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POST OFFICE
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TECHNICAL PAMPHLETS FOR WORKMEN

Subject :

C.B. EXCHANGES. No. 12 TYPE.

ENGINEER-IN-CHIEF'S OFFICE
1919

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C.B. EXCHANGES—NO. 12 TYPE

(D. 10.)

The following pamphlets in this series are of kindred interest:

D. 1. Elementary Principles of Telephony.
D. 8. C.B. Exchanges, No. 9 type.
D. 9. C.B. Exchanges, No. 10 type.
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C.B. EXCHANGES—No. 12 TYPE.

The C.B. No. 12 type of multiple switchboard was introduced to meet the requirements of an exchange where the floor space was limited and where the ultimate capacity of the exchange would not exceed six operators' positions. It has now been replaced by the multiple type of C.B.S. board.

LAY OUT OF PLANT.

The line of switchboards is made up of one position 2 panel sections. The multiple field has a capacity for 2,000 subscribers' lines, which are multipled once per four panels. The subscribers' multiple jacks are in strips of twenty and are of the break jack type. Below these, similarly multipled, are the outgoing junction jacks, usually of the branch jack type. Below these outgoing junction jacks, and separated from them by marking strips, are their engaged signal lamp jacks. At this level occur also the miscellaneous jack strips, busy back tests, etc., multipled in alternate panels. Lowest are arranged the answering jacks (break jacks) in strips of twenty over their lamp jack strips, but with designation or marking strips between. The subscriber's calling lamp and line relay are combined on the same mounting strip. In this combined relay and lamp socket the relay is fitted above the lamp socket, and the designation strip for the answering jacks lies in front of the relay cores From the front of the sections the effect is normal. At the base of the panels are the pilot lamps, line pilot one per panel, meter pilot one per panel. On the sections where incoming junction calls are handled, the incoming junction jack strips are fitted at the level of the subscribers' answering jacks of the subscribers' positions. The keyboard has capacity for seventeen listening and ringing keys, with a meter key per cord circuit. At the right of the line of keys are usually fitted, common to a section, order wire, ringing, cord test, ineffective meter, howler and generator reversing keys. The strips of order wire keys are arranged on the left of the keyboard.

CABLING ARRANGEMENTS.

As previously mentioned, the subscribers' line relays and calling lamps are combined on the same mounting strip in the jack field. Further, as the subscribers' multiple is of the break jack type, cut off relays are not required, therefore the usual relay rack accommodation, necessary in C.B. exchanges for line and cut off relays, is not needed. The subscribers' line cables are run from the Main Frame *viâ* the multiple jacks to the Intermediate Distributing Frame. These cables from the Main Frame are first wired to terminal strips located on the last sections, before proceeding to the multiple jacks. As the switchboard is arranged to grow in the direction of the Main Frame, extensions to the multiple are easily effected. From the Inter-

mediate Distributing Frame cables are run to the combined answering jack equipments in the sections. The Intermediate Distributing Frame is usually accommodated in the Switch-room itself, the Main Frame and auxiliary junction equipment relay racks occupying a separate room.

SUBSCRIBERS' CIRCUITS.

Subscriber's Line Circuit.—Fig. 1 illustrates the rough theory of this circuit, which is arranged for the following requirements :—

(a) To call exchange on subscriber lifting receiver.
(b) To disconnect calling lamp on operator answering.
(c) To engage all jacks in a multiple when a plug is inserted into any jack of that multiple or its associated answering jack.
(d) To provide metering conditions.

SUBSCRIBER'S LINE CIRCUIT.

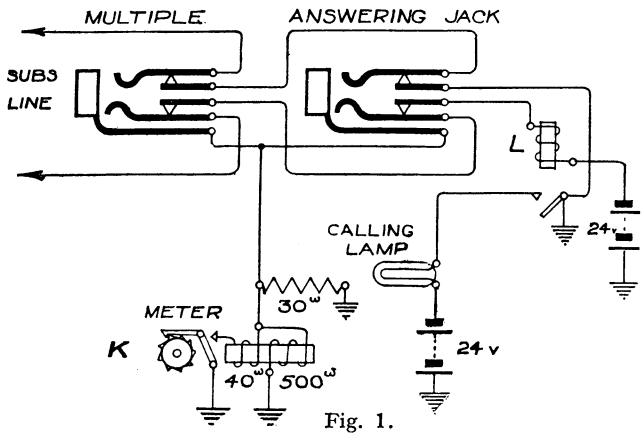

Fig. 1.

The action of the circuit is as follows :—

(a) The looping of the subscriber's line (subscriber lifting receiver) energises the line relay *L*, *viâ* negative, *L relay winding*, inner of long spring answering jack, long spring of answering jack, similarly *viâ* multiple jack, subscriber's B line, telephone, subscriber's A line, through multiple short springs and inners, to earth. The line relay (energised) closes its contact, completing a circuit for the line calling lamp, which glows.

(b) Operator "plugs in." The insertion of the plug into any jack will break the contact between the inner springs

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and the line springs. As these spring contacts form part of the circuit by which relay *L* is energised (para. a) this relay will be de-energised, thereby breaking the calling lamp circuit.

(c) A line multiple of jacks is engaged when " negative " is connected to the jack bushes. From the cord circuit diagram (Fig. 4) it will be seen that "negative" is connected to the barrels of the plugs, and thence to a jack bush when a plug is inserted. All jack bushes of a subscriber's circuit are in parallel, therefore all jacks in the multiple affected become " engaged." For the circuit when an operator " tests " a multiple see description of " operator's telephone circuit " (page 14).

(d) The depression of the meter key in the cord circuit

SUBSCRIBER'S LINE CIRCUIT (Complete).

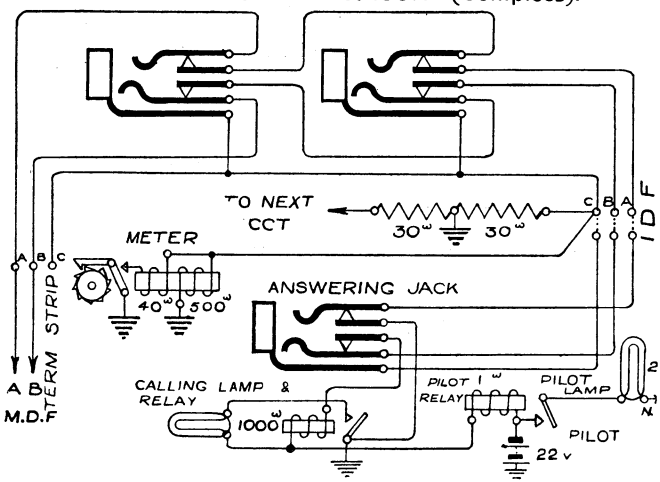

Fig. 2.

impresses a higher voltage (30-volts) on the plug sleeve, thence to jack bush, as described in subscriber's cord circuit (Fig. 4). The increased current, thereby available for the 500-ohm winding of the meter, is sufficient to pull up the subscriber's meter armature, thereby recording a call thereon and making the contact *K*. This contact brings into circuit the 40-ohm winding of the meter. This winding being of low resistance, enough current will now pass to actuate the position effective meter.

Fig. 2 shows the complete arrangement of a subscriber's line circuit, and little further description is necessary. Two

multiple jacks are shown, but more would, of course, be used as needed. The pilot lamp is generally common to a panel of calling equipment. Its function is to bring into circuit the pilot lamp and night bell, and it is further described under " Line Pilot Lamps and Night Alarm."

By means of the I.D.F. a multiple may be jumpered to any answering equipment as the traffic demands. Two 30-ohm " sleeve " resistances are wound on one spool for space economy. These 30-ohm resistances and also the meters are cabled to the multiple side of the I.D.F.

CORD CIRCUIT (Transmission).

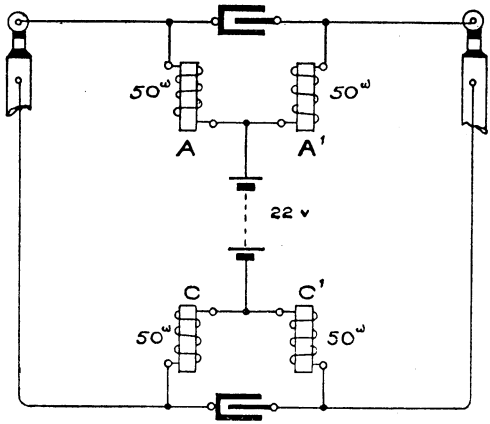

Fig. 3.

Subscribers' Operator's Cord Circuit.—In this type of cord circuit the **Stone System** is used. Fig. 3 shows the apparatus in the " talking " circuit. The relays *A* and A^1 are the supervisory relays and are also used in conjunction with the balancing retardation coils *C* and C^1, as the means of feeding current to line for speaking purposes. The condensers separate the answering and calling plugs, thus allowing separate supervision for each subscriber. Whilst, however, separating the two plugs so far as the steady supervisory current is concerned, these condensers allow effective passage to the varying electrical impulses due to speech.

Fig. 4 shows the complete cord circuit. This circuit is arranged to cater for the following requirements :—

(a) Feed current to lines for speech.

(b) Provide supervisory (clearing) signals for called and calling subscriber separately.

(c) Engage multiple jacks of lines connected and cut out calling signal.

(d) Facility for operator to meter calls as requisite.

(e) Provide for ringing on calling plug.

(f) Give operator " listening in " facilities on both plugs simultaneously.

The circuit action fulfils these requirements in the following manner :—

(a) This is described on page 5 (Fig. 3).

CORD CIRCUIT (Complete).

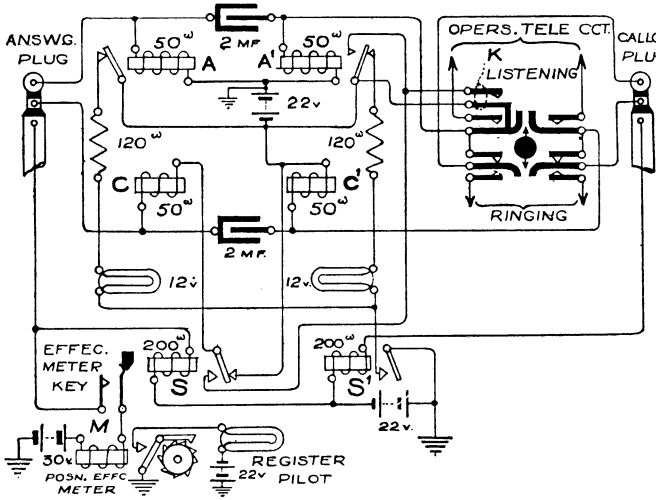

Fig. 4.

(b) In a connection between two subscribers the answering plug will be in an answering jack, and the calling plug in a multiple jack. The sleeve relays *S* and S^1 (Fig. 4) will be energised, *viz.*, negative of battery, relay *S* or S^1 winding, plug sleeve, jack bush, 30-ohm resistance, earth (Fig. 1). Considering the answering plug, it will be seen that the 12-volt supervisory lamp circuit is completed when relay *A* is de-energised, *viz.*, 22-volt negative, *A* relay contacts, 120-ohm resistance, 12-volt supervisory lamp, contacts of S^1 relay (energised), earth. If, however, the subscriber is at his telephone (receiver lifted) a circuit is completed thereby for relay *A*, *viz.*, earth, *A relay winding*, plug tip, "A" line, subscriber's telephone, " B " line, ring of plug, retardation coil *C*, tongue to inner of *S* relay (energised) and thence to negative of battery. *A* relay being energised,

its contacts break, disconnecting the supervisory lamp. The circuit for the calling supervisory relay is similar, but *viâ* the speaking and ringing key. The respective supervisory lamps are, therefore, controlled by the connected subscribers' telephones and will glow when either subscriber " hangs up." It is probably unnecessary to state that with the receiver on the hook the subscriber's instrument presents a circuit of a condenser *plus* 1,000-ohm bell, being equivalent to a disconnection to the 22-volt steady current. At this stage it is necessary to point out that the circuit *viâ* the back contact of relay *S* is not needed for direct subscriber to subscriber connections. Its use is for junction working, and is described later. It will be seen that both supervisory lamp circuits are dependent upon the contacts of S^1 being made. Where required, however, an additional relay is added, which provides for the answering cord lamp circuit being controlled independently of the calling plug.

The function of the 120-ohm coils is to reduce the 22-volts to approximately 12-volts, to suit the 12-volt supervisory lamps.

(c) The engagement of a line is effected by connecting the negative of the battery to the jack bushes, *viâ* the plug sleeves, *S* or S^1 windings, to the negative of the 22-volts. The circuit arrangement for the operator " tapping " for an engaged signal is dealt with in the description of the operator's telephone circuit. With reference to the " cutting out " of the subscriber's calling lamp, this is effected by the breaking of the line jack contacts by the answering plug, as described under (b) " Subscriber's line circuit."

(d) *Metering.* The meter key is shown in Fig. 4 associated with the answering plug. It is necessary to record a call on the meter of the party originating the call. It will readily be seen from the diagram that the action of depressing the meter key will impress 30-volts on the plug sleeve, thence to the jack bush to which the meter is connected (in parallel with the 30-ohm resistance spool, Fig. 2).

The application of this extra high voltage will actuate the originating subscriber's line meter. The precise action of this meter is described under " Subscriber's line circuit."

The preceding description refers to the effect of the meter key on the subscriber's line meters which are associated with individual subscribers' line equipments. In addition, there are two meters common to each operator's position; the function of one, known as the position effective meter, is to record all effective calls handled at the position. This meter is shown marked *M* in Fig. 4. It is of low resistance, ·25-ohm, and is in circuit with the subscriber's line meter when the meter key is depressed. It is arranged to operate

only when the line meter armature is pulled up, whereby the 40-ohm winding is placed in parallel with the 500-ohm winding. The glowing of the pilot lamp thus denotes that the line meter has properly actuated. The second meter is known as the operator's ineffective meter. Its function is to allow the operator to register ineffective calls if required. It is, of course, necessary that the actuation of this meter should not record the subscriber's line meter, and it is, therefore, quite a distinct circuit with a separate meter

OPERATOR S INEFFECTIVE METER.

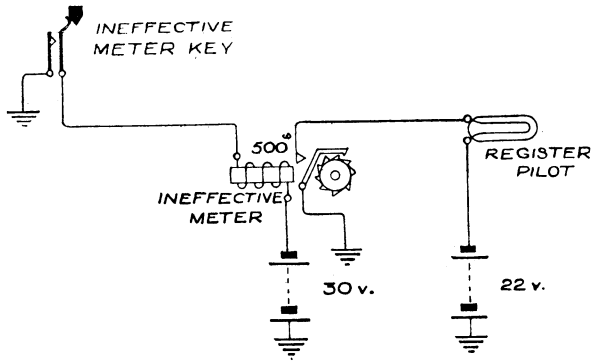

Fig. 5.

key common to the position. Its provision is required in order to enable the operator's load to be satisfactorily checked. The circuit is shown in Fig. 5.

(e) A glance at Fig. 4 will show that in the forward or spring position of the keys, ringing generator is connected to the calling plug.

(f) In the back or lock position of the keys the operator's telephone is in " bridge " with both plugs. The key normally is in the " through " or talking position.

Extra contacts *K* (Fig. 4) are shown on the keys, and are closed when the operator " listens in." The utility of this is mainly for the junction requirements already referred to on page 7. It will be seen that the contacts control battery over the " A " line of the junction. The listening in of the operator has, therefore, the same effect as the energising of relay A^1, so far as through clearing *viâ* the junction to the originating exchange is concerned.

JUNCTION CIRCUITS.

Incoming Jack Ended Junction (Short C.B.).—For this type of junction, an answering equipment similar to that for ordinary

subscribers is used in combination with additional relay equipment. The arrangement is shown in Fig. 6. Generally, C.B. junction calling and clearing circuits are designed on the following principles :—

Calling signals are actuated by an incoming current on the *B* line. Current is returned by the answering exchange on the *A* line to " darken " the supervisory signal at the distant exchange, and conversely the cessation of this current will " light " the supervisory lamp at the distant exchange. The cord circuit at the calling exchange will be similar in principle

INCOMING SHORT C.B. JUNCTION. JACK ENDED.

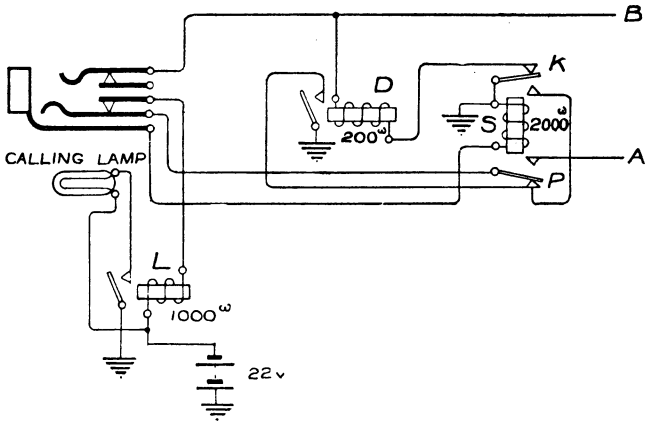

Fig. 6.

to that described for a No. 12 Exchange. The insertion of a plug into an outgoing junction jack at the calling exchange will connect negative to the *B* line. The effect at the called exchange will be to energise relay *D via B* line, *D relay winding*, outer and tongue *K* of relay *S*, to earth. *D* relay contact closes, energising calling relay *L via* negative, *winding of L relay*, inner and long spring of jack, tongue *P* and outer of relay *S*, contacts of relay *D* (energised), to earth. *L* relay contacts close and the calling lamp glows. When the operator answers, it is necessary to disconnect the calling lamp and connect the answering plug direct to *A* and *B* lines free of junction relay equipment. As described for the cord circuit (Fig. 4), negative is connected to the answering plug sleeve. Relay *S* will now be energised *via* plug sleeve, jack bush, *S relay winding*, earth. Relay *S* contacts close, its tongue *P* connecting *A* to the long spring of jack, and tongue *K* disconnecting *D relay winding* from earth. The calling relay *L* is de-energised as the long

spring of the jack breaks with its inner when the plug is inserted. The calling lamp circuit is broken on *L* relay armature falling back. Considering the supervisory or clearing signal action, it will suffice to assume that the cord circuit at the distant end is similar to Fig. 4, a calling plug being, of course, in the outgoing jack. It will be noticed that the *A* and *B* lines are reversed on the incoming jack. The circuit will be roughly represented by Fig. 7. The relays *A* and A^1 are energised by the current *viâ* the respective retardation coils C^1 and *C*. The clearing lamp circuits are dependent on the back contacts of relays *A* and A^1 (as described for Fig. 4). The withdrawal of a plug at either exchange will, therefore, bring in the clearing lamp at the other exchange.

CONDITION FOR JUNCTION CALL.

N° 12 EXCHANGE

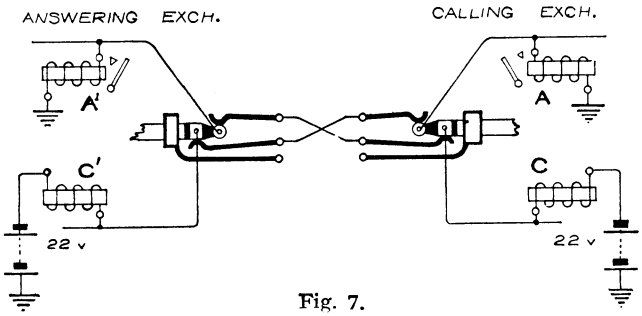

Fig. 7.

Through Clearing on Junction Connections.—When an incoming junction is extended to a subscriber it is an advantage if the called subscriber can, on " hanging up," give a clearing signal direct to the originating exchange operator. In the subscribers' operator's cord circuits (Fig. 4), a back contact on relay *S* is shown. In the description (para. (b), page 6) of this cord circuit, this is referred to as being used in connection with junction working. The circuit action involving its use is as follows :—Comparing the circuit to earth from the jack bush of a subscriber (Fig. 1) with that of an incoming junction (Fig. 6), it will be noticed that the former is 30-ohms and the latter 2,000-ohms. The relay *S* (Fig. 4) will not actuate through 2,000-ohms. For an incoming junction call the cord circuit answering plug at the called exchange will be in the jack of an incoming junction, and the calling plug in, say, a subscriber's jack. During the call relay A^1 will be actuated (through the called subscriber's telephone), putting out not only its own supervisory lamp, but that associated with the cord circuit at the calling exchange, *viz.*, negative, tongue and inner relay A^1,

back contact and tongue relay *S* (not energised), retardation coil *C*, plug ring, *A* line of junction (see Fig. 6) and supervisory relay of calling exchange cord circuit, to earth. Relay A^1, therefore, controls the supervisory lamp at the calling exchange, which will glow on the called subscriber " hanging up." Actually, the sequence from the operator's point of view is as follows :—

Called subscriber " hangs up," calling cord lamps glow at both exchanges.

Calling subscriber " hangs up," answering cord lamp glows at calling exchange.

Originating exchange operator, seeing both her cord lamps glowing, takes down connection, thus clearing to the answering cord lamp at the incoming exchange.

BOTHWAY C.B. JUNCTION (Explanatory).

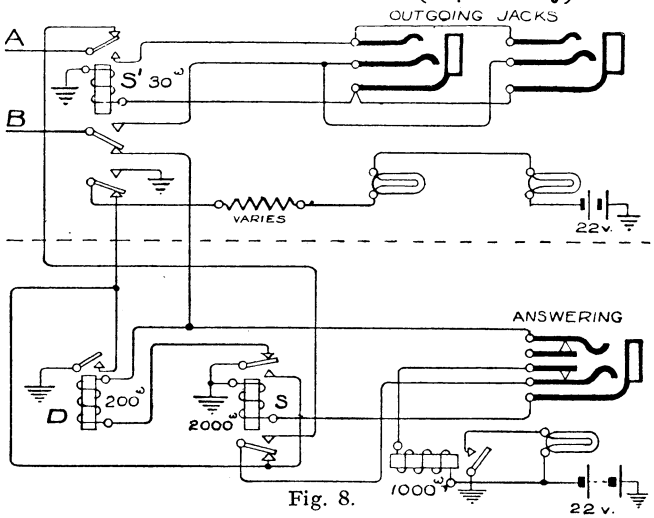

Fig. 8.

The incoming operator now receiving clear on both lamps, takes down connection.

The extra contacts *K* on the key of the subscriber's cord circuit (Fig. 4) are made when the listening key is actuated. As these contacts control battery over the *A* line of the junction similarly to the A^1 relay, the supervisory lamp at the distant calling exchange is " darkened " when the key is actuated. If the junction were extended to another exchange over an outgoing junction, the terminal exchange subscriber could similarly clear through to the exchange originating the call, assuming, of course, that similar equipment were provided.

Bothway Junction, C.B.—Fig. 8 shows the theoretical circuit.

Being a combination of outgoing and incoming junction equipments, little further description is necessary. The insertion of a plug into an outgoing jack will actuate relay S^1 from the cord circuit sleeve negative, thereby connecting the outgoing junction jack direct to the line and lighting the engaged lamps. For an incoming call, the outgoing multiple engaged lamps are lighted on relay *D* actuating. As the sleeve relay S^1, however, when energised, breaks the circuit of relay *D*, it is necessary again to cater for the circuit of these lamps and, therefore, the upper tongue of relay S^1 (energised) is arranged to complete the engaged lamp circuit. Fig. 9 shows a wiring arrangement for bothway C.B. junctions. Subscribers' line equipment is used *minus* the earth on the inner short jack spring. The

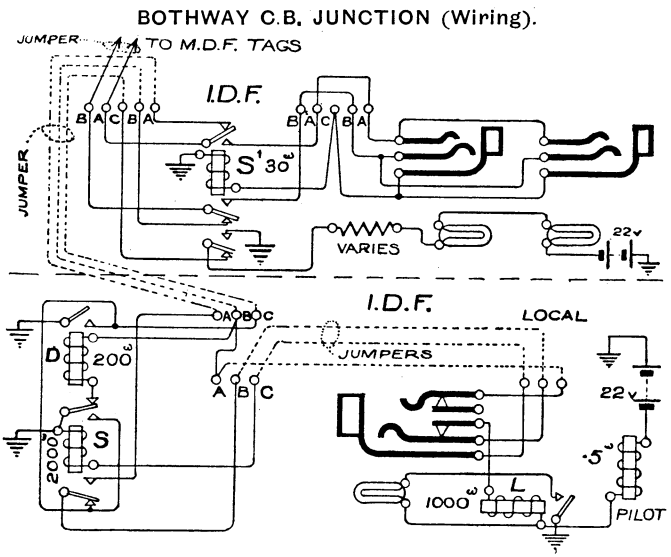

Fig. 9.

various equipments are terminated on I.D.F. tags, so that various circuit combinations may be made up by jumpering suitably, such as outgoing junctions, incoming C.B. junctions, C.B.S. junctions. For the last, other relay equipment would be used.

Outgoing Junction, C.B.—Fig. 8 shows an outgoing junction circuit, the portion above the dotted line in the diagram only being used in this case. The working of the circuit has already been practically covered in the description of the incoming jack ended C.B. junction. If the junction were outgoing to a

C.B.S. exchange, the conditions at that exchange would be similar to an incoming C.B. junction. The wiring arrangement is shown in Fig. 9, the portion above the dotted line again referring. The engaged lamps are controlled by the relay S^1, which also is used to provide the necessary path to earth for the cord circuit sleeve relays.

Incoming Junction from C.B.S. Exchange.—Fig. 10 shows a circuit for an incoming junction from a C.B.S. exchange. The cord circuit at the C.B.S. exchange would be of the balanced battery type, 22-volts negative being connected to both tip and ring of the plug *viâ* the centre point and windings of an eyeball supervisory signal. On insertion of the calling plug at the

INCOMING JUNCTION FROM C.B.S. EXCHANGE.

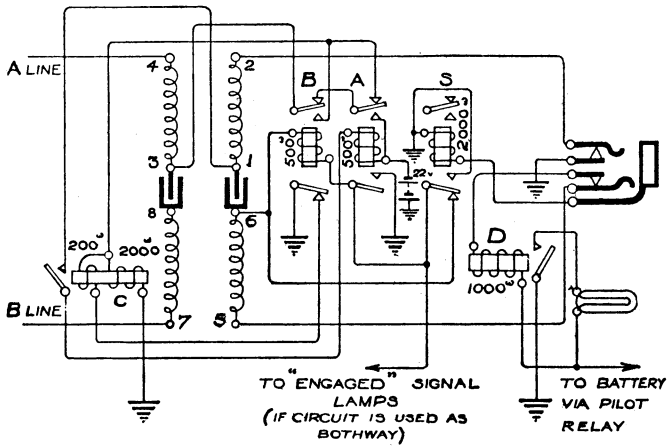

Fig. 10.

C.B.S. exchange, relay *C* will be energised by the incoming current on both the lines. Relay *A* will operate *viâ* the contacts of *C* (energised), repeater winding, thence to earth at the answering jack. The engaged lamps for the outgoing multiple are lighted *viâ* the bottom tongue of relay *A*. Relay *D* is also energised, *viz.*, negative, relay *D winding*, jack long spring and inner repeater winding, outer and tongue relay *S*, bottom tongue and inner of relay *A*, to earth. The calling lamp now glows. At this stage negative is connected direct to "A" line, *viz.*, negative, inner and top tongue relay *A* (energised), outer and top tongue relay *B* (not energised), repeater winding, "*A*" *line*. The "B" line is to earth *viâ* 200-ohm winding relay *C*, bottom tongue of relay *B* (not energised). The supervisory signal at the C.B.S. exchange will be operated owing to the unbalanced lines. On the operator at the No. 12 exchange plugging in to

answer, relay *S* will be energised *viâ* the plug sleeve negative and the circuit for relay *D* (controlling the calling lamp) will be broken at the jack springs. Relay *B* will be energised from the cord circuit ring negative, as the short-circuit across its winding is removed on relay *S* energising. All relays except *D* will now be energised, relay *A* being maintained operated *viâ* the cord circuit to earth. The "A" and "B" lines being balanced to earth *viâ* the 2,000-ohm winding of relay *C*, the eyeball at the C.B.S. exchange will not be operated. On the called subscriber hanging up, relay *B* will be de-energised (in accordance with the through clear principle), thereby unbalancing the lines to the C.B.S. exchange. That exchange will disconnect and release relay *C*. As the latter relay contacts control the circuit from the negative *viâ* relay *A winding* to the plug tip, the No. 12 cord circuit supervisory lamp will light. The outgoing junction circuit to a C.B.S. exchange is the same as for an outgoing junction to a C.B. exchange, the apparatus at the C.B.S. end giving C.B. conditions.

OPERATOR'S TELEPHONE CIRCUIT.

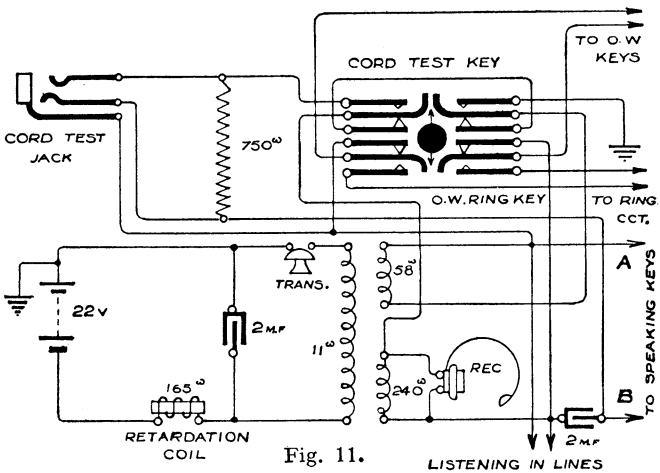

Fig. 11.

OPERATOR'S TELEPHONE CIRCUIT.

Fig. 11 shows the operator's telephone circuit. In the primary circuit a retardation coil (165-ohms) and a 2 m.f. condenser are wired as shown. The retardation coil reduces the current suitably for the transmitter. The impedence of the retardation coil prevents high frequency variations of current from traversing its winding. Over-hearing from or to other circuits *viâ* the battery bus bars is, therefore, eliminated. The presence of the

retardation coil would militate against the efficiency of the primary circuit but for the condenser. This condenser completes, with the transmitter and primary winding, a local circuit for the high frequency speech currents to which the condenser offers an easy path. The combination of the condenser and retardation coil, therefore, is to give, in some measure, the effect of a separate battery for each operator's transmitter.

The induction coil, in addition to its primary winding, has two other windings of 58-ohms and 240-ohms respectively. The latter is connected across the receiver and the arrangement tends to reduce side tone. The term "side tone" is used to express the effect in the receiver, of the operator's own voice, and noises in the room affecting the transmitter. Confusion and reduced clearness of hearing would result. Fig. 12 (A) shows the arrangement. The currents induced from the primary are shown by heavy arrows for the 58-ohm winding and by dotted arrows for

SIDE TONE ARRANGEMENT.

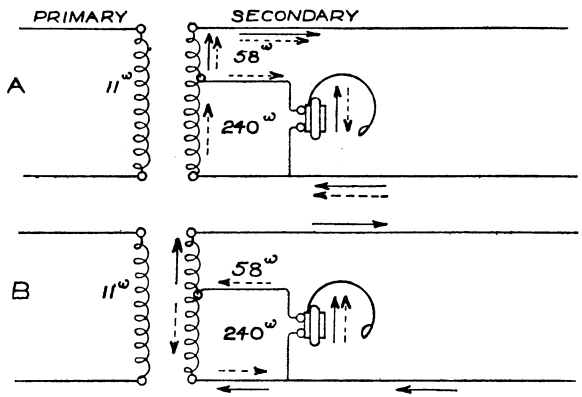

Fig. 12.

the 240-ohm winding. The current in the latter winding divides and a portion passes *viâ* the receiver coils in the opposite direction to the current due to the 58-ohm winding. The effect of this is to reduce the current variations, due to the transmitter, so far as the receiver is concerned.

The whole of received current traverses the 58-ohm winding, but only a small portion passes *viâ* the 240-ohm winding, as this is bridged by the receiver. In the 240-ohm coil, however, the winding is such that current is induced from the 58-ohm winding in an opposite direction to the inducing current. The currents due to the two sources, therefore, assist each other in the receiver circuit itself, see Fig. 12 (B). The thick arrows represent

an incoming line current and the dotted arrows the induced currents in the 240-ohm winding.

The condenser in the secondary circuit prevents steady current passing from the cord circuits and thereby actuating the super-

CORD TEST CIRCUIT.

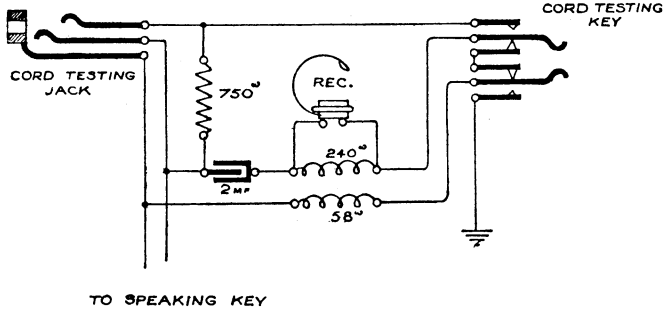

Fig. 13.

visory signals and, incidentally, the possibility of demagnetising the receiver magnets. A cord test key and order wire ringing key are shown (Fig. 11); the former, if actuated, produces suitable conditions for use with the cord test jack, see Fig. 13. The order wire ringing key, if actuated, disconnects the operator's secondary from the order wire commons and connects the latter to generator for ringing on any order wire as required. Listening-in leads are shown which are wired to the chief operator's desk.

TESTING FOR ENGAGED LINE,

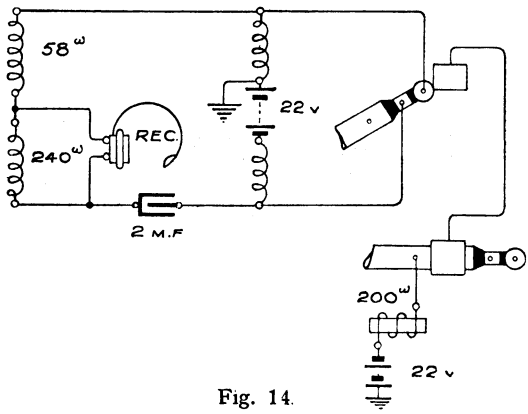

Fig. 14.

Fig. 14 gives the circuit involved when the operator is testing a line for engaged conditions. If the line be disengaged no plug will be in any of the subscribers' multiple jacks and all the bushes will be at zero potential. The tip of the calling plug is also at the same potential, being connected to the earthed side of the battery. There will, therefore, be no redistribution of potential when the tip touches a jack bush and, consequently, no transference of potential between the terminals of the operator's speaking set, and no sound will be heard in the receiver.

If, however, a plug be in any one of the switch springs the bush of the jack will be connected to the negative side of the battery *viâ* the sleeve of the plug, and will no longer be at zero potential. The result of touching any one of them with the tip of the plug will now be to cause a redistribution of potential which will extend to the operator's telephone and cause a click to be heard in the latter.

LINE PILOT LAMPS AND NIGHT ALARM.

Fig. 15 shows the circuit. For the subscriber's and incoming junction line signals, a pilot lamp is fitted per panel. Low resistance pilot relays are wired in the battery circuit of a group

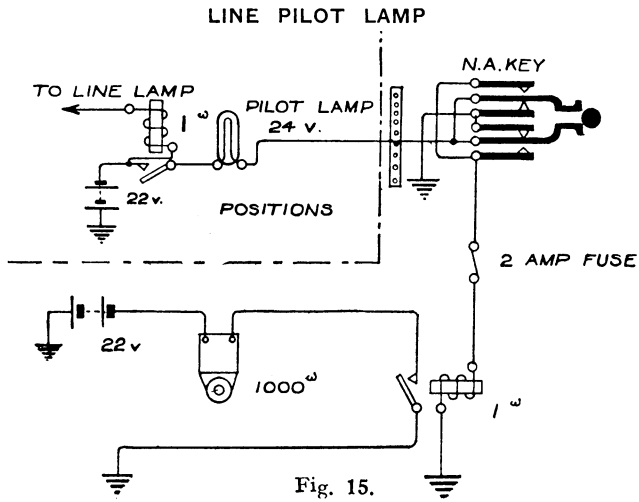

Fig. 15.

of calling equipments (see Fig. 2) and, of course, operate when current passes *viâ* their windings. Their contacts control the panel or position pilot lamps which obtain a circuit to earth direct or *viâ* the common night alarm relay, according to the position of the night alarm control key.

The key is usually fitted in the face of a cable turning section. Leads from the subscribers' and junction, etc., line pilot lamps are terminated on the tag strips shown. Reference to Fig. 2 where the pilot lamp is shown as continuing to N.A. will make the circuit clear. Negative *viâ* the position pilot lamp N.A. key (if in "on" position), and night alarm *relay winding* to earth will energise the latter, closing the circuit for the 1,000-ohm bell. Should the N.A. key be in the "off" position, the night alarm relay is substituted by an earth at the key.

RINGING DISTRIBUTION.

Fig. 16 shows the circuit arrangement. Lead covered leads are taken from the fuse panel, one from the ringing generator bus bar and one from the 22-volt negative bus bar. Two 1-pair

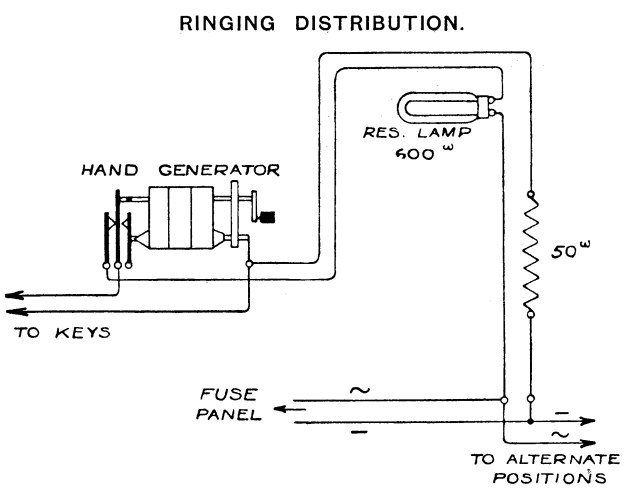

Fig. 16.

leads are used, each supplying alternative sections so as to minimise the trouble of a fuse blowing or similar failure and thereby cutting off the ringing from all positions at the same time. A 660-ohm resistance lamp fitted per position limits the ringing current to a safe value, and prevents a temporary short, say, on a subscriber's line, from robbing the other positions of current.

The hand generator is brought into use for night working when the ringing machine is not running.

FUSE ALARMS.

The fuse panel is fitted usually in the Apparatus Room. The battery is connected to the fuse panel bus bars, and battery is fed through alarm fuses to the various circuits; generally, fuses are provided as follows: one per cord circuit, one per operator's telephone, one per group of calling lamps and relays. When a fuse blows, the fuse alarm bell and the pilot lamps are brought into circuit by the fuse spring itself making contact with a bar which runs up the panel in the centre of the line of fuses between the negative bus bar and the individual lead terminals. Circuits such as "machine ringing," "ringing return," are catered for by means of relays fitted behind the

FUSE ALARM.

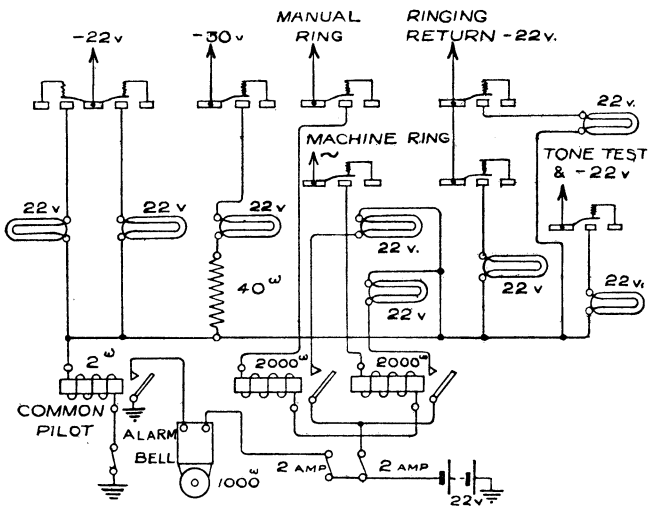

Fig. 17.

fuse panel. One arrangement is shown in Fig. 17. Should, say, the machine ringing fuse blow, the relevant 2,000-ohm relay operates *viâ* the ringer slip ring to earth. On the relay contacts closing, the pilot lamp circuit is completed *viâ* the pilot relay winding to earth. The 1,000-ohm alarm bell then rings. Similarly for the other special circuits. The 22-volt and 30-volt fuse strips need, of course, no relays other than the common pilot.

ORDER WIRES.

Outgoing order wires are used when the traffic justifies them. The keys for an order wire are teed together on the position tags as shown in Fig. 18. The inners for each section are wired to the position order wire ringing key (Fig. 11). Provision for receiving a generator ring when the incoming operator is not in circuit is made at the distant exchange.

This description of the No. 12 Exchange applies generally to the later exchanges. The subscribers' cord circuits in some of the earlier exchanges do not have the through clearing

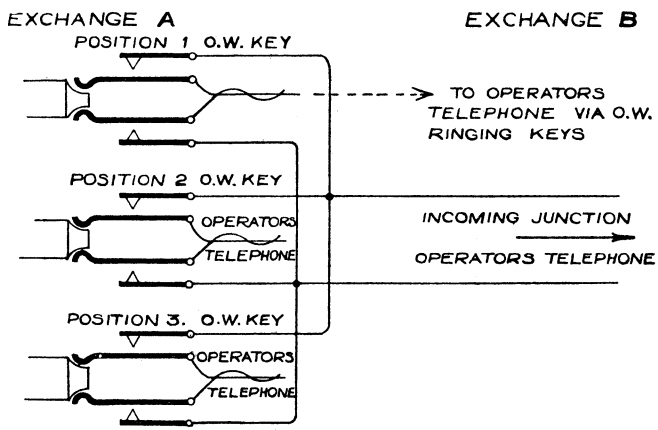

Fig. 18.

arrangement, this being fitted only for the incoming junction positions. Variations in wiring and circuit design and in the voltage of the battery occur at different exchanges, but the circuit principles are fundamentally similar to those described in this pamphlet.

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