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R. S. BAILEY

TELEPHONE EXCHANGE SYSTEM

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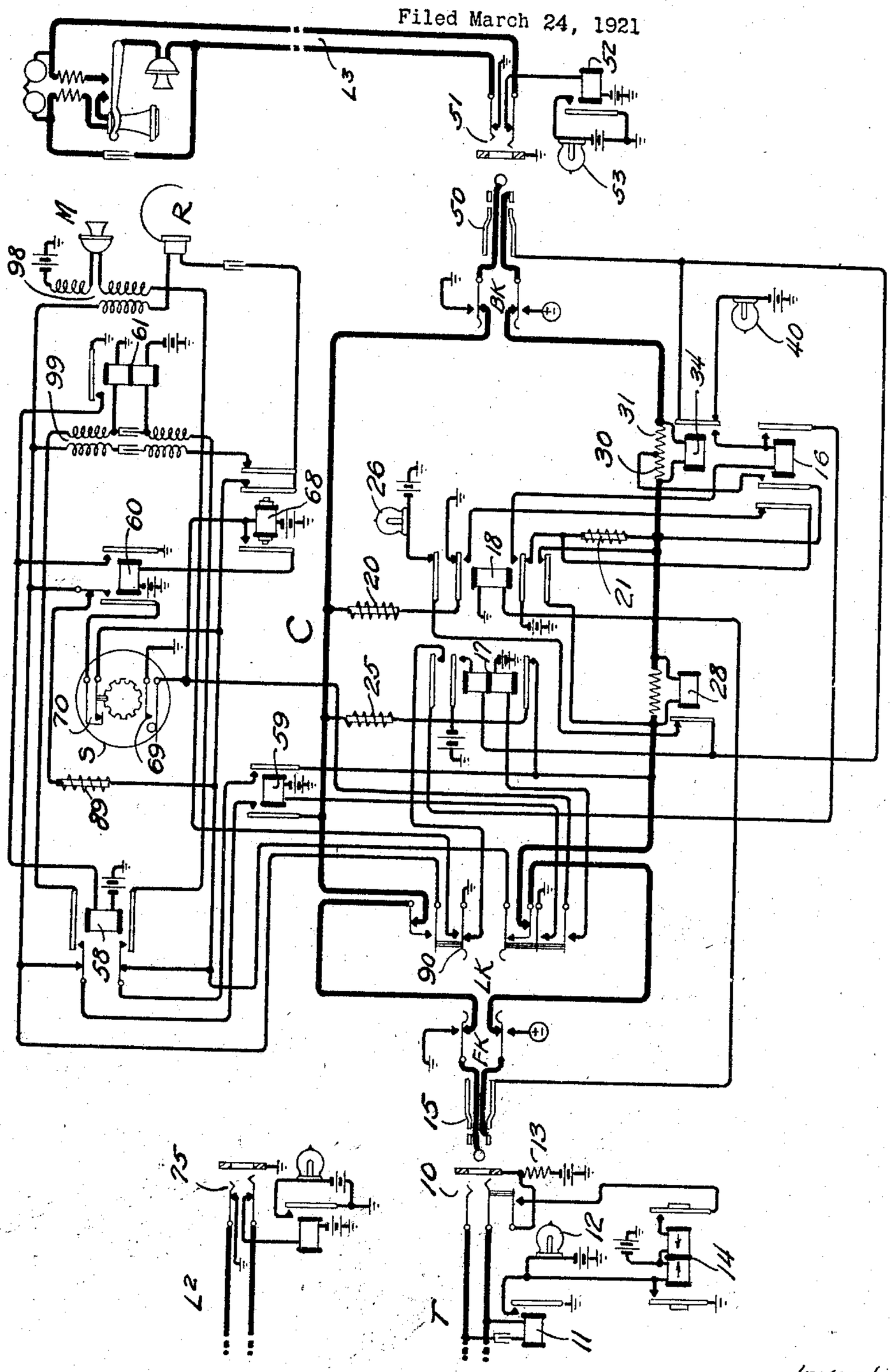

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TELEPHONE-EXCHANGE SYSTEM.

Application filed March 24, 1921. Serial No. 455,014.

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 Telephone-Exchange systems, of which the following is a specification.

This invention relates to telephone exchange systems and more particularly to a cord circuit arrangement for use at a private branch exchange where such an exchange is used in connection with a main central office of the automatic type.

An object of the invention is to provide an improved cord circuit for use at a private branch exchange to inter-connect extension lines of the private branch exchange and to connect extension lines of the private branch exchange with trunk lines leading to the main central office, wherein through-supervision is provided on outgoing calls over the trunk line and non-through-supervision is provided on incoming calls over the trunk line.

A feature of the invention consists in the provision of means for converting automatically the cord circuit from one class of supervision to another, such means being controlled by an impulse sender which is employed in establishing connections between extension lines of the private branch exchange and lines at the main central office.

For a more complete understanding of the invention reference may be had to the accompanying drawing which illustrates one embodiment of the invention applied to a cord circuit C which may be employed for interconnecting extension lines such as L^2 and L^3 of the private branch exchange and for interconnecting extension lines such as L^3 of the private branch exchange and trunk lines such as T extending from the private branch exchange to the main central office.

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 L^3 of the private branch exchange, ringing current will be transmitted over the trunk line T from the main central office, thereby energizing relay 11. Relay 11, upon energization, completes an obvious circuit for line lamp 12 and through the left-hand winding of differential relay 14. Relay 14 thereupon operates and locks through its left-hand winding thereby completing a circuit for maintaining line lamp 12 illuminated. The operator at the private branch exchange, observing the glowing of the line lamp 12, may insert plug 15 into the jack 10 thereby closing the lower contact of jack 10. A circuit is thereupon completed as follows: ground, winding of relay 18, sleeve contacts of plug 15 and jack 10 and thence in parallel, one path extending through resistance 13 to grounded battery and the other path extending through the lower contacts of jack 10, right-hand armature, front contact and right-hand winding of relay 14 to grounded battery. Relay 14 being of the differential type, immediately releases due to the current flowing through its right-hand winding. Relay 18 energizes in the circuit just traced. Normally, battery is supplied to the tip and ring conductors of the cord circuit C over the upper and lower inner back contacts of relay 18. When the relay 18 is energized, however, the battery supply connections are opened and the tip and ring conductors leading to the plug 15 are connected together through the low impedance coils 20 and 21 by a connection extending through the upper alternate contacts of relay 18, back contact and outer left-hand armature of relay 16. A low impedance bridge is thus established across the cord circuit. Connected in parallel with the low impedance bridge is a dry high impedance bridge comprising coil 25 which is normally connected, through the lower armature and back contact of relay 17, to the tip and ring conductors of the cord circuit, the term "dry" being employed to define a circuit which does not include a source of current. Either of these bridges may trip the machine ringing apparatus at the main central office, in the manner well known in the art, when plug 15 is inserted into jack 10 in response to an incoming call.

The operator may now actuate the key LK in order to connect her set with the cord circuit. When the key LK is in normal position, the tip conductors of the front and back cords are connected by a path extending from the tip contact of the plug 15, over the upper normal contacts of key FK, upper normal contacts of key LK, upper normal contacts of key BK to the tip con-

tact of plug 50. In a similar manner a path extends from the ring contact of the plug 15, through the lower normal contacts of key FK, lower normal contacts of key LK, lowermost contacts of relay 18, winding of supervisory relay 34 and the serially connected non-inductive resistances 30 and 31 in parallel, lower normal contacts of key BK, and ring contact of plug 50. When the key LK is actuated, however, relay 59 operates over an obvious circuit and the circuit above described is changed so that the tip conductors of the front and back cords are connected over a path extending through the uppermost alternate contacts of key LK, upper normal contacts of relay 58 and front contact and left-hand armature of relay 59. Ring connections, on the other hand, extend through the lowermost alternate contacts of key LK, lower normal contacts of relay 58 and front contact and right-hand armature of relay 59. The operator's talking and listening set including a transmitter M and a receiver R, respectively, and the associated induction coil 98 are bridged across the cord circuit so that the operator is enabled to converse with the calling subscriber at the distant central office to determine what extension is desired. The operator upon obtaining this information and ascertaining that a connection to the extension L^3 is desired, restores the listening key LK to normal and inserts the plug 50 into the jack 51, thereby closing a circuit from ground, over the sleeve contacts of jack 51 and plug 50, armature and back contact of relay 34, and through the supervisory lamp 40 to grounded battery. The lamp 40 is now caused to glow. The operator may then actuate the ringing key BK to signal the desired subscriber.

Upon the response of the called subscriber at the station associated with the extension L^3, a non-through-supervisory circuit is completed from the subscriber's station, through a 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 the grounded side of the battery (not shown) at the main central office, over the tip conductor of the trunk line T, tip contacts of jack 10 and plug 15, upper normal contacts of key LK, upper normal contacts of key BK, tip contacts of plug 50 and jack 51, through the called substation loop, ring contacts of jack 51 and plug 50, lower normal contacts of key BK, winding of supervisory relay 34 and the serially connected resistances 31 and 30 in parallel, lowermost contacts of relay 18, lower normal contacts of keys LK and FK, ring contacts of plug 15 and jack 10 and thence over the ring conductor of the trunk line T to battery (not shown) at the main central office. It will be noted that until the called subscriber responds, the high impedance bridge 25 and the low impedance bridge comprising the impedance coils 20 and 21 are both connected across the cord circuit. As soon as the called station responds, however, the low impedance bridge is removed in a manner hereafter described. A supervisory relay (not shown) at the main central office will be included in the machine switching circuit, in the manner well-known in the art. While the supervisory relay 34 which is energized over the circuit just traced is controlled by the called subscriber, the supervisory relay at the main central office is controlled by the operator, so that non-through supervision exists on incoming calls over the trunk line. The supervisory relay 34, upon being energized, opens the circuit of lamp 40 and completes a circuit for relay 16 over a path extending from grounded battery, lower alternate contacts of relay 18, winding of relay 16, front contact and armature of relay 34, sleeves of plug 50 and jack 51 to ground. Relay 16 in attracting its inner left-hand armature short-circuits the non-inductive resistance 30 shunted about the supervisory relay 34; and in attracting its outer left-hand armature, it opens the low impedance bridge across the cord circuit. By the opening of the bridge the shunting effect of the low impedance coils 20 and 21 of the battery supply from the main central office of the subscriber's instrument to the extension is obviated and a better transmission circuit is provided.

When the subscriber at the extension L^3 hangs up, the circuit for relay 34, previously traced, is opened and, consequently, the supervisory relay 34 is deenergized. Relay 34 in retracting its armature opens the circuit for relay 16, which relay thereupon deenergizes and closes at its outer left-hand contacts, the low impedance bridge for the cord circuit. Relay 34, upon deenergizing, also completes a circuit from ground, through the sleeve contacts of jack 51 and plug 50, armature and back contact of relay 34 and through the supervisory lamp 40 to grounded battery, causing the said lamp to glow to inform the private branch exchange operator that the connection may be taken down. Due to the maintenance of the high impedance bridge across the cord circuit during conversation and due to the high impedance and low impedance bridges being connected across the cord circuit after conversation has ceased and the called subscriber has restored the receiver to the switchhook, the machine switching apparatus at the main central office is prevented from releasing.

The operator at the private branch exchange noting the lighting of lamp 40 may remove plugs 15 and 50 from their respective jacks thereby removing the bridge from

the trunk circuit T and causing the release of the switches at the main central office in the manner well-known in the art.

Should a subscriber at an extension line such as L^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 52 is energized to close the circuit of the line lamp 53. The operator in response to the lighting of the line lamp may insert the plug 50 of the cord circuit C into the jack 51, thereby disconnecting the line relay 52 and extinguishing the line lamp 53. As the relay 18 is not now energized, the battery supply may be traced from grounded battery, through the lower inner normal contacts of relay 18, impedance coil 21, through the winding of supervisory relay 34 and the serially connected resistances 30 and 31 in parallel, lower normal contacts of key BK, ring contacts of plug 50 and jack 51, through the calling substation loop, tip contacts of jack 51 and plug 50, upper normal contacts of key BK, impedance coil 20 and upper inner normal contacts of relay 18 to ground. The supervisory relay 34 is energized over the circuit just traced and opens the circuit of the supervisory lamp 40 which would otherwise be closed over the sleeve contacts of plug 50 and jack 51.

The operator may now actuate the listening key LK, thereby actuating relay 59 and connecting her set to 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 may insert the plug 15 into the jack 10. A circuit is now completed from grounded battery, through resistance 13, sleeve contacts of jack 10 and plug 15 and winding of relay 18 to ground. Relay 18, in operating, disconnects the battery supply through the impedance coils 20 and 21, so that the battery supply for the calling subscriber's station will now be supplied directly from the main central office. Relay 18 in operating also completes the circuit for the energization of relay 16 previously traced. Relay 18, in operating, also short-circuits at its lowermost contacts the winding of supervisory relay 28.

The line relay (not shown) associated with the trunk line T at the main central office will be energized as soon as plug 15 is inserted in the jack 10 by the loop circuit through the calling subscriber's station, which circuit has been previously traced and due to the coil 25 being bridged across the cord circuit. If the key LK is operated, as will normally be the case under the condition described, a circuit for said line relay would also be completed over the following circuit: battery (not shown), through said line relay (not shown), over the ring conductor of the trunk line T, ring contacts of jack 10 and plug 15, lower normal contacts of key FK, lower alternate contacts of key LK, impedance coil 89, normal contacts of relay 60, upper alternate contacts of key LK, upper normal contacts of key FK, tip contacts of plug 15 and jack 10, and thence over the tip conductor of the trunk line T to grounded battery (not shown) at the main central station. After the key LK is actuated and until the operator actuates the sender S, coils 89, 25 and the calling subscriber's station are bridged across the cord circuit in parallel.

The operator may then actuate the impulse sender S a number of times corresponding to the number desired at the main central office for the purpose of setting the machine switching apparatus thereat. Upon the initial movement of the impulse sender or dial S, off-normal contacts 69 thereof are closed, thereby completing circuits for relays 68 and 17 over a path extending from ground, off-normal contacts 69 of the sender S and thence in parallel, one path extending through the winding of relay 68 to grounded battery, and the other path extending through the lowermost contacts of key LK and the lower winding of relay 17 to grounded battery. Relay 68, in operating, completes an obvious circuit for relay 60. Relay 17, in operating, locks up over a path extending from grounded battery, upper inner armature and front contact and upper winding of relay 17, sleeve contacts of plug 50 and jack 51 to ground. Upon the energization of relay 17, relay 16 will now lock up over a path extending from grounded battery, lower alternate contacts of relay 18, winding, front contact and right-hand armature of relay 16, upper outer armature and front contact of relay 17 and contacts 90 of key LK to ground (when key LK is in normal position). Relay 17, in operating, opens at its lowermost contacts the high impedance bridge, comprising the impedance coil 25, across the cord circuit. Relay 60, in attracting its right-hand armature completes an obvious circuit for relay 58, which relay in operating opens the conductive connection which as previously stated extends from the front to the back conductors of the cord circuit through the operator's set. Battery supply is now furnished for the extension L^3 through the windings of relay 61, over a path which may be traced as follows: from grounded battery, through the lower winding of relay 61, lower right-hand winding of repeating coil 99, lower alternate contacts of relay 58, front contact and right-hand armature of relay 59, lowermost armature and front contact of relay

18, through the winding of supervisory relay 34 and non-inductive resistance 31 in parallel, lower normal contacts of key BK, ring contacts of plug 50 and jack 51, through the calling substation loop, tip contacts of jack 51 and plug 50, upper normal contacts of key BK, left-hand armature and front contact of relay 59, upper alternate contacts of relay 58, upper right-hand winding of repeating coil 99 and upper winding of relay 61 to ground. Supervisory relay 34 is held energized over this circuit during the actuation of the dial and relay 61 is now energized. Relay 61 at its armature and front contact completes a holding circuit for relay 58 to maintain the connection thus established independently of the relay 60 whose energization depends upon the dial being off-normal.

When relay 60 was energized upon the initial movement of the dial, a dialing circuit was completed to the trunk line T extending from the tip conductor of said line, over the tip contacts of jack 10 and plug 15, upper normal contacts of key FK, upper alternate contacts of key LK, left-hand alternate contacts of relay 60, interrupting contacts 70 of the dial S, lower alternate contacts of key LK, the lower normal contacts of key FK, ring contacts of plug 15 and jack 10 to the ring conductor of the trunk line T. The dial operates in the well-known manner to interrupt the dialing circuit just traced and to set the machine switching apparatus at the main central office. The dialing circuit it will be noted, is independent of the supervisory circuit controlled by the extension L^3. If the operator for any reason should fail to restore the listening key LK, at the conclusion of the dialing operation, a holding circuit for the trunk line T will be provided through the impedance coil 89 of the operator's set as this coil will be bridged across the tip and ring conductors of the trunk line T. This bridge is closed by the deenergization of the relay 60, which takes place as soon as the dial S returns to normal. With the circuit in this condition, the calling subscriber is able to converse with the called subscriber even though the listening key LK has not been restored, by reason of the fact that the left-hand windings of the repeating coil 99 are bridged across the tip and ring conductors of the cord circuit in parallel with the impedance coil 89, as soon as the slow-to-release relay 68 is released. Repeating coil 99 serves to inductively couple the front and back conductors through the operator's set so that the subscribers can talk through the repeating coil. It will be noted that the left-hand windings of repeating coil 99 were held open during the dialing operation by the relay 68 so as to prevent the dialing impulses from being transmitted to the calling subscriber. If the operator fails to restore the key immediately after dialing, she will thus be audibly informed that she has failed to restore said key and will thereupon move the key LK into normal position.

At the completion of conversation the hanging up of the calling subscriber's receiver causes the release of the supervisory relay 34 and the release of the machine switching apparatus at the central office in the manner well-known in the art. Relay 34, upon deenergization, opens at its armature and front contact the original energizing circuit for relay 16. Relay 16 remains energized, however, over the locking circuit previously traced and prevents the reconnecting of the low impedance bridge comprising coils 20 and 21, across the cord circuit. The high impedance bridge 25 is prevented from being reconnected across the cord circuit by means of the relay 17 which still remains locked up as previously described through the sleeve contacts of the plug 50 and jack 51. Relay 34 in deenergizing also completes a circuit for supervisory lamp 40 over the path previously traced causing said lamp to glow to inform the private branch exchange operator that the connection is to be taken down.

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 L^3 will withdraw the plugs 15 and 50 from their respective jacks, thereby causing all apparatus of the cord circuit to be restored to normal position.

In case the subscriber of the extension L^3 should desire to be connected with another extension such as L^2 of the same exchange, the operator will insert the plug 50 into the jack 51 and actuate the listening key LK as before. Relay 18 of the cord circuit not being operated, current is supplied through the impedance coils 20 and 21 for the calling subscriber's transmitter and for operating the supervisory relay 34. The operator, upon ascertaining the number of the desired subscriber, may insert the plug 15 into the jack 75. The sleeve contact of the jack 75 being grounded, the relay 18 is not energized over the sleeve circuit as in the case previously described and consequently current is supplied for the called subscriber through the impedance coils 20 and 21. Relay 16 is not energized by the supervisory relay 34 during a connection of this character for the reason that the circuit for relay 16 depends upon relay 18 being energized. After signaling the called subscriber in the well-known manner by the actuation of the key FK and upon the response of the called subscriber, conversation may proceed. The restoration of the receivers to

the switchhooks of the calling and called subscribers causes supervisory lamp 40 associated with the answering cord and supervisory lamp 26 associated with the calling cord to operate over a path extending from ground, sleeve contacts of jack 51 and plug 50 and thence in parallel, one path extending through the armature and back contact of relay 34 and lamp 40 to grounded battery and the other path extending through the left-hand armature and back contact of supervisory relay 28, upper outer armature and back contact of relay 18 and the lamp 26 to grounded battery. The operator noting the disconnect signals may remove the plugs 15 and 50 from their respective jacks, whereupon all apparatus is restored to normal. While, as above described, the end of the cord circuit terminating in the plug 50 was used as the answering end and the end of the cord terminating in the plug 15 was used as the calling end, the cord circuit will function equally well for local connections if the plug 15 is used as the answering plug and the plug 50 as the calling plug, since the two ends of the cord circuits are symmetrical so far as local connections are concerned.

It will thus be noted that a cord circuit, having double supervision when used for local interconnections, is so arranged that when it is employed for completing outgoing connections from subscribers at the private branch exchange through-supervision is provided, whereas, when used for completing incoming connections from the main central office to subscriber's in the private branch exchange, non-through-supervision is provided. In other words, the subscriber of the private branch exchange controls the release of switching apparatus at the main central office on all outgoing connections, whereas, the operator controls the release of the switches of all incoming connections from the main central office. The conversion from one class of supervision to the other is thus automatically controlled by an act necessary to the completion of an outgoing connection, said act being the actuation of the impulse sender employed in setting automatic switching apparatus at the main central office.

What is claimed is:

1. In a telephone exchange system, a trunk line, a subscriber's line, a cord circuit including means for controlling the character of supervision thereover for interconnecting said lines, and an impulse sender associated with said cord circuit adapted to control said means.

2. In a telephone system, a two-way trunk line, a subscriber's line, a cord circuit for interconnecting said lines, said cord circuit being arranged to provide through and non-through supervision, an impulse sender, and means responsive to said impulse sender for changing said cord circuit from one class of supervision to the other.

3. In a telephone exchange system, a trunk line, a subscriber's line, a two-way cord circuit for interconnecting said lines, a dry bridge normally connected across said cord circuit, a relay associated with said cord circuit adapted when energized to remove said bridge from said cord circuit, and means associated with said cord circuit for actuating said relay only when a call is outgoing over said trunk line.

4. In a telephone exchange system, a trunk line, a subscriber's line, a cord circuit for interconnecting said lines, a dry bridge normally connected across said cord circuit, a relay associated with said cord circuit adapted when energized to remove said bridge from said cord circuit, an impulse sender associated with said cord circuit and a circuit completed upon the initial actuation of said sender for actuating said relay.

5. In a telephone exchange system, a trunk line, a subscriber's line, a cord circuit for interconnecting said lines, a bridge normally connected across said cord circuit, a relay associated with said cord circuit adapted when energized to remove said bridge from said cord circuit, an impulse sender associated with said cord circuit, a circuit completed upon the initial actuation of said sender for actuating said relay, and a locking circuit for said relay completed upon actuation.

6. In a telephone system, extension lines, trunk lines, a cord circuit for interconnecting extension lines or extension lines and trunk lines, a dry bridge normally connected across the cord circuit, an impulse sender for building up connections over the trunk line when calls from an extension line to a trunk line are established, and means in the cord circuit responsive to the actuation of the sender for removing the bridge.

In testimony whereof, I have signed my name to this specification this 23rd day of March, 1921.

RAND S. BAILEY.