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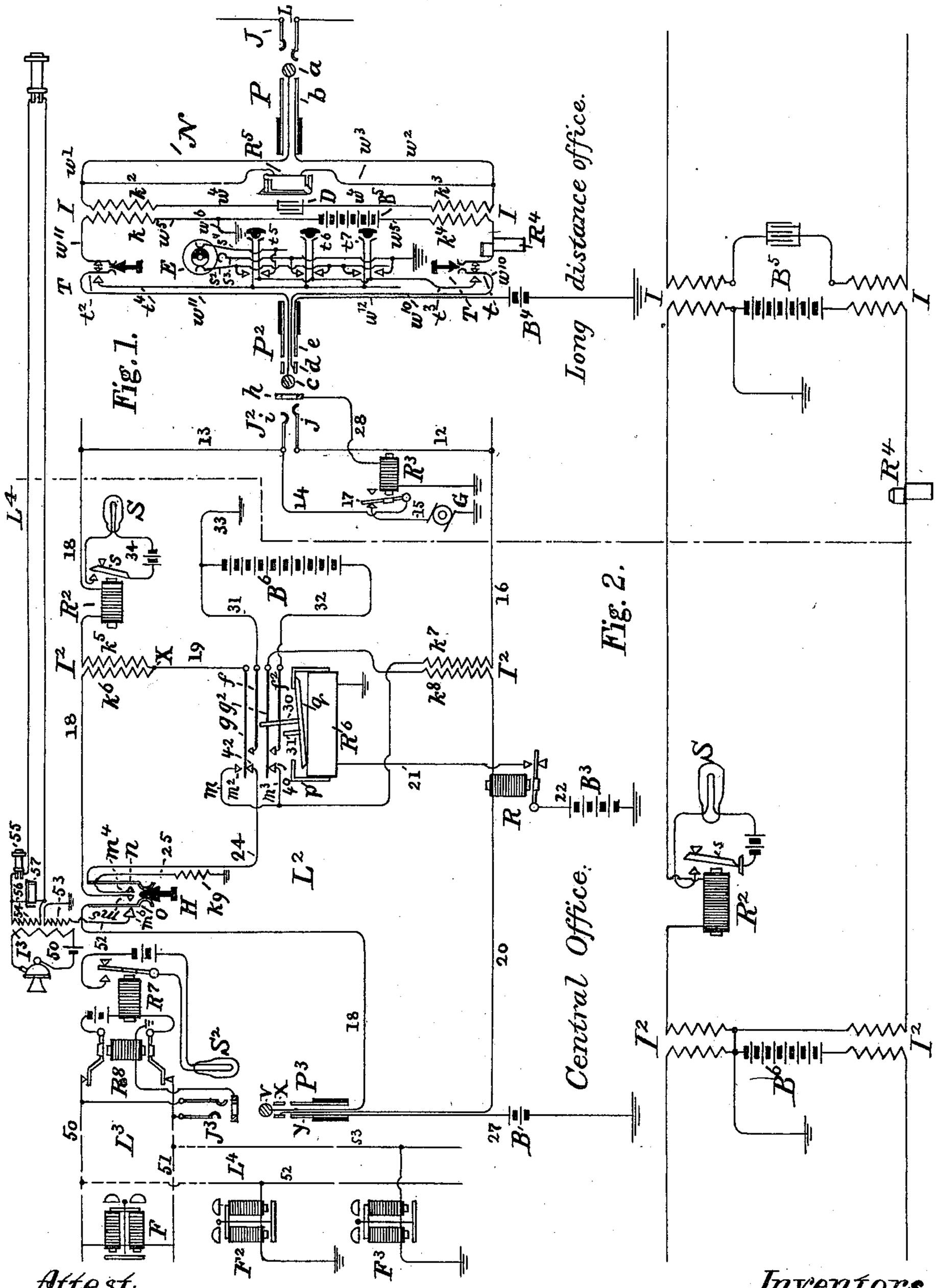
TELEPHONE CONNECTING CIRCUIT.

(Application filed Aug. 6, 1898.)

(No Model.)



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TELEPHONE CONNECTING-CIRCUIT.

SPECIFICATION forming part of Letters Patent No. 626,111, dated May 30, 1899.

Application filed August 6, 1898. Serial No. 687,898. (No model.)

To all whom it may concern:

Be it known that we, GEORGE K. THOMPSON, residing at Malden, and THOMAS C. WALES, Jr., residing at Newton, in the county of Middlesex and State of Massachusetts, have invented certain Improvements in Telephonic Connecting-Circuits, of which the following is a specification.

To successfully perform telephonic service over large areas of territory, it has been found desirable to divide the business into separate branches, and a town or city may have one or more central stations, from which circuits radiate to substations. The different central stations are connected to each other by trunk-lines in order that their respective subscribers may converse with one another, and to further extend the facilities for intercommunication circuits are provided between towns and cities widely separated from one another, and such circuits have been designated as "long-distance" lines. Such long-distance lines, while having terminals at offices of their own, where the public can come and carry on conversation with distant places, are also provided with switching connections and trunk-circuits, whereby any substation-circuit connected with the local central stations can be connected at and through the said central stations with said lines. The present invention relates to means whereby such long-distance lines may be switched to substation relay-circuits, which are multipled to the several operators' tables at the central-station switchboard, and in carrying out the invention special cord-circuits at the long-distance central station are adapted to make connection with special trunk-circuits extending between the said station and an exchange central station. The operator at the long-distance central station is connected with the B operator of the central exchange-station by an order or instruction circuit, and when the latter operator connects a trunk-circuit with the substation-circuit called for over the order-circuit the former operator then signals to the said substation and afterward supervises the connection. The cord-circuits at the long-distance office are inductively connected by a repeating-coil, and the plug-circuit on one side includes a condenser in series between two of the coil-helices, a line-signal being bridged in between the circuit-conductors. The other plug side includes two helices of said coil and has between them a battery and a ground branch and is provided with a keyboard-signal and ringing-keys, and the test-ring contact of the plug connects with ground through a battery. The connecting trunk-circuit terminates at the long-distance office in a jack or switch socket at each of the tables of the trunk operators and at the central office by a plug. At the jack end there is a direct-current generator normally connected with the upper spring of the jack, but adapted to be cut off when the cord-plug is inserted, and at the plug end of the trunk there is an operator's set and listening-key normally depressed to connect the said set with the order-circuit, and thereby open the upper conductor of the trunk-circuit, and the trunk is divided into separate conductive sections by a repeating-coil of four windings, the two at the upper side being normally in series with each other and also joined centrally to a branch which extends through a spring adapted to be operated by a main relay or compound electromagnetic switch and also through one side of the listening-key and a resistance-coil to ground, while the two windings on the lower side are normally in series with each other through a second spring relay or switch. There is a disconnecting lamp-signal operated by a relay in the upper conductor and a normally-disconnected battery adapted to be automatically connected between the two left-hand windings of the repeating-coil when the trunk terminal plug is inserted in a relay substation-circuit jack and when the telephone at said substation is off its hook, this being effected by the magnetization of a relay in the lower trunk-conductor, which operates to close a battery-circuit through the said electromagnetic switch, thereby causing its armature to reverse the said springs. Upon receiving a call for a relay substation-circuit the long-distance operator gives the

order over the instruction-circuit to the B operator, who selects the trunk-circuit and notifies the former operator of its number and then inserts the plug of the trunk into the jack of the substation-circuit, which is made to test "busy" and its cut-off relay operated. The long-distance operator inserts the plug of the cord-circuit into the jack of the trunk, thereby cutting off the direct-current calling-generator and setting the keyboard-signal, and by pressing the proper ringing-key can call the substation, whether it be a single subscriber with a bell in a bridge or a party-line subscriber having a bell in a ground branch from either conductor of the circuit. When the substation answers, the removal of the telephone and the closing of the circuit by its hook-switch causes current to flow from the battery in the cord-circuit at the long-distance office and operate the keyboard-signal there and also energize the relay in the lower trunk-conductor to send a current through the said electromagnetic switch, which by the consequent change in the position of its armature causes the reversion of its springs and the changing of the circuits of the trunk, so that the two left-hand helices will be in series with each other, the trunk-battery, and the trunk relay-substation, and the two right-hand helices will be in series with each other and the battery in the cord-circuit at the long-distance office. When the called relay substation-subscriber replaces the telephone upon the hook-switch, thereby opening the circuit, the keyboard-signal at the long-distance section operates as a disconnection-signal to the operator, who withdraws the plug of the cord-circuit, whereupon the direct-current generator connected to the upper conductor of the trunk is switched in and current flows therefrom and causes the display of the disconnecting-signal at the section of the B operator, who removes the trunk-plug from the substation relay-circuit, all of which will now be fully described.

Figure 1 of the drawings is a diagram illustrative of the details of the circuits constituting the invention in their disconnected condition, and Fig. 2 is a diagram of a part of the same organized as a conversation-circuit.

J represents the jack-terminal of a long-distance line L at the long-distance office, and N is a cord-circuit whose plugs P and P^2 are inductively connected with each other by the repeating-coil I, having four helices k, k^2, k^3, and k^4, the helices k^2 and k^4 being in series with one another and the condenser D in a bridge w^4 between the conductors w' and w^2, extending from the tip a and sleeve b, respectively, of the plug P. The disconnecting-signal R^5 is in the bridge w^3 between the said conductors. The helices k and k^4 are in series in the conductor w^5, provided with a grounded branch w^6 and uniting in a loop by the conductors w^{11} and w^{10}, the tip c, and sleeve d of the plug P^2, and T T is a double ringing-key in said conductors, (shown as two separate keys, but adapted to be operated as one,) whose springs t and t^2 are adapted to make contact with the wires t^3 and t^4 and when either of keys t^5, t^6, or t^7 are depressed with the alternating generator E.

R^4 is a disconnecting-signal for the circuit of plug P^2, and w^{12} is a grounded wire through the battery B^4 from the test-contact e of plug P^2.

The trunk-circuit L^2 is provided with a plug P^3 at the B operator's switchboard-section and with jacks J^2 at the several switchboard-sections (in a manner well understood) at the long-distance office. The jack-springs i and j are connected to the respective branches 13 and 12, which connect with the conductors 18 and 16, and the test-ring h connects to ground, through the relay R^3, by wire 28. A wire 14 connects spring i with armature 17, whose back contact is connected with grounded wire 15 to direct-current generator G. The conductor 18 connects with tip v of plug P^3 and includes helices of relay R^2, helices k^5 k^6 of repeating-coil I^2, spring-contact m^5, and spring o of listening-key H, and the conductors 16 includes helix k^7 of the said coil and ends in branches m m^3 of the contacts m^2 and 40, and normally continuing from the contact 40, via spring-switch g^2, helix k^8 of said coil, relay R to conductor 20, which terminates at the sleeve-contact x, the test-contact y is connected to ground by wire 27, which has in circuit the battery B.

The relay R^2 is adapted to attract armature s to its front contact and close the local circuit 34 and light the lamp-signal S. Wire 19 connects the helices k^5 and k^6 at point X with the spring-switch g, which rests upon the contact 42, connected by wire 24 with the spring n of the listening-key H, whose contact m^4 extends to ground by the wire 25, having in circuit the resistance k^9. Normally the listening-key H is depressed and the upper conductor 18 is opened at the contact m^5, while the spring o connects with the contact m^6 of wire 52, which it grounded through the helix 53 of the induction-coil I^3. The opening of the conductor 18 prevents current from generator G flowing therein and causing the signal S to be lighted.

L^4 is an order-circuit between the long-distance office and the central office and terminates in a helix 54 of the coil I^3 and has in circuit the telephone 55. 57 is an annunciator in a bridge 56 between the conductors of the order-circuit.

50 is a local circuit with transmitter and battery.

R^6 is a relay or an electromagnetic switching device included in a wire 21, grounded at one end and terminating in a front contact of relay R at the other. The armature of said relay is a terminal of the grounded wire '22, which has in circuit the battery B^3. The armature q of the relay R^6 is provided with extension-pins 30 and 31 and is adapted to have one of its ends attracted to the pole p, so that the pin 30 will force the spring f against the

spring g and move the latter to make connection with contact m^2 and also that pin 31 will force spring f^2 into contact with spring g^2 and move the latter away from the contact 40. The spring f is connected by wire 31 with one pole of the battery B^6 and by wire 33 to ground, and the spring f^2 is connected by wire 32 with the opposite pole of the battery.

L^3 is a relay substation-circuit provided with a jack J^3 at each switchboard-section, as is usual, cut-off relay R^8, line-signal S^2, and relay R^7. The conductors 50 and 51 extend to a single substation, at which is shown the call-bell F in a bridge, as usual, and L^4 shows a party-line relay substation-circuit, which for convenience of illustration is shown as terminating at the same cut-off relay R^8 and signal S^2 as the circuit L^3 (which would not occur in practice) to show bells F^2 and F^3 at different substations, each bell being in a ground branch from the respective conductors of the circuit L^4. The circuits L^3 and L^4 are respectively intended to represent the operation of signaling a substation on a single line and substations on a party line.

In the operation of the invention the long-distance operator receives a call from the line L and inserts plug P in the jack J, and to make connection with a relay substation-circuit speaks over the order-circuit L^4 to the listening B operator at the central-office switchboard, who selects the trunk L^2 and notifies the long-distance operator of its number, at the same time touching the tip of plug P^3 to the test-ring of the jack J^3, and if the line is not engaged no click will be heard in the operator's telephone 55, whereupon the plug is inserted into jack J^3 of the substation-circuit and withdrawing the listening-key H to close the conductor 18 at contact m^5, and the long-distance operator inserts plug P^2 into jack J^2 of the trunk, and to ring the bell F of an individual line the double key T and the single key t^5 are depressed to send current from generator E, and to ring bells F^2 and F^3 on a party line the double key T and single key t^6 or t^7 may be depressed, as previously arranged, to send a current out over conductor 52 to ground or over conductor 53 to ground. If when the test is made by the plug P^3 the line is engaged, a click will be heard in the telephone 55, for the reason that current will pass to the tip of the plug and to ground through the primary winding 53 of the induction-coil I^3, and the said surge of current will be repeated inductively in the primary 54, and as the high-resistance electromagnetic signal 57 is bridged across the order-circuit L^4 an eddy-current will circulate therethrough, causing a sudden change of potential in the telephone 55 whether the order-circuit is open in the long-distance office or not, which will produce the click sound. When the plug P^3 is inserted in the jack J^3, its test-surface y makes contact with the test-ring of the jack, and current flows through the cut-off relay R^8 to ground, and the test-conductor of the circuit is made busy and the line-signal S^2 cut off in a well-known manner. When the plug P^2 is inserted into jack J^2, current flows from battery B^4, wire w^{12}, test-surface e, ring h, wire 28, and relay R^3 to ground, and the armature 17 is attracted to its front contact and the generator G is cut off. This is all the change that occurs until the called subscriber removes the telephone from its hook-switch. When the double key T and the single key t^5 are both depressed to call an individual substation, the circuit may be traced as follows: from generator E, spring s^2, wire t^4, spring t^2, conductor w^{11}, tip c of plug P^2, conductors 13 and 18, helices k^5 and k^6, tip of plug P^3, conductor 51, bell F, returning by conductor 50, sleeve x of plug P^3, conductor 20, helix k^8, spring g^2, branch m^3, helix k^7, conductors 16 and 12, sleeve d of plug P^2, conductors w^{10} and t^3 to spring s^4 of generator E. When bell F^2 at substation on circuit L^4 is to be rung, the double key T is pressed to its contacts, and also, say, key t^6, and current will flow from generator E, grounded at one side, spring s^2, by wire t^3, conductor w^{10}, sleeve d of plug P^2, conductors 12 and 16, helix k^7, branch m^3, spring g^2, wire 20, helix k^8, sleeve x of plug P^3, and conductor 52 to ground, and to ring bell F^3 keys T and t^7 are pushed in, and the current goes from generator E, via spring s^2, wire t^4, conductors w^{11}, tip of plug c, conductors 13 and 18, tip v of plug P^3, and conductor 53, to bell and ground. At the junction X there is an alternate path via wires 19 and 24 to ground through coil k^9, whose impedance must be sufficient to prevent an undue shunting of current through it. The usual systems of party-line ringing may be extended to three and four substations, as will be readily understood. The removal of the telephone at the substation operates to close a low-resistance bridge across the circuit. Then current flows from battery B^5, helix k^4, operating the signal R^4 by wire w^{10}, sleeve-contact d, spring j, wire 12, conductor 16, helix k^7, contact 40, spring g^2, helix k^8, conductor 20, relay R, contact x of plug P^3, through the substation-line and telephone set to the tip v of the plug, conductor 18, spring o, and contact m^5 of listening-key H, helix k^6 to point X, from whence there are two paths by which current may flow to earth. One of these paths is through wire 19, spring g, contact 24, contact m^4 of key H, and wire 25 and resistance k^9 to ground. The other is through helix k^5, relay R^2, conductor 13, spring i of jack J^2, tip c of plug, conductor w^{11}, and helix k. The current through relay R energizes it and attracts its armature to its front contact, closing a circuit from battery B^3, wire 22, and the electromagnetic switch R^6 to ground. The said switch is operated, and as its armature q is lifted the pin 30 forces spring f against spring g, causing spring g to break contact at 42 and make contact at m^2. Similarly spring f^2 is lifted by pin 31 into contact with spring g^2,

thereby raising spring g^2 from the contact m^3 with the following results: Battery B^6 is substituted for battery B^5 as a means for supplying current to the called substation and for operating relay R, and, secondly, the coil-windings k^5 and k^7 are connected in series, as are windings k^6 and k^8, thus completing the talking-circuit between the called substation and the long-distance office, as is clearly shown in Fig. 2, which shows the new conditions of the circuits and the current-supply for each. Owing to the operation of the switch R^5 current does not cease to flow through relay R and the substation-telephones even momentarily, since contact m^3, through which flows the current from battery B^5, is not broken until connection is made between springs f^2 and g^2. Thus for an instant batteries B^5 and B^6 are in multiple. The relay R^2 is wound to be responsive to direct currents and irresponsive to alternating currents. The four windings of the induction repeating-coil I^2 are upon a common core and are so connected that when in their normal condition, as illustrated by Fig. 1, in which helices k^5 and k^6 are in series with the upper conductor and helices k^7 and k^8 are in series with the lower conductor of the trunk, they offer no inductive resistance; but when they are arranged as shown in Fig. 2, in which helices k^6 and k^8 are in series and in which helices k^5 and k^7 are also in series, considerable impedance is offered to currents. When at the completion of conversation the called subscriber replaces his telephone upon the hook-switch, the circuit becomes open thereat and current ceases to flow through relay R, and its armature falls away and opens its circuit, and therefore current from battery B^3 ceases to energize the electromagnetic switch or relay R^6, whose armature falls away and the spring-switches return to their normal contacts. There being now no circuit to earth from battery B^5 through signal R^4, the latter ceases to operate, this being notice to the long-distance operator that the subscriber has replaced his telephone upon the hook, who then removes plug P^2 from jack J^2. When the plug P^2 is removed from jack J^2, current ceases to flow through relay R^3, whose armature falls back and closes the circuit of generator G, and current now flows therefrom through conductors 13 and 18, relay R^2, helix k^5, wire 19, spring g, contact 42, wire 24, spring n of key H, wire 25 to ground. This current operates relay R^2, whose armature closes the local circuit 34, and the lamp-signal S is lighted, and this is the disconnecting signal for the B operator, who withdraws plug P^3 from jack J^3 and throws or depresses the key H. The effect of depressing the key H is to break connection at contact m^4 and open the circuit to earth from generator G, and current ceases to flow through relay R^2, and the signal S is extinguished.

Having thus explained our invention, we claim—

1. In a telephone signaling-circuit, in combination, a trunk-circuit having a repeating-coil with four windings which are normally in series in pairs with the conductors of the circuit respectively, an electromagnetic switching device and a normally-disconnected battery; a cord-circuit having a battery in a bridge; with a substation-circuit; whereby when the trunk-circuit is interposed between and connected with the cord-circuit and substation-circuit, current from the cord-circuit battery circulates through the circuit thus organized; and when the telephone at the substation is removed, the said electromagnetic device operates to switch the coil-windings in the opposite conductors into series with each other and in bridges between said conductors, and include the disconnected battery in circuit with the substation side, and establish two inductive circuits each with a separate battery, as set forth.

2. A trunk-circuit adapted to link a cord-circuit with a relay substation-circuit, the tip-conductor of the terminal plug being normally open in a listening-key and in inductive relation with an order-circuit; a relay in the plug-tip conductor adapted to operate a disconnecting-signal, a grounded relay connected with a member of the terminal jack whose armature operates to switch a direct current through said first relay, a repeating-coil having four windings connected by pairs in series with each conductor of the trunk, a disconnected battery, an electromagnetic switch adapted to be operated by a relay in the plug-sleeve conductor to switch the opposite windings of the coil in series with each other and to include the said battery between the windings of the plug-circuit, as set forth.

3. In a telephone signaling-circuit, the combination of a trunk-circuit having a repeating-coil with four windings normally in series in pairs with the respective conductors of the circuit, an electromagnetic switching device; a cord-circuit divided by a repeating-coil of four windings, with a battery, signaling-keys and a disconnected source of calling-current in one plug-circuit thereof; with a relay substation-circuit having a call-bell in a bridge between its conductors; whereby when the trunk-circuit is interposed between and connected with the cord-circuit and relay-circuit current from the cord-circuit battery circulates through the circuit thus organized; and by manipulating said signaling-keys the said call-bell is operated, as set forth.

4. In a telephone signaling-circuit, the combination of a trunk-circuit having a repeating-coil with four windings normally in series in pairs with the respective conductors of the circuit, an electromagnetic switching device; a cord-circuit divided by a repeating-coil of four windings, with a battery, signaling-keys and a disconnected source of calling-current in the calling plug-circuit; with a party relay substation-circuit having a call-bell in a ground branch from each conductor thereof;

whereby when the trunk-circuit is connected between the cord-circuit and the relay-circuit, current from the battery circulates through the circuit thus organized, and by manipulating said keys the call-bells are selectively operated, as set forth.

5. In a telephone signaling-circuit, the combination of a trunk-circuit having a repeating-coil with four windings normally in series in pairs with the respective conductors of the circuit, an electromagnetic switching device, and a normally-disconnected battery; a cord-circuit whose plug-circuits are inductively connected by a repeating-coil having four windings two in each side in series, with a battery and signaling-keys in the calling-plug side; with a relay substation-circuit having a call-bell; whereby when the trunk-circuit is connected between the cord-circuit and relay substation-circuit, current from the cord-circuit battery circulates through the circuit thus organized; and when the signaling-keys are manipulated the call-bell will be operated; when the telephone at the substation is removed the said electromagnetic device operates to switch the coil-windings into the opposite trunk-conductors in series with each other and in separate bridges between said conductors, and include the disconnected battery in the substation-circuit, and thereby establish two inductive circuits each with a separate battery, as set forth.

6. In a signaling-circuit, the combination of a trunk-circuit adapted to link a cord-circuit with a relay substation-circuit, a tip-conductor of the terminal plug being normally open in a listening-key and in inductive relation with an order-circuit; a relay in the plug-tip conductor adapted to operate a disconnecting-signal, a grounded relay connected with a member of the terminal jack whose armature operates to switch a battery-current through said relay, a repeating-coil having four windings connected by pairs in series with each conductor of the trunk, a disconnected battery, an electromagnetic switch adapted to be operated by a relay in the plug-sleeve conductor to switch the opposite windings of the coil into series with each other and to include the said battery between the windings of the plug-circuit; a cord-circuit having associated with the calling-plug, calling-keys, a main battery, a keyboard-signal, and a second battery in a grounded branch; with a relay substation-circuit; whereby when the said trunk, cord-circuit and relay-circuit are linked together, and the listening-key operated, current flows from said main battery in the circuit thus organized, the substation can be signaled, the main circuit will be divided into two inductive circuits, each with a separate battery upon the removal of the substation-telephone, and upon the replacement of the telephone the said keyboard-signal is operated, and upon the separation of the cord-circuit from the trunk-circuit the disconnecting-signal will be displayed as set forth.

In testimony whereof we have signed our names to this specification, in the presence of two subscribing witnesses, this 3d day of August, 1898.

GEORGE K. THOMPSON.
THOMAS C. WALES, Jr.

Witnesses:
GEO. WILLIS PIERCE,
ARTHUR W. PERCIVAL.