

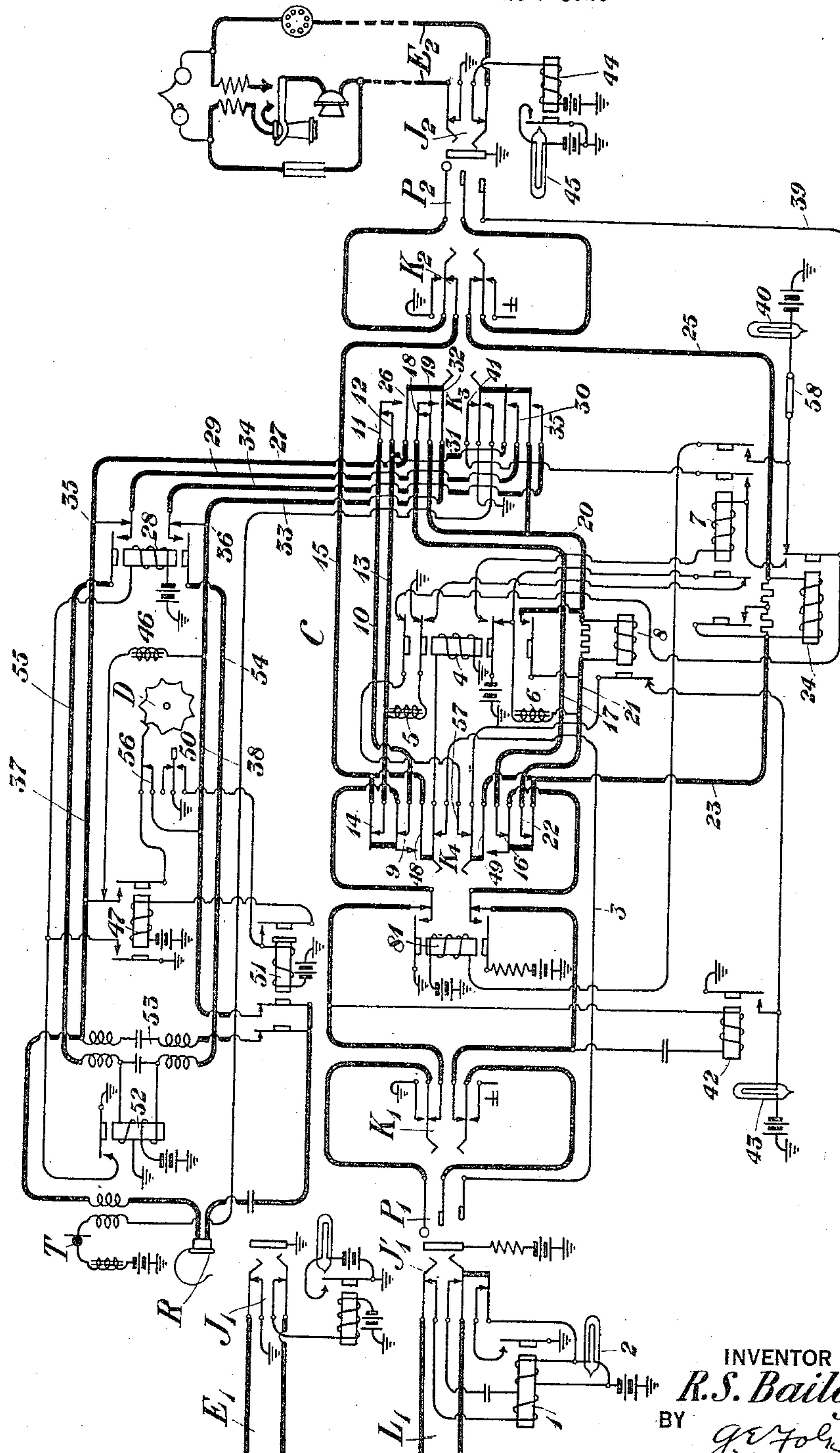
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PRIVATE BRANCH EXCHANGE CIRCUITS

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PRIVATE-BRANCH-EXCHANGE CIRCUITS.

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To all whom it may concern:

Be it known that I, RAND S. BAILEY, residing at Montclair, in the county of Essex and State of New Jersey, have invented certain Improvements in Private-Branch-Exchange Circuits, of which the following is a specification.

This invention relates to telephone systems, and more particularly to a link circuit arrangement for establishing connections between subscribers.

One of the objects of the invention is to provide a link circuit arrangement for establishing connections between the extension lines of a private branch exchange, and between such extension lines and trunks leading to the main central office.

Another object of the invention is to provide a link circuit of the character just described, which is adapted to the requirements of a private branch exchange associated with the main exchange in which connections are established by mechanical switches.

Another object of the invention is to provide a link circuit of the character just described, which is so arranged that in the establishment of connections between extension lines and trunk lines leading to the main exchange, through supervision will be provided after the connection to the trunk line is established so that the subscribers upon the extension line will have control of the supervisory apparatus at the main central exchange as well as the supervisory apparatus at the private branch exchange.

Another object of the invention is to provide a link circuit or cord circuit of the character above described in which, when a subscriber at the private branch exchange hangs up after being connected to a trunk line leading to the central office, the trunk line will automatically be free for an incoming call from the main office.

Another object of the invention is to provide a cord circuit of such character that under the conditions set forth in the preceding paragraph, the cord circuit will be opened to prevent a ringing signal incoming from the main office over the trunk line from ringing the bell of the subscriber at the private branch exchange in case the connection has not been taken down.

Another object of the invention is to provide means whereby under the circumstances

just described, the subscriber on an extension line of the private branch exchange may recall the operator at the private branch exchange in order to establish another call, or may initiate a new call at the distant central office without the aid or intervention of the private branch exchange operator.

Another object of the invention is to provide means whereby, under the conditions previously described, a recall may be made over the trunk line from the main central office.

Another object of the invention is to provide means in connection with the cord circuit for tripping machine ringing, when the cord is plugged into the jack leading to a trunk line from the main central office.

Another object of the invention is to provide means whereby, when a connection is to be established from an extension line at the private branch exchange over the trunk line to the main automatic exchange, the dialing operation for setting the switches at the main exchange may be performed either by the private branch exchange operator or by the subscriber on the extension line.

Still another object of the invention is to provide means whereby, when the operator's set has been connected to the cord circuit during the dialing operation, the subscribers may carry on a conversation through the operator's set after the connection has been completed in case the operator should for any reason, fail to disconnect her set.

A further object of the invention is to provide means whereby the cord circuit may be used during periods when no operator is in attendance at the private branch exchange for patching a connection from the trunk line leading to the main exchange directly to an extension line of the private branch exchange so that an attendant at the station associated with the extension line may answer incoming calls from the main exchange.

These objects, as well as other objects of the invention, may be attained by means of the apparatus set forth in the following description and illustrated in the accompanying drawing, the figure of which illustrates a circuit diagram of one embodiment of the invention.

Referring to the drawing, a cord circuit C for establishing connections at a private branch exchange is shown terminating in plugs P₁ and P₂. The plug P₁ is adapted

to co-operate with the jack J_1' of a trunk line L_1 leading to the main central office, or with jacks such as J_1 of extension lines such as E_1 leading to individual stations of the private branch exchange. The plug P_2 is also adapted to co-operate with jacks such as J_2 of extension lines such as E_2 extending to individual stations of the private branch exchange. The trunk line L_1 may terminate at a main central office at which connections are established either manually or by means of switching machinery. Ringing keys K_1 and K_2 are associated with the front and back cords terminating in the plugs P_1 and P_2 respectively, for ringing the stations connected to the private branch exchange when local connections are established. A key K_3 is also provided for associating the operator's set with the cord circuit, the key being so arranged that when operated the conductors of the front and back cords, instead of being directly connected together, are interconnected through the operator's set, the operator's set being provided with the usual transmitter T and receiver R , and in addition, a dial D is provided in order that the operator may establish connections by means of the switching machinery at the main central office. The additional key K_4 is provided in the cord circuit C , this key being for the purpose of connecting the front and back cords of the cord circuit independently of the supervisory apparatus. When this key is thrown and the cord is used for connecting an extension line to the trunk line leading to the central office, the subscriber on the extension line may dial directly through the cord to set the switching machinery at the main office. The cord may also be used in this condition for connecting the trunk line leading to the main office to some individual extension line so that during periods when no operator is in attendance at the private branch exchange, the trunk line is, in effect, extended directly to a subscriber's station.

Further details of the apparatus will now be clear from the description of the operation, which is as follows:

Assuming that a subscriber at the main central office desires to be connected to a subscriber at one of the extensions, as, for example, the extension E_2 of the private branch exchange, ringing current will be transmitted over the trunk line L_1 from the main office, thereby energizing the left-hand winding of the relay 1. The relay 1, upon being energized, closes a locking circuit through its right-hand winding, and also closes a circuit from the lamp 2, both circuits extending over the lower contact of the jack J_1 . The operator at the private branch exchange, upon observing the glowing of the lamp 2 inserts the plug P_1 into

the jack J_1' thereby opening the lower contact of the jack J_1' and extinguishing the lamp 2. The circuit is now extended from battery over the sleeve conductor of the jack J_1' and the sleeve conductor of the plug P_1 and thence over conductor 3 and a contact of the key K_4 to ground through the winding of the relay 4. Normally, battery supply is provided to the tip and ring conductors of the cord circuit C over the inner back contacts of the relay 4 and impedance coils 5 and 6. When the relay 4 is energized, however, the battery supply connections are opened and the tip and ring conductors leading to the plug P_1 are connected together through the impedance coils 5 and 6 by a connection extending over the inner front contact of the upper pair of contacts of the relay 4 and over the inner left-hand back contact of the relay 7. A bridge is thus established across the cord circuit for tripping the machine ringing apparatus at the main office in a manner well understood in the art. The relay 4 also operates to short circuit at its lower contact the winding of the supervisory relay 8, which is connected in the ring conductor of the front cord.

The operator now throws the key K_3 in order to connect her set with the cord. When the key K_3 is in normal condition, the tip conductors of the front and back cords are connected by a path extending from the tip contact of the plug P_1 over the upper contact of the ringing key K_1 , the upper normal contact of the relay 8, contact 9 of key K_4 , conductor 10, contacts 11 and 12 of the key K_3 , conductor 13, contact 14 of key K_4 over conductor 15, upper contacts of the ringing key K_2 to the tip contact of plug P_2 . In a similar manner, a path extends from the ring contact of the plug P_1 over the lower contact of the ringing key K_1 , lower normal contact of the relay 8, contact 16 of the key K_4 , over conductor 17, contacts 18 and 19 of the key K_3 , over conductor 20, lower contact of the relay 4, over conductor 21, contact 22 of the key K_4 , conductor 23, through the winding of the supervisory relay 24 associated with the back cord, over conductor 25 and the lower contacts of ringing key K_2 to the ring contact of the plug P_2 . When the key K_3 is actuated, however, the circuit above described is changed so that the tip conductors of the front and back cords are connected over a path from conductor 10, over contacts 11 and 26 of the key K_3 , over conductor 27, upper normal contact of relay 28, of the operator's set, conductor 29, contact 30 of the key K_3 , conductor 31, and thence over the conductor 13 and over the path previously traced to the tip contact of the plug P_2 . The ring connections, on the other hand, extend from conductor 17, over contacts 18 and 32 of the

key K_3 , over conductor 33, lower normal contacts of relay 28 of the operator's set, conductor 34, contact 35 of the key K_3 , over conductor 20 and thence over the path previously traced to the ring contact of the plug P_2 . The operator's talking and listening set comprising transmitter and receiver, T and R respectively, and the associated transformers, is bridged across the circuit just described at the points 35 and 36 by means of conductors 37 and 38 so that the operator is enabled to converse with the calling subscriber or operator at the distant central exchange to determine what extension connection is desired.

The operator, upon obtaining this information and ascertaining that a connection to the extension E_2 is desired, restores the listening key K_3 to normal and inserts the plug P_2 in the jack J_2 thereby closing a circuit from ground over the sleeve contacts of the jack J_2 and the plug P_2 and over the conductor 39, back contact of the relay 24 and through the lamp 40 to battery. The lamp 40 is now caused to glow. The operator then actuates the ringing key K_2 to transmit ringing current to the desired subscriber over the extension E_2 .

Upon the response of the subscriber at the station associated with the extension E_2 , a supervisory circuit is completed from the subscriber's station through the cord circuit at the private branch exchange and over the trunk line leading to the main central office. This circuit may be traced as follows: from one side of the battery (not shown) at the main central office over the tip conductor of the main line L_1 , and tip contacts of the jack J_1' , and plug P_1 , upper contact of ringing key K_1 , upper normal contact of the relay 81, contact 9 of key K_4 , conductor 10, contacts 11 and 12 of key K_3 , conductor 13, contact 14 of key K_4 , conductor 15, upper contact of ringing key K_2 , tip contacts of the plug P_2 and the jack J_2 , over the tip conductor of the extension E_2 , through the bridge closed by the switchhook at the subscriber's station, back over the ring conductor of the extension E_2 , contacts of jack J_2 and plug P_2 , lower contact of ringing key K_2 , conductor 25, winding of supervisory relay 24, conductor 23, contact 22 of the key K_4 , conductor 21, lower front contact of relay 4, conductor 20, contacts 19 and 18 of the key K_3 , conductor 17, contact 16 of the key K_4 , lower normal contact of relay 81, lower contact of ringing key K_1 , ring contacts of the plug P_1 and the jack J_1' , and over the ring conductor of the main line L_1 to the other terminal of the battery at the main central office. As is well-known the circuit over the line L_1 , if said line leads to a manual office, will include a supervisory relay in the cord circuit at the main central office. In case the main

central office is a machine switching office, a relay corresponding somewhat in function to the supervising relay will be included in the machine switching circuit. Consequently both the supervisory relay 24, which is energized over the circuit above traced, and the supervisory relay at the main office will be under the control of the switchhook at the subscriber's station of the extension E_2 , so that through supervision is maintained under the control of the subscriber.

The supervisory relay 24, upon being energized, opens the circuit of the lamp 40 and closes the circuit through the relay 7 from ground over the sleeve contacts of the jack J_2 and the plug P_2 over conductor 39, front contact of relay 24, winding of relay 7, and inner lower front contact of relay 4 to battery. The relay 7, upon being energized is locked up over its inner right-hand contact, and the contact 41 of the key K_3 . At its outer right-hand contact relay 7 prepares the circuit of the relay 81, and at its outer left-hand contact short-circuits a portion of the non-inductive resistance shunted about the supervisory relay 24. At its inner left-hand contact, relay 7 opens the direct current bridge through the impedance coils 5 and 6, which, it will be remembered, functions to trip machine ringing at the main central office. By the opening of this bridge the shunting effect of the battery supply from the main central office to the subscriber's instrument on the extension E_2 is obviated. When the subscriber at the extension E_2 hangs up his receiver, the supervisory circuit previously traced is opened, and consequently the supervisory relay 24 is deenergized. If the main line L_1 leads to an automatic exchange, the switching machinery by which the connection was set up at the main office will be released in a well-known manner. If, on the other hand, the main exchange at which the line L_1 terminates is a manual exchange, the opening of the supervisory circuit above traced results in the deenergization of a supervisory relay in the cord circuit at the main central office, so that the operator at such office will be informed that the connection is to be taken down.

The relay 24, upon being deenergized, completes a circuit from the grounded sleeve wire 39, over the back contact of said relay and through the supervisory lamp 40, causing said lamp to glow to inform the private branch operator that the connection is to be taken down. Another circuit is completed at the same time from the grounded sleeve wire over the back contact of relay 24, outer right-hand front contact of relay 7, and through the winding of relay 81 to battery. Relay 81 is now energized to disconnect the back cord

from the front cord. By thus opening the cord circuit ringing current transmitted over the line L_1 from the main office will not, in the event the private branch operator has delayed taking down the connection, be transmitted to the extension E_2 , with which the cord circuit is still associated, to ring the bell at the subscriber's station. A ringing responsive relay 42 is bridged across the front cord between the point of disconnection and the plug P_1 , so that this relay will respond to any ringing signal of this character, and will cause the lamp 43 to glow, thereby giving the private branch exchange operator a recall signal.

The relay 81, at the same time that it opened the cord circuit as already described, connects ground to the tip conductor and battery to the ring conductor of the end of the cord circuit associated with the plug P_2 . Consequently, if the subscriber on the extension E_2 should recall by taking the receiver off the hook before the connection has been taken down, a circuit is provided for energizing the supervisory relay 24, and by flashing the switchhook the lamp 40 may be caused to glow intermittently to attract the attention of the operator. The supervisory relay 24, when again energized by the subscriber removing his receiver before the private branch exchange operator takes down the connection, opens the circuit of the relay 81. Relay 81 releases and again closes the cord circuit so that the connection extends directly to the main central office, and battery for the supervisory relay 24 is now supplied therefrom. With the circuit in this condition the subscriber may now extend one or more new calls through the distant central office without the aid or intervention of the private branch operator.

If no recall signal as above described should be transmitted, the private branch exchange operator, upon observing the glowing of the lamp 40 in response to the hanging up of the receiver associated with the extension E_2 , will withdraw the plugs P_1 and P_2 from the corresponding jacks. By withdrawing the plug P_1 , the supervisory lamp 40 will be extinguished and the relay 8 will be deenergized, so that the talking conductors of the cord circuit will be restored to their normal condition. When the plug P_1 is withdrawn, battery is disconnected from the relay 4, which is accordingly deenergized to again bridge the battery supply across the talking conductors, and to open the circuit of the relay 7, thereby restoring the cord circuit apparatus to normal.

Should a subscriber on an extension such as E_2 desire to be connected to a subscriber at the main central office, the operation is

as follows: When the subscriber removes his receiver from the switchhook the line relay 44 is energized to close the circuit of the line lamp 45. The operator, in response to the glowing of the line lamp, will insert the plug P_2 of the cord circuit C in the jack J_2 , thereby disconnecting the line relay 44 and effacing the line lamp. As the relay 4 is not now energized, the battery supply circuit may be traced from battery over the inner lower back contact of the relay 4 through the impedance coil 6, over contact 22 of the key K_3 , conductor 23, through the winding of the supervisory relay 24, conductor 25, lower contact of the key K_2 , ring contacts of the plug P_2 and jack J_2 , ring conductor of the extension E_2 , through the subscriber's bridge and back over the tip conductor of the extension E_2 , tip contacts of jack J_2 and plug P_2 , upper contact of ringing key K_2 , conductor 15, contact 14 of ringing key K_4 , through impedance coil 5, and over the upper inner back contact of relay 4 to ground. The supervisory relay 24 is energized over the circuit above traced and opens the circuit of the supervisory lamp 40, which would otherwise be closed over the sleeve contacts of plug P_2 and jack J_2 .

The operator now throws the key K_3 , thereby connecting her set in the cord circuit in the manner already described, so that she is enabled to converse with the calling subscriber. Upon ascertaining that the subscriber desires a connection through the main central office, the operator will insert the plug P_1 in the jack J_1' . A circuit is now completed over the sleeve conductor 3 to energize the relay 4, which functions in the manner previously described to disconnect the battery supply through the coils 5 and 6, so that the battery current for the subscriber's transmitter will now be supplied directly from the main central office. Relay 4 also short circuits the winding of the supervisory relay 8, and at its inner lower front contact connects battery to one terminal of the winding of the relay 7, the other terminal of which is connected to ground over the contact of the supervisory relay 24 and the grounded sleeve conductor 39. Relay 7 is accordingly energized with results previously described.

Further action upon the part of the private branch exchange operator will now depend upon whether or not the main central office is a manual office or an automatic office and whether in the latter case the calling subscriber at the private branch exchange desires to dial the called subscriber himself, or whether the calling subscriber desires the operator to perform the dialing operation. In case the main central office is a manual office the line relay (not shown) associated with the line L_1 at the main office

will be energized as soon as the plug P_1 is inserted in the jack J_1 by means of the through supervisory circuit already traced, if the listening key K_3 is in normal position, but if the key K_3 is operated as would normally be the case under the conditions now being described, a circuit for said line relay would be completed as follows: from battery through said line relay (not shown) over the ring conductor of the line L_1 , ring contacts of the jack J_1' , and plug P_1 , lower normal contact of relay 81, contact 16 of key K_4 , conductor 17, contacts 18 and 32 of key K_3 , conductor 33, point 36, through the impedance bridge 46 in the operator's set, right-hand back contact of relay 47 in the operator's set, over conductor 37, point 35, conductor 27, contacts 26 and 11 of the key K_3 , conductor 10, contact 9 of the key K_4 , upper normal contact of relay 81, upper normal contact of key K_1 , over tip contacts of the plug P_1 of the jack J_1' , and over the tip conductor of the line L_1 to ground at the main central office. The operator at the distant central office being apprised through a line lamp that a call has come in over the line L_1 , answers the call in the usual manner, and the private branch operator, through her telephone set which is connected with the cord C over the contacts of the key K_3 , is able to converse with the operator at the main office and communicate to said operator the desired number, so that the operation at the main office may complete the connection. The private branch exchange operator, after having passed the call to the main office operator, will restore the listening key K_3 to normal, so that the talking circuit will be the same as previously described for a call incoming from the main central office.

In case the main office is a machine switching office and the subscriber desires to dial the connection for himself, the private branch operator, after inserting the plug P_1 in the jack J_1' , will restore the key K_3 to normal and actuate the through dialing key K_4 . When the through dialing key K_4 is actuated, the two ends of the cord circuit are directly connected together independently of the various auxiliary apparatus already described, except that the supervisory relay 24 will still be included in the through dialing circuit, which is as follows: from the tip conductor of the line L_1 , tip contacts of the jack J_1' and plug P_1 , upper contact of ringing key K_1 , upper normal contact of relay 8, contact 48 of key K_4 , conductor 15, upper contact of ringing key K_2 , tip contacts of the plug P_2 and jack J_2 , tip conductor of the extension E_2 , through the subscriber's set including his dial, back over the ring conductor of the extension E_2 , ring conductors of the plug P_2 and jack J_2 , lower normal contact of ring-

ing key K_2 , conductor 25, winding of supervisory relay 24, conductor 23, contact 49 of the key K_4 , lower normal contact of the relay 81, lower normal contact of ringing key K_1 , ring contacts of the plug P_1 and the jack J_1' to the ring conductor of the line L_1 . The subscriber is able, by means of his dial, to intermittently interrupt the circuit above traced, to set the switching machinery at the main office in a well-known manner. The circuit of the supervisory relay 24 will, of course, be interrupted intermittently by the dialing operation, and may cause a fluttering of the line lamp 40. This will be of no significance, however, except in so far as it may be an indication to apprise the operator that a dialing operation is proceeding.

When the calling subscriber hangs up at the end of the conversation, the through dialing circuit which has just been traced, and which functions as the talking circuit, is interrupted, thereby deenergizing the supervisory relay 24, so that the supervisory lamp 40 is caused to glow. The interruption of this circuit also causes the restoration of the switching machinery at the distant central office. The operator, upon observing the glowing of the lamp 40, will withdraw the plugs P_1 and P_2 and restore the apparatus to normal. It will be observed that, owing to the fact that the actuation of the key K_4 opened the circuit of the relay 4, relay 7 was not energized, since the circuit of the relay 7 depends on the relay 4. Consequently, the feature of opening the cord circuit through the action of the relay 8 does not come into play when the key K_4 is actuated.

In case the calling subscriber desires that the operation of dialing shall be performed by the private branch exchange operator, the operator having already inserted the plug P_2 in the jack J_2 and thrown the listening key K_3 to determine the number of the called party (the key K_4 being at normal) will insert the plug P_1 in the jack J_1' as before. The operator now proceeds to manipulate the dial D in a well-known manner, to set up the connection by means of the switches at the main office. As soon as the dial D is moved off normal, the dial switch 50 is closed, and completes the circuit for a slow release relay 51, which in turn completes the circuit of the relay 47. Relay 47, at its left-hand contact, completes a circuit for the relay 28, which, upon operating, opens the conductive connection which had previously existed between the front and back conductors of the cord through the operator's set. Battery supply is now furnished to the extension E_2 through the windings of the relay 52 as follows: from battery through the lower winding of the relay 52, lower left-hand coil of trans-

former 53, conductor 54, lower front contact of relay 28, conductor 34, and thence over a circuit previously traced through the winding of the supervisory relay 24, and
 5 over the conductors of the extension E_2 , through contacts of the key K_3 as previously traced, to conductor 29, and thence over the upper front contact of the relay 28, conductor 55, upper left-hand winding of the
 10 transformer 53, and through the upper winding of relay 52 to ground. Supervisory relay 24 is held energized over this circuit during the dial operation, and the relay 52 is now energized. Relay 52, at its front
 15 contact, completes a holding circuit for the relay 28 to maintain the connection thus established, independently of the relay 47, whose energization depends upon the dial being off normal.
 20 When relay 47 was energized by moving the dial off normal a dialing circuit is completed to the trunk line L_1 , from the tip conductor of said line over the tip contacts of the jack J_1' and the plug P_1 over the
 25 upper normal contact of ringing key K_1 , upper normal contact of relay 81, contact 9 of key K_4 , conductor 10, contacts 11 and 26 of key K_3 , conductor 27, point 35, conductor 37, right-hand front contact of relay
 30 47, make and break contacts 56 of the dial D, conductor 38, point 36, conductor 33, contacts 32 and 18 of key K_3 , conductor 17, contact 16 of key K_4 , lower normal contact of relay 81, lower normal contact of ring-
 35 ing key K_1 and ring contacts of plug P_1 and jack J_1' to the ring conductor of the line L_1 . The dial operates in a well-known manner to interrupt the dialing circuit just traced and operate the switching machinery
 40 at the main office.

This dialing circuit, it will be noted, is independent of the supervisory circuit controlled over the extension E_2 . However, at the conclusion of the dialing operation, if
 45 the operator for any reason should fail to restore the listening key K_3 , a holding circuit for the trunk line L_1 will be provided through the impedance coil 46 in the operator's set, as this coil will be bridged across
 50 conductors 37 and 38 which are connected to the tip and ring conductors of the line L_1 respectively. This bridge is closed by the deenergization of the slow release relay 51, which takes place a moment after the dial-
 55 ing operation ceases, and which results in the deenergization of the relay 47. With the circuit in this condition, the calling subscriber is able to converse with the called subscriber, even though the listening key K_3
 60 has not been restored, by reason of the fact that the right-hand winding of the induction coil 53 in the operator's set is bridged across conductors 37 and 38 in parallel with the impedance coil 46, as soon as the slow re-
 65 lease relay 51 is released. The transformer

53 serves to inductively couple the front and back conductors of the cord circuit through the operator's set, so that the subscribers can talk through the transformer. It will be noted that the circuit of the right-hand
 70 winding of the transformer 53 was held open during the dialing operation by the relay 51 to prevent the dialing impulses from being transmitted to the calling subscriber.

At the completion of the conversation the
 75 hanging up of the calling subscriber's receiver causes the release of the supervisory relay 24, which in turn causes the energization of the relay 81 in a manner previously described. Relay 81 opens the cord circuit
 80 as before with the result that the holding circuit for the line L_1 through the impedance coil 46 is open, and the connection at the main central office is released in a well-
 85 known manner. The connection of the battery and ground to the tip and ring sides of the cord circuit by the relay 81 is without effect at this time, as it merely causes a flow of direct current through impedance coil 46
 90 without producing any useful effect. The operation of recalling either over the line L_1 or the extension E_2 in case of a delay in taking down the connection will be as already described, except that in this instance the
 95 supervisory relay 24 is supplied with direct current through the windings of the relay 52 in the operator's set, instead of over the contacts of the relay 81 in the cord circuit.

If, at the conclusion of the dialing operation, the operator had restored the listening
 100 key K_3 , as would normally be the case, the cord circuit would be switched back to the through supervisory condition described in connection with the call originating at the distant central office, and the relay 52 would
 105 be at once released, causing the release of the relay 28, thereby restoring to normal of the operator's set. With the cord circuit in the through supervisory condition, the calling subscriber, upon hanging up, would
 110 directly cause the release of the switches at the main office and the release of the supervisory relay 24 would give the disconnect signal and operate the relay 81 to disconnect the cord circuit as already described in con-
 115 nection with the call originating at the main office.

In case a subscriber on the extension E_2 , for example, should desire to be connected with another extension E_1 on the same pri-
 120 vate branch exchange, the operator will insert the plug P_2 in the jack J_2 and throw the listening key K_3 , as before. Relay 4 of the cord circuit not being operated battery is supplied through the impedance windings
 125 5 and 6 to supply current for the calling subscriber's transmitter, and to operate the supervising relay 24. The operator, upon ascertaining the desired subscriber, will in-
 130 sert the plug P_1 in the jack J_1 . The sleeve

contact of the jack J_1 being grounded, the relay 4 is not energized over the sleeve circuit as in the cases previously described, and consequently the battery supply current for the called subscriber flows through the impedance coils 5 and 6. Relay 7 is not energized by the supervisory relay 24 during a connection of this character for the reason that the circuit of relay 7 depends upon the energization of the relay 4. The lamp 43 now functions as a supervisory lamp for the calling end of the cord circuit, the circuit of said lamp extending from battery through the lamp, over the back left-hand contact of the supervisory relay 81 in the calling end of the cord circuit, over contact 57 of the key K_3 , over the upper back contact of the relay 4 to the grounded sleeve conductor 39 of the answering end of the cord circuit. When the called subscriber on the extension E_1 responds, the supervisory relay 81, which is included in the battery supply circuit to the called subscriber and which is not in this instance short-circuited over the lower contact of the relay 4, becomes energized and opens the circuit of the supervisory lamp 43. When the two subscribers hang up, the supervisory relays 24 and 8, which are separately controlled by the two subscribers, become deenergized and the lamps 40 and 43 are again caused to glow to give the disconnect signal. While, as above described, the end of the cord terminating in the plug P_2 was used as the answering end and the end of the cord terminating in the plug P_1 as the calling end of the cord, it will function equally well for local connections if the plug P_1 be used as the answering plug and the plug P_2 as the calling plug, since the two ends of the cord are symmetrical so far as local connections are concerned. For local connections also it will be noted that the feature of opening the cord circuit by means of the relay 81 in response to a disconnect signal is not present.

The cord circuit is also adapted for use as a patching cord to connect the trunk line L_1 to some particular extension as, for example, the extension E_2 at night or during other periods when no operator is on duty at the private branch exchange, thus enabling the attendant at the subscriber's station associated with the extension E_2 to answer calls incoming to the private branch exchange. When it is desired to thus use the cord circuit, the through dialing key K_4 is operated and the plugs P_1 and P_2 inserted in the jacks J_1' and J_2 respectively. The two ends of the cord circuit are now directly connected independently of the apparatus associated with the listening key K_3 and the apparatus controlled by the relays 4, 7 and 81 exactly as described with reference to the through dialing condition. While the winding of the supervisory relay 24 is included in the sleeve

conductor, its control over the lamp 40 may be prevented and wastage of current through said lamp may be obviated by opening a switch 58. The effect is that of directly connecting the tip and ring conductors of the trunk line L_1 with the tip and ring conductors of the extension line E_2 , so that the trunk line and extension line together function exactly like an ordinary subscriber's line terminating at the main office.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a telephone system, a private branch exchange having extensions leading to a plurality of subscribers, a trunk line leading from the private branch exchange to the main exchange, a cord circuit for establishing connections at the private branch exchange, a supervisory relay for said cord circuit, and means whereby, when a cord circuit is used in establishing a connection between said trunk line and an extension, a circuit will be established for controlling said supervisory relay, and a supervisory circuit controlled by the subscriber's switch hook will also be extended over said trunk line.

2. In a telephone system, a private branch exchange, a plurality of extensions leading from said exchange, a trunk line leading from said exchange to a main central office, a cord circuit at the private branch exchange for completing connections between extensions or between an extension and said trunk line, a supervisory relay associated with said cord circuit, means for supplying battery current to said cord circuit at the private branch exchange for energizing the subscriber's telephone sets when said cord circuit is used in connecting local extensions, and means automatically responsive to the interconnection of an extension with said trunk line through said cord circuit to disconnect the local source of battery supply current from the cord, render said supervisory relay inoperative, and establish a through supervisory circuit from the extension through the cord circuit and over the trunk line.

3. In a telephone system, a private branch exchange, a plurality of extensions leading therefrom, a trunk line extending from said exchange to a main central office, a cord circuit at the private branch exchange for completing connections between an extension and said trunk line, and means whereby, when said cord circuit is used in establishing a connection between an extension and said trunk line and a subscriber hangs up, the talking conductors of the cord

circuit will be opened, said talking conductors remaining closed when said cord is used to interconnect two extensions.

4. In a telephone system, a private branch exchange, extensions leading therefrom, a trunk line extending from said exchange to a main central office, a cord circuit at said private branch exchange for completing connections between an extension and said trunk line, a supervisory relay associated with said cord circuit, means whereby, when the cord circuit is associated with an extension only, battery supply current will be furnished locally to energize said supervisory relay under the control of said extension, means whereby, when a connection is completed from said extension through the cord circuit to the trunk line, said local battery supply is disconnected and the circuit of the supervisory relay is extended over the trunk line, and means responsive to the hanging up of the receiver by a subscriber to open said cord circuit to prevent ringing current transmitted over said trunk line from being transmitted to the extension.

5. In a telephone system, a private branch exchange, extensions leading therefrom, a trunk line extending from said exchange to a main central office, a cord circuit at said private branch exchange for completing connections between an extension and said trunk line, a supervisory relay associated with said cord circuit, means whereby, when the cord circuit is associated with an extension only, battery supply current will be furnished locally to energize said supervisory relay under the control of said extension, means whereby, when a connection is completed from said extension through the cord circuit to the trunk line, said local battery supply is disconnected and the circuit of the supervisory relay is extended over the trunk line, and means responsive to the hanging up of the receiver by a subscriber to open said cord circuit to prevent ringing current transmitted over said trunk line from being transmitted to the extension, said means also operating to supply current to the portion of the cord circuit associated with the extension, in order that the supervisory relay may be operated for recall purposes.

6. In a telephone system, a private branch exchange, extensions leading therefrom, a trunk line extending from said exchange to a main central office, a cord circuit at said private branch exchange for completing connections between an extension and said trunk line, a supervisory relay associated with said cord circuit, means whereby, when the cord circuit is associated with an extension only, battery supply current will be furnished locally to energize said supervisory relay under the control of said

extension, means whereby, when a connection is completed from said extension through the cord circuit to the trunk line, said local battery supply is disconnected and the circuit of the supervisory relay is extended over the trunk line, and means responsive to the hanging up of the receiver by a subscriber to open said cord circuit to prevent ringing current transmitted over said trunk line from being transmitted to the extension, said means also operating to supply current to the portion of the cord circuit associated with the extension, in order that the supervisory relay may be operated for recall purposes, and means responsive to ringing current and associated with the end of the cord circuit connected to the trunk line for producing a recall signal when ringing current is transmitted from the main central office.

7. In a telephone system, a private branch exchange with extensions leading therefrom, a trunk line extending from said exchange to a main central office, a cord circuit for establishing connections between said extensions and said trunk line, a supervisory relay for said cord circuit, switching means associated with said cord circuit, and circuits controlled by said switching means whereby when the cord circuit is used in establishing a connection between an extension and said trunk line, dial signals for operating mechanical switches at the main central office may be transmitted from said extension line directly through said cord circuit and supervisory relay to the trunk line.

8. In a telephone system, a private branch exchange, extensions leading therefrom, a trunk line extending from said exchange to a main central office, a cord circuit at said exchange for completing connections between extensions and said main line, an operator's set including dialing means adapted to be associated with said cord circuit, and switching means whereby, when said cord circuit is used to interconnect an extension and said main line, the dialing means of the operator's set may, under certain conditions, be used for transmitting signals through the cord circuit and over the main line to actuate mechanical switches at the main office, and whereby, under certain other conditions, dial signals for setting said mechanical switches may be transmitted from the extension through said cord circuit to the main line.

9. In a telephone system, a private branch exchange, extensions leading therefrom, a trunk line extending to a main central office, a cord circuit for completing connections between extensions and between an extension and said trunk line, a supervisory relay for said cord circuit, means for interconnecting the ends of said cord circuit

through auxiliary apparatus including means for controlling the supervisory arrangements of the cord circuit and the operator's set, and switching means whereby the ends of the cord circuit may be directly connected through said supervisory relay and independent of said auxiliary apparatus, so that the cord may be used for patching an extension to said trunk line, whereby the extension becomes in effect a continuation of the trunk line.

10. In a telephone system, a private branch exchange, extensions leading therefrom, a trunk line extending from said exchange to a main central office, a cord circuit at said private branch exchange for completing connections between an extension and said trunk line, a supervisory relay associated with said cord circuit, means whereby, when the cord circuit is associated with an extension only, battery supply current will be furnished locally to energize said supervisory relay under the control of said extension, means whereby, when a con-

nection is completed from said extension through the cord circuit to the trunk line, said local battery supply is disconnected and the circuit of the supervisory relay is extended over the trunk line, and means responsive to the hanging up of the receiver by a subscriber to open said cord circuit to prevent ringing current transmitted over said trunk line from being transmitted to the extension, said means also operating to supply current to the portion of the cord circuit associated with the extension, whereby the supervisory relay may be operated when the switch hook is again actuated and means whereby when the supervisory relay is thus operated the cord circuit is again closed and battery is supplied from the main central office to maintain said supervisory relay operated.

In testimony whereof, I have signed my name to this specification this 22nd day of October, 1920.

RAND S. BAILEY.