôt where telegraph and telephone instruments and open line work are the principal items in the syllabus.

It will be understood that, although many men employed in the Signal Service had some knowledge of permanent line construction at the time that they joined the Army, the majority possessed no knowledge of this or any other class of electrical work.

The scheme of training has been designed with a view to make the men of some use to the Signal Service in as short a period as possible, and, at the same time, to enable a selection to be made of those who show aptitude for more advanced work. Training conditions are always more or less artificial, and the real test of a man can only be made when he is working under active service conditions. Experience has shown, however, that a man who has undergone a definite scheme of training qualifies more quickly as an efficient lineman than a man who gathers his knowledge in scraps.

The first few weeks of military training are devoted to foot-drill and musketry.

Each man then undergoes a cycling test, and, if he is not able to ride, is given instruction.

He then commences a course of instruction in light air-line work, *i. e.* erecting lines carrying from one to eight wires at a fast rate.

The stores are carried on motor lorries and are laid out as the work proceeds.

Each man has a definite duty to perform, such as digging holes, paying-out wire, straining, binding-in, etc.

This work teaches two important principles:

(1) The advantage and importance of team-working.

(2) The necessity for strict attention to detail, as if certain rules are not observed whole sections of line are seen to fall down.

The number of men employed in a team varies according to the number of wires to be erected. A commander and twelve men are required for building a 2-way line. A commander and thirty-three men are required for building an 8-way air-line near a carriage road. If the stores have to be carried some distance by hand thirty-nine men are required.

Four wires are supported on standard poles 2 in. to 2½ in. diameter at the butt and 13 ft. to 16 ft. long. A wood arm 33 in. long is clipped to the top of the pole, and carries four ebonite insulators on iron spindles 9 in. apart. The holes for the poles are made by means of sledge-hammers and a jumper or boring-bar.

Eight wires are supported on rough fir poles, 15 ft. to 17 ft. long, 3 in. to 4½ in. at the butt, and 2½ in. to 2 in. at the tip. Holes for these poles are dug with a shovel or grafting tool. The depth of the hole is from 2 ft. 6 in. to 3 ft., according to the nature of the soil. The average time taken to dig a hole is five minutes. Earth augers have proved useful in some soils, but are practically useless where stones are met with.

Every eighth pole is stayed fore and aft, and between each set of fore and aft stays is a set of rocking stays. The stays are made fast to fences, trees, or specially provided stakes.

It is found that after a few weeks' training a squad can build this type of route at the rate of one mile per hour.

At the same time that the men are being trained in outdoor work they also receive lectures in elementary electricity and the construction details, care and use of simple instruments, such as the "Q and I" detector, direct working sounder, simple telephone, etc.

Every wire is tested and spoken over as soon as it is completed, and no line is allowed to be dismantled until any fault, either in the line or apparatus, which interferes with speech or signals is cleared.

At the end of three weeks each man is tested. Assuming that he is found suitable for further instruction in permanent line work the man is placed in a squad for a three weeks' course to enable him to qualify as a "lineman, permanent, proficient."

He commences by receiving lectures on the underlying principles of permanent line construction. These lectures are short, and are followed by demonstrations and practical work in pole and stay-hole digging, pole erection, pole climbing, wire jointing, soldering, binding-in and making-off stays.

Racks are erected breast-high with insulators 2 ft. apart. A wire is stretched along these insulators, and each man must be able to bind-in and terminate all the classes of wire in Army use.

Each man must pass in jointing and soldering.

A brief lecture is given on wiring principles. The squad then wires a standing route, on which the poles are of such a height that the men can do the work while their feet are on the ground.

The men are next equipped with safety-belts and climbers, and are put to wire a standing route on which the top arm is 8 ft. from the ground. This is done to give the men confidence in the climbers and belts. It also permits of the work being easily inspected by the instructors.

Routes from 20 to 30 ft. high are next wired. Each of these routes consists of from 16 to 20 spans.

The squad is now organised into a small working party and erects a route of sixteen wires, the poles having been dressed by a squad which is in a more advanced stage of training. When this route is completed two or three spans of open wires are replaced by suspended cable. The route is then taken down and re-erected so as to include stayed, strutted, side-armed and cross-armed poles, also "flying" or "gallows" stays. On completion some spans are cut away to represent breakdowns and the squad has to restore communication speedily.

After some practice has been obtained in the daylight a working route is broken down at night, and it must be repaired without the use of lights and with no conversation above a whisper.

Practice is next given in inserting crosses, test points, pole test-boxes, leading-into offices, wiring test-boards, labelling, etc.

The next operation is to build two 16-wire routes crossing on one pole. A third route of 8 wires is then built which crosses the other two routes at the same junction pole. As there is not head-room for the 8-wire route to cross beneath the 16-wire routes, the junction pole is replaced by a taller pole. The circuits must be kept working during the change.

Lectures on apparatus and the use and care of construction tools and appliances are sandwiched between the periods of heavy practical outdoor work. Each man must be able to clear common faults on the instruments and protective apparatus in general use.

The men receive lectures on testing procedure and are then sent to test and clear faults on standing lines. Much ingenuity is exercised by the N.C.O. instructors to put on such faults as may occur in practice and yet not be too easily traced.

Lectures are given on the duties of a maintenance lineman. The men are then divided into small parties and set to patrol the military and Post Office lines in the vicinity. They make pole diagrams, and report what is necessary in order to put the routes into a satisfactory state of maintenance.

At the end of three weeks the men are examined, and those that can satisfy the examiners are given "sappers'" rating as "lineman, permanent, proficient." The examiner's test is a practical one, and he is helped in his final decision by the report of the squad commander, who is expected to make a daily note of each man's progress. Those that fail are sent out as "pioneers"—that is, general labourers or gang-hands. A certain number of men are picked out of each squad for a further four weeks' training in more advanced work.

The advanced or "skilled" course lasts four weeks, a large proportion of which is spent on maintenance duties and apparatus work.

A number of telegraph and telephone instruments have been dissected and wired on flat boards so that every connection can be traced. These are working models. Faults are caused and their effects noted.

Standard tests which can be memorised are taught, and the men are also given notes of more detailed tests for insertion in their notebooks.

The men in the "skilled" squads do the final regulation on the wires run by the "proficient" squads. They cut-in test points, lead wires down to pole test-boxes, and also lead the wires from the open routes by means of suspended or buried cable. They dress poles for other squads as required. Various spans of open wire are replaced by suspended cable, the circuits being kept working.

Internal wiring is included in the course. Practice is given in jointing the various types of paper-core, enamelled and armoured cable used in the Army.

A number of buildings and huts are wired to represent the headquarters of army, corps, division, etc. Routes carrying from 8 to 24 wires are built to connect the various offices.

On completion of the above work a move is ordered, and the men must carry out all the necessary rearrangement and reconstruction of the external and internal work.

The new offices occupied must be completed to the state at which the telegraphists and telephonists may commence work.

Stress is laid upon the necessity for neat internal wiring and satisfactory labelling of circuits.

At the end of the course each man is examined in line and instrument work. His notes are inspected and also the record which the instructor has kept. If the man is able to satisfy the examiners that he has reached the required standard of proficiency he is given a skilled rating which carries with it increased pay. Those that fail to pass retain their proficient rating.

A somewhat similar course but with more lectures and less heavy manual work is given to officers.

At the commencement of the training each man is given a note-book, and this book is inspected from time to time.

The lectures are standardised in order that each man may receive exactly the same information. The theoretical lectures contain short, pithy notes to be taken down by the men, and these notes are put in a form which is easily understood. The instructors are constantly being changed, owing to the exigencies of the service, but the provision of the standard notes ensures that each man receives the same instruction in theory. Lectures in practical work are also given, and the instructors enrich these lectures with individual experiences gained in the war.

As most readers of this JOURNAL are probably aware, the Army Authorities have great faith in "courses." If linemen, instrument repairers, motor mechanics, drivers, cooks, doctors, lawyers, signal officers, or any other specialists are required, a number of men are given a special course of a few weeks or a few months, and the finished article turned out. No doubt this is much overdone. Every experienced engineer knows that a good telegraph lineman of the type required in the Post Office cannot be trained in seven weeks or seven months; *nor can an officer who has had a few months' intensive training on a course, followed by two or three years in the field, be regarded as a telegraph and telephone engineer.* Yet experience has shown that the linemen and officers so trained have been able to carry out satisfactorily the construction and maintenance of the comparatively simple systems in use in the Army, where there is always plenty of labour available, and accounts of expenditure have not to be rendered.

The "course" system has been productive of much good, inasmuch as the officers and men have the advantage of working under experienced instructors. They do the actual work themselves; they carry a job right through and see it when completed; the faults are pointed out. There is usually a standard to which their own efforts can be compared and interest is sustained throughout.

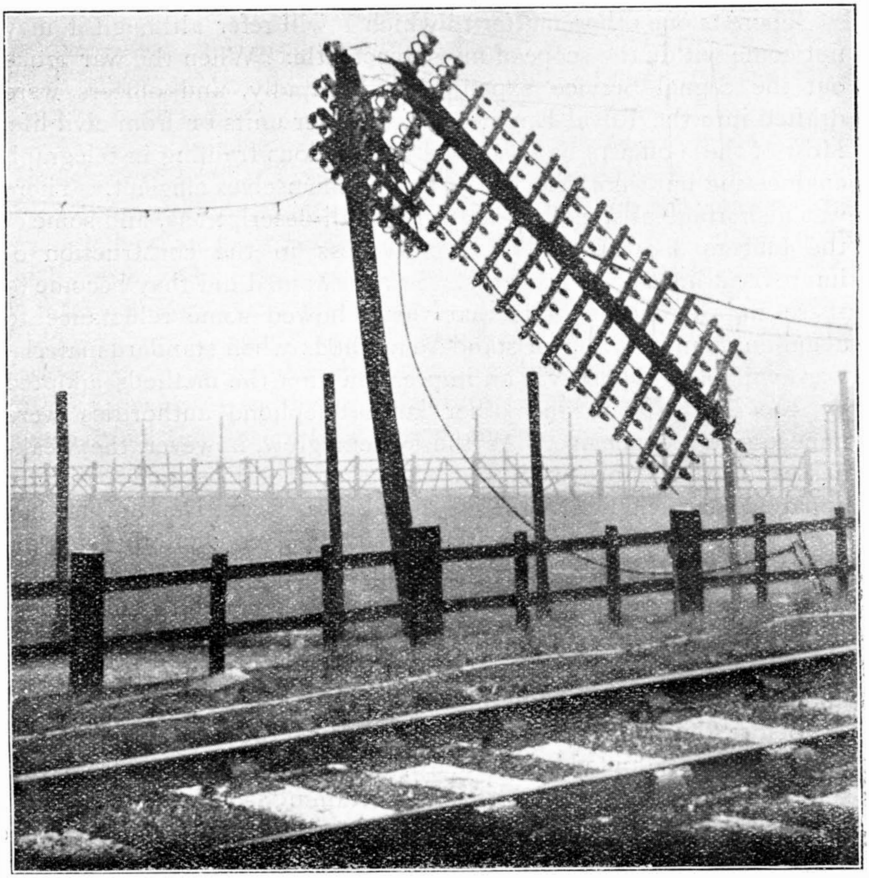
Some Post Office engineers would be astonished to see the routes which have been erected by "fire-pot boys" from their own sections after five or six weeks' training. I had the pleasure of showing the training system in operation to a superintending engineer and a staff engineer who paid a visit to the depôt, and I think they were convinced that if this intensive method were still further developed in the Post Office we should be able to turn out efficient wiremen and linemen in much less time than is taken at present.

There is one other matter to which I will refer although it may not come within the scope of my subject title. When the war broke out the Signal Service expanded very rapidly, and officers were drafted into the Royal Engineers from other units or from civil life. Most of these officers had received no previous training in telegraph engineering but were very keen to make themselves efficient. There was a shortage of signalling material of all descriptions, and some of the officers showed much inventiveness in the construction o improvised lines and apparatus. So accustomed did they become to these improvised methods that they showed some reluctance to abandon them in favour of standard methods when standard material was available. There was an impression that the methods adopted by the Post Office and other large telephone authorities were unnecessarily expensive. As the system grew, however, the weaknesses of the improvised and cheap methods became painfully apparent, and one by one the cherished ideas were given up. It has been rather interesting to watch the growing conviction that principles which have evolved as the result of many years of experience have something to commend them, and that although isolated lines, required for a short period only, may be built in a rough-and-ready manner, yet if the system is to grow and be efficient it must be built up on sound engineering methods.

Before the end of the war Post Office methods and Post Office material were adopted as standard, and, as will be seen from the scheme which has been described, the training is very largely based on Post Office practice.

SNOWSTORM DAMAGE IN SOUTH LANCASHIRE DISTRICT.

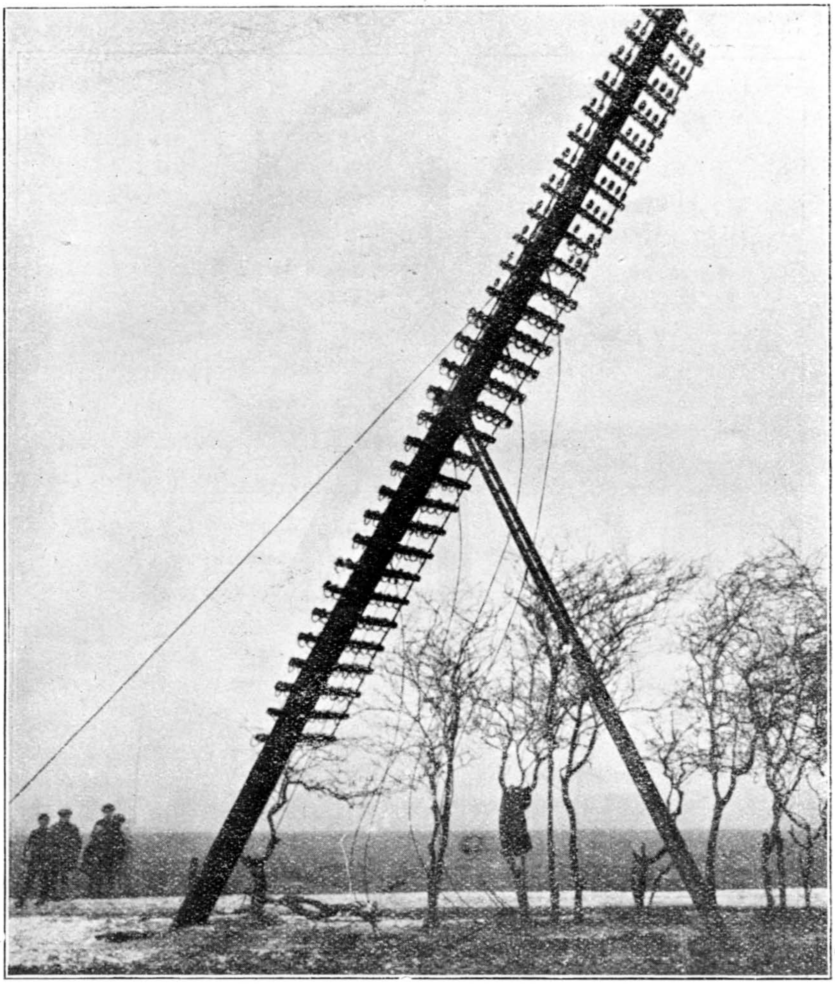
SNOW began to fall about 4 a.m. on January 4th, continuing for about 9 hours, and froze on the wires as it fell to an estimated diameter generally of about two inches.



I.—LOCAL LINE, MONTON TO SWINTON IN ECCLES AREA. LINE ALL DOWN FOR ABOUT A MILE.

Manchester Telephone District comprises 39 exchange areas, including trunk and local lines. The overhead mileages are: main lines 9172 miles, local lines 22,639. The trunk routes nearly all carry between 50 and 60 wires; many of the local routes carry more than 100 wires and some of them over 150. Some of the very heavy lines were entirely wrecked; one line carrying about 140 wires came down from end to end—a distance of about a mile; another line carrying 80 to 130 wires was wrecked for about 2½ miles.

There are about 25,500 exchange lines and external extensions in the district. Of these, 12,849 were listed as faulty on January 6th.



2.—Local Line, Quaker Bridge, Eccles to Swinton.

Additional faults subsequently occurred or were discovered, and on March 15th the number had increased to 25,637. By the latter date 22,688 faults had been cleared, leaving a balance of 2949 outstanding. The maximum listed at one time was 14,782. It is estimated that a large number of additional faults which were not reported or listed were also removed during the clearing-up process. At one time there were more than 5700 subscribers' line faults in the Manchester City area, where there are extensive over-house routes. There were also 250 junction faults, and 1500 of the 2000 private wires were interrupted.

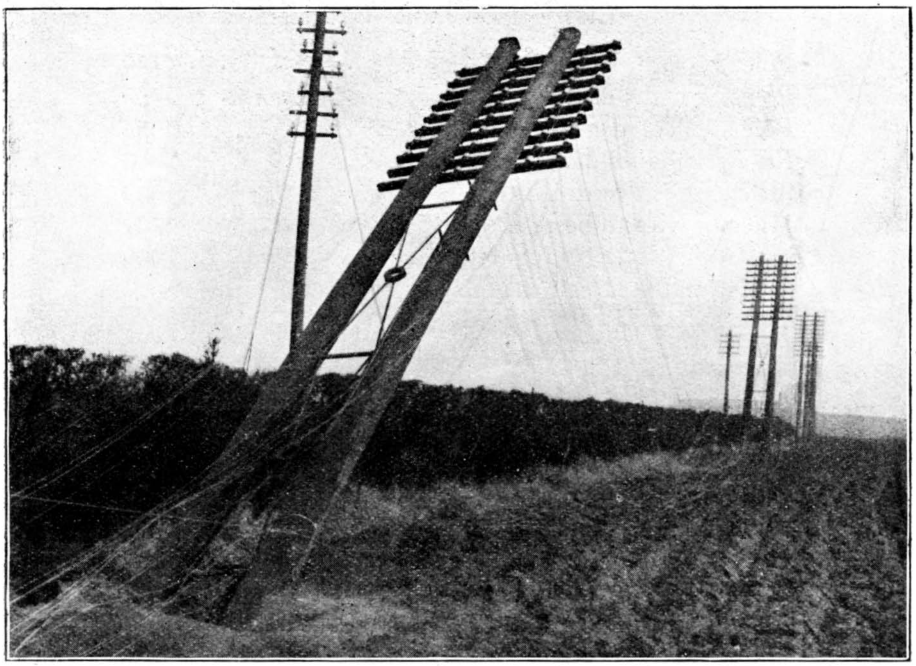
On the evening of January 11th the Manchester Corporation

3.—Local Line, along Canal Bank between Brooklands and Timperley. Practically all down for about a mile.

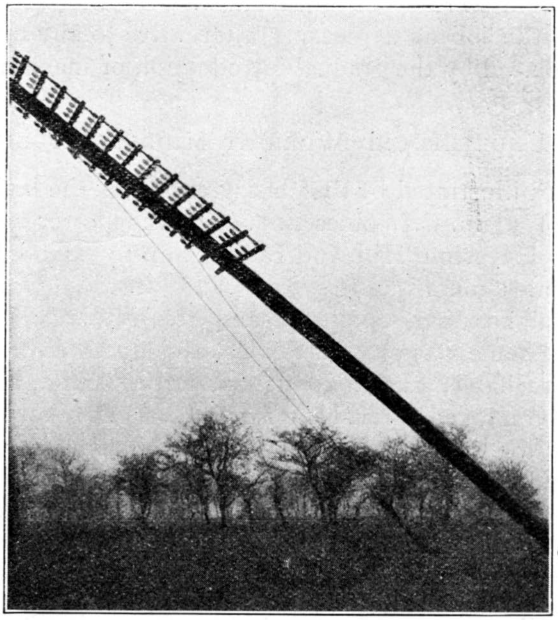
power mains broke down, and burned through two cables carrying about 500 subscribers' lines.

But for the war, much of the overhead wire that has been brought down would have been replaced by underground cables long ago.

With the exception of slight damage in the Lymm Exchange area, the whole of the Liverpool Telephone District escaped.



4.—On Trunk Route MR–WA–LV, via Heatley.



5.—Original Junction Route to Cheadle. Many Poles broken in 2½ miles. Line of 66 40-lb. bronze and 32 100-lb. copper.

LIST OF DAMAGE, ETC.

Poles broken	120
Poles brought down	150
Poles deflected	4954
Roof standards damaged	3
Stays broken or drawn	663
Miles of wire to be re-erected	8700
,, ,, ,, regulated	7900

Estimated labour for repairs, 870,000 man-hours.

FEMALE LABOUR ON LINE CONSTRUCTION WORK.

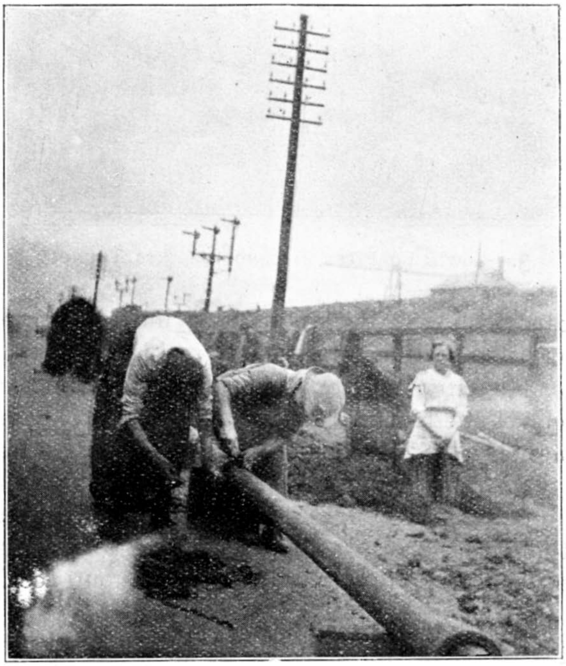
DURING the war it was found necessary to employ women on line construction work in several districts, and it may be of interest, more from a historical than from an economic point of view, to chronicle one or two of the results. Although the work is hard and means exposure to all weathers, the experiment has been a success in the circumstances; before our militant suffragist friends can claim the occupation as an industry suitable for an extension of female labour, however, a more prolonged test with stricter attention to costs would have to be undertaken. We are not prepared to recommend the job as a pleasing alternative to any operators who may be displaced by the gradual introduction of machine-switching.

UNDERGROUND WORK AT MIDDLESBROUGH.

The work illustrated by the photographs was the laying of about 2½ miles of 3¼-in. C.I. pipes from the Transporter Bridge at Port Clarence to Haverton Hill and Billingham, to extend the Middlesbrough local underground system and provide circuits for the Furness Shipbuilding Company and the Ministry of Munitions. When the scheme was proposed it was thought that military labour would be available, but this was not forthcoming, and as female labour was employed extensively for rough work of all kinds in this locality and the question of employing such labour for the Department's purposes was under consideration it was thought the opportunity was a good one for making the experiment. The Labour Exchange was informed of the requirements and applicants soon arrived in considerable numbers.

The work was started with twenty women, three men and a foreman, but for the greater part of the time only one man (a labourer), in addition to the foreman and night-watchman, was

1.—Digging Trench, Middlesbrough.



2.—Caulking Pipes.

employed, and the number of women was increased to an average of about thirty. The women, who had had no previous experience of this work, quickly adapted themselves to the circumstances, and carried out all portions of the work in a highly creditable manner. They not only excavated and filled in the trench, carted and laid out the pipes, etc., but caulked the pipes both in and out of the trench, lowered the pipes into the trench in sections of two or three pipe-lengths, and generally performed all the duties in connection with the pipe—laying in exactly the same manner as a gang of men would have done.

3.—Lowering Pipes (3 lengths) into Trench.

The greater portion of the paving was cinder or gravel footway but there were also sections of flags, bricks (partly on concrete), tar-paving, macadam, etc., and for a considerable distance the ground was made up of large blocks of slag up to 12 in. in diameter. The climax was, however, reached at a railway bridge, where, for a distance of 33 yds., macadam on a foundation of 12 in. of concrete was encountered. Steel wedges and sledge-hammers were used for this, and although progress was of course slow for several days the work was carried through successfully and without accident of any kind.

On completion of the pipe-laying the cable was drawn in by the help of the women, the gang in this case consisting of a foreman, one man and ten women.

The same women have since been employed in laying 120 yds. of pipe in the public streets of Thornaby (Stockton) and to strengthen the gangs generally, including those engaged on open-line work, but pending the supply of suitable clothing have not yet worked up poles. G. N. PECK.

AERIAL CONSTRUCTION IN SCOTLAND EAST.

Early in 1918 the withdrawal of a comparatively large number of young men for service in the Forces made it necessary to consider whether an extension of the employment of young women should not

4.—A SMART TEAM IN SCOTLAND EAST.

be arranged so that the release of men could be provided for with less inconvenience. (It should be remembered that at the time referred to there appeared a possibility of further heavy demands for men.) The question was carefully considered, and the opinion was formed that there was room for the employment of some women on the construction of telephone lines during a period when sufficient men were not available for such work. As a consequence five young women were found willing to be trained.

These young women were carefully trained under a Skilled Workman, Class I, before they were employed on work. The training consisted of:

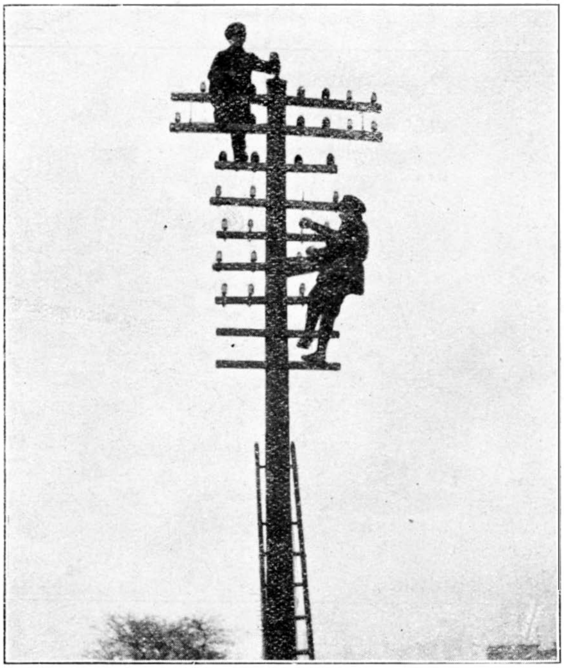
(1) A series of lectures based on T.I. XIII, illustrating the theory and practice of line construction; telephone subscribers' apparatus

(including the exchange which they visited); the "leading-in" arrangements; the line, etc., with explanation of "conductivity," "insulators," "dis.," "earth," etc.

(2) Illustrations and practice of jointing, binding-in, making-off, etc.

(3) Practice in ladder work and pole-climbing; arming of poles; fitting and changing of cups; the running and fitting of brackets and wall spikes, etc.

Most of the lectures were given in the Operators' School, but the



5.—Removing Insulators.

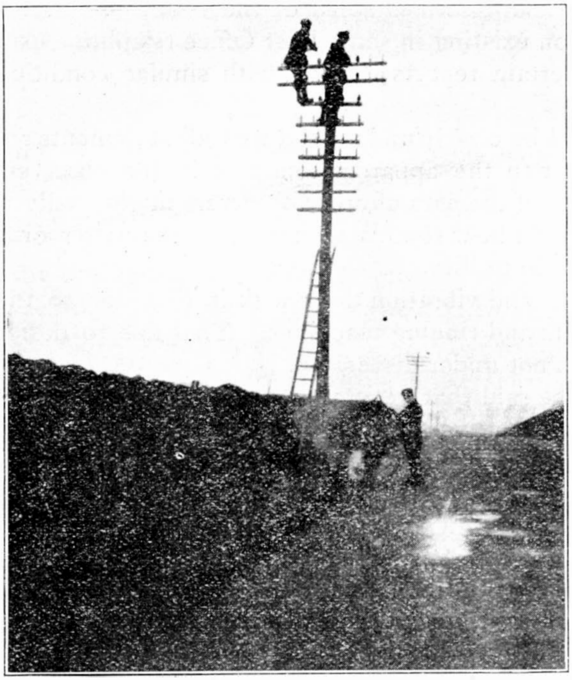
remainder of the lectures and the practical training were given at a pole yard, which was fairly secluded and gave good facilities for the erection of two or three poles with brackets, etc., and wall spikes.

The making of the joints and manipulation of bronze wire was somewhat trying to their fingers at first, but constant practice brought a considerable measure of efficiency.

Following their training, the women, still under the supervision of the skilled workman, were put on actual work, their first job being the erection of a light pole. They did the work well, and the "*man-hours*" were very little in excess of the estimated time. Since then they have been engaged on the cutting down of spare wires, etc., the erection of subscribers' circuits in the suburban area and the regulation of light wires.

The young women have given a very good account of themselves. They undertook their duties with energy and enthusiasm; and "came in" just when they were wanted.

One would not employ female labour on telegraph and telephone line construction and maintenance work save in an emergency, and



6.—Regulating Wires.

no useful purpose would therefore be served by the preparation of elaborate details of comparative costs. Besides, it would scarcely be fair to compare costs of work done by females, who had only a few weeks' training, with costs of work done by the men fully trained.

The experiment was a success. It proved that if conditions had made it necessary to extend the employment of females the Department could with safety and advantage have trained young women to undertake an appreciable amount of construction and maintenance work on telegraph and telephone open lines. Young women cannot do all kinds of line work, but it has been demonstrated that there is much they can do.

J. D. Taylor.

VIBRATIONS IN BUILDINGS DUE TO ELECTRICAL MACHINERY.

By A. B. Eason, M.A.

For satisfactory working in telephone exchanges it is essential that there should be no loud noises present in the switch-rooms and at the test desk. For general comfort the noise in rest rooms should also be reduced to as small an amount as is conveniently possible.

This article describes some of the conditions as regards noise and vibration existing in some Post Office telephone exchanges, and mentions certain reports dealing with similar conditions in other buildings.

It should be clearly understood that all statements as to loudness of noise refer to the apparent loudness in the observers' ears: the sensitiveness of the ears of other observers might easily be different, and they might hear sounds inaudible to the writer or fail to hear sounds audible to him.

The noise and vibration dealt with is that due to the telephone charging sets and ringing machines. That due to desiccators, lifts, fans, etc., is not under discussion.

It may be said that generally trouble is only apparent when the supply is alternating, and is always apparent when the supply is single-phase. The vibration is due to poorly-balanced machines. The noise is due to—(1) Windage, or the movement of rotating bodies in air; (2) A.C. or electrical or molecular hum; (3) brushes. These noises can be examined separately by running the machines with brushes off and on, and by cutting off the supply and letting the machine slow down.

At the moment of writing no suitable *portable* instrument has been evolved or discovered for measuring the absolute amplitudes of vibration and the absolute amount of noise, so that all statements of amounts are only relative to each other.

New Cross.—Langdon-Davies motor, S.P. 200 volts, 85 cycles; W.E. generator 9 kw.—From information given locally, it appears that this machine gave considerable trouble when it was first installed, owing to the vibrations set up throughout the building. In order to overcome this difficulty the machine was placed on cocoanut mats (door-mats) placed upside down. This was not found to be entirely satisfactory, as the bed-plate moved on the door-mat, and arrangements were therefore made to fill the bed-plate with concrete. This gave satisfactory results, and for many years now the machine has been running on the same mats, which still appear to be in excellent condition. The vibrations are almost entirely eliminated.

Greenwich Exchange.—Crompton set: Motor S.P. 400 volts, 50 cycles; generator 5·5 kw.—The machine runs excellently and the vibrations have practically been eliminated. The note given by this machine is similar to the note at Portsmouth, but the amplitude is considerably less. The note is transmitted to a certain extent throughout the building, and can be heard in the switch-room under the main roof girders, but the amount of disturbance is negligible, and no trouble has been experienced by the operators.

Reigate Exchange.—Fuller motor, S.P. 200 volts, 50 cycles; W.E. generator 3 kw.—The noise from the machine was troublesome in the public office. The trouble was removed by mounting the machine on four felt buffers upon a slate bed which itself rested on six similar buffers.

Portsmouth Exchange.—Crompton set: Motor 100 volts S.P., 75 cycles; generator 8 kw.—The noise of running machinery is perceptible in entering the yard, but most of the noise in the yard and up the stairs came from the Root's blower used for the pneumatic tubes.

On opening the door to the power-room a loud noise from the machines is heard. This noise is chiefly electrical and due to the A.C. supply. When the supply is switched off most of the noise vanishes. The speed is 960 r.p.m., and evidently the noise from mere rotation, *i.e.* windage, is not excessive.

As to vibration: Set No. 1, near the door, vibrates more than No. 2 Set. The vibration was very slight on the floor of the room, but was perceptible. The local inspector was of opinion that this vibration was communicated *viâ* the lead-covered cables in the troughing and not *viâ* the bed itself. This small vibration was perceptible on some cupboards in an adjoining room, but none could be felt on the ringer bed; an extremely small motion there was revealed by water in a saucer.

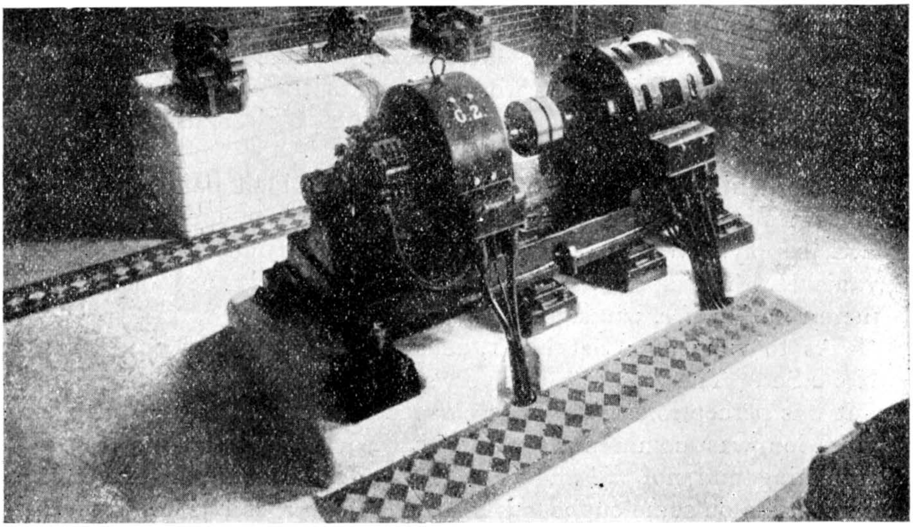
While the machines were running at various speeds during starting and stopping the machine vibrations reached one, and possibly two maxima, no doubt when the machine speed and period of the anti-vibrators were in resonance. Each machine rests on eight "anti-vibrators" supplied by W. Christie and Grey, Ltd., placed on the bed, which itself rests on a layer of cork composition (see **1**).

Before the installation of this apparatus the A.C. hum or note was communicated all over the building.

Leeds Automatic Exchange.—Crompton set: Motor, 2 phase, 200 volts, 50 cycles; generator, 18 kw.—There is practically no vibration on the machines, and in the test-room no unpleasant noise is noticeable; the speed is 750 r.p.m. The machines rest on two layers of cork, 7 ft. long, 2 in. wide, 1 in. thick. Foundation bolts are used, but are surrounded with a cylinder of felt where they pass through the bed-plate.

In the room below there is a considerable hum from the machine, but the note is low.

Blackpool Exchange.—Crompton set: Motor S.P. 200 volts, 85 cycles; generator 3·3 kw., 1650 r.p.m.—The charging machine sets up great vibrations on the test-room floor, and the noise in the sorting office is considerable, and comparable with the noise at Huddersfield when machine No. 1 was running with the fan and with only cocoanut mats under it, and is much greater than the noise from A.C. ringer at Huddersfield. The Root's blower at Blackpool also creates a great deal of noise, and is clearly heard up in the engineer's room; this noise travels partly up the lift-well.



I.—Machine Resting on Eight "Anti-vibrators." Crompton Set at Portsmouth Exchange.

The charging machine is just audible (when one specially listens for it) in the entrance to the public office.

The machine is not audible in the battery room above or in the switch-room alongside the test-room. The switch-room floor showed no trace of vibrations. The A.C. hum and running noise is quite audible at the test desk but not objectionable; its volume is less than that at Huddersfield.

Strong vibrations were perceptible on the test-room floor near the machine beds, and small vibrations were perceptible all over the floor. The ringers created some of the disturbance. The charging-machine rests on six cork pads placed on the brick bed, which is in intimate contact with the concrete floor. The bed itself does not vibrate so much as the floor. The machine vibrations appeared to be all in the horizontal plane, not in the vertical direction where one usually finds them.

The telegraph charging set in the same room creates very little noise and almost inappreciable vibration. The motor is made by Brooks, Huddersfield, and the 1·3 kw. generator by Mawdsley's.

Huddersfield Exchange.—Langdon-Davies motor, S.P. 210 volts, 100 cycles; Lancashire Dynamo generator 6 kw., 1450 r.p.m.—The investigation of noise and vibration was commenced because of the trouble caused by the charging sets as originally installed at this Exchange. It may be of interest to describe the results of various tests made and the processes by which the solution of the problem was arrived at.

The machines as installed in the test-room created (1) noise and (2) vibration—(*a*) in the test-room, (*b*) in the sorting office below, (*c*) in the switch-room above.

Various small alterations were made to No. 1 set, but it had to be rebalanced by the makers. When this was done it was tested at the manufacturer's works; when placed on a big test-bed it showed little vibration; when placed on 8-in. square rubber pads 1 in. thick there was vibration. There was considerable noise from the fan on the armature, but the noise created was hardly noticeable in the midst of the general noise in the factory.

On the same day set No. 2 was inspected at Huddersfield Exchange. The concrete bed or pier for set No. 2 rests on a main girder; the bed for set No. 1 is in the middle of a floor bay, and rests only on small joists. This set No. 2 was on bed No. 2, and rested on three cocoanut-fibre mats placed across the bed. The vibration and noise were apparent in (*a*), (*b*), (*c*).

The next week set No. 1 was tested first on bed 1, and then on bed 2. On bed 1 the set rested on cocoanut mats; strong vibrations were felt all across the floor to the test-desk in a straight line from the bed; they were also apparent in the switch-room above on the same line, and slightly apparent in a pillar in the sorting office. The noise in the test-room was very objectionable; a large part was due to the fan on the generator armature; the noise in the sorting-office was also obnoxious.

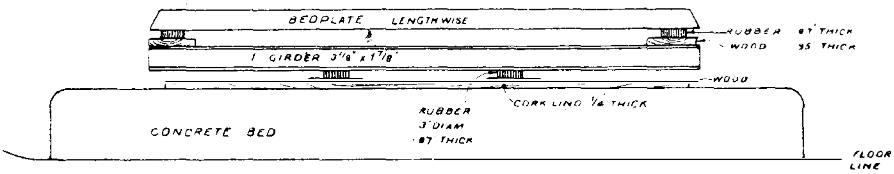
Set No. 1 was then tested on bed No. 2—which cannot vibrate so easily as bed No. 1—with various types of packing between the bed-plate and bed, and with and without the fan.

This test showed that (1) most of the noise came from the fan; (2) the vibration on the floors was very much reduced when the set rested on a combination of cocoanut mats and wood and rubber pads; (3) the noise was reduced, but was still apparent in the sorting office.

It was then decided to remove the fan from set No. 2 and to have it rebalanced. From information gained in the meantime it seemed that a spring-beam suspension might get rid of the remaining vibration. When set No. 2 was redelivered at the Exchange it was set up on bed No. 1 with support somewhat as shown in **2**, but with an iron bar as a fulcrum in place of rubber, and with a rubber pad at the centre of the girder below the bed-plate. The noise still existed in the sorting office; by placing rubber pads to act as the fulcra under the girder, and by removing the centre rubber pad, thus increasing the springiness of the girder, the transmission of noise and vibration through the supports was prevented.

Set No. 2 was then put on bed 2, which was always the one which transmitted most sound, but even there the supports checked the transmission of sound. The only trouble that remained was the noise from the machine, which travelled straight across the room to the test-desk; the noise was made up of—

(1) A high note from the copper gauze brushes.



HUDDERSFIELD EXCHANGE

2

(2) A rattling of the carbon brushes on the slip-rings, which were eccentric.

(3) A moderate hum from the A.C. windings.

(4) A dull note from air windage, but this was not particularly noticeable.

(3) was the loudest of these. The erection of a partition round the machines was arranged for so as to enable work to be carried on easily at the test-desk.

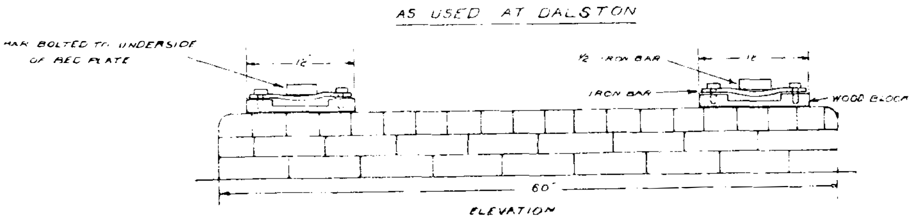
Two other noises were slightly audible in the sorting office: (*a*) The one was an A.C. hum or note which had been supposed to be due to the charging set, but was actually entirely due to the ¼-H.P. motor driving the ringer. This A.C. ringer was bolted direct to a big bed, and the A.C. noise travelled directly through the walls and columns to the sorting office. To get rid of the hum, the A.C. motor and belt-driven generator and interrupter were mounted on a board which rested on some pads of cork linoleum. The amplitude of noise vibrations was so slight, and the weight of the ringer was so little, that no noise would travel through the cork.

It created a great surprise that the ringer noise was so considerable.

(*b*) The second noise was due to the rumble of the Root's blower in the basement, and was only audible near the lift-well. The noise in the blower-room was reduced by about half merely by turning the exhaust pipe into a big space instead of into an enclosed space.

Woking Exchange.—Crompton set: Motor S.P. 200 volts, 100 cycles; generator 2·5 kw., 1460 r.p.m. This machine is installed on the ground floor, but trouble was experienced from vibration after the set had been running for some time. The supports had been six cork pads 6 in. × 5½ in. × ½ in. These were replaced by wood planks separated by rubber (3), and the trouble ceased to exist.

Kensington Exchange.—Langdon-Davies motor, 200 volts, S.P., 83 cycles; W.E. generator, 12 kw., 950 r.p.m. This machine has moderate vibration, but, being placed in the basement, does not cause trouble in the building, though a slight vibration is felt on the floor close by the bed. The motor does not give forth a pure note, but a mixture of A.C. hum and a deep drone; the windage is slight.



3

Up in the switch-room above the sound is not audible, but in one spot on the floor the vibration is perceptible; it would not be noticed unless specially sought for. The other charging set consists of a Fuller-Wenström motor driving by belt a W.E. kw. generator. The motor is bolted direct to its bed and has no vibration, but creates a pleasant A.C. note; the note is not at all troublesome in the test-room. Up in the switch-room the hum is quite perceptible, though not obnoxious in any way.

Hammersmith Exchange.—Wagner 110 volt, S.P. 50-cycle motor; W.E. 5 kw. generator, 1460 r.p.m. The set is placed on the first floor, and runs beautifully without any noise beyond a very soft note; there is slight vibration, but it is imperceptible on the floor until the two sets run together, and even then is very slight.

Dalston Exchange.—Wagner motor, 400 volts, S.P., 50 cycles; W.E. generator, 6·7 kw. There is considerable vibration on the machine but practically very little upon the floor, as transmission is prevented by means of the supports shown in 3.

These supports could perhaps have been made more sound-proof if the wood blocks had rested upon felt or rubber.

Two conclusions regarding the best method of preventing noise in exchanges are:

(1) Never place an A.C. machine in direct contact with the beds, or piers or walls. Always have a layer of felt or rubber somewhere between the machine bed-plate and the foundations.

(2) Place as elastic as possible a support between the machine and the foundations: an arrangement of iron beams or springs and rubber is suitable.

Some reference to reports upon vibrations experienced in houses, etc., may be useful.

Bousquet ('La Nature,' /296/1918) mentions some tests made on the amplitude of vibrations in motor-buses, trams and taxis in Paris, and then describes the precautions taken to prevent the vibrations of the ground caused by the traffic being communicated to an hotel. He placed a layer of cork and resin, ½ metre wide and only 1 metre deep, along the frontage of the hotel (10 metres) between the footpath and the hotel walk; this reduced the vibrations in the building considerably.

Clarke ('Gen. Elect. Review,' 19/649/1916), in a paper concerning balancing of machines, mentions one case where excessive vibration set up by an engine on a girder floor was cured by merely placing a small girder and columns underneath, so that a small portion of the weight was taken by the girder; evidently the natural period of vibration of the floor was altered, and resonance was avoided.

In Fielden's 'Engineering Review,' 26/1/1912, there is a full description of the vibrations experienced by trains on Japanese railway lines; the vibrations were measured by a seismograph. As the subject has no reference to buildings the detailed figures of amplitude have not been abstracted.

Hall, in 'Engineering News,' 68/198/1912, gives the records of vibrations in certain bniidings due to street traffic and to tramcars crossing certain points near by. The amplitudes varied from 0·006 mm. to 0·035 mm. He states that vibrations become imperceptible to the human touch when their double amplitude is less than 0·03 and 0·10 mm. with frequencies 6–7 and 2 per second respectively. The same writer in 'Electrical World,' 60/200/1912, gives photographic records of vibrations due to 16-ton armatures of 1000 kw. motor generators rotating at 510 r.p.m.; these vibrations were only 0·001–0·0042 mm.; the vibrations due to street traffic were much more pronounced. He suggests that sound vibrations travel *viâ* the walls and floors rather than by the air through open windows. For foundations he suggests the use of leather and asbestos in layers; also, sharp broken rock is good, but sand is a bad foundation. The amplitude of vibration is less in elastic materials, such as steel and iron, than in unelastic materials such as cork, brick, etc.

Galitzine ('Comptes Rendus,' 150/901, 1041/1910) discusses the vibrations in a building in Petrograd caused by a Diesel motor near by. Diesel motors produce troublesome vibrations, especially when the subsoil is marshy. The amplitude of vibrations due to a 4-cylinder 200-h.p. Diesel motor was 0·0255 mm. in an upper floor and 0·0056 mm. at the ground level. The destructive effects of vibration arise from the forces due to acceleration, which in this instance amounted to a blow of 248 kg./qm. 9 times a second.

His conclusions concerning the Diesel motor vibrations are:

(1) Vertical vibrations were greatest by the motor.

(2) The vertical and horizontal motions became equal at a short distance from the motor.

(3) The disturbances in the upper floors were worse than at the ground.

(4) The horizontal vibrations were greatest in directions perpendicular to the front of the house where the investigations were made.

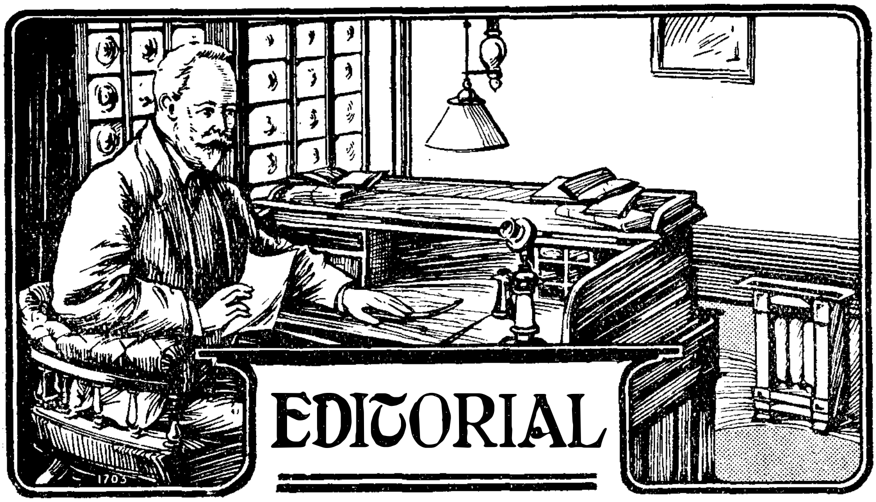
(5) The vibrations became *nil* about 75 to 100 mètres from the motor.

In 'Nature,' v, 101, p. 456, 1918, is a short description of experiments made to determine the amplitude of vibration due to the wind at the top of a 550 ft. reinforced concrete chimney in Japan. The diameters of the chimney were: base, 42 ft. 8 in. (13 m.); top, 27 ft. 5 in. (8·3 m.). In 'Engineering,' v, 106, p. 334, 1918, a full description of the chimney and of the tests is given. The amplitude, with a wind velocity of 7 mètres/sec., was less than 1 mm. The amplitude at 35 mètres/sec. was 93 mm. at right angles to the wind, and 10 mm. in the direction of the wind. The period of vibration was approximately 2·5 sec. The tests were undertaken to compare the effects of wind with the effects due to earthquakes; it was found that the wind was as likely to do damage as an earthquake.

A report well worth consulting is that of the Board of Trade Committee on "Vibration Produced by the Working of the Traffic on the Central London Railway" (1902).

Vibrations were caused in many houses along the railway; these were due to the non-spring-borne load on the axles of the electric locomotives, and were reduced to bearable dimensions by using geared motors in various passenger coaches. The surface of railway rails is never straight; the vibrations are caused by the non-spring-borne loads following the vertical curve of the rail; it happened that with the speed of twenty to thirty miles per hour the frequency of these vibrations was about fifteen per second. The floors of the large houses along the route (Marble Arch, Hyde Park, etc.) had natural periods of about ten to fifteen per second, and thus were in resonance with the vibrations of the earth caused by the trains.

The vibrations in the earth which were directly communicated to the houses were only 1 to 2×10^{-4} in., but the walls of the house vibrating at fifteen per second set up resonant vibrations on the floors. These resonant vibrations were of sufficient magnitude to cause annoyance. The amplitude of vibrations caused by stamping on the floors of the houses exceeded the vibrations caused by the trains, but were not so noticeable, as they occurred during periods of noise when people were walking about. The train vibrations were noticeable during periods of stillness at night.



EDITORIAL NOTES AND COMMENTS.

CONSIDERABLE interest has been created by the reports that have appeared in the lay and technical press regarding the so-called multiplex telegraph and telephone system recently developed by the American Telegraph and Telephone Company, but, so far, very little information beyond a popular description has been published. Some authorities in this country are inclined to regard the arrangement as a mere "scientific stunt," but in view of the claim of Mr. Bancroft Gherardi, acting Chief Engineer of the Company, that "these circuits were placed in regular service during October last year, being terminated on the toll switchboards at Washington and at Pittsburgh in the usual manner, and being, as far as the operators were concerned, exactly similar to ordinary telephone circuits; since October they have been used interchangeably with the regular telephone circuits in handling the traffic," we prefer to accept it as a practical achievement, provided that the physical characteristics of the lines can be permanently maintained. We are not arguing, of course, that the system can be worked satisfactorily in this country with its moist and variable climate, but, given suitable conditions, there are no reasons why such a system should not be operated.

Mr. Gherardi describes the arrangement as follows: "In addition to carrying a telephone circuit of the usual type, the pair of lines between Baltimore and Pittsburgh was equipped on each wire with composites for duplex telegraph work, and, further, that portion of the circuit from Baltimore to Dallastown was combined with another pair into a phantom telephone circuit. Without disturbing the working of any of these arrangements, by means of our multiplex system we superimposed on the wires in question four additional telephone circuits together with the complete signalling arrangements necessary to operate them. Both the talking and signalling on these new circuits provided by means of the multiplex were as good as the original telephone circuit in the ordinary way. Each ordinary telephone current has combined with it a carrier current of definite higher frequency. The frequency or the wave-length of each of the carrier currents is different from that of the other carrier currents used on the same pair of wires, and is adjusted to the separating devices at the distant end of the line."

Now, there is nothing fundamentally new in this to those who have kept in close touch with advanced work in recent years, but great credit is due to the technical officers who have combined the principles embodied in up-to-date transmission apparatus in various fields and produced a workable arrangement. High-frequency small-power generators, such as the oscillating valve circuits of continuous-wave wireless, the heterodyne combination of currents of different frequencies, loaded circuits, and the introduction of telephone repeaters to maintain the amplitude of the high-frequency carrier currents, which would otherwise be attenuated by the capacity and resistance of the lines, wave filters of either a differential or resonant type—all these have been seemingly impressed into the service, in addition to the old Van Rysselberghe superimposed system, of which the Fullerphone is our modern instance. It is clear that such a circuit must be carefully selected and scrupulously maintained, and that the cost of the apparatus, plus the capitalised value of the skilled maintenance and nursing required, must almost approach that of the copper for additional lines.

Mr. Theodore N. Vail, the President of the Company, in his report of December 11th to the Hon. Albert S. Burleson, Postmaster-General of the States, acknowledges that the amounts of apparatus required at the terminals and re-arrangements in the wires themselves limit the usefulness of the circuit economically to long lines. In his letter he gives credit to Major-General George O. Squier, Chief Signal Officer of the U.S. Army, for his suggestions on the subject of multiplex telephony some ten years ago, and also to Dr. Lee de Forest, who invented the audion. The suggestions and methods of these two gentlemen, modified and improved by the officers of the Telegraph and Telephone Company and the Western Electric Company, form an important part of the system. We take the opportunity of congratulating these gentlemen upon the results attained by the trial of what is practically a selective wireless system.

with a directional aërial stretching between the terminal stations. In this country conditions are different: development will proceed here on lines that may be less sensational, but are equally economical and equally sound.

Throughout the war we have endeavoured to keep a record of the naval and military honours won by officers of the Engineering Department in the various active services, and we now reproduce it below in summary form. The list may not be complete, but as it stands its length and brilliancy bring no small credit, not only to the officers concerned, but to the Department from which the men came. It includes the 103 officers and men of "K" Company, R.E., who were serving with us in Ireland at the outbreak of war.

	No. won.
British Awards :	
Victoria Cross	1
Distinguished Service Order	7
Distinguished Service Medal	5
Bar to ditto	1
Military Cross	29
Bar to ditto	1
Distinguished Conduct Medal	57
Military Medal	200
Bar to ditto	5
Meritorious Service Medal	29
Brought to notice of Secretary of State for War for Valuable Services	5*
Mentioned in Despatches	141
French :	
Legion of Honour, Croix de Chevalier	1
Croix de Guerre	5
Medaille Militaire	4
Belgian :	
Order of Leopold II, Chevalier	2
Croix de Guerre	7
Italian :	
Military Order of Savoy	1
Silver Medal for Military Valour	1
Serbian :	
Order of White Eagle, 5th Class, with Swords	1
Gold Medal	1
Silver Medal	3

* Including one civilian member of Staff.

Russian :

Medal of St. George, 2nd Class	1
Ditto, 3rd Class	3
Ditto, 4th Class	3
Total	514

In the January list of recipients of Honours under the Most Excellent Order of the British Empire, the names of the following officers of the Engineering Department were included :

John McLorinan Robb, Superintending Engineer, South Midland District ; Capt. Henry Frank Bordeaux, Assistant Submarine Superintendent, to be Officers of the Order; George Frederick Greenham, Assistant Superintending Engineer, London District ; George Henshilwood, Executive Engineer, Canterbury ; Daniel Benjamin Sheriff Saville, Chief Engineer, Cable Ship "Monarch," to be Members of the Order.

We offer our congratulations to these gentlemen upon the recognition of their strenuous labours. At the risk of being invidious we might mention that it is exceptionally pleasing to see the name of Mr. Robb, who has suffered as well as worked hard for the cause. The "Monarch" has been a mystery ship throughout the war except to those in the inner circle; her story would be worth the telling.

CORRESPONDENCE.

A GRAPHICAL METHOD OF CALCULATING THE ATTENUATION CONSTANT: A CORRECTION.

The Editor, THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

DEAR SIR,—I am sorry to say I have discovered a rather serious error in my article on p. 193 of the January, 1919, issue.

Under the heading of "The Spacing of Loading Coils," the figures given for kilometre and nautical mile units should be the *same* as those given for mile units, *i. e.* instead of 9·6 and 33 read 25; instead of 60 and 210 read 160; instead of ·06 and ·21 read .16. The figures given for the mile units are correct.

The mistake arose in converting capacity per mile to per kilometre by multiplying C_1 by the same factor as D; instead of dividing C_1 by the factor and multiplying D by the same factor, thus making no change in the total.

I am,

Yours faithfully,

RESEARCH SECTION. E. S. RITTER.

MAGNETIC RECTIFIER.

The Editor, THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

DEAR SIR,—Mr. S. Flemons, on p. 234, vol. xi, January, 1919, shows that our American cousins are late again, for I invented this apparatus in 1901.

In pp. 169 to 172, vol. iv, July, 1911, you allowed me to give a description of the parent rectifier. An enterprising American, under promise of working the U.S. patents, obtained a sample instrument, but, so far, no royalties have materialised. I was permitted by the Department to try the rectifier under service conditions in May, 1911, and though the instrument struggled gamely for days under an obvious overload, both of magnetic saturation and current density in the transformer, the relay and working parts suffered very little.

The firm who undertook to manufacture for the market made no difference between customers with 100 volts 100 ∽ or 200 volts 50 ∽, and the fact that it worked over these variations was its undoing, being strongly reminiscent of Dr. Johnston's dictum of a lady's preaching.

I am, Dear Sir,

Yours faithfully,

GEORGE SUTTON (Lieut.).

MELFORD HOUSE,
MELFORD ROAD,
E. DULWICH, S.E. 22.
January 23rd, 1919.

HEADQUARTERS NOTES.

WE are pleased to announce that His Majesty the King of the Belgians has conferred the following honours upon Sir William Slingo, Engineer-in-Chief, and Mr. W. Noble, one of the Assistant Engineers-in-Chief, in recognition of constant and generous help given to Belgium :

Sir William Slingo to be Chevalier de l'Ordre de Leopold.

Mr. Noble to be Chevalier de l'Ordre de la Couronne.

LONDON DISTRICT NOTES.

INTERNAL CONSTRUCTION.

Telephone Lines and Stations.—During the thirteen weeks ended January 21st, 1919, 1393 exchange lines, 2649 internal extensions and 391 external extensions were provided. In the same period 700 exchange lines, 850 internal extensions and 145 external extensions were recovered, making net increases of 693 exchange lines, 1799 internal extensions and 246 external extensions.

External Construction.

For the three months ended January 31st, 1919, the net increase in telephone exchange wire mileage in the London Engineering District was 7656 miles, the increase under the head of underground being 8930 miles, whilst the open (bare wire) and aërial cable decreased by 488 miles and 786 miles respectively. Telephone trunk wire mileage increased by 181 miles, underground telegraphs increased by 101 miles and aërial telegraphs by 41 miles. Pole line decreased by 3 miles. Pipe line increased by 22 miles.

The aggregate mileages in the District at the end of January, 1919, were as follows:

Line Mileage.

Pole line	2,567 miles.
Pipe line	3,575 ,,

Single Wire Mileage.

Telegraphs	17,920 miles	Exclusive of wires on railways maintained by railway companies.
Telephone exchange .	1,012,845 ,,	
,, trunks . .	17,409 ,,	
Spare wires . . .	18,235 ,,	

The total length of underground cable is 7166 miles.

Telephoning Government Offices during the War.—The following statistics in connection with work carried out during the war for Government Departments have been extracted from official records. From the figures given it will be appreciated that more than ordinary difficulty obtained at times in meeting the requirements of special and other Government Departments, and considerable foresight required to be exercised in order that overlapping and confusion and consequent delay might be avoided. All conditions could not, however, be foreseen, and in many cases non-multiple positions provided in the first instance had to be replaced subsequently by multiple switchboards, owing to the rapid growth of the various Departments concerned.

Non-Multiple Type P.B.X's.

No. provided.	Fitted capacity.	Total working lines.
446	16,730	12,809

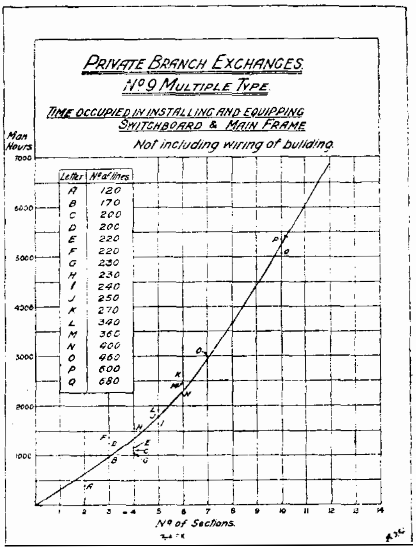
Multiple Type P.B.X's.

No. provided.	No. of sections.	Fitted capacity.	Total working lines.
38	323	20,910	16,130

During the progress of the work numerous alterations in the grouping of the telephones were required to meet the ever-changing conditions, and in this respect great difficulty was experienced in getting the Departments concerned to specify their requirements early enough to give the Post Office time to complete with a minimum of inconvenience to both Departments. It was usually found that the telephone system was the last thing thought of and the first thing required.

In connection with the commandeering of blocks of offices by the Office of Works, the removal of the displaced tenants to new premises and the provision of telephone facilities thereat was a factor which presented great difficulties at times. In many cases double changes had to be made before everyone was satisfactorily accommodated. In this respect a troublesome matter, both from the Post Office point of view and that of the Office of Works, was that seemingly the only vacant premises available were situated in areas where telephone plant was either very scarce or the provision of new plant presented exceptional difficulty.

A curve is shown herewith which may be of interest and possibly of assistance to those who may be called upon at any future time to provide multiple-type P.B.X's. in similar circumstances to those which obtained during the war. Figures in respect of extensions to P.B.X's. are not given, as these varied not only with the size of the extension but also with the size of the initial installation, and the time occupied in extending a P.B.X. cannot therefore be reduced readily to curve form.



Hydraulic Main Trouble.—An incident of an exceptional nature occurred at the City and Central Exchange on the afternoon of February 12th, when, owing to the bursting of a street hydraulic main, water gained an entry into a cable manhole immediately outside the Exchange and flowed thence in considerable volume into the sub-basement of the Exchange. It was soon evident that the situation could not be dealt with adequately by the local staff, and an urgent summons for assistance was sent to two adjacent fire stations. The call was promptly answered, but difficulty was experienced at first in adapting the fire brigade's pumping appliances to the peculiar conditions under which the pumping-out operations had to be conducted. A 30-ft column of water had to be lifted, and the armoured hose collapsed under the strain. It was then a case of all hands to the pumps and buckets, and by these means the inundation was stayed for a time until an improved pump loaned by the London Hydraulic Co., together with a rearrangement of the fire hose by the fire brigade, speedily effected the removal of the greater part of the water, the remainder being dealt with by the hand-pumps, etc.

Although several cables were subjected to the test of water pouring over them for some hours, consequent trouble developed on one cable only, causing the temporary interruption of 38 subscribers' circuits. The fault (a split in the lead sheath) was repaired, and all the circuits were in working order by the afternoon of the 13th.

In reviewing all the circumstances it must be considered exceedingly fortunate that the water leakage manifested itself during ordinary working hours. Otherwise the incident might have culminated in a serious breakdown of trunk telephonic communication.

The promptitude of the fire brigade in responding to the unusual "call" and the zeal of the local engineering staff in rendering all possible aid during an anxious and strenuous period, extending over several hours, cannot be too highly commended.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS.

COUNCIL MEETING.

A COUNCIL MEETING was held in London on March 4th and 5th, under the presidency of Mr. A. J. Stubbs, M.I.C.E., Assistant Engineer-in-Chief.

The Secretary submitted a statement regarding the general situation, in which he reviewed the difficulties that had been experienced in carrying on the work of the Institution during the years of war. The period of reconstruction ahead would be brimful of interesting developments, and the Institution would prove of great value to the Department and to the State by keeping its members in close touch with the rapid progress now being made in transmission improvements. The membership had been well maintained, and a promising feature was the increase in Colonial members. Nominations had been received for the new Council, and voting papers would be issued within a few days.

The finances were in a sound position. Owing mainly to the absence of many members on military service there were arrears of subscriptions to be collected. It is hoped those members who have not paid attention to this important matter will promptly remit their subscriptions, and so save the Institution the necessity of enforcing the rule regarding arrears.

Owing to the enormous increase in the cost of paper and engraving the Journal of the Institution had been carried on at a loss, but the Council decided that it had performed an extremely useful function in a period of abnormal stress, and would support it until the return of more normal conditions.

Several papers which had been read before the various Local Centres were in the printers' hands, and would be issued to members at an early date.

Papers read during the sessions of 1914–15 and 1915–16, which have been printed and supplied to members, were considered with a view to the awarding of the Institution Medals. The following awards were granted :

Senior Silver Medal to Mr. J. G. Hill for his paper on "The Loading of Underground Telephone Circuits for Phantom Working."

Senior Bronze Medal to Mr. B. S. Cohen for his paper on "Telephonometry."

Junior Silver Medal to Mr. J. Hedley for his paper on "The Western Electric Company's Semi-Automatic Telephone System."

Junior Bronze Medal to Mr. S. C. Bartholomew for his paper on "Power Circuit Interference with Telegraph and Telephone Circuits."

The annual general meeting will be held under the auspices of the London Local Centre about the end of April.

LOCAL CENTRE NOTES.

LONDON DISTRICT.

A GENERAL meeting took place on February 14th at the Royal Society of Arts, Mr. F. Tandy in the chair. Among others present were Dr. Sinclair, and Mr. Morgan, Controller of the Stores Department. Unfortunately the Secretary was precluded from being present by a previous engagement, and Sir Andrew Ogilvie was absent through indisposition. Mr. A. J. Stubbs read a paper on "Accidents in the P.O. Engineering Department," in the course of which the author gave some very interesting facts and statistics, and made some suggestions for a systematic and organised effort to reduce the number of "preventable" accidents which occur every year. He urged that apart from the inevitable misery caused to those dependent upon the victim for support, there was also a serious economic loss to the industrial life of the nation whenever an accident occurred, and this aspect of the matter alone made it highly desirable that every effort should be put forward to eliminate accidents from our life.

The author described a number of cases which had occurred in the Engineering Department, and showed on the screen some scenes illustrating accidents in America.

Messrs. Gunton, Bartholomew, Winny, Wright, Henley and the Chairman took part in the subsequent discussion.

Mr. Gunton doubted whether the footplate device mentioned in the paper to protect a foot (accidentally protruding over a lift-well) would prove effective, and suggested that it would be better to construct the shaft so that it would be impossible for any person to protrude his foot.

Mr. Winny really supplemented the author by giving some details of first aid and ambulance work.

Mr. Bartholomew, in the course of racy remarks, drew attention to the element of unreliability in the evidence given by eye-witnesses of accidents which was sometimes met with, and cited an instance. He considerably amused the audience by reading the report of an accident by which the reporting officer conveyed the impression that it was only by his most strenuous efforts that a dreadful calamity had not occurred.

Mr. Tandy pointed out that applied science had only progressed through inventors and experimenters taking personal risks of loss of life and bodily injury, and whilst applauding every effort to reduce the number of accidents, yet thought care should be taken not to discourage progress by carrying caution to extreme lengths.

Mr. Stubbs replied to the discussion, and upon the motion of the Chairman the meeting concluded with a hearty vote of thanks to the author.

W. G. O.

NORTHERN CENTRE.

THE first meeting of the Session (1918–19) was held on December 11th, when a good attendance was registered.

In the introductory remarks of the Chairman (Mr. Elliott), allusion was made to the numerous alterations and improvements which were likely to receive consideration now that the cessation of hostilities was an accomplished fact, and we were looking forward to the return of normal conditions.

The main business of the evening was the reading of a paper prepared for the benefit of the Institution by the late Mr. E. W.

Newton, and entitled—"Some Notes on External Work Associated with Telephone Exchange Transfers." This was read by the local Hon. Secretary.

The paper dealt with the "lay-out" and selection of sites for distribution poles as ascertained from the spotted plans, on which the various classes of circuits affected by the work were shown. Stress was laid upon the importance of choosing the best sites for the distribution poles in order that they might properly serve the area under consideration. Details were given as to the provision of branch and main ducts and cables, and particularly as regards the leading into new exchange premises. After mature consideration of all details of the work to be carried out, proper working plans should be prepared.

Four headings were summarised under which the method of transfer might be made, though this was usually performed by the use of underground or overhead cables, or a combination of both, between the old and the new exchanges. It was, however, pointed out that no hard and fast line could be laid down, as circumstances vary greatly.

The importance of having all details of procedure fully outlined and recorded either by plans, drawings, or works' instruction forms was particularly emphasised.

It was suggested that the question of standardising the method of dealing with exchange transfers generally was one that should receive consideration. The present time appeared to be an opportune one for its adoption, as such would be of invaluable assistance and the means of effecting a substantial saving.

A discussion followed, in which the Chairman, Messrs. Baldwin, Kitchen, Whillis and Peel participated.

Meeting on January 15th, 1919.

Chairman, Mr. Elliott.—An interesting paper was read on "The Baudôt Telegraph System" by Mr. H. Kitchen, who traced the early developments and improvements carried out by M. Baudôt, of the French Telegraph Service. The early struggles of this illustrious Frenchman and the difficulties encountered in providing the necessary funds for research work were graphically outlined.

By means of a fine selection of lantern-slides Mr. Kitchen explained the working parts of this intricate system, which differed materially from anything previously installed at Newcastle-on-Tyne. The phonic wheel-drive, which has proved so successful at Newcastle, was described, and the fact that the quadruple duplex has worked uninterruptedly since its installation in August, 1917, was commented upon.

In the discussion which followed Mr. Elliott gave some very interesting statistics comparing the costs of working the different telegraph systems in use in this country. Mr. J. Webster, of the Telegraph Branch, drew attention to the use of the "G" Relay, which enabled the TS–NT circuit to be worked on an underground loop without a repeater in circuit.

The good attendance at this meeting indicated that the members are fully aware that a knowledge of the Baudôt system is now a requirement of an up-to-date engineer.

E. E. Gregory,
Local Hon. Secretary.

SOUTH MIDLAND CENTRE.

The first meeting of the I.P.O.E.E. in the district since war broke out was held on January 14th, 1919, in the Physics Lecture Hall, University College, Reading, kindly lent for the occasion by Prof. Duffield, D.Sc. Thirty-four members attended, and the meeting was honoured by the presence of the Engineer-in-Chief, the Deputy-Mayor of Reading, Prof. Duffield and H. Knapman, Esq., University College. The Postmaster, District Manager and Traffic Superintendent were also present.

Apologies for absence were received from the Mayor, and from the President and the Registrar of the University College.

A paper on "The Automatic Telephone Exchange at Portsmouth" was read by Chief Inspector A. Bates, who illustrated his remarks by means of the demonstration set of apparatus (kindly lent by the Engineer-in-Chief), and by a large number of photographic slides. The work of combining the Corporation, National and Post Office Exchanges was described, and various modifications and improvements subsequently introduced into the new exchange were explained. Mr. Bates supplied valuable data showing saving in staff, low maintenance, expenditure and freedom from faults. A discussion was opened by Mr. R. W. Callender. He was followed by Prof. Duffield, who asked that the demonstration set might be allowed to remain for a day or two—a request at once granted by the Engineer-in-Chief. Sir William Slingo complimented Mr. Bates on his paper, and, after referring to the excellent work done at Portsmouth, proceeded in a masterly speech to enumerate and emphasise the various ways in which the automatic telephone system had proved to be an engineering success. He had no doubt as to its being an economic success also, but the problem could not be handled definitely at present as we had not enough knowledge. What we really wanted were reliable and exact figures as to maintenance costs from the engineers. The success of the automatic system as an engineering proposition had been demonstrated and admitted, and the system would no doubt be extended—the sooner the better. The general verdict was that the automatic service was quicker than the old system. Sir William concluded by expressing his congratulations on the signal honour recently conferred upon their Chairman (Mr. Robb) by His Majesty the King. Mr. Robb thanked Sir William and the other speakers, and took an opportunity of referring to the loyal and devoted service rendered by the staff in the District during the war, and to the great advantage in the provision of war communications which had resulted from the underground development schemes and main cables provided in the period between the National transfer and August, 1914.

Mr. Bates briefly replied to the discussion, and a hearty vote of thanks was passed to him for his excellent paper, after which those present were entertained to tea in the University Common Hall, and a most successful and instructive meeting was brought to an enjoyable conclusion.

WAYLEAVES.

THERE is no phase of our Department's work which necessitates the study of human nature so much as that of "wayleaves."

The engineer comes into contact with the genuine business man, the man who is scrupulously fair, neither giving nor taking any advantage; the keen business man, whose vision is always the bank balance; the æsthetic, who has ever before him the ideal of purity of outline; the timid, whose fear is that the signing of any paper may ultimately by some strange process lead them into courts of law, and whilst negotiating with this class of people you can see the picture in their minds—that of being browbeaten by a heavy-faced, clean-shaven barrister. Then there is the free-and-easy, whose "Aye, so long as you don't do any damage," cheers the day's work of many an engineer. These and many other types come under review, and with each type the engineer must know how to treat in such a manner as to get their consent to a work to which they do not wish to give consent.

A few instances will be of interest, as well as being entertaining. The first case, and perhaps the most tiresome of all people, was a dear old lady of eighty summers (and winters too, I suppose), who would insist upon giving me her family history, and that of the brown cow who in a moment of selfishness robbed the Department of a short piece of copper wire which one of the Department's workmen had placed in the long grass for safety. Patiently I listened for one and a half hours, consoled her when necessary, agreed with her views on the great loss, complimented her on her youthful appearance after she had me guessing her age, and went through all the practices of respect to age, with the result she withdrew her additional claim.

Then came the retired publican, who openly agreed that he could not have asked for an increased rental had not his daughter put him up to it—"An' you know what women folk is!"

Another case of a family quarrel, which was early settled by pointing out that it was scarcely within the province of our Department to decide who was in the right, and that so soon as the case was decided I should be most happy to forward the rental.

The man who is going to chop down everything belonging to the Post Office is harmless, and you have only to quote the Act to him and he buries the hatchet.

Then comes into view the man who pities you because you are a Government official; tells you of the great world outside, expounds "business" methods as compared with Post Office methods, and generally treats one as though you belong to an institution of idiots. It is not very difficult to convince this person, not by direct contradiction, but by a tactful handling of facts and figures, and a businesslike method of presenting your demand for his consent, that there are "brains" in the Department. After the discussion this class of man appreciates the fact that he made idiotic charges, and is generally willing to grant the consent without further parley lest he get further into the mire.

I venture to give the following hints:

(1) Let the "other man" do the talking, irrespective of the fact that his chatter may have no relation to the granting of the consent. *A good listener is ever appreciated.*

(2) Make it clear that you are deeply interested in any pet ideas the grantor may have; in most cases pet ideas are on top.

(3) Express doubt, at first—it gives the impression of balanced judgment—but always agree with him. You are out for a consent, not to air *your* views.

(4) Keep off politics, but if it comes into play, become one of the actors.

(5) Always be respectful. Don't try the heavy key; *it generally makes too big a noise!*

(6) When you come to the point, *i. e.* the consent, put your request briefly, concisely, and if he wanders to other pastures, give him rope: he will return of his own will, and seeing you still patiently listening, wonder why you are there, and grant the consent.

Leeds. G. H. H.

THE "VANDYKE" PROCESS.

THIS little article has been written in the hope that it will prove of interest to those members of the Post Office staff who use the well-known circuit plans, telegraph and telephone route maps, etc., issued from the office of the Engineer-in-Chief.

Vandyking is a process somewhat akin to lithography. By its means drawings, tracings, Ordnance Survey maps and so forth can be quickly, cheaply and satisfactorily reproduced. The circuit plans, etc., referred to above are reproduced at the Ordnance Survey Office, Southampton, by this particular process from tracings furnished by the Engineer-in-Chief.

The printing plate consists of ordinary commercial sheet zinc, roughly $\frac{1}{32}$nd of an inch in thickness. One side of the plate has to be "grained," *i.e.* rubbed down by hand with small blocks of zinc moistened with a weak solution of sulphuric acid until it receives a perfectly smooth matt surface. Fish glue is poured over the grained surface of the plate, followed immediately by a solution of bichromate of ammonia, the former being the holding medium and the latter a medium sensitive to light. The wet plate is then placed in a "twirler" (similar to the old "wheel of life"), which, on being rapidly revolved, spreads the mixture evenly over the surface of the plate. The plate is then placed in a drying oven, and when dry it is ready to receive the drawing or tracing to be reproduced.

The drawing should preferably be made on tracing-linen or tracing-paper, but paper can be used *provided it is not too thick to exclude the passage of light through it.* The paper on which Ordnance Survey maps are printed gives good results. The lines of the drawing must be perfectly opaque for the reason given hereafter, and should therefore be drawn in dense black ink. Thickness of line is immaterial but density is essential.

The drawing is placed face downwards on the sensitised surface of the plate and the whole placed in a printing-frame, drawing uppermost, and exposed to the action of light. The time of exposure, which is calculated by a meter or by actual experience, varies with the actinic value of the light and the density of the tracing linen or paper on which the drawing is made. The light penetrates through the bare or uncovered portions of the paper, tracing-linen or tracing-paper, to the sensitive medium on the plate below, and has the effect of rendering the medium insoluble in water. Alternatively, the light, being unable to penetrate through the actual lines of the drawing, that portion of the sensitive medium on the plate below is soluble in water. The importance of the plan being drawn in *dense* black is here apparent.

The plate, after correct exposure, is taken from the printing-frame and placed in a rocking tank (action of tank similar to a pair of scales) containing water slightly coloured by an aniline dye (generally blue), and the tank rocked gently to and fro until the soluble portion of the medium—the actual drawing which has not been acted on by light—is completely washed off. The plate is then dried and examined.

It is next completely covered with greasy printers' ink by means of a hand-roller, after which it is placed in another rocking tank containing a weak solution of hydrochloric acid, and the tank gently rocked to and fro. Now the acid is incapable of acting on the printers' ink, but it can, and does, attack the fish-glue beneath it, causing it to shale off, bringing with it the ink on top. The ink adhering directly to the zinc is unaffected. The drawing now appears on the plate in black printers' ink, the remaining surface of the plate being perfectly clean.

The next process consists of "etching" the plate, that is, *rendering the bare or uncovered portions incapable of taking up greasy printers' ink*. This is effected by rubbing it with a linen pad moistened with a mixture of phosphoric and gallic acids, the actual drawing being all the time protected by its original coating of greasy printers' ink.

The plate is then proved—that is, it is placed in a hand-machine, inked by means of a hand-roller and one or two prints made on paper. If these proof-prints are satisfactory the plate is taken to the printing room, fixed in a printing machine, and the necessary number of prints struck off. The ink from the printing-roller will only adhere to the actual lines of the drawing, *i. e.* the greasy portion of the plate which has not been "etched."

Printing plates can be stored for an indefinite period, and when no longer needed for their original purpose are regrained for further use.

The process is quick, efficient and cheap, perhaps the cheapest known in the case of reproduction of large drawings. Printing can be done in any colour; for drawings of two or more colours a separate printing plate is of course required for each particular colour. The sole rights of the Vandyke process are vested in the Ordnance Survey Department.

H. G. FISHER.

BOOK REVIEW.

'Standard Tables and Equations in Radio-Telegraphy.' By Bertram Hoyle, M.Sc.Tech., A.M.I.E.E. (London: The Wireless Press, Ltd. Pp. 159. Price 9s. net.)

The book consists, in the main, of a collection of tables and formulæ of particular use to the wireless engineer. Although most of the information is available in a scattered form in the text-books and engineering year books already published, yet some very useful purpose is served in collecting under one cover for reference information germane to a particular branch of engineering; it is in this direction that the chief recommendation of the book is to be found. The usefulness of the formulæ is enhanced by Section 3, which is devoted to typical worked examples of the application of some of the formulæ.

Section 4, however, which purports to be "Notes on Elementary Arithmetic for Operators," gives the method of contracted multiplication and division and the simpler trignometrical ratios. This section, together with illustrations showing the theoretical mechanical advantages of various simple forms of pulleys, could, with advantage, have been omitted; in our opinion it savours of padding.

On p. 20 the formula for wave-length is given as $1885 \sqrt{KL}$ metres, without reference to the fact that K and L are in microfarads and microhenries respectively, but this is apparently a displacement by the printer, and will, no doubt, be rectified in future issues.

On the whole the book is free from error, and can be recommended as a comprehensive collection of tables and formulæ for the use of the wireless engineer.

A good index adds to the usefulness of the volume.

E. H. S.

MILITARY HONOURS.

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

Staff Sergeant H. J. Williams, R.E. (Labourer, South-Western District). Awarded the Meritorious Service Medal.

Sapper M. Monaghan, R.E. Signal Service (Labourer, North Midland District). Awarded Bar to the Military Medal.

Second Lieutenant J. E. Thomson, Manchester Regiment (Assistant Clerk, London District). Awarded the Military Cross.

Air-Mechanic T. Leyland, R.A.F. (Unestablished Skilled Workman, North-Western District). Awarded the Military Medal.

Sapper E. H. Marshall, R.E. Signal Service (Labourer, North Midland District). Awarded the Military Medal.

Lance-Corporal W. Mounter, R.E. Signal Service (Unestablished Skilled Workman, London District). Awarded the Distinguished Conduct Medal.

Lance-Corporal H. O'Leary, R.E. Signal Service (Unestablished Skilled Workman, London District). Mentioned in Despatches.

Private J. H. Price, Post Office Rifles (Labourer, London District) (killed in action). Awarded the Military Medal.

Lance-Corporal G. Redfern, R.E. Signal Service (Unestablished Skilled Workman, North-Western District). Awarded the Croix de Guerre (Belgian).

Sergeant (now Second Lieutenant) T. Sanders, R.E. Signal Service (Third-Class Clerk, North Midland District). Awarded l'Ordre de Leopold II Chevalier (Belgian).

Staff Sergeant-Major E. C. Suttle, A.S.C. (Clerical Assistant, South Midland District). Awarded the Meritorious Service Medal and Mentioned in Despatches.

Gunner W. H. Thompsonn, R.G.A. (Unestablished Skilled Workman, London District). Awarded the Military Medal and Mentioned in Despatches.

Pioneer F. Feneley, R.E. Signal Service (Youth, Eastern District). Awarded the Croix de Guerre (French).

Corporal H. W. Read, R.E. Signal Service (Inspector, South-Western District). Awarded the Military Medal.

Quartermaster and Lieutenant B. Pooley, Cambridgeshire Regiment (Chief Inspector, Eastern District). Mentioned in Despatches.

Quartermaster-Sergeant S. F. Bonner, A.S.C. (Clerical Assistant, Eastern District). Mentioned in Despatches.

Sergeant S. A. Finn, R.E. Signal Service (Unestablished Skilled Workman, South-Eastern District). Mentioned in Despatches.

Lance-Corporal H. Stanley, R.E. Signal Service (Unestablished Skilled Workman, North-Eastern District). Awarded the Military Medal.

Acting Quartermaster-Sergeant H. L. P. Stockwell, R.F.A. (Clerical Assistant, South Midland District). Brought to the notice of the Secretary of State for War.

Sergeant E. Johnson, R.E. Signal Service (Skilled Workman, Class II, North-Eastern District). Awarded the Meritorious Service Medal.

Sergeant H. Butler, R.E. Signal Service (Skilled Workman, Class I, South Midland District). Awarded the Meritorious Service Medal.

Sergeant R. E. Deakin, R.A.F. (Inspector, North Wales District). Awarded the Meritorious Service Medal.

Sergeant H. L. Maskrey, R.E. Signal Service (Unestablished Skilled Workman, London District). Awarded the Military Medal.

Lieutenant R. Gauld, R.E. Signal Service (Skilled Workman, Class II, South-Western District). Awarded the Croix de Guerre and Mentioned in Despatches.

Temporary Second Lieutenant A. Arnold, R.E. Signal Service (Skilled Workman, Class II, Scotland West District). Mentioned in Despatches.

Sapper (Acting Sergeant) C. A. Gadd, R.E. Signal Service (Skilled Workman, Class II, London District). Awarded the Meritorious Service Medal.

Second Corporal (Acting Corporal) A. A. Hammond, R.E. Signal Service (Unestablished Skilled Workman, South Midland District). Awarded the Distinguished Conduct Medal.

Sapper (Acting Sergeant) G. C. Chislett, R.E. Signal Service (Skilled Workman, Class II, South Wales District). Mentioned in Despatches.

Sapper P. W. Christie, R.E. Signal Service (Unestablished Skilled Workman, Northern District). Awarded the Military Medal.

Sergeant G. H. Crocker, R.A.M.C. (Labourer, South-Western District). Awarded the Military Medal.

Second Corporal E. G. Geary, R.E. Signal Service (Unestablished Skilled Workman, South Midland District). Awarded the Military Medal.

Sapper J. H. A. Hallett, R.E. Signal Service (Clerical Assistant, South Midland District). Awarded the Military Medal.

Second Corporal F. N. Boyce, R.E. Signal Service (Unestablished Skilled Workman, South-Western District). Awarded the Military Medal.

Sergeant H. W. Codling, R.F.A. (Labourer, London District). Awarded the Military Medal.

Lance-Corporal J. Jones, R.E. Signal Service (Unestablished Skilled Workman, North Wales District). Awarded the Military Medal.

Sergeant W. H. Wood, R.E. Signal Service (Unestablished Skilled Workman, London District). Awarded the Meritorious Service Medal.

Lieutenant J. H. Watkins, R.E. Signal Service (Assistant Engineer, E.-in-C's. Office). Awarded the Military Cross.

Lance-Corporal L. C. Suggars, 8th London Regiment (Temporary Draughtsman, E.-in-C's. Office). Awarded the Meritorious Service Medal.

Lieutenant (acting Major) H. Cranage, R.E. Signal Service (Chief Inspector, South Wales District). Mentioned in Despatches.

Lieutenant (acting Captain) F. Reid, R.E. Signal Service (Assistant Engineer, E.-in-C's. Office). Awarded the Military Cross, the Croix de Guerre (Belgian), and Mentioned in Despatches.

Sapper G. H. Brueton, R.E. Signal Service (Skilled Workman, Class II, North Wales District). Awarded the Military Medal.

Gunner W. Lillie, R.G.A. (Clerical Assistant, South Lancs, District). Awarded the Meritorious Service Medal.

Second-Corporal J. Williams, R.E. Signal Service (Skilled Workman, Class II, North Wales District). Mentioned in Despatches.

Temporary Second Lieutenant C. A. Taylor, R.E. Signal Service (Assistant Engineer, E.-in-C's. Office). Awarded the Military Cross.

Sergeant S. B. Austin, M.G. Corps, (Clerical Assistant, South Eastern District). Awarded the Military Medal.

Sergeant A. C. Billson, Middlesex Regiment (Labourer, London District). Awarded the Military Medal.

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

Sergeant-Major A. W. Marks, R.A.M.Corps (Clerical Assistant. South Wales District). Awarded the Meritorious Service Medal.

Sergeant W. Monteith, R.E. Signal Service (Skilled Workman, Class II, North Wales District). Awarded the Meritorious Service Medal.

Sergeant W. Norbury, R.E. Signal Service (Skilled Workman, Class II, North Wales District). Mentioned in Despatches.

Sergeant J. Orger, Rifle Brigade (Labourer, London District). Awarded the Military Medal.

Sapper (Acting Quartermaster-Sergeant) T. J. Robson, R.E. Signal Service (Clerical Assistant, Northern District). Awarded the Meritorious Service Medal.

Sergeant W. R. Thorpe, R.E. Signal Service (Unestablished Draughtsman, London District). Mentioned in Despatches.

ROLL OF HONOUR.

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

Name.	Rank.	District.
S. Atkinson	Labourer	N.W.
J. B. Barnard	,,	S. Wales.
G. J. W. Barnes	Unest. Skilled Workman	London.
G. W. Barter	,, ,, ,,	S. Mid.
C. A. Beman	Labourer	London.
Major P. C. O. Berkeley	Assistant Clerk	,,
T. Blackwell	Labourer	N. Mid.
Lieut. W. C. Brown	,,	S.E.
W. A. Charlton	Skilled Workman Cl. II	N. Wales.
H. A. Clayton	Unest. Skilled Workman	N. Mid.
W. A. Clayton	Third Class Clerk	N.E.
G. F. Collins	Unest. Skilled Workman	S. Wales.
J. F. Cooper-Smith	Assistant Clerk	London.
Sec. Lt. F. B. S. Counsellor	Unest. Skilled Workman	N.
R. B. Crowe	Youth	S. Lancs.
M. Cunniffe	Skilled Workman, Cl. II	N.E.
H. C. Davis	Inspector	London.
W. R. Davison	Labourer	N.
C. W. Day	Unest. Skilled Workman	London.
A. E. Doxsey	Skilled Workman, Cl. II	N. Mid.
W. Drage	Unest. Skilled Workman	E.
A. G. Dunce	Skilled Workman, Cl. II	London.
E. Eastley	,, ,, ,,	N.W.
J. Ellwood	Labourer	N. Wales.
H. Evans	,,	,,
B. A. Farrant	Unest. Skilled Workman	E.
A. Fletcher	Youth	N. Mid.
W. J. Fowler	Unest. Skilled Workman	S. Wales.
A. Gill	Labourer	N.E.
A. J. S. Hall	Unest. Skilled Workman	London.
W. H. Hebington	Labourer	E.
J. Hydes	,,	N.W.
W. Johnson	,,	,,
H. Kitchen	,,	,,
J. W. Laxton	Unest. Skilled Workman	N. Mid.
R. Lilley	Labourer	,,

W. L. McBain .	. Unest. Skilled Workman .	Scot. E.
W. McKnight .	. ,, ,, ,, .	Scot. W.
B. G. Manning .	. Clerical Assistant .	S. Wales.
R. H. Marlow .	. Labourer .	S.W.
R. Martin . .	. Assistant Clerk .	London.
A. E. Meakin .	. Labourer .	,,
G. Millson . .	. Unest. Skilled Workman .	S. Mid.
J. Mullengar .	. Labourer .	London.
A. Nightingale .	. Unest. Skilled Workman .	S. Lancs.
S. E. North .	. Youth .	E.
H. Primett .	. Unest. Skilled Workman .	,,
E. Ratcliffe. .	. Labourer .	London.
H. J. Reed . .	. Unest. Skilled Workman .	S. Wales.
P. A. T. Roberts	. Clerical Assistant .	Ireland.
J. W. Rutherford	. Skilled Workman, Cl. I .	London.
G. J. Sanders .	. Unest. Skilled Workman .	S. Lancs.
L. Sharp . .	. ,, ,, ,, .	London.
W. Shields . .	. Labourer .	N.E.
E. W. Shortt .	. ,, .	E.
P. Simons . .	. Unest. Skilled Workman .	London.
F. A. W. Sinclair	. Skilled Workman, Cl. II .	S.W.
Sec. Lt. A. V. Smoothy	Unest. Wayleave Officer .	E.
F. E. K. Sneddon	. Unest. Draughtsman .	E. in C.O.
W. A. Stirling .	. Skilled Workman, Cl. II .	Scot. W.
B. G. Strudwick .	. Labourer .	S. Mid.
N. J. Stubbs .	. Clerical Assistant .	S. Wales.
J. Swales . .	. Labourer .	N.W.
A. Turner . .	. Unest. Skilled Workman .	Scot. W.
A. G. Ward .	. ,, ,, ,, .	London.
E. J. Ward . .	. ,, ,, ,, .	,,
B. E. Webb .	. Youth .	,,
W. W. Welsh .	. Unest. Skilled Workman .	E.
A. H. White .	. Youth .	Scot. E.
V. J. Wilkins .	. Unest. Skilled Workman .	N. Mid.
H. C. Wilson .	. Labourer .	London.

STAFF CHANGES.

POST OFFICE ENGINEERING DEPARTMENT.

PROMOTIONS.

Name.	District.	From.	To.	Date.
Motyer, J. A.	Northern	2nd Cl. Clerk	1st Cl. Clerk	13 : 1 : 19
Morison, G. E. N.	Scot. W.	3rd Cl. Clerk	2nd Cl. Clerk	13 : 1 : 19
Badger, E. C. J.	S. Wales	,,	,,	27 : 1 : 19
Linsell, F. A.	S. Mid. Dist.	2nd Cl. Engr.	Asst. Engr.	24 : 2 : 19
Henley, F. L.	E. in C.O.	Asst. Staff Engr.	Staff Engr.	1 : 4 : 19
Herbert, T. E.	N. Mid.	Exec. Engr.	Asst. Suptg. Engr.	To be fixed later
Wood, A. H.	London.	Asst. Engr.	Exec. Engr.	
Newlands, T. H.	E. in C.O.	,,	,,	
Burton, G. M.	N.E.	,,	,,	
Roche, T.	Ireland.	,,	,,	
Patrick, J.	Scot. E.	,,	,,	
Scott, A.	,,	,,	,,	
Roberts, A. H.	E. in C.O.	,,	,,	
McNicol, A. J.	S.E.	,,	,,	
Markwick, J. J.	E. in C.O.	,,	,,	
Cockshott, W. J.	S.W.	,,	,,	
Simmance, J. H.	E. in C.O.	,,	,,	

RETIREMENTS AND RESIGNATIONS.

Name.	District.	Rank.	Date of retirement or resignation.
Lever, G.	Woolwich	Asst. Subm. Supt.	31 : 7 : 18
Gorton, S. G.	,,	Asst. Cable Engr.	28 : 2 : 19 (resigned)
Tiffin, J. H.	S. Wales	1st Cl. Clerk	17 : 12 : 18
Jolley, L. B. W.	E. in C.O.	Asst. Engr.	10 : 1 : 19 (resigned)
Shorrock, L.	S. Lancs.	,,	24 : 2 : 19

DEATH.

Name.	District.	Rank.	Date.
*Clayton, W. A.	N.E. District	3rd Cl. Clerk	24 : 2 : 19

* Died on active service.

COMMUNICATIONS.

TRANSFERS.

Name.	Rank.	Transferred.		Date.
		From	To	
Gwilliam, W. J.	Exec. Engr.	S. Mid.	E. in C.O.	13 : 2 : 19
Lock, F.	Assist. Engr.	S. Wa.	,,	1 : 3 : 19
Devereux, T.	,, ,,	E. in C.O.	S. Wa.	13 : 2 : 19
Latimer, P. D.	,, ,,	S. Lancs.	S.E.	15 : 3 : 19
Purves, T. F.	Staff Engr.	Designs Section	Telephone Section	1 : 4 : 19
Gall, J. R.	,,	Test Section	Designs Section	1 : 4 : 19
Sirett, A. W.	Exec. Engr.	S. Wales	N.W.	To be fixed later
Henshilwood, G.	,,	S.E.	S.E. (Tech. Section)	To be fixed later
Wilby, E. J.	,,	Ireland	E. in C.O.	To be fixed later

COMMUNICATIONS.

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

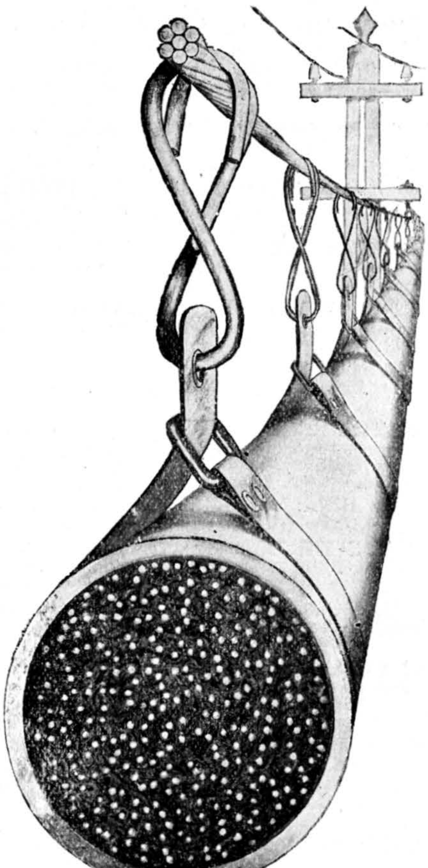
Binding covers and copies of the Contents Index for Vol. 11 are available, and may be obtained from the local agents for 1*s.* 6*d.* and 3*d.* respectively. Subscribers can have their copies of Vol. 11 bound, with index included, at a cost of 2*s.* 6*d.*, by sending the JOURNALS to the local agents. Orders should indicate whether the original binding with black lettering, or the later pattern in gold, are required. Covers for earlier volumes and indices may be obtained in the same manner, prices 1*s.* and 2*d.* respectively.

A supply of copies of the Station List of Engineering Officers, down to Assistant Engineers, is in stock, and may be obtained on demand, price 3*d.* each.

The Board of Editors has decided to raise the price for all back numbers of the JOURNAL to 2*s.* per copy. Will local agents please note the rise in price, when orders come in, for any parts prior to and including that of January, 1919.

INDEX TO ADVERTISERS.

HENLEY TELEPHONE CABLES OF ALL KINDS



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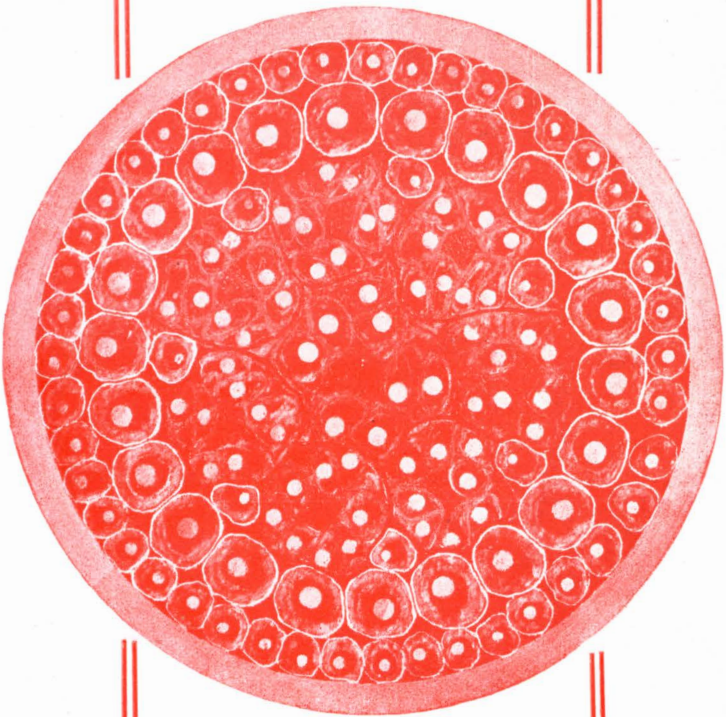

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