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Post Office Engineering Department

TECHNICAL PAMPHLETS FOR WORKMEN

Subject:

Principles of Telephone Exchange Signals

ENGINEER-IN-CHIEF'S OFFICE
1919

(Reprinted July, 1925, incorporating amendments issued to date)
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6. C.B.S. No. 1 Exchanges—Non-Multiple Type.
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[*Continued on page iii of Cover.*

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PRINCIPLES OF TELEPHONE EXCHANGE SIGNALLING.

(D.3)

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G. 1. Maintenance of Secondary Cells.
G. 2. Power Plant for Telegraph and Telephone Purposes.

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PRINCIPLES OF TELEPHONE EXCHANGE SIGNALLING.

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PRINCIPLES OF TELEPHONE EXCHANGE SIGNALLING.

INTRODUCTORY NOTES.

The object of this pamphlet is to outline the general operating procedure of telephone exchanges, and, more particularly, to describe the working of the various signals used in calling the attention of the exchange and in controlling the circuit during the period of the conversation and after its completion.

It is assumed that the reader is more or less familiar with the theory of the electrical circuit and of electromagnets, is aware that a complete conducting circuit is necessary for the flow of an electric current, and knows that the passage of an electric current round the windings of an electromagnet will cause magnetic attraction of the piece of soft iron (known as the armature) placed near to the coils.

The types of signalling are divided into two classes, namely, magneto and battery, and the descriptions and relative diagrams have been arranged under these headings for convenience of reference.

The switching operations at all manual exchanges are put in hand upon the actuation of a calling signal, except in the case of junction circuits controlled by "order wires," over which the switching instructions are passed verbally from operator to operator.

The connexions are made by means of flexible conducting cords fitted with metal connecting plugs for insertion into the various "jacks" or springs to which the lines are joined. Associated with each pair of cords there is usually a switching key for connecting to the cord circuit as desired either the operator's telephone or the ringing-generator circuit. Also, as will be described, each cord circuit has associated with it some signalling device actuated by the subscriber to assist the operator in supervising and disconnecting.

On the receipt of a calling signal the operator inserts an answering plug into the jack of the calling line, and, by the operation of the key, puts her own telephone into circuit with the caller and ascertains his requirements. The other plug is then inserted into the jack connected with the required line, and, by a different manipulation of the key, a magneto ringing current is sent over the line.

The various types of exchanges and exchange apparatus as at present designed have been the outcome of a number of years of investigation and consideration of traffic requirements. They are described in detail in separate pamphlets in this series, and only an outline of the systems will be given here, sufficient to lead to general understanding of the methods of operating and of the signalling arrangements.

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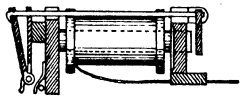
Although the general principles are more or less the same, the actual switching and signalling operations vary with the different types of switchboard. For convenience of explanation they may be divided into three systems :—

(1) Magneto (or Generator) Signalling.
(2) C.B.S. System.
(3) C.B. System.

(a) W.E.Co 2 Coil Indicator.



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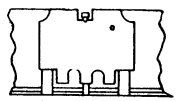
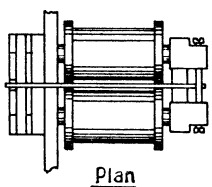
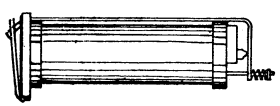


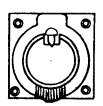
Front Elevation



Plan

(b) Ericsson Indicator





(c) Tubular or Ironclad Indicator

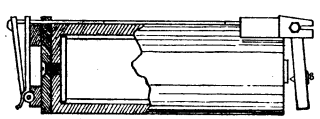


Fig. 1.

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(1) MAGNETO (OR GENERATOR) SIGNALLING SYSTEMS.

Although magneto switchboards are being gradually replaced by other types, as reconstruction or addition becomes necessary, large numbers are still in existence, and a clear understanding of this method of signalling is therefore essential.

The calling signal, or indicator, of any mechanically restored type, consists of a small electromagnet with an armature so arranged that, when energized by the signalling current, a small shutter, normally held in place by the armature or by an attachment to it, is allowed to fall forward and thus to give a visual signal that a connexion is desired.

These calling signals are actuated by alternating currents sent over the line by the turning of a small magneto generator which forms part of the telephone equipment at subscribers' offices.

Fig. 1 gives illustrations of these types of indicator in general use. Mechanical replacement of the shutter is necessary in each case. The shutters, in falling, depress small contact springs associated with a local alarm bell circuit so that an audible as well as a visible signal is given.

Fig. 2 gives a simplified diagram of (a) the Calling circuit and (b) the Cord circuit.

Associated with the pair of cords will be seen a clearing indicator, which requires for its actuation a " ring-off " current given by the subscriber turning his generator on hanging up his receiver at the end of a conversation. As the clearing signal is bridged or shunted across the circuit during conversation, it is specially designed with a high resistance (1,000Ω) and inductance in order that the speech currents may not be unduly affected. The calling signals are cut out of circuit by the movement of the jack springs when the plug is inserted, and are therefore usually of lower resistance (100Ω).

In a large exchange it is necessary to provide what is known as a *multiple* switchboard. On a switchboard of this type the jack connexions of every subscriber's line on the exchange are repeated or multipled at short intervals, so that each operator, although having only to attend to the calling signals of a limited number of lines, yet has within reach every subscriber's line on the exchange.

With such an arrangement it is essential that the operator should be provided with some means of ascertaining quickly whether the subscriber required is already engaged on another portion of the switchboard.

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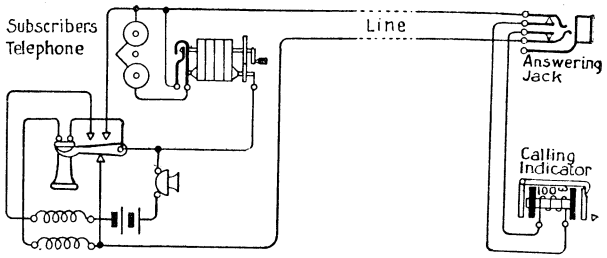
Fig. 3a gives the circuit arrangement of the multiple connexions for a magneto exchange, and Fig. 3b shows the corresponding arrangement of the cord circuit for providing the engaged test.

(a) Calling Circuit.



(b) Cord Circuit.

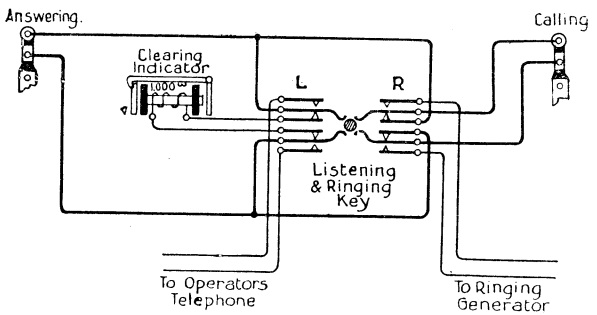


Fig. 2.

The third conductors of all the cords are connected to a special earthed battery. Thus, when a line is taken up (as shown on the first multiple), the earthed battery is connected through the sleeve of the plug to the bush of the jack, and so to the bushes of all the other jacks of that particular line on the

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exchange. A differential induction coil and differential receiver are provided in the operator's telephone circuit, and the centre point of the receiver coils is earth connected. If an operator sitting opposite, say, to the third multiple wishes to ascertain if this line is engaged she depresses one of her listening keys, picks

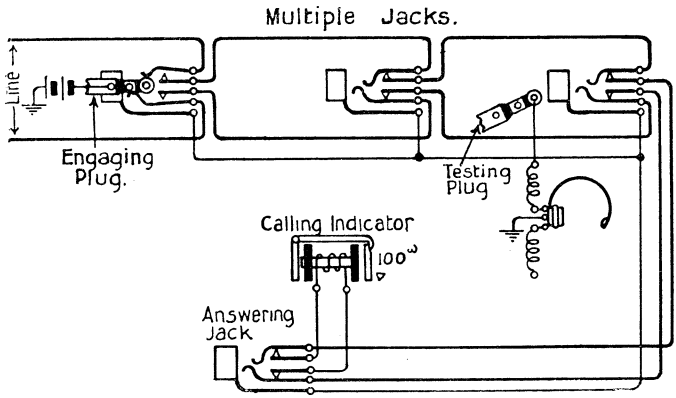

Fig. 3a.

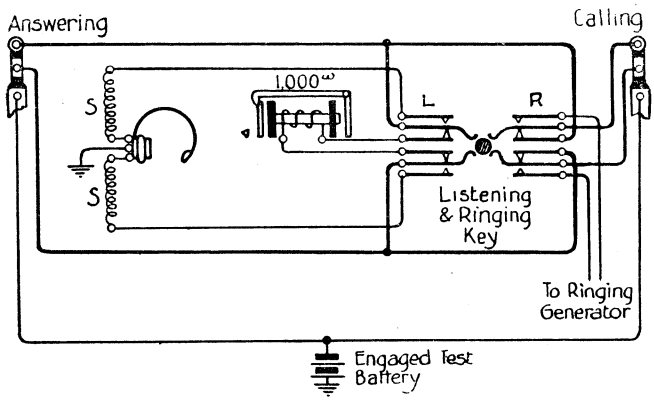

Fig. 3b

up one of the corresponding plugs and touches the bush of the jack with the tip of the plug. A current will then flow from the engaged test battery through one half of the induction coil and half of the receiver windings to earth, and a click will be produced in the receiver denoting that the line is engaged.

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Fig. 4 shows the line connexions when using 7-point break jacks in which the test circuit is slightly different, two-way plugs and cords being used. The test spring is not rigidly connected to the bush of the jack, but is movable and, on the insertion of the plug into the jack, is pressed away from the bush, and makes connexion instead with an outer contact, common to the strip of jacks and connected to the engaged test battery. This battery is thus connected by means of the other test springs to all the bushes of an engaged line.

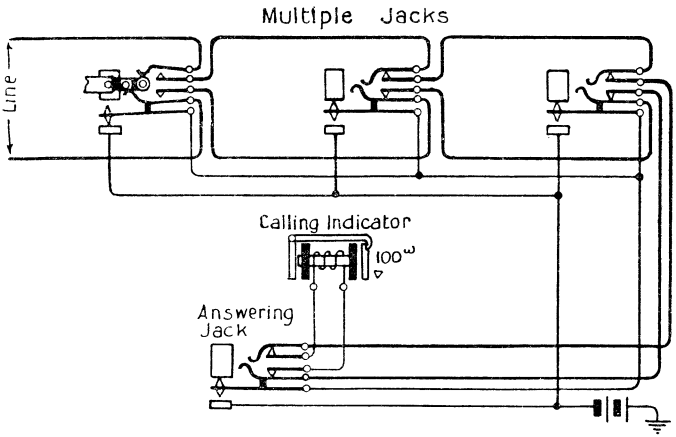

Fig. 4.

Magneto System, with Self-Restoring Indicators.—In this system the mechanically-restored indicator is replaced by one of special design, which is electrically restored on the insertion of the answering plug into the jack.

The construction of a self-restoring indicator is shown in Fig. 5. The long back coil is the line or signalling coil, and is usually 1,000Ω resistance. The short front coil is the restoring coil, usually of 40Ω resistance.

The passage of a signalling current energizes the line coil which pulls up the back armature. The lever attached to this armature lifts and releases the front armature, which, in falling slightly forward, lifts a light shutter and discloses the number of the calling line.

Upon the operator plugging into the circuit a restoring current is sent through the short coil. The front armature is strongly attracted, and is restored behind the lever catch, allowing the shutter to fall to its normal position. The restoring action is rendered more efficient by the special extension of the

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core of the restoring electromagnet into the recess cut in the front armature.

Self-restoring indicators may be fitted in connexion with 5-point break jacks, and this arrangement is shown in Fig. 6.

The bushes of all the jacks of a line are connected through the restoring coil to earth. On the insertion of a plug into a

Electrically Restored Indicator.

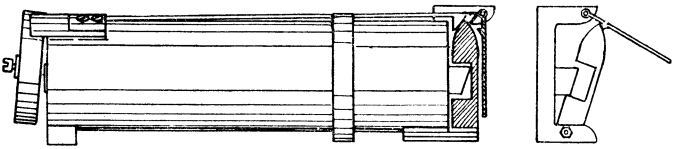

Fig. 5.

jack, a current will flow from the combined restoring and engaged test battery through the sleeve connexions and the restoring coil, to earth. The indicator will then be electrically restored to normal and, at the same time, the engaged test potential is placed on the bushes of the jacks of the engaged line.

Self-restoring Indicators,
Magneto Calling, with Break Jacks.
Multiple Jacks.

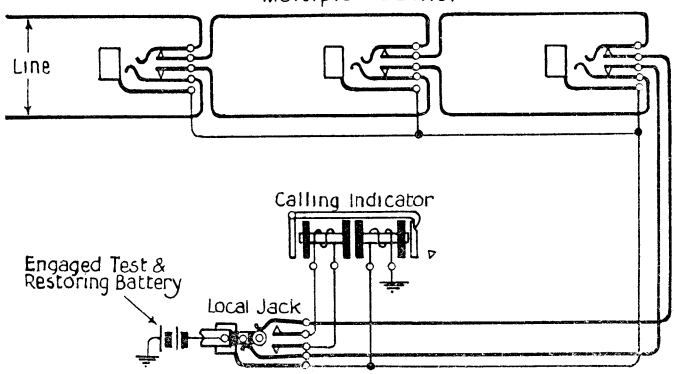

Fig. 6.

The clearing signals in the cord circuit are also of a similar self-restoring type, replacing the ordinary hand restored indicators. They are actuated by the "ring-off" current from the subscriber's circuit, the restoring current being given, by means of an extra spring and contact, on depression of the listening key.

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Self-restoring indicators are also used in connexion with special branching jacks as shown in Fig. 7.

One line of the circuit is connected to the short inside spring and the other line is connected to the barrel of the jack. The two other springs are used in connexion with the restoring and engaged test circuits, one spring being connected to the

Self-restoring Indicators,
Magneto-calling, with branching Jacks.

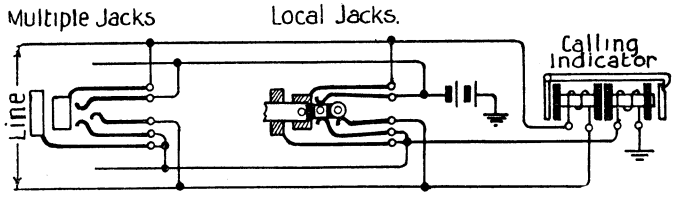

Fig. 7.

earthed battery and the other to the restoring coil of the line indicator. This latter spring is also connected to the short test bush which is in front of the barrel of the jack. This bush is of larger internal diameter than the diameter of the plug, so that it is not in contact with the plug when the latter is inserted in the jack, and it is used for the purpose of the engaged test only.

The plug used is provided with an insulated brass ring placed between the tip and the sleeve for the purpose of connecting the test and restoring springs when it is inserted in the jack, thus energizing the restoring coil of the indicator and

Self-restoring Indicators,
Magneto-calling, with branching Jacks.

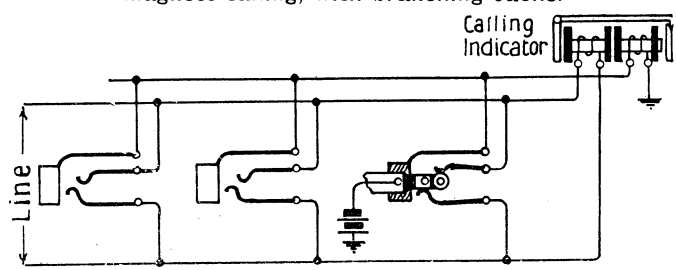

Fig. 8.

locking it during the call. It also places an engaged test potential on the outer bushes of all the jacks of the engaged line.

The cord circuit is similar to that used with the break jacks, a self-restoring clearing indicator being bridged across the lines

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and the restoring coil circuit being completed by means of an extra contact and spring provided in the listening key.

Fig. 8 shows the connexions for self-restoring indicators used with ordinary 3-way branching jacks with 3-way plugs and cords.

Magneto-calling and Clearing with Lamps.

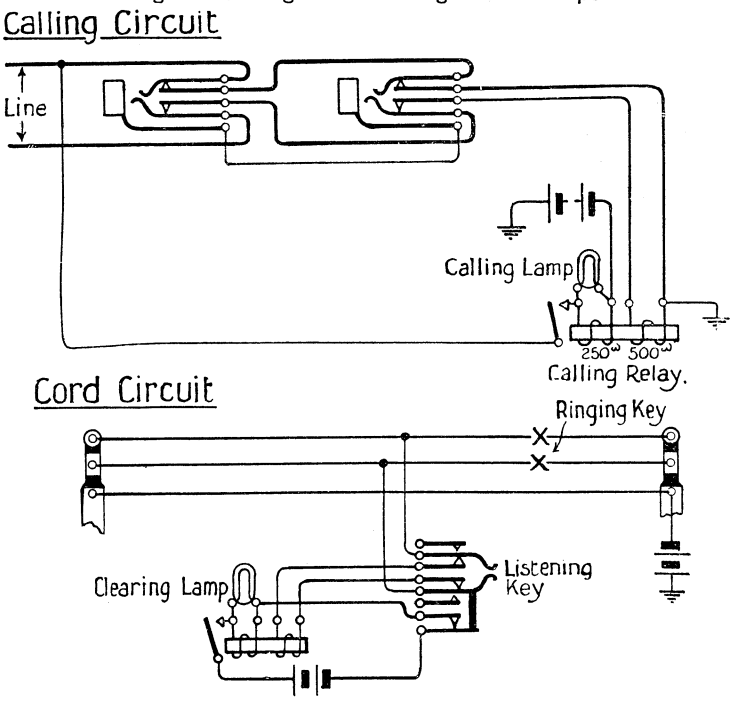

Fig. 9.

In this case the bush is used for the engaged test and to convey the current from the battery, connected to the sleeve of the plug, to the restoring coil of the indicator.

The advantage gained with a self-restoring indicator system lies chiefly in the greater space available for the multiple jacks, as the indicators can be placed above the multiples, it being unnecessary to have them within reach of the operator.

Magneto System, with Lamps instead of Indicators.—In some systems the self-restoring indicator is replaced by a relay and lamp, which remain actuated until the plug is inserted in the jack.

Fig. 9 shows one method of attaining this. The subscriber,

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on turning the handle of his generator, vibrates the calling relay. Directly the armature of the latter touches the inner contact a circuit is completed from the earthed battery through the relay and small 24-volt lamp, both in parallel, to earth *vid* one of the break springs of the jack. The relay is, therefore, retained and the lamp remains alight until the operator, by inserting a plug into the jack, breaks the circuit.

In the cord circuit the self-restoring indicator is replaced by a retaining coil relay. When either subscriber rings off, the ringing current flows through the back coil of the relay, so that the armature is pulled up and retained by the circuit completed for the signalling battery through the retaining coil of the relay and the clearing lamp. The lamp remains alight until the operator withdraws the plugs and restores the key to the normal position, thus breaking the circuit for the signalling battery.

There are very important advantages gained in using lamps instead of indicators for signalling purposes. The first is that the lamp can be readily arranged to take up no greater space than the jacks, and the calling lamps can therefore be directly associated with the home jacks. It is thus only necessary for the operator to plug into the jack against the corresponding glowing lamp signal instead of having to search for the particular jack belonging to an indicator. This facilitates working and therefore increases the number of lines an operator is able to work. A second advantage is the greater space available and the greater capacity of the switch sections.

Self-restoring Indicator.

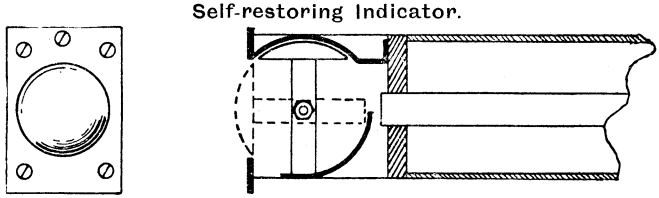

Fig. 10.

(2) C.B.S. SYSTEM.

In the C.B.S. No. 1 system, the lifting of the receiver from its rest completes the circuit at the switchhook for current to pass through the calling signal from a central battery installed in the exchange.

In the smaller switchboards of the wall pattern type the signals are usually indicators of the "doll's eye" or "eyeball" type. This type of indicator is energized and actuated by the signalling current, but is automatically self-restored by gravity on the cessation of the signalling current, which is effected when the operator plugs into the jacks.

Details of the signals referred to are shown in Fig. 10.

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Fig. 11 shows (a) the Calling circuit and (b) the Cord circuit for a small C.B.S. switchboard. Associated with each side of the cord circuit will be seen a self-restoring supervisory signal, which gives to the operator full information regarding

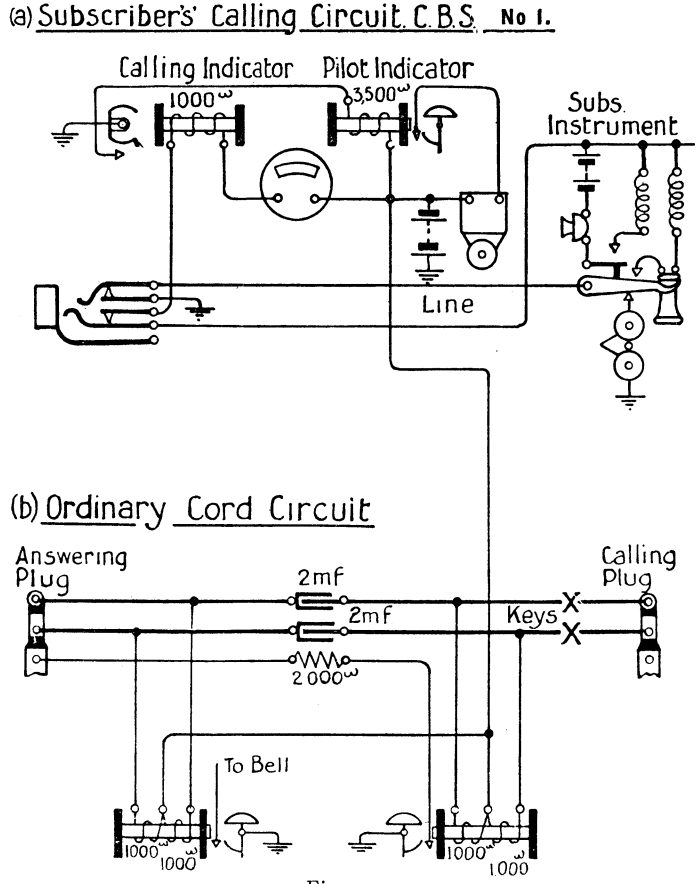

Fig. 11.

the progress of the call. Upon plugging into a subscriber's circuit when the receiver is on the hook, the supervisory signal is actuated by a current passing from the central battery, through one winding of the supervisory signal, to earth at the subscriber's instrument. As soon as the receiver is lifted by the

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called subscriber the earth is removed and the supervisory signal is de-energized, thus notifying the operator that the subscriber has answered.

Similarly, at the end of a conversation, when both subscribers hang up their receivers, positive clearing signals are

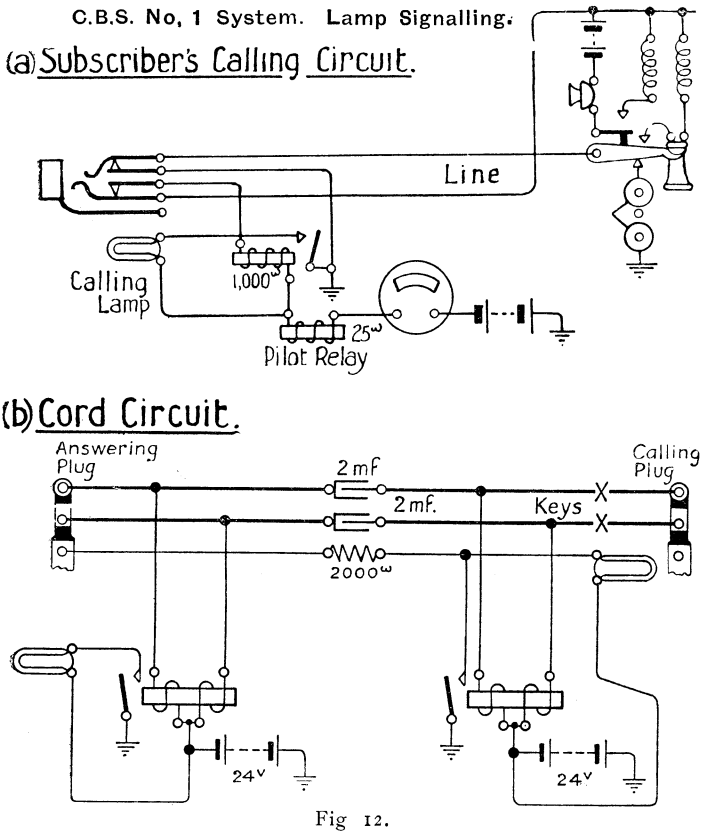

Fig 12.

given to the operator on each cord by the operation of the two respective supervisory indicators.

In the larger switch sections the signal consists of a small electric lamp, the local circuit for which is completed by the operation of a relay energized by the signalling current.

Similarly, the supervisory indicators in the cord circuit are replaced, in the larger switch sections, by supervisory relays which, when energized, connect the local circuits to supervisory lamps.

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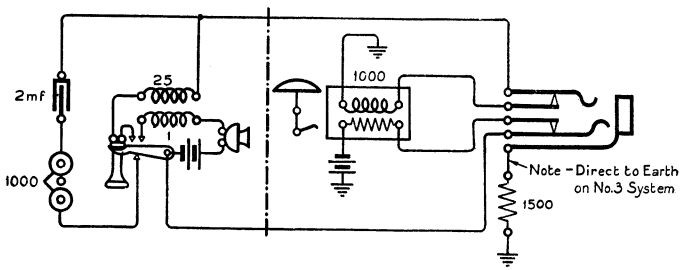
C.B.S. No. 2 and 3 System.

A new C.B.S. system has now been adopted as standard for small exchanges. The new system is operated on a "loop" call and "disconnexion" clear basis and is therefore in these respects similar to the C.B system which is described later in this pamphlet.

The C.B.S. No. 3 system is intended for small exchanges where junction traffic does not justify through signalling and the junction may be worked on a private branch exchange basis. Fig. 13 shows (a) the subscriber's calling circuit; (b) and (c) the cord circuits.

(a) Subscriber's Calling Circuit.



(b) Cord Circuit, C.B.S., No. 2.

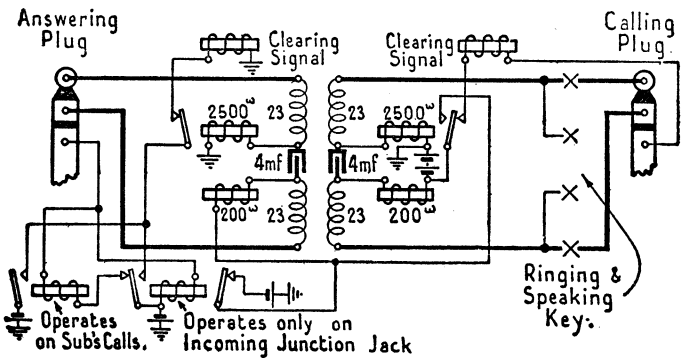


Fig. 13 (See also p. 17).

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(c) Cord Circuit, C.B.S., No. 3.

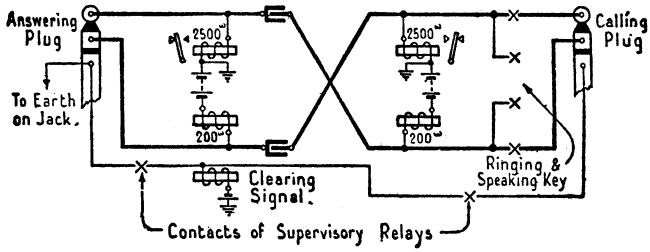
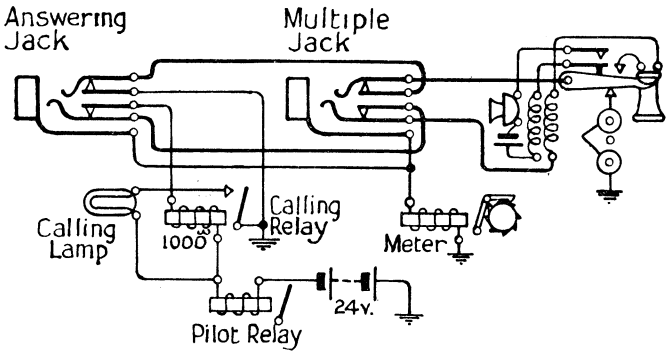


Fig. 13 (cont.).

(a) Subscriber's Calling Circuit



(b) Cord Circuit.

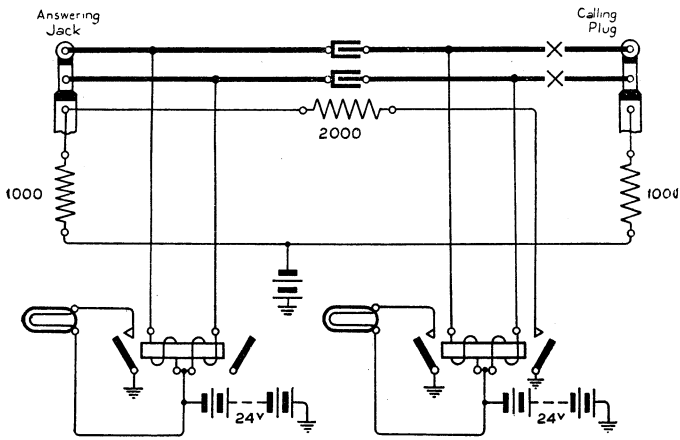


Fig. 14.
C.B.S. System. Multiple Exchanges.

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Fig. 12 gives a simplified diagram of the calling circuit and cord circuit of a lamp signalling C.B.S. Exchange.

Where more than two C.B.S. lamp signalling sections are fitted at an exchange it becomes necessary to multiple the lines. The circuit arrangements are shown in Fig. 14. The engaged test is provided by means of a buzzer and condenser in the sleeve circuit of the cords.

(3) C.B. SYSTEM.

In the C.B. system, which is used for large exchanges, the principle of the Central Battery Supply is further extended. Current is supplied by the main exchange battery to each subscriber's line for the purpose of speaking instead of having separate speaking batteries at each subscriber's telephone.

The signalling arrangements are very similar to those of the C.B.S. system. Lamp signals, on account of their many advantages, are now standard, although in some of the existing small type of switch sections, self-restoring indicators are in use.

Fig. 14a illustrates, in a simple form, a calling circuit on one type of C.B. exchange. The removal of the receiver from its rest completes the circuit at the switch-hook for a current from the central battery through the calling relay. This relay is energized and completes the circuit for a central battery current through the calling lamp and gives the signal to the operator.

Fig. 14b shows a cord circuit associated with this type of switch section. It will be seen that when the answering plug is inserted into the spring jack of the calling line, a path is completed for a current from the central battery *viâ* the sleeve circuit of the 3-way cord and the bush of the jack, through the cut-off relay to earth. This relay energizes and disconnects the calling relay, which immediately restores and disconnects the calling lamp.

When the operator plugs into the line required by the caller, a similar sleeve current will flow through the cut-off relay of the called line, and will therefore prevent the calling lamp of that line being lit when the called subscriber answers.

It will be seen that this sleeve current passes through a supervisory lamp, and this lamp will glow until, by the lifting of the receiver by the subscriber, a loop circuit is completed for a current from the central battery through the supervisory relay. The actuation of this relay places a shunt across the supervisory lamp and it no longer glows, thus indicating to the operator that the call has been responded to.

Similarly, when both receivers are replaced at the close of a conversation, both supervisory relays are de-energized by the breaking of the loop circuits at the respective switch-hooks, the shunts across the lamps are removed, and both lamps glow.

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This positive clearing signal, automatically given on each cord by the replacing of the receiver, is of very great advantage

C.B. System. 24 Volts.

(a) Line Connections

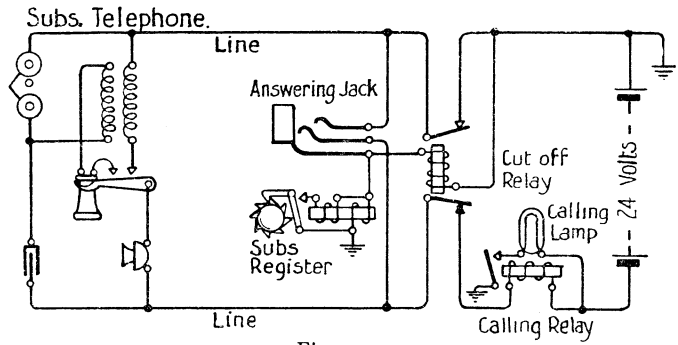

Fig. 14a.

(b) Cord Circuit

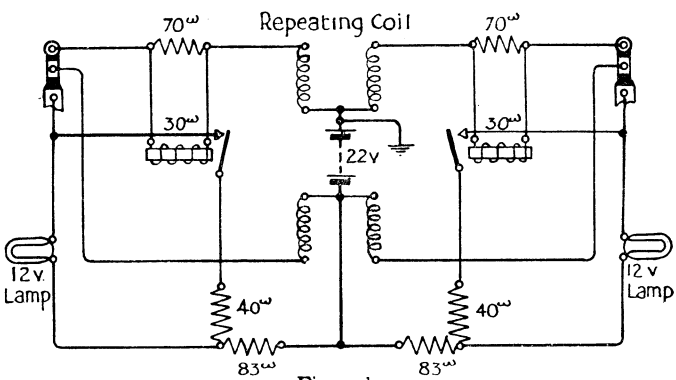

Fig. 14b.

in speeding up the disconnexion of the circuits and restoring them to normal conditions in readiness for further calls.

In the system just described, the current is fed to the lines through the windings of a repeating coil, and the speech transmission between the circuits is carried out inductively by this coil.

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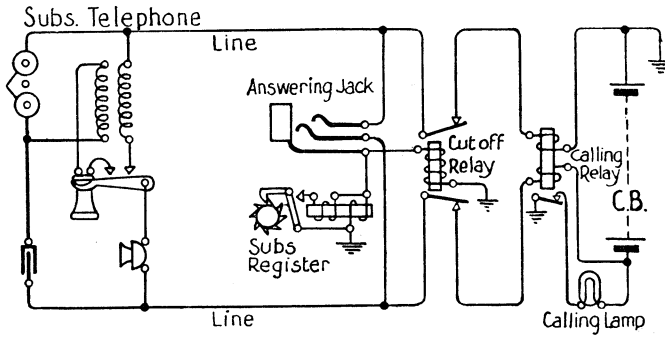
In another type of exchange, the current is fed to the lines through special impedance coils, and the speech transmission currents pass through condensers.

Fig. 15 shows, in simplified form, the circuit arrangements for an exchange of this type. The signalling arrangements are

C.B. System. 40 Volts.

(a) Line Connections



(b) Cord Connections.

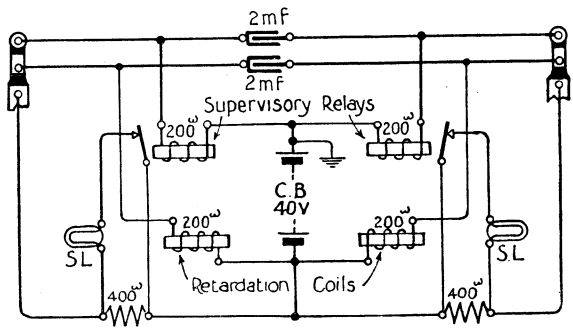


Fig. 15.

practically the same, in principle, as those previously described, except that, in the cord circuit shown, the actuation of the supervisory relay entirely disconnects the supervisory lamp instead of shunting it.

It should be noted that the maximum facilities obtainable

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on manual switchboards as regards speed of operating, supervision of signals, capacity of the multiple, testing facilities, keeping lines under observation, etc., are associated with C.B. systems.

Automatic Telephone systems, in which the Central Battery currents, instead of operating calling signals, are made to operate selective switches which connect the caller to the desired line, form the subject of P.W.-E.1.

JUNCTION AND TRUNK WORKING.

So far only local calls between subscribers connected to the same exchange have been considered.

It is now proposed to deal with the signalling arrangements and operating procedure for calls originated by a subscriber connected to one exchange for a subscriber connected to some other distant exchange. These calls are passed over "Junction" or "Trunk" circuits which link up the various exchanges of the country.

Small groups of lines are arranged to work in either direction. As the group increases in size, a point is reached when "both-way" working can advantageously be replaced by a system of working in one direction only, the lines being divided into two groups—"outgoing" and "incoming."

For instance, between two large exchanges, X and Y, there will be one set of lines "outgoing" at X and "incoming" at Y, and another set of lines "outgoing" at Y and "incoming" at X. The respective number of lines in each group will depend on the relative amount of traffic to be dealt with in each direction.

Again, in some cases, where there are large groups of lines between important exchanges, instead of employing the usual calling signals, the instructions for connecting to the various circuits are given over separate "order wires" which are connected to the telephone of an operator at the "incoming" end, who is continually listening during the busy hours. Under certain traffic conditions this is found to be a much quicker and more efficient method of working the circuits than by using them as "ringing" lines.

Junction Working.—"*Outgoing*" *junctions* are multipled on the same principle as subscribers' lines, so that any operator can connect direct to any one line. The outgoing junction multiples are usually provided at more frequent intervals than the subscribers' multiple and with a different spacing of jack (in strips of ten instead of twenty) in order to improve the speed and accuracy of working.

"*Incoming*" *junctions* are not multipled, but are assembled on special junction or "B" positions of the switchboard, and the "incoming" calls are dealt with by special "B" operators.

The apparatus connected to the incoming junctions is usually

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more or less complicated, whereas that at the outgoing end is comparatively simple, consisting, in the case of C.B. Exchanges, of a jack, the bush of which is connected *viâ* a resistance spool to earth for the engaged test.

The usual plan of working junctions is for the operator who receives the subscriber's call to have complete control, at the "outgoing" end of the junction, of the whole connexion. Her supervisory signal on the calling cord is controlled by the called subscriber at the distant end. At the termination of the conversation she receives a signal from him, and, in withdrawing the connecting plug from the outgoing junction jack, a clearing signal is automatically given to the "B" operator at the "incoming" end.

Junction circuits are of two distinct types—*jack ended* and *plug ended.* All signalling junctions, except at large exchanges or in exceptional cases, are now worked jack ended, whilst all order-wire junctions are plug ended, that is, terminated on a plug and cord instead of on a jack.

The principles obtaining on all types of junction circuits where attention is called by means of signalling are, in the main, and so far as the operating procedure is concerned, similar.

A uniform system of providing for junction signals has now been adopted and is applied generally with a few exceptions. The C.B. junction has been taken as the type, and suitable conversion apparatus is provided at the ends of the circuits terminated in Magneto, C.B.S. and Trunk exchanges for sending and receiving line signals similar to those of the C.B. junctions. A standard junction circuit in use, therefore, exhibits towards the outgoing end the same electrical conditions as the C.B. cord circuit, *viz.,* battery on the "B" line and earth on the "A" line. The battery on the "B" line provides for the automatic call, and its removal gives the automatic clear. The supervisory current controlled by the distant subscriber is sent over the "A" line and actuates the supervisory relay connected to earth at the outgoing end. A standard junction circuit may, therefore, be defined as a circuit in which the line conditions are those obtaining in C.B. practice, and in which the current for signalling to the telephonist at the incoming end passes over the "B" line and the current for signalling from the called subscriber to the telephonist at the outgoing end passes over the "A" line. Fig. 16 illustrates the method of signalling over the standard junction. *Upon the insertion of the plug of the calling cord* into the jack at the outgoing end, a current passes over the "B" line and actuates the relay (B1) at the incoming end, thus causing the junction calling lamp to glow. At the same time the supervisory lamp at the outgoing end glows, the current passing to earth *viâ* the bush of the junction jack and resistance R. *When the circuit is extended to the line of the subscriber wanted,* the third conductor relay S is actuated by

Diagram illustrating the principles of signalling on a standard junction.

(The speaking circuit is not shown).

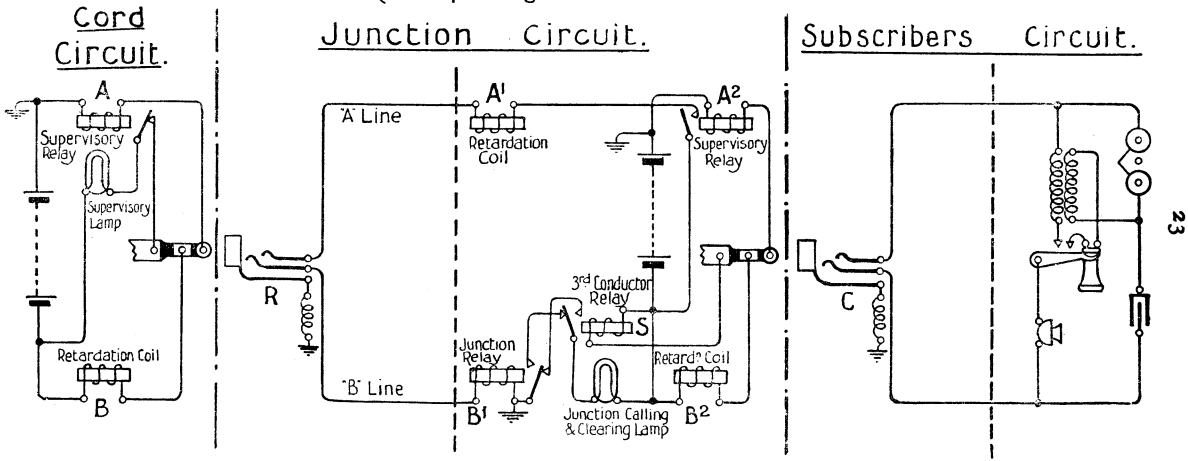

Fig. 16.

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the current passing through the bush of the subscriber's jack to earth *viâ* the "cut off" relay C. This extinguishes the junction lamp and re-arranges the connexions to this lamp so that it is in a position to receive the clearing signal. *When the subscriber answers,* the current from the exchange battery finds a path through retardation coil B2, "B" line of the subscriber's circuit, transmitter and induction coil, "A" line of the subscriber's circuit, and the supervisory relay A2. The operation of this relay connects the battery to the "A" line of the junction and a current flows over this line to earth through the supervisory relay A in the cord circuit at the outgoing end. Relay A breaks the circuit of the supervisory lamp, which ceases to glow and assures the operator that the distant subscriber has responded to the call. *When the conversation terminates* and the distant subscriber replaces the receiver on the hook, this process is reversed—current ceases to flow in the subscriber's line, relay A2 falls back, breaking the flow of current to the "A" line of the junction, and in turn de-energizing the supervisory relay A and causing the lamp to glow. Finally, the operator at the outgoing end, in withdrawing the plug from the junction jack, disconnects the battery from the "B" line and causes the junction relay B1 at the incoming end to fall back, thus lighting the junction lamp and giving the clearing signal. The withdrawal of the plug at the incoming end causes the release of relay S, extinguishing the junction lamp and restoring the conditions to normal in readiness for a succeeding call.

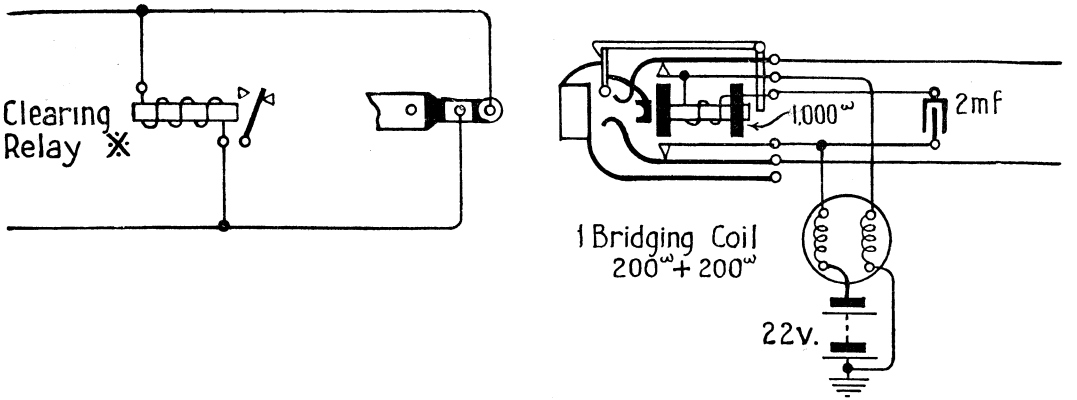
Trunk Working.—The Department's standard trunk exchange circuits prior to the transfer were all worked on a magneto call and a loop current automatic clear basis.

The principles of working can be readily followed by reference to Fig. 17. 22-volt batteries are normally connected to the trunk line through bridging coils, "like" poles being connected to the two ends of each conductor. The calling signal consists of a combined indicator and connecting jack. The generator signalling current causes the armature of the indicator to be attracted, a shutter is projected through a horizontal slit and gives a visual signal to the operator. Contact springs connected to the shutter also complete a local bell circuit for an audible alarm. When a plug is inserted into the jack the shutter is automatically restored to normal by mechanical pressure.

At large trunk exchanges lamp signalling is provided. The calling relay, when actuated by the generator calling current, brings into circuit a second relay with a retaining connexion which lights the calling lamp. The retaining circuit is broken at the switch spring when a plug is inserted in the line jack and the calling lamp circuit is thereupon broken.

On the withdrawal of a plug by either operator at the completion of a call, battery current is automatically sent round the loop to the distant end and will actuate the clearing signal associated with the cord circuit.

Trunk Termination.



※ This relay responds to the battery connected to the inner contacts of the jack at the distant end. A retaining device is also associated with the relay so that a magneto ring will cause a distinctive signal to be displayed until unlocked by operating the listening key.

Fig. 17

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An exception to this method of working occurs in the case of superposed trunk circuits, where automatic clearing by battery current is impossible owing to the repeating coils or transformers breaking the direct circuit. Clearing has, therefore, to be effected by a generator current sent over the line.

On the amalgamation of the trunk and local systems a number of trunk exchanges were closed, the trunks being transferred to work direct to the local exchange.

In many cases it was then found desirable, for traffic reasons, to operate the shorter trunks (up to about 60 miles in length) on a junction basis—that is, with circuits so arranged that the control of the whole connexion is in the hands of the "A" operator.

The operating of trunk lines entails a good deal of attention on the part of the operator, so that only a few lines are allotted to each operator during the busy hours of the day. Provision is made for certain of the trunk lines being concentrated during the slack periods on special sections of the switchboard, so that fewer operators are then needed.

When a separate trunk exchange exists in a town, a subscriber requiring a trunk call is connected by the local operator to one of several "trunk record lines" on which he is answered by an operator at a "trunk record table" in the trunk exchange. This operator writes out a ticket recording the town, exchange and number of the subscriber required and also that of the calling subscriber: the record line is then cleared.

The record ticket is passed to the section of the trunk switchboard to which connexion can be effected to the required town and is attended to in turn with other calls.

When the trunk line is free, the operator connects to it and instructs the distant operator to connect the desired number. The local exchange is also called and the junction operator instructed to connect the calling subscriber.

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2. Subscribers' Apparatus, C.B.S. Part I—C.B.S. No. 1 System.
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4. Private Branch Exchanges—Common Battery System.
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