WS No. 19 Mark III

 PW—D 8

Post Office Engineering Department

TECHNICAL PAMPHLETS FOR WORKMEN

Subject

C.B. EXCHANGES No. 9 Type

ENGINEER-IN-CHIEF'S OFFICE,
1919

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CORRECTION SLIP TABLE

The month and year of issue is printed at the end of each amendment in the Correction Slips, and the number of the slip in which any particular amendment is issued can, therefore, be traced from the date. In the case of short corrections made in manuscript, the date of issue of the slip should be noted against the correction.

The Summary portions of the Correction Slips should be completed and affixed below in numerical order.

C.B. EXCHANGES, No. 9 TYPE

(D 8)

The following pamphlets in this series are of kindred interest:—

D. 1. Elementary Principles of Telephony.
D. 2. Telephone Transmission. "Loading," Telephone Repeaters and Thermionic Valves.
D. 3. Principles of Telephone Exchange Signalling.
D. 9. C.B. Exchanges, No. 10 type.
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C.B. EXCHANGES—No. 9 TYPE

INTRODUCTORY NOTES

The C.B. No. 9 switchboard was primarily intended for use in localities where the traffic to be handled was not heavy, but where it was desired to provide all the essential advantages of C.B. working at low cost. It has an ultimate capacity of not more than 800 subscribers' circuits.

The main difference between this and other C.B. types is that it has " eyeball " indicators, in place of the usual lamp signals, for subscribers' calling and clearing. It meets all the requirements of common battery systems in so far as it provides for :—

(1) Subscribers calling exchange automatically by lifting receiver off hook and clearing to exchange by replacing the receiver.

(2) Speaking current for subscribers' transmitters, supplied from the common battery in the exchange by means of cord circuit.

Owing to the fact that indicators are used in place of lamps, no relays are required on the subscribers' calling and clearing circuits.

SEQUENCE OF APPARATUS IN SUBSCRIBERS' CIRCUIT.

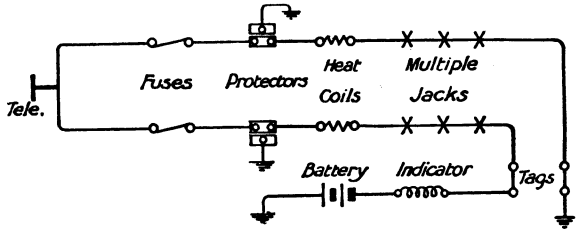


Fig. 1.

The sequence of apparatus on the subscribers' line is shown in Fig. 1, and the subscribers' circuits in the exchange will be described in the order shown there.

MAIN DISTRIBUTING FRAMES

These frames are used for terminating the leading-in cables from the lines on one side, and the cables from the switchboard on the other side, with the means of connecting any pair of a line cable with any pair on the switchboard side. The wire used for this purpose is called a " jumper." The M.D.F. is also

used for accommodating the protective devices, but as " Protective Fittings " form the subject of pamphlet P.W.—A5, a general description only will be given here.

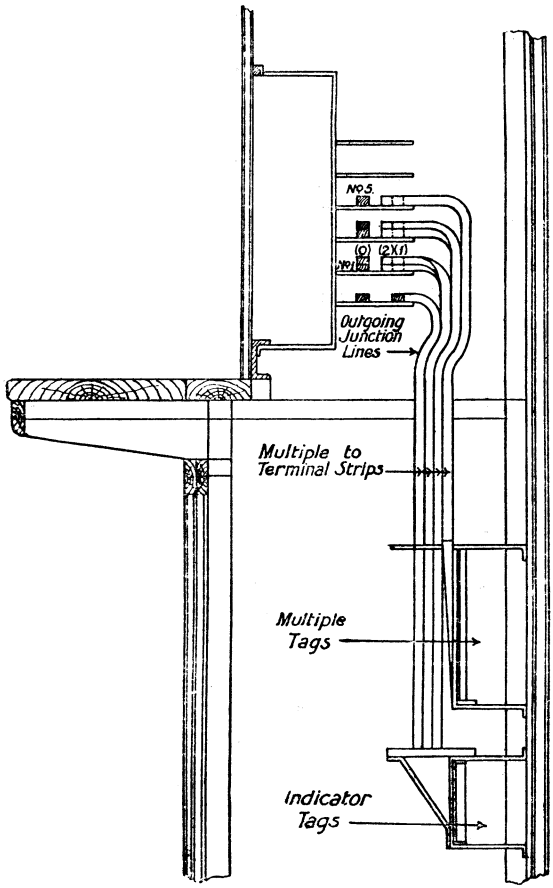


Fig. 2.

Some types of M.D.F. have fuses, protector and heat coils all on the line side (mounted vertically), and the cables from switchboard on the other side on connection strips (mounted

FACE EQUIPMENT.

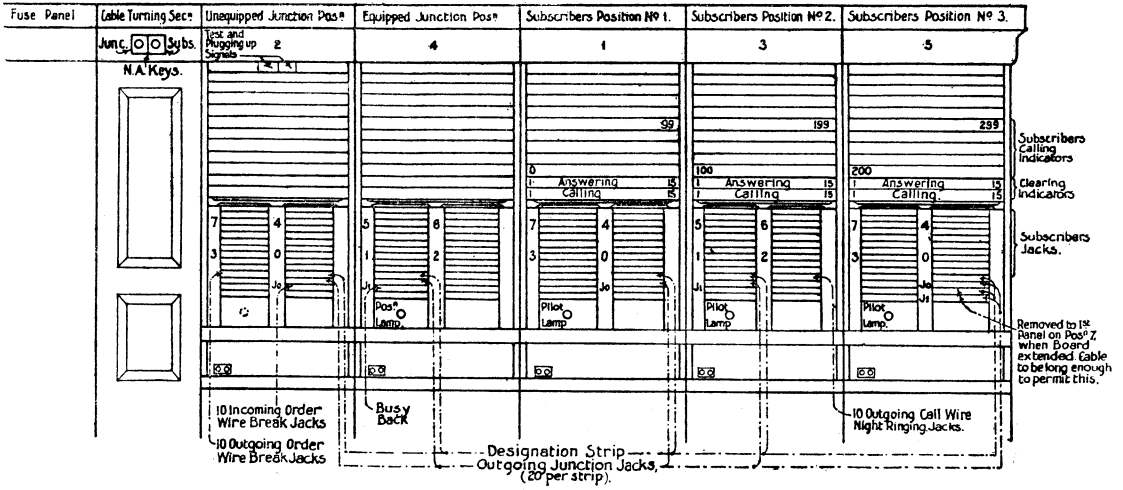


Fig. 3

horizontally). Other types have the fuse mountings on the line side and protectors and heat coils on the switchboard side. The sequence of apparatus between the line and the switchboard is the same in each case, as shown in Fig. 1.

In both types the line cables are connected first to fuses, but in the first-mentioned types the fuses are joined direct to heat coils and then (by means of a jumper wire) to switchboard connection strips. In the last-mentioned types the "jumper" is between the fuses and heat coils.

The M.D.F. therefore is the connecting link between the outside lines and the switchboard.

It is impracticable to number the line cables in accordance with the subscribers' numbers.

The *line cables* are numbered according to code suitable to the cabling scheme and are terminated on one side of the M.D.F. The *switchboard cables* are terminated in numerical order on the other side. To connect any number on the switchboard to any cable pair on the line side, a "jumper" of "Wire E. and F.P., 1 pair/12½" is used. (Main Distribution Frames are described more fully in P.W.—D18).

The switchboard cables are taken direct from the M.D.F. to the first multiple of switchboard jacks, through the other multiple jacks to connection strips on the rear of the switchboard.

The cables from the last multiple jacks are cut and formed so that, when additional sections are required, these cables when taken off the connection strips shall be the exact length to reach the next multiple jacks on the new sections.

The positions of the connecting strips are shown in Fig. 2.

A typical arrangement of the multiple jacks is given on the face equipment sketch, Fig. 3.

The suite is made up of one-position sections, each of which contains, on the lower portion of the vertical above the keyboard, two panels for jacks, and on the upper portion one panel for indicators.

The calling indicators are wired with one end of each coil

to battery and the other end of the coil to tags on the lower portion at the rear of the board.

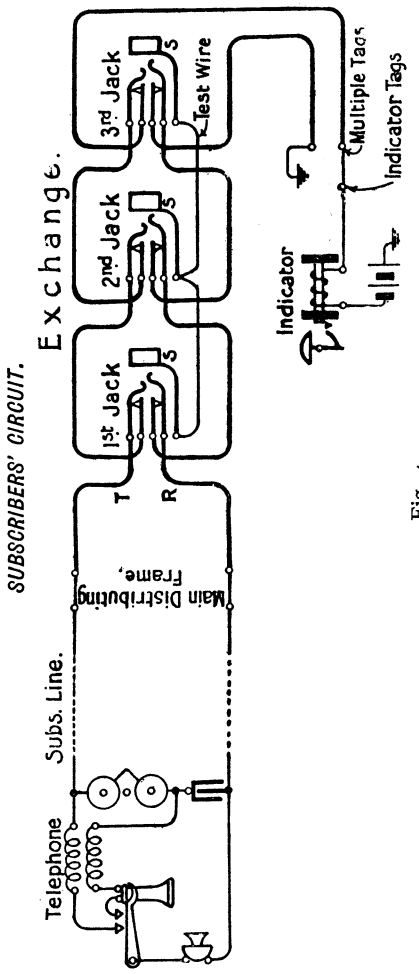


Fig. 4.

It should be observed that a feature of this board is that there are no separate answering jacks. The multiple jacks are used as answering jacks also and, with the object of facilitating their use as such, are arranged in the multiple field so as to place, as far as possible, the blocks of 100 jacks in the same section as their respective calling indicators.

The subscriber's circuit is shown in Fig. 4. The jacks are "series" or "break" jacks, and are cabled as follows:—M.D.F. to line springs of first jacks on multiple, inner springs of first jacks to line springs of second jacks, and so on until the inner springs of the last multiple jacks, which are cabled to the connection strips, already mentioned, at rear of board. The bushes of the jacks are joined by a third wire, which is not connected to the line, but is used for the "engaged test" and will be referred to later. The "A" line of subscriber's circuit is earthed

at the connection strips, and the "B" line is connected to the calling indicator tag by means of a jumper wire or cable. This arrangement forms an intermediate cross-connection field which can be used for arranging the calling indicators to suit the traffic requirements.

It will be seen from Fig. 4 that a switchboard plug, inserted in any one of the series of multiple jacks, cuts off the calling indicator from the line. This will be referred to again in describing the operation of a subscriber making a call.

CORD CIRCUIT

The cord circuit in a C.B. Exchange performs the following functions :—

(1) Cuts off the calling signal and substitutes a clearing signal.

(2) Enables the operator to ring and speak to the subscribers.

(3) Provides the means of connecting one subscriber's circuit with another.

(4) Provides speaking current for each subscriber connected to it.

It is comprised of the following :—

(1) Two 3-way plugs, one "answering" and the other "calling" or front plug. The exposed parts of each are of three metal sections insulated from each other and known as "Tip," "Ring" and "Sleeve."

(2) One combined ringing and listening key.

(3) Two condensers of 2 m.f. capacity.

(4) Two clearing indicators of 200^{w}, each coil of which is split into halves of 100^{w} each. One indicator is associated with the answering and the other with the calling plug.

Other apparatus on the cord circuit is common to the position and is referred to elsewhere.

A diagram of the cord circuit is given in Fig. 5.

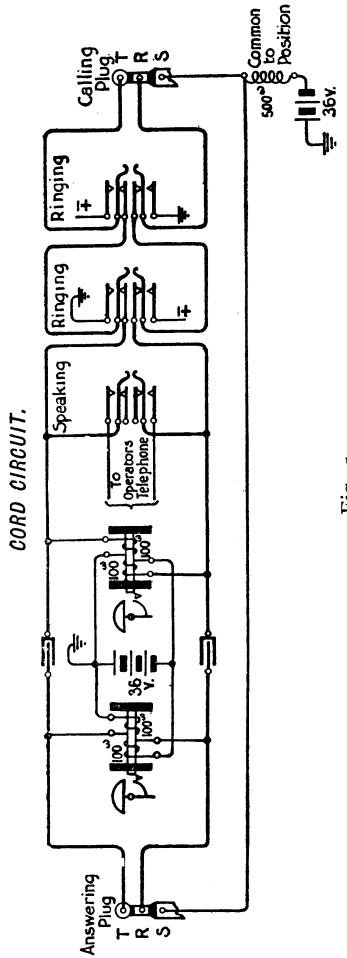


Fig. 5.

In order to explain the functions of the cord circuit, it will be necessary to describe the operation of one subscriber getting connected to another subscriber.

The calling subscriber, by lifting the receiver (see Fig. 4), connects the transmitter circuit of his telephone across the line. This action allows current from the exchange battery to flow round the circuit through the calling indicator, which is actuated. The operator, seeing the calling signal, inserts the answering plug of a pair of connecting cords into the nearest multiple jack corresponding to the number of the calling indicator. This has the effect of cutting off the calling indicator from the line and, of course, the flow of current through it. The indicator eyeball then returns to normal.

A reference to Fig. 5 will show that, instead of the calling indicator of 500ω or 1,000ω, there is a clearing indicator of

200^{w}, made up of two parts of 100^{w} each, to the centre of which is connected the common battery of 36 volts. The clearing indicator, in addition to performing the function which gives it its name, also acts as a feed to distribute the current for the subscribers' transmitters. This is the reason for the lower resistance of the clearing indicator as compared with that of the calling indicator.

The operator is provided with a combined ringing and

OPERATORS' TELEPHONE CIRCUIT.

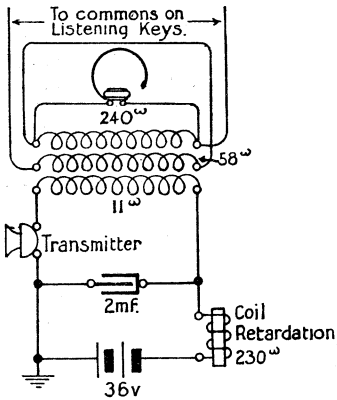


Fig. 6.

speaking key to each pair of connecting cords and plugs, and after inserting the answering or back plug into the jack of the calling subscriber, is able to connect her telephone to the line by throwing the key corresponding to the plug used into the speaking position and to ask the calling subscriber for the number wanted. Having obtained this, the operator lifts the other (calling) plug of the pair, tests the jack of the called subscriber to ascertain that it is not engaged, and, if it is disengaged, inserts the plug into the called subscriber's jack, pulls the key over to the ringing position and holds it there for a second or two. This operation connects the calling plug to the ringing lead and rings the called subscriber's bell.

When the called subscriber answers the call by lifting the receiver, his telephone speaking circuit is connected to the line, the clearing indicator of the calling plug is actuated, and the two subscribers are then "through."

The clearing indicators of both answering and calling plugs remain actuated during conversation, and only fall back to normal when the subscriber clears by replacing the receiver. This is known as a "negative" clear as against the "positive" clear given in lamp signalling systems.

OPERATOR'S TELEPHONE CIRCUIT

The connections of the operator's telephone are shown in Fig. 6, and should be studied in conjunction with the cord circuit (Fig. 5).

The induction coil is in three parts, Primary 11^{w}, Secondary 240^{w} and Tertiary 58^{w}. In "A," or subscribers' positions, the secondary and tertiary are joined in series with the receiver across the 240^{w} winding; this arrangement results in reducing the side-tone in the receiver.

ENGAGED TEST

When a plug is inserted in a subscriber's jack, the bush of that jack and its multiples (see Fig. 4) are joined, *viâ* the sleeve connection of the plug, to battery (see Fig. 5). If an operator is asked for a number which happens to be engaged at the jack nearest to that operator it will be at once apparent to her that it is engaged, because there is a plug already in it. But it may be engaged at another position, and in order to prove this she touches the bush (marked *S* in Fig. 4) of the jack with the "tip" of the calling plug. If it is engaged a

HOWLER CIRCUIT.

In conjunction with Subscribers' Operators Cord Circuit.

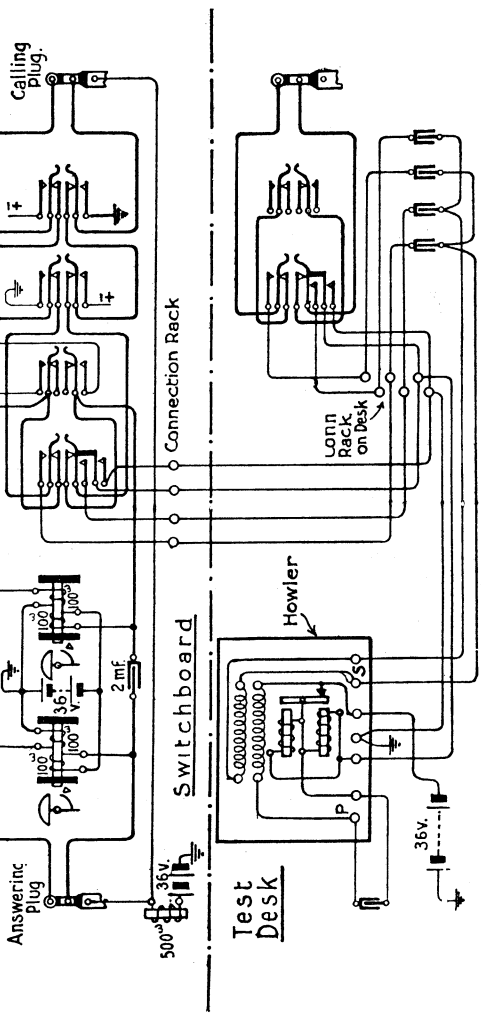


Fig 7.

"click" is heard in the operator's receiver, due to current passing from battery on bush to earth on tip of cord circuit *viâ* clearing indicator. If the line is disengaged no "click" is heard.

HOWLER CIRCUIT

Cases arise where a subscriber omits to replace the receiver on the hook. The result of this omission is to give a calling signal to the exchange.

The "Howler" is provided as a means of attracting the attention of the subscriber to this omission.

An ordinary cord circuit is equipped with an extra key, so that when this key is thrown the "Howler" is applied to any circuit to which the calling plug of this special circuit is connected. The connections of the "Howler" are shown in Fig. 7.

The apparatus used in this circuit is a "buzzer," with its two coils joined in parallel through a condenser and one coil of an induction coil. The battery is connected through the contacts of the special key, so that when the key is thrown the battery is joined up. With the same movement of the key the connections from the secondary side of the induction coil are connected through a condenser to the tip and ring of the cord circuit. The result is to reproduce in the subscriber's receiver the "buzzer" tone which can be heard in the room where the telephone is situated. When the receiver is replaced on the hook, the clearing signal on the cord circuit falls back to normal and indicates that the Howler may now be taken off the line. The condenser in series with the secondary circuit of the induction coil is inserted so that this clearing signal may be effective. If the condenser were not in the circuit, current would flow all the time through the clearing indicator *viâ* the induction coil, and the indicator would remain actuated.

PILOT AND NIGHT-ALARM CIRCUITS

The pilot circuit, Fig. 8, serves the purpose of indicating to the operator or supervisor that a calling signal has been actuated on the section corresponding to the particular pilot signal. Each line signal is so designed that, when the "eyeball" is actuated, a local contact is made. One side of the contact is formed by the iron indicator mounting, which is earthed. The other side is commoned to all the contacts on one position and connected to one "pilot" lamp, which is fitted on the lower portion of the left jack panel on each section (see Fig. 3).

When the day operating staff is on duty, one side of the pilot lamp is connected (through Night Alarm key) direct to the 36-volt battery. The pilot lamp associated with any section, therefore, glows when any calling signal on that section is actuated.

PILOT AND NIGHT ALARM CIRCUITS.

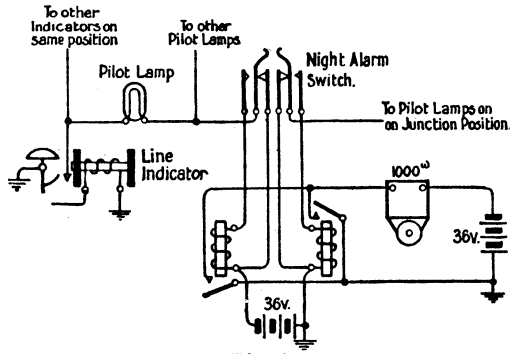


Fig 8.

When the night staff is on duty, it is necessary to provide a signal which can be heard more distinctly than the "click" of an eyeball indicator, so a night-alarm bell is provided. This night alarm is so arranged that it can be switched on when required (see Fig. 8).

This switch or key disconnects the pilot lamp common from direct connection with the battery and inserts a night-alarm relay of low resistance (0.45ω) in series with the battery and the pilot common.

A low-resistance relay is necessary in this circuit in order to maintain sufficient current for lighting the pilot lamps. All current passing through pilot lamps being supplied through the night-alarm relay, when night alarm is switched on, it follows that this relay is actuated, and the bell connected to its local contacts will be joined up and so cause it to ring.

JUNCTION CIRCUITS

These are lines between any two exchanges, and are provided

for the purpose of enabling subscribers in one exchange to be connected with those in another exchange There are three classes of junctions, viz. :—

Outgoing, Incoming and Bothway.

The *last* is a combination of outgoing and incoming junctions, and is provided only when the number of junctions between the exchanges concerned is so small that it would be inadvisable to divide them into outgoing and incoming groups.

The *outgoing junctions* are used for calls originated in the exchange where the outgoing ends of the junctions are terminated.

OUTGOING JUNCTION.

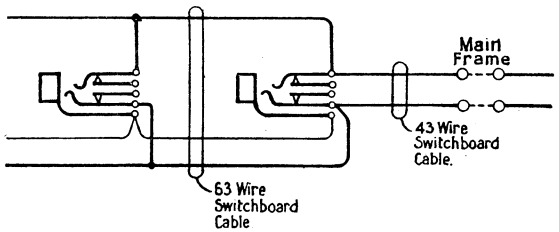


Fig. 9.

The outgoing end of a junction in any C.B. exchange is a simple circuit (except in some special cases not dealt with in this pamphlet). The connections for a No. 9 switchboard are shown in Fig. 9.

The distant end of an outgoing junction is, of course, incoming to that exchange. The *incoming ends of junctions* in any exchange are provided for connecting inward calls for that exchange. A typical incoming circuit is shown in Fig. 10. The type shown is plug-ended. The line is divided for signalling purposes by a repeating coil, the centres of each coil being connected by a condenser, also for signalling purposes. The only path for a direct current from the cord circuit to which the outgoing end is connected is through the line relay, which has two coils, 12,000^{w} and 27^{w} respectively.

The high resistance coil is normally in circuit with the line, and, when current is sent round the loop from the cord circuit of the calling exchange, the line relay is actuated and the lamp glows, but the supervisory or clearing signal at the calling exchange is not actuated, on account of the very small amount of current which can flow through the high resistance coil of the line relay on the junction.

The operator tests the line asked for with the tip of the junction plug in the same manner as at the subscribers' positions, but in this case the plug is directly associated with the junction.

A reference to Fig. 10 will show that the "tip" of the plug is normally connected to earth *via* the 58^{w} coil of the operator's induction coil. If the tip of the junction plug is applied to the bush of an engaged jack, current will flow (see Engaged Test paragraph) from the bush of the jack to earth *via* the 58^{w} coil and induce a current in the 240^{w} coil, and produce a "click" in the operator's receiver, which is in series with the 240^{w} coil. If the line tested is not engaged there will be no "click," and the operator inserts the plug into the jack and

(1) Throws over key *S*. This movement (a) cuts off the "tip" of the plug from the 58^{w} coil and joins it through to the repeating coil, (b) reverses the connections of the local contacts of the calling and clearing relay *CC* into the position for receiving a clearing signal.

(2) Depresses one of the ringing keys *R*. (If the connection is to an ordinary subscriber's circuit R_3 is used.) These keys are provided with a coil which acts as a magnetic clutch to retain the key in the ringing position.

When the called subscriber answers, current is sent round the "Tripping Relay" *T*, which, in turn, cuts off the current from the coils of the magnetic clutch and releases the ringing key. The circuit is again joined up to the repeating coil and relay *A* is actuated. Current flows round the loop *via* coils of relay *A*, and provides current to the called subscriber's transmitter for speaking. The action of the armature of relay *A* causes the 12,000^{w} coil of line relay *C* to be shunted with the 27^{w} coil.

This has the effect of dimming the supervisory signal on the cord circuit at the outgoing end, and indicates to the operator there that the called subscriber has answered.

When the conversation is finished and the called subscriber replaces the receiver on hook, the condenser in the subscriber's bell circuit prevents current from flowing round the loop, relay *A* armature is released, the 27^{w} shunt is disconnected from line relay *C*, and a clearing signal is given on the supervisory lamp at the outgoing end. The operator there takes the connection off, relay *C* is released, the armature falls back and disconnects relay *CC*, the armature of the latter returns to normal, and lamp *CL* glows as a clearing signal at the incoming end.

The junction operator withdraws the plug from the called subscriber's jack, throws back key *S* to dim the lamp *CL*, and the junction is then available for another call.

The foregoing description deals with a completed call, but when the subscriber called for is engaged it is necessary for the operator at the incoming end to indicate this to the distant end. The method provided for the operator is described under the heading of "Busy Back."

There are two methods of calling junction positions. One is by plugging into the outgoing end of a junction to give a calling

POST OFFICE COMMON BATTERY TELEPHONE SYSTEM.

Incoming Junction from C.B. Exchange at C.B. Exchange of No. 9 Type (using 12,000ω + 27ω Relay).

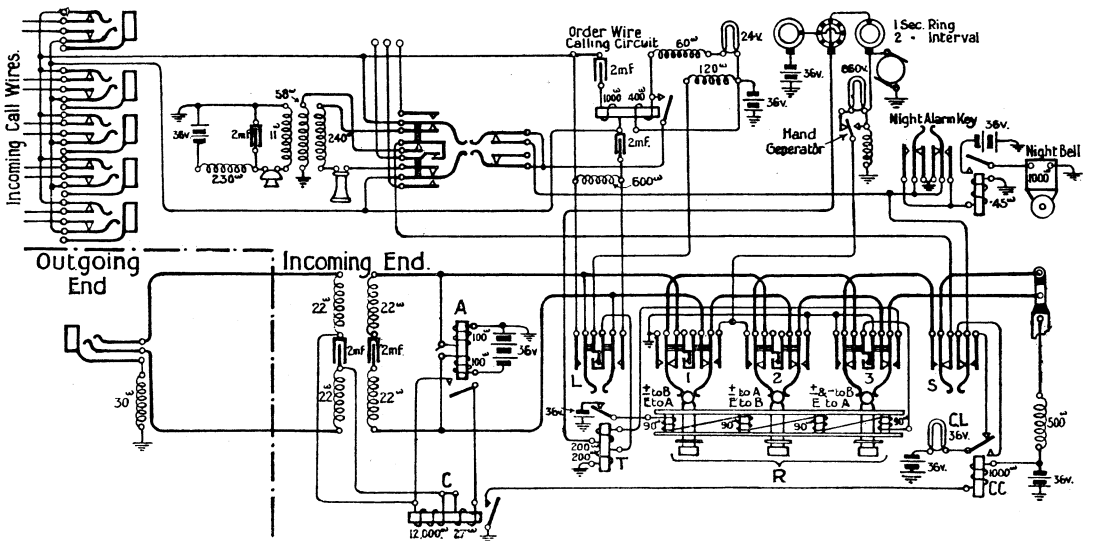


Fig. 10.

signal to the incoming end. The incoming operator, by means of throwing over a listening key, comes directly into the circuit and is asked for the required number.

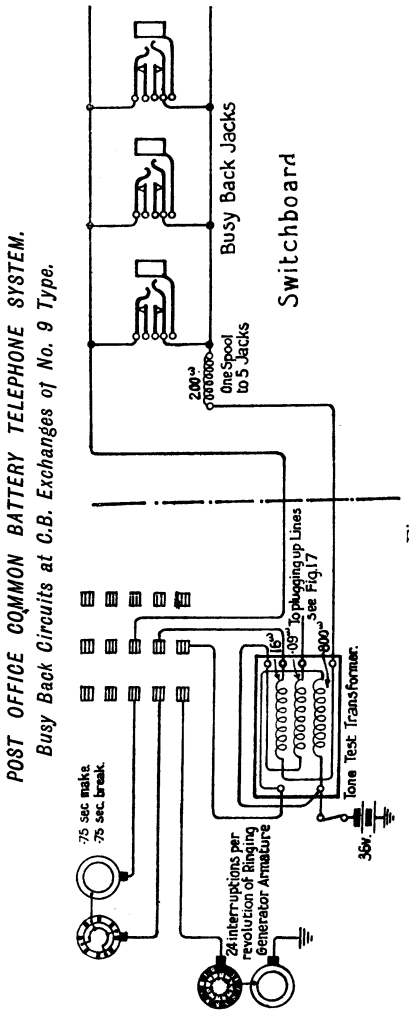


Fig. 11.

Junctions worked on this method are called "*Ringing*" *junctions.*

This title must not be taken as having any connection with generator calling, as it is applied to all junctions, whether joined up for generator or on automatic calling, where the incoming operator answers direct.

Where a large group of junctions exists between one exchange and another, the direct or ringing method is unsuitable, as it takes up the time of the operator at the outgoing end in finding a disengaged junction. In such cases the "Order Wire" method is adopted. The order wire is used only between operators, and subscribers cannot be connected to it. The outgoing end of an order wire is connected to a plunger key, multipled to every operator's position, so that when the key is depressed the operator connects her telephone to the order wire.

During the ordinary hours of duty the operator at the incoming end is listening continuously on the order wire.

The method of working is as follows :—An "A" operator in one exchange, having been asked for a number in another exchange, depresses the O.W. key connected to the required exchange and "orders" the required number. The "B" operator repeats that number and then gives the number of the junction which she allots for the called subscriber. The outgoing operator releases the order wire key and connects the calling subscriber to the junction allotted. The "B" operator, therefore, only speaks to other exchanges connected to the order wire and has no need to speak to a subscriber at all.

In some cases the number of lines from one exchange is not sufficient for one "B" operator's load. In such cases two or more O.W.'s are grouped at the M.D.F. to one position. It is sometimes convenient, owing to the geographical position of the exchanges concerned, to group the order wires at different points. This is termed a "split" order wire.

For night working the order wire is arranged so that the junction position may be called by generator ringing (see order wire calling circuit in Fig. 10). The generator, when applied at the outgoing end, sends an alternating current through the 1,000^{w} coil of the relay. Its armature is actuated, and this joins up the 400^{w} retaining coil to battery and earth. The lamp is in shunt with the 400^{w} coil and therefore glows.

The earth connection is made *viâ* the night alarm, which is, therefore, also brought into operation at the same time.

All junction order wires are connected through jacks on the incoming position so that, in the event of an order wire becoming faulty, a junction can be substituted temporarily as an order wire. The insertion of a junction plug into an order wire jack cuts off the line of the faulty order wire and connects that junction to the operator's speaking circuit (see Fig. 10).

"BUSY BACK" CIRCUIT

This is provided to enable the "B" operators to indicate to the distant end that the subscriber asked for is engaged. When a "B" operator is asked for a number which tests engaged, the plug of the junction is inserted into one of the Busy Back Jacks. The effect of this is to produce a buzzing tone on the junction line which can be heard by the calling subscriber and also to "flash" the supervisory lamp in the originating exchange. If the subscriber fails to recognise this audible signal, the "A" operator does, and advises the calling subscriber. It is necessary in any case to draw the "A" operator's attention to the fact that the number called for is engaged, so that the calling subscriber may not have a completed call registered against his circuit for an ineffective one.

The method of joining up the Busy Back circuits is shown in Fig. 11. The ringing machine gearing is utilised to produce a "hum" from a high speed interrupter joined through a trans-

former to induce the tone in the coils of the transformer connected to the Busy Back jacks.

The tone is also joined through a low speed interrupter which makes the "hum" a pulsating one at the rate of three-fourths second "hum" and three-fourths second silence alternately. The details of the interrupters will be explained in the description of Ringing Machines.

RINGING MACHINES

In a C.B. exchange, ringing machines (see Fig. 12) perform the primary function of supplying generator current for ringing subscribers' bells or indicators. The average speed of the spindle on which the armature is wound is 1,000 revolutions per minute. An extension of the armature spindle carries a drum of 5 rings of gunmetal or brass insulated from each other and from the common spindle. The first and second are complete rings, to one of each of which the ends of the generator are connected. Each of the first two rings has one brush rubbing on it. Any circuit connected to these two brushes will have alternating current produced in it. The third ring is split by insulating material into two segments and has a brush at each side of it.

If it is remembered that these rings are revolving with the generator spindle, and that one complete revolution of the armature produces an alternation of one "positive" and one "negative" impulse, it will be understood that the ring which has two equal segments in it will send out positive pulsations on one brush and negative pulsations on the other. This third ring is required only where party line selective ringing is desired. The fourth ring is used as an earth connection to the fifth ring, which has one segment equal to three-fourths of its circumference and the remaining one-fourth split into three segments. These three segments are connected to the fourth or earth ring. The fourth and fifth rings are not connected to the generator coils, but to battery through to one coil of the Busy Back transformer. The rapid make and break of the battery circuit through the action of the segments on the fifth ring produces the tone for the Busy Back and also for the "Test and Plugging-up" circuits which will be referred to later.

Slow speed interrupters are fitted to a second spindle, which is revolved at the rate of 10 revolutions per minute by means of a worm gear on the high-speed spindle.

It will be observed that one of the connections from the brush of the second high-speed ring is connected direct to the bus bars for "Manual" ringing. This is for "A" operators, who can send out ringing current from the cord circuit as required. The other connection from the second high-speed ring is taken to a brush on one of the low-speed rings. This is for "machine" ringing on "B" positions.

CONNECTIONS OF RINGING MACHINE AND INTERRUPTER ATTACHMENTS.

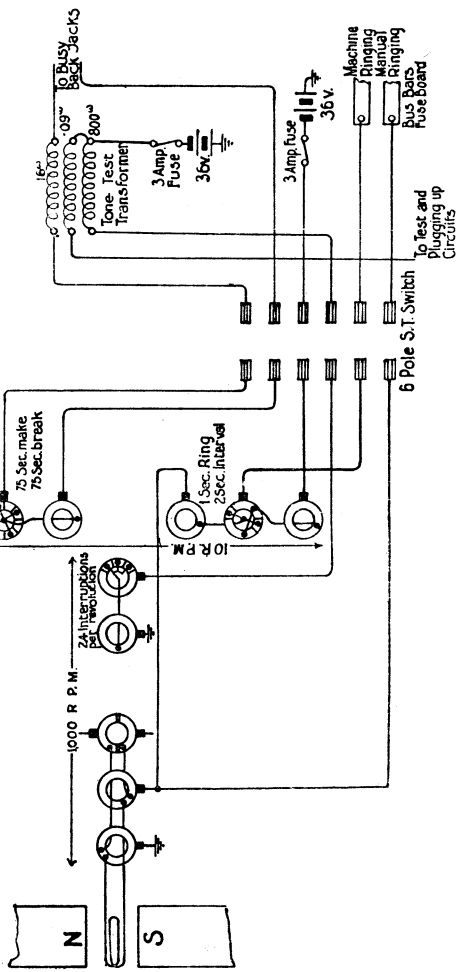


Fig. 12.

The lower three of the five low-speed rings form a group for junction ringing. The first of the three is connected to the ringing generator and the last to the 36-volt battery. The centre of the three is split into four segments. Opposite segments are equal to each other and adjacent segments are in the ratio of 2 to 1.

The three rings are connected to produce successively on the brush of the middle ring an alternating current from the generator of one second duration and a steady current from battery of two seconds duration. This brush is connected to the bus bar for distributing ringing current to " B " positions.

The battery is applied to this arrangement in order to ensure the action of the tripping relay referred to in the description of incoming junctions.

The other pair of rings on the low-speed drum is for " interrupting " the Busy Back and Test and Plugging-up lines and, as already stated, give three-fourths second intervals.

For manual ringing each position has a 600^{w} resistance lamp in series with the wire from the fuse on the ringing bus bar. This resistance is primarily to avoid risk of fire due to sparking and arcing which may result from applying the full voltage to line; incidentally it prevents the absorption of too much current on any one position when ringing on low resistance circuits.

FUSE PANEL

Current supplied from secondary cells is invariably distributed through fuses. Fig. 13 is a typical arrangement of fuses on a panel. The main battery leads are taken to the two vertical bars. The bar shown on left by full lines is the " negative " or " live " bar. That on the right, shown by dotted lines, is the " positive " or earth bar. The horizontal bars connected with the " negative " bar are drilled and provided with screws to receive one end of each of the fuses. The screws for the other ends of the fuses are into separate bushes which go through the slate panel to tags at the rear of the panel. On

FUSE PANEL.

Method of Fusing and Appropriation of Fuse Positions.

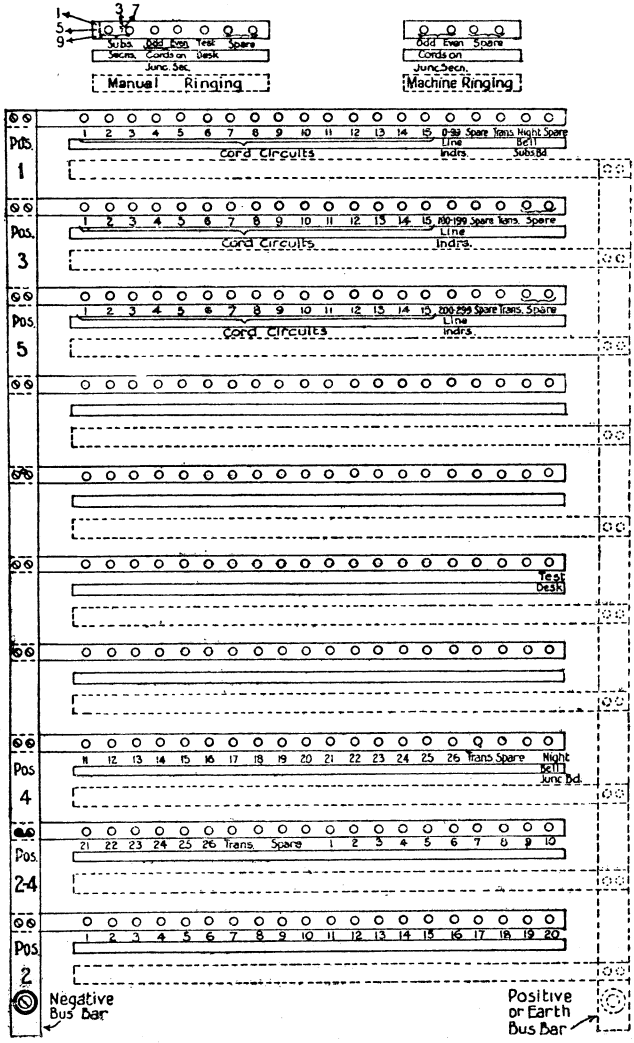


Fig. 13.

these tags the separate leads to the different circuits are connected as in Fig. 14.

The fuses are provided with an alarm attachment as in Fig. 15. The fuse wire *A B* is soldered to a wire spring *S* at

BATTERY DISTRIBUTION

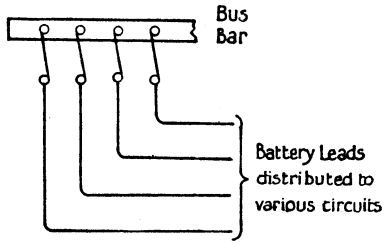


Fig. 14.

A and to a flat spring *D* at *B*, in such a manner that *D* is held up off the alarm bar *C*.

When a fuse breaks—say, owing to a faulty circuit allowing more current than the fuse wire can carry—the breakage of the

ALARM FUSE.

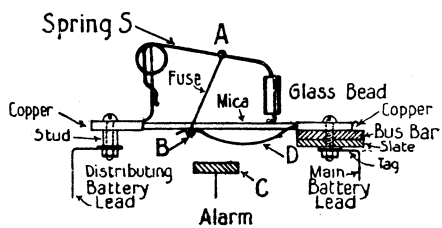


Fig. 15.

fuse wire allows the spring *D* to make contact with the alarm bar *C* and connects up the fuse alarm bell. The wire spring *S* has a tubular shaped glass bead on it which is normally end on to the fuse panel, but when a fuse breaks the bead comes into

a vertical position and enables the attendant to locate the broken fuse.

In the fuse leads to junction positions it is the practice to distribute the "even" numbers to one fuse and the "odd" numbers to another fuse. This is a safeguard against all the junctions from one exchange being thrown out of order at one time by the breaking of a fuse.

Referring again to Fig. 13, it will be seen that separate bus bars for ringing current are provided at the top of the fuse panel. These are the bus bars shown in Fig. 12.

TEST CLERK'S DESK

The Test Clerk's Desk (Fig. 16) is invariably accommodated in the same room as the M.D.F. The desk or panel is equipped with the following :—

(1) Testing set, complete with voltmeter and keys, to enable the Test Clerk to apply any necessary tests to the circuits under his control.

(2) Test and Plugging-up circuits.

(3) An exchange line or more.

(4) A connection to the Howler circuit.

(5) A connection to the M.D.F.

Circuits 2 to 5 are terminated on jacks on the test panel. The series of testing keys is terminated on a plug. The keys give the Test Clerk the means of making tests on any circuit connected through the plug. The functions of the keys will be described in the order shown in Fig. 16.

The key marked " Howler " connects the test plug with the Howler circuit. This circuit has already been described. The key marked " Buzzer " is not in the testing circuit, but is merely used to switch on or off the buzzer associated with the exchange line indicator. The third and fourth keys provide for ringing on *A* or *B* sides of a circuit. The Reversing Key reverses the conditions applied to the tests in hand. For example, in a test for " earth " the test is normally applied to the *B* line, but when the reversing key is thrown the test is transferred to the *A* line. The " Earth " key enables the Test Clerk to earth the *A* or *B* line and test the other.

The voltmeter key takes the Test Clerk's telephone off the circuit and joins the voltmeter to the line. The " Sounder " key is associated with a " Sounder " actuated by a 150^{w} relay, which allows a comparatively heavy current to pass to line with the object of breaking down latent faults. Incidentally it can be used as a buzzer for locating intermittent faults. The Test Clerk, by leaving the sounder on the line under test instead of the voltmeter, gets an audible signal and is freed from the necessity of having to watch the voltmeter for the time.

The sounder is also useful to the Test Clerks or other members of the exchange staff in making location tests inside.

The " Voltmeter Reversing " key reverses the terminals of the voltmeter. As the voltmeter only deflects to current in one direction, it is necessary, in order to receive, say, a negative current on " B " line, to connect the " negative " terminal of the voltmeter to that line. The battery switching key cuts off the testing battery from the voltmeter and connects it across the testing circuit direct.

The " Retard Coil " key is used while speaking to a subscriber direct, and provides a battery feed to the subscriber's transmitter similar to what is done by the ordinary cord circuit.

The " Voltmeter Shunt " key connects a shunt coil across the voltmeter terminals, and has the effect of increasing the value of the deflections by 10. For instance, a current at 40 volts pressure would give a full deflection on a voltmeter calibrated to read 0-40 volts, and there would be a doubt as to whether the voltage was just 40 or more than that. The introduction of the shunt in this case would reduce the deflection to 4, and voltmeter readings up to 400 could be indicated on the shunted voltmeter. These voltmeters are sometimes provided with two scales, one for the shunted and the other for the unshunted meter.

The T.R.S. key is to enable the Test Clerk to " short-circuit " the transmitter on his telephone.

This is sometimes advisable when carrying out listening tests for overhearing faults, as it eliminates any noises in the Test Clerk's locality which would be reproduced by the transmitter into the receiver.

POST OFFICE COMMON BATTERY TELEPHONE SYSTEM.

Engineer's Desk Circuits, Switchboard No. 9, and Private Branch Exchanges, No. 2501.

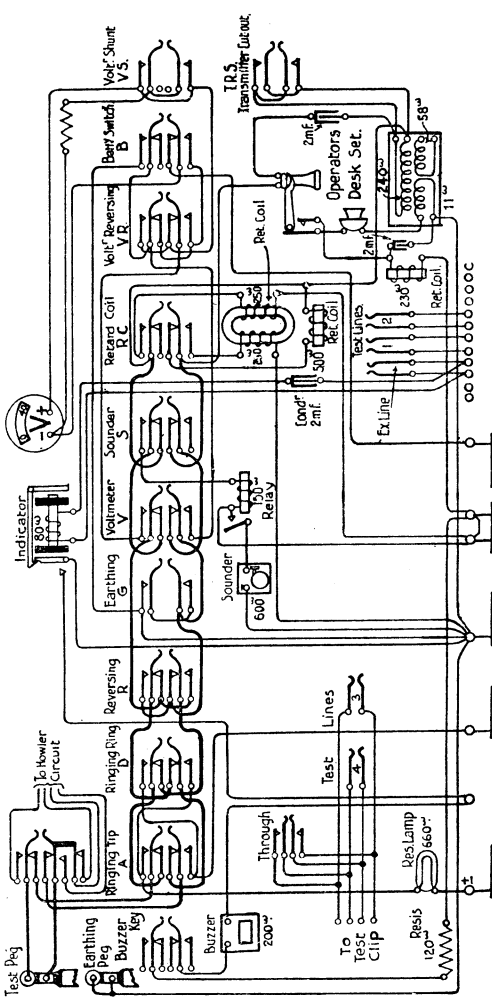


Fig 16.

In addition to the keys there are five jacks on the test panel. One marked "Exchange Line" is self explanatory. Jacks marked 1 and 2 are connected to the "Test and Plugging-up" lines.

The Test and Plugging-up lines are provided (1) to enable the Test Clerk to make a test through the exchange and the M.D.F. to any circuit; (2) to enable the operators in the exchange to "Plug up" a faulty line which is giving a constant calling signal to the exchange.

The Test and Plugging-up lines each terminate on plugs on the switchboard and are equipped with calling signals as in the case of an ordinary subscriber's circuit. When a circuit is plugged up, the ordinary calling signal is, of course, cut off, and the signal associated with the plugging-up circuit substituted. This signal will show until the fault is removed. See Fig. 17.

POST OFFICE COMMON BATTERY TELEPHONE SYSTEM.

Test and Plugging-up Circuits at C.B. Exchanges of No. 9 Type.

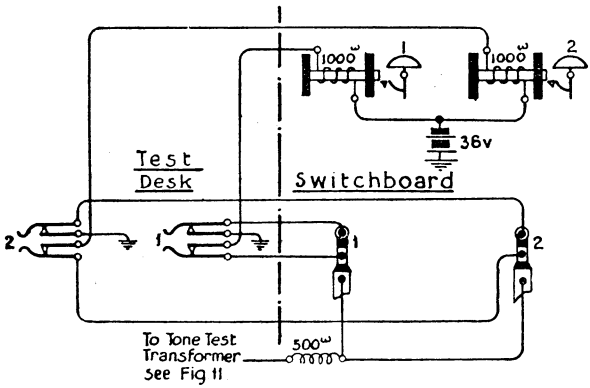


Fig. 17.

When the circuit is used by the Test Clerk for testing, the signal is cut off by the operation of plugging into the jack at the test panel.

The other two jacks marked 3 and 4 are connected to a testing clip which can be inserted in place of the heat coils at the protector strip. By plugging into jack 3 the Test Clerk can test the exchange side of the circuit under test with the line side cut off. Jack 4 is for testing the line side with the exchange side cut off. The key marked "Through" joins up the line again to exchange if required temporarily.

The plug marked "Test Peg" is associated with all the tests described above. The plug marked "Earthing Peg" has no connection with the keys, but is used to earth any lines which are being tested from the distant end.

The keys operated in general tests and the electrical conditions produced in each case are shown in Figs. 18 and 19.

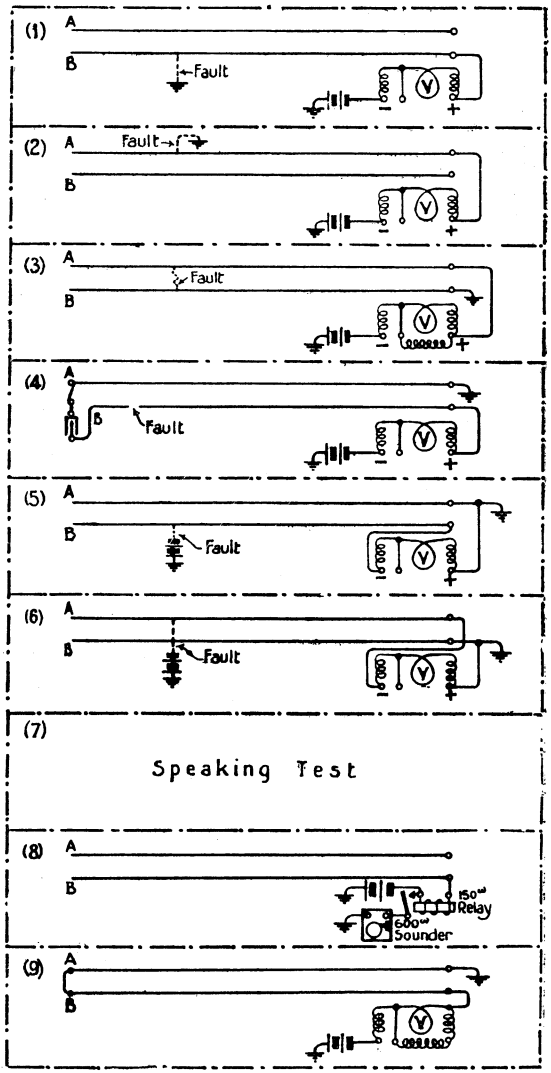
MANIPULATION OF TESTING KEYS.

Reversing	Earthing	Voltmeter	Sounder	Speaking Test	Retardation Coil	Voltmeter Reversing	Battery Switching	Voltmeter Shunt	Fault tested for	Result of test, if fault proved to exist
		X							(1) Earth on B	Deflection on V
X		X							(2) Earth on A	Deflection on V
X	X	X						X	(3) Loop	Deflection on V
	X	X							(4) Dis.	No Deflection on V
	X	X				X	X		(5) Current on B	Deflection on V
X	X	X				X	X		(6) Current on A	Deflection on V
				X					(7)	
			X						(8) Inter E	
	X	X						X	(9) Resistance of Loop	$R = V\frac{T-D}{D}$ R = Resistance V = Voltmeter Constant T = Total Scale Divs. D = Deflection on V.
					X				(10) Speaking to Subs	
X	X	X							(11) OK Test	Deflection on V momentarily, then needle returns to Zero

The Mark X indicates the keys operated for each test.

Fig. 18.

DIAGRAMS OF CONNECTIONS OF TEST.



Note.—The coils shown as inductances are actual non-inductive resistances

Fig. 19.

(29270) Wt. 2446/547 750 12/35 Hw. G.344 (T.S.8)

LIST OF
Technical Pamphlets for Workmen
(Continued)

GROUP D—*continued.*

18. Distribution Cases, M.D.F. and I.D.F.
19. Cord Repairs.
20. Superposed Circuits. Transformers. Bridging Coils and Retardation Coils.
21. Call Offices.
22. Units, Amplifying. (*Not on Sale.*)

GROUP E.

1. Automatic Telephony : Step by Step Systems.
2. Automatic Telephony : Coded Call Indicator (C.C.I.) Working.
3. Automatic Telephony : Keysending " B " positions.

GROUP F.

1. Subscribers' Apparatus. Common Battery System.
2. Subscribers' Apparatus, C.B.S. Part I—C.B.S. No. 1 System.
3. Subscribers' Apparatus. Magneto.
4. Private Branch Exchanges—Common Battery System.
5. Private Branch Exchange—C.B. Multiple No. 9.
6. Private Branch Exchanges—Magneto.
7. House Telephone Systems.
8. Wiring of Subscribers' Premises.

GROUP G.

1. Maintenance of Secondary Cells.
2. Power Plant for Telegraph and Telephone Purposes.
3. Maintenance of Power Plant for Telegraph and Telephone Purposes.
4. Telegraph Battery Power Distribution Boards.

GROUP H.

1. Open Line Construction, Part I.
2. Open Line Construction, Part II.
3. Open Line Maintenance.
4. Underground Construction, Part I—Conduits
5. Underground Construction, Part II—Cables.
6. Underground Maintenance.
7. Cable Balancing.
8. Power Circuit Guarding.
9. Electrolytic Action on Cable Sheaths, etc.
10. Constants of Conductors used for Telegraph and Telephone Purposes.

GROUP I.

1. Submarine Cables.

GROUP K.

1. Electric Lighting.
2. Lifts.
3. Heating Systems.
4. Pneumatic Tube Systems.
5. Gas and Petrol Engines.

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