(No Model.) 2 Sheets—Sheet 1.

J. J. O'CONNELL.

SIGNALING APPARATUS FOR TELEPHONE EXCHANGE CIRCUITS.

No. 543,559. Patented July 30, 1895.

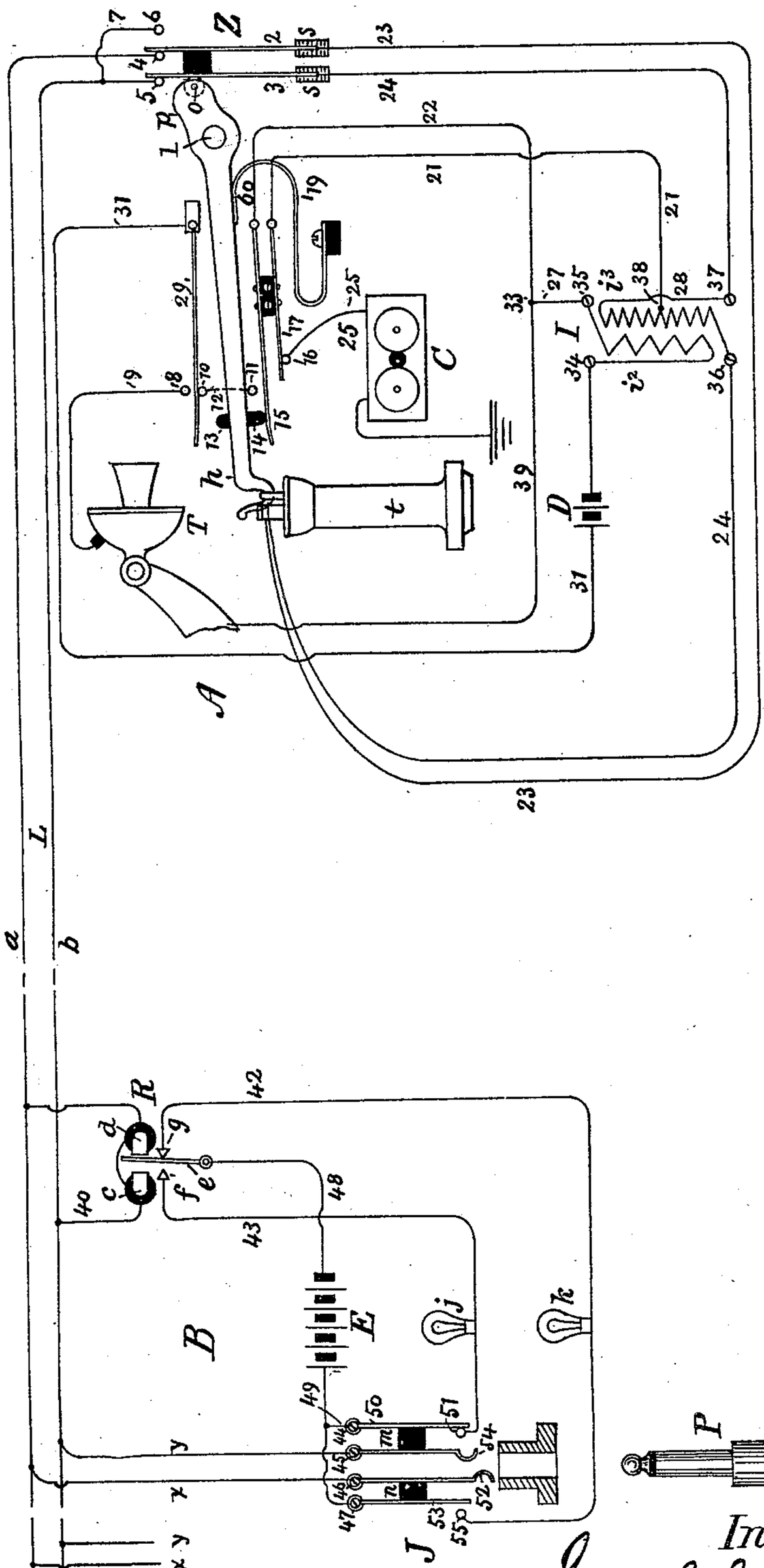

Fig. 1.

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(No Model.) 2 Sheets—Sheet 2.

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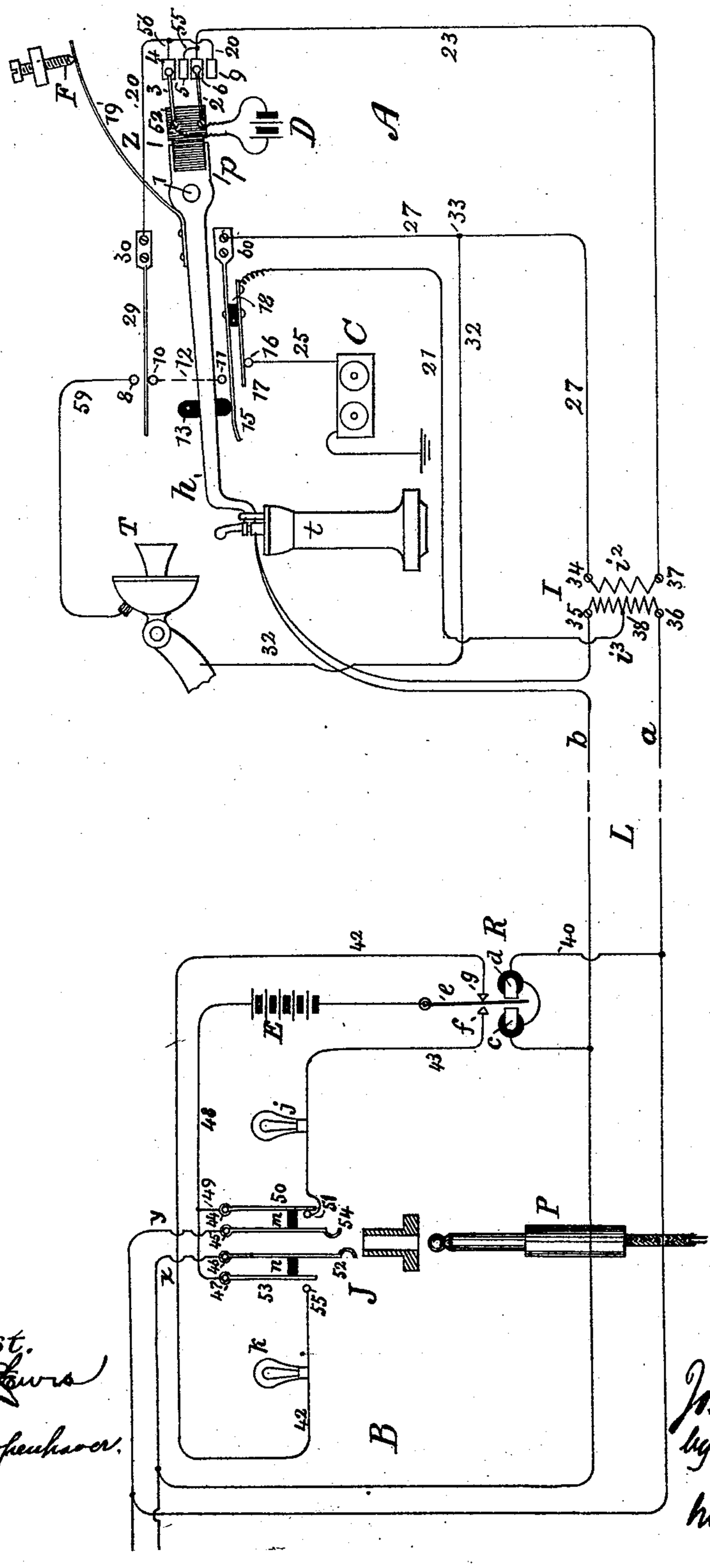
Fig. 2.



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UNITED STATES PATENT OFFICE.

JOSEPH J. O'CONNELL, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE AMERICAN BELL TELEPHONE COMPANY, OF BOSTON, MASSACHUSETTS.

SIGNALING APPARATUS FOR TELEPHONE-EXCHANGE CIRCUITS.

SPECIFICATION forming part of Letters Patent No. 543,559, dated July 30, 1895.

Application filed May 14, 1895. Serial No. 549,294. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH J. O'CONNELL, residing at Chicago, in the county of Cook and State of Illinois, have invented certain Improvements in Signaling Apparatus for Telephone-Exchange Circuits, of which the following is a specification.

This invention relates to signaling apparatus for telephone-exchange circuits, and particularly to the arrangement and control of call and disconnecting or "clearing-out" signals for such circuits at their switchboard terminals at the central station, and to devices at the sub-stations for automatically effectuating the operation of the said signals.

The more ordinary means employed for indicating a call from a sub-station consists of an electromagnetic or other signal appropriately numbered and placed at the conductor-terminals, while to indicate the conclusion of a message a similar signal has been associated with the cord connections employed in uniting circuits.

The object of this invention is to provide at the central station for each line a call-signal and a disconnecting-signal addressed to the eye of the attendant, which shall both display themselves when the operation they call for is to be performed, and which shall automatically withdraw or disappear when such operation is attended to or performed; and, further, to provide at the sub-station or at the initiatory end of the circuit means for the automatic actuation of both signals, requiring no special act on the part of the attendant there, but operated without his volition by taking up the receiving-instrument for use and by replacing the same in its customary place.

The most convenient visible signal for switchboard-work is an incandescing or glow lamp, inasmuch as such lamps can be made exceedingly small, involve no electromagnetic mechanism, and are of themselves more readily responsive than other apparatus to ordinary changes of current. Accordingly I prefer to employ them, although, if desired, other well-known forms of self-setting visible signals can be used.

At the central station the invention comprehends two such visible signals in independent normally-open local circuits provided with a common current-generator such as a voltaic battery, which signals, when made operative, respectively indicate a call and a required disconnection.

The current-generator may be in a section of circuit-conductor common to both circuits, and both local circuits have two points of control, one associated with the switch-socket and operated by the insertion and withdrawal of the switch-plug in answering calls and completing connections, and the other operated by the armature of a polar-relay or receiving-instrument whose helices are in the main telephone-circuit when quiescent and in a bridge thereof when concerned in a connection, and are therefore of high impedance. These appliances and circuit connections are so arranged that when any line is at rest the local circuit of the call-signal is open at the polar-relay and closed at its switch-socket controller, while the circuit of the disconnecting-signal, on the contrary, is closed at the relay and open at the switch-socket. Further, the switch-socket circuit-controllers are so arranged that the insertion of a switch-plug in its socket to answer a call acts not only to make the requisite and ordinary main-line connections between the main-circuit terminals and its attached cord-conductors, but likewise to open the call-signal circuit and to close the disconnecting-signal circuit; and the withdrawal of the plug to disestablish a through connection will operate reversely to again open the circuit of the disconnecting-signal and close that of the call-signal. These preliminaries being understood, it will be evident that the display of the call-signal can only occur when the main line is unemployed and is brought about by the movement of the relay-armature from one magnet-pole to the other, and that the display of the clearing-out signal can only occur when the main line has a plug in its switch-socket and in virtue of the return-swing of the relay-armature. It is also manifest that a call-signal once displayed can be withdrawn by the insertion of the switch-plug in the appropriate socket, and that a clearing-out signal when displayed dis-

appears when obeyed by taking the plug from the socket and so effectuating the disconnection.

At the sub-station, by the act of taking the receiving-telephone from its place of rest, induced currents are developed from the steady current of the transmitter-battery through the intermediation of suitable circuit closing and breaking contact springs and points and the transmitter induction-coil, these co-operating with a circuit or current reverser or circuit or pole-changing switch, which may be particularly associated with the transmitter-battery circuit to reverse the connection of the battery-poles therewith, or which preferably may be specially associated with the main line, in which event it reverses the connection of the incoming line-conductors with the terminals of the induction-coil secondary winding. The purpose of this circuit-changing switch is to prevent the transmission of false signals, as will hereinafter more fully be made manifest, and it, as well as the several circuit closing and breaking contact springs and points, are automatically controlled by the movement of the telephone switch-lever when freed from the telephone. The induced currents so developed and directed pass over the main circuit, and, acting upon the relay at the central station, produce the call-signal. Conversely, the replacement of the telephone operates them oppositely, and other induced currents are developed and selected, which pass over the main-line circuit to give the disconnecting-signal.

In the drawings which accompany and form a part of this specification, Figure 1 is a diagram of a telephone-circuit connecting a sub-station with a central station embodying a preferred form of my invention; and Fig. 2 is a similar diagram showing a modification of the circuits and apparatus. Both figures show the circuits and apparatus in their normal or quiescent condition.

Referring to Fig. 1, L is a telephone-circuit connecting a sub-station A with the central station B, its two limbs or conductors *a b* extending from the respective contact-pins 4 and 5 to their respective terminal line-springs 52 and 54 in the jack or switch-socket J. At the sub-station the main circuit continues normally by contact-springs 2 and 3, which may be fixed to supports *s s*, through the telephone-loop formed of wires 23 and 24, and leads through the helix of the receiving-telephone *t* and the secondary helix of the induction-coil I, which is connected therewith by means of the posts 36 and 37.

A wire 21 extends from the center of the said secondary winding to a spring 17, which is insulated from and is carried by the spring 15, which is fixed at its end 60. The spring 17 rests upon the pin 16, from which a wire 25 extends to earth and completes a circuit for the call-bell C.

The automatic telephone-switch *h* is pivoted at 1, and when the telephone *t* is hung thereon the insulating-pin 14 depresses the spring 15 and keeps the spring 17 in contact with pin 16; also elevating the arm *p*, so that the rotating contact *o* permits the springs 2 and 3 to be in contact with their pins 4 and 5, and these springs, together with their contact-pins 5, 4, and 6 and the arm *p* of the switch-lever, constitute a circuit or current changing or reversing device Z.

A wire 22 connects the spring 15 with one side of the transmitting-telephone T, which, from its other side, is connected by the wire 9 with the contact pin or stop 8, and from a point 33 on the wire 22 a wire 27 connects with screw-post 35, between which and screw-post 34 is the primary helix of the induction-coil I. From the screw-post 34 a wire 21 extends to the fixed end of the spring 29 in normal contact with the pin 10, which is united by wire 12 with the pin 11. The wire 31 includes the transmitter-battery D. The springs 29 and 15, the points 8 10 11, and the switch-lever *h*, together form a compound circuit breaking and closing apparatus for developing and controlling in association with the circuit-changer Z the required signaling induced currents.

At the central station is a signal-receiving device consisting of a polarized relay R, the helices of which are in the main circuit L when unemployed, and when the same is at work in a bridge thereof 40, extended between the circuit-conductors *a b*. The armature *e* of the relay is connected by wire 48 to a permanent connection with the circuit-controlling springs 50 and 53, which are insulated from the line-springs 54 and 52, but mechanically connected therewith by the non-conducting blocks *m* and *n*. The call-signal *k* (shown as a glow-lamp) is included in the wire 42, which extends from the armature contact-stop *g* to the switch-socket pin 55, and the disconnecting-signal *j* (similarly shown) is in the circuit of the wire 43, which connects the armature-stop *f* with the switch-socket pin 51.

The wire 48 includes the electrical generator E, and alternatively forms a section of both of the local signal-circuits. The springs 50 and 53, with their contact-stops 51 and 55, form the switch-socket controllers of the signal-circuits 43 and 42, respectively.

The relay R is operated by means of induced currents of electricity transmitted through the circuit, these being developed by the induction-coil I, consequent upon the sudden closing and opening of the circuits of the transmitter-battery D as the switch-lever *h* rises or falls by the removal or replacement of the telephone *t*, the induced currents of opening being, of course, of opposite sign or direction to those developed on closing unless the main-line or battery connections are likewise reversed. The arm *p* of the switch-lever *h* operates the circuit-changer springs 2 and 3 as the said circuits of the transmitter-battery are closed and opened by the main lever in its movements, and it changes the

direction of some of the said induced currents in order that the relay R may properly perform its functions.

When a call is to be made from the substation the telephone *t* is removed from the supporting-switch, which immediately commences to rise, owing to the resiliency of the spring 19, and the spring 15 follows the hook-switch until it makes contact with the pin 11, the spring 17 meanwhile having parted from the pin 16, cutting the bell C out of circuit. When the spring 15 comes in contact with the pin 11 the circuit of the battery D is completed, and may be traced *via* wire 31, primary coil i^2, wires 27 and 22, spring 15, pin 11, wire 12, pin 10, spring 29, and wire 31 to the other pole of the battery. A current circulates through this circuit, and an inductive impulse developed thereby in the secondary winding i^3 is sent through the line and relay, causing the armature *e* of the latter to be attracted to the pole *c* and to make contact with the stop *f*, thus closing the call-signal local circuit and illuminating the lamp *j* to denote a call. Immediately thereafter the arm *p* presses the springs 3 and 2 away from contacts 5 and 4, and into contact, respectively, with the pins 4 and 6, thus reversing the line or relay conductors *a b* relative to the substation wires 23 and 24—that is, to the terminals 23 and 24 of the secondary induction-coil winding, which reversal has of course no effect upon the relay-armature. As the hook-switch continues to rise its insulating-pin 13 presses the spring 29 away from the pin 10, thus opening the battery-circuit described, and into contact with the pin 8, thereby closing the battery-circuit through another path containing the transmitter T, which may be traced as follows: from battery D, wire 31, primary coil i^2, wire 39, transmitter T, wire 9, pin 8, spring 29, and by the other section of wire 31 to the other pole of the battery.

When the first battery-circuit is broken by the spring 29 leaving the pin 10, an induced current is caused to circulate in the wires 23 and 24 by means of the induction-coil of opposite sign or direction to that induced therein when the said circuit was closed; but as the current or circuit changer or reverser Z has in the meantime reversed the said wires relatively to the line-conductors *a b* the said induced current acts upon the poles of the relay as did the first induced current, and such effect as ensues is merely that of holding the armature in the position in which it was set by the said first induced current; and when the spring 29 comes into contact with the pin 8 a third induced current is developed in the line-circuit, having a direction opposite to that of the second impulse, which tended to hold the calling-signal circuit closed, but being a weak current, owing to the added resistance of the transmitter in the primary circuit, it has no effect upon the relay.

The operator at the central office noting the appearance of the call-signal *j* inserts the answering-plug P into the switch-socket J to ascertain the wish of the caller. The plug forces the springs 52 and 54 apart and into electrical union with its own conducting-surfaces, and also presses the spring 50 away from the pin 51, thus opening the calling-signal circuit and withdrawing the lamp-signal *j*. At the same time the spring 53 is brought into contact with the pin 55, closing the disconnecting-signal circuit at that point, so as to be in readiness for the reverse action of the relay R. When the telephone *t* is hung upon the switch-support at the termination of conversation, the said switch is depressed and as the spring 29 leaves the pin 8 an induced impulse, generated, as before described, circulates in the relay-helices, which tends to hold the armature to the contact *f*. Then as the spring makes contact with the pin 10 a current of opposite direction is induced and transmitted over the line-circuit, which causes the attraction of the relay-armature to the stop *g*, thus again opening the call-signal circuit at its relay controller, and closing the disconnecting-signal circuit, which being also closed at its switch-socket controller permits the flow of current from the generator E and the consequent display of the signal; and when the switch-lever comes to rest the spring 15 is parted from the pin 11 and the spring 16 is brought into contact with the pin 17, thus restoring all of the connections operated directly by the said lever. Before the spring 15 leaves the pin 11 the arm *p* has been elevated to allow the springs 2 and 3 of the circuit-changer Z to resume contact with their respective pins 4 and 5, thus reversing the wires 23 and 24 relatively to the conductors *a b*. Thus when the induced impulse, caused by the parting of the spring 15 from the pin 11 and the opening of the battery-circuit, circulates through the wires 23 and 24 and conductors *a b*, though its direction is opposite to the last impulse generated, it causes the relay to continue to attract the armature to the stop *g* and to display the disconnecting-signal *k*. The operator upon seeing the display of the disconnecting-signal withdraws the plug P, and the spring 53, leaving the pin 55, opens the disconnecting-signal circuit and causes the disappearance of the signal, and at the same time the spring 50 comes into contact with the pin 51 and closes the calling-signal circuit at that point.

In the modification shown in Fig. 2 the circuit-changer Z is placed in the primary circuit of the induction-coil I, but otherwise the two plans are substantially alike. As in Fig. 1, the first upward movement of the switch-lever *h* acts to disconnect the call-bell C. The bell is connected with the earth branch 21, leading from the middle of the induction-coil secondary winding, in order that the two main-line wires may together serve as the circuit-conductor for outgoing signals in a manner well understood; and since this feature forms no part of my invention I have not shown any

central-station apparatus for sending such signals, and the bell-circuit is led through the switch connections 16 and 17 to insure that its terminal at earth shall be severed from the talking-circuit on the establishment thereof. The second change effected by the switch is that the circuit of the transmitter-battery is closed at 11. This sends a current through the primary winding i^2 and an inductive impulse through the line and relay R; but by reason of the sluggishness of said relay, or the relative weakness of an induced current of this class, or the high resistance of the relay, or of all these causes combined, though this induced current has such a direction as will tend to move the relay-armature to its opposite position, it does not do so. The next change made is to reverse the direction of the battery-current in the circuit just formed by means of the circuit-changer or current-reverser Z, and this applies, of course, first a break and next a make of the circuit. The current induced in the main circuit by the break is in opposition to the first impulse which was sent, and tends, though strong, only to hold the armature against its normal stop; but the circuit is instantly again closed with the current reversed in the battery-circuit. Hence on the closing, also, the tendency of the induced current is to hold the armature in the same place. The next operation of the lever *h* is to again break the battery-circuit at the point 10, and since as the original closure of the circuit before the current was reversed tended to move the armature away from its normal stop the break of the circuit which now occurs will give the signal, because a break with the present direction of current is equivalent to a make with the former direction of current and because the induced current is stronger, that resulting from the opening of a circuit being very much stronger, indeed, than that resulting from a closure of the same circuit with the same battery. Finally, the lever closes the circuit of the battery through the transmitter at 8, and in this case while the tendency of the current induced is to pull the armature back to its original position, and thus cause the signal to disappear, we once more have a current which is not only itself weak, but is further weakened by the resistance of the transmitter included therein, and it, therefore, has no effect upon the relay-armature, so that the signal stays in view until the plug is inserted in the spring-jack or switch-socket J. On hanging up the telephone at the conclusion of a conversation, the series of operations performed are similar, but in reverse order, and bring about the display of the disconnecting-signal exactly in the same manner as is done by the apparatus of Fig. 1.

Having now fully described my invention and its mode of operation, I claim—

1. The combination of a main telephone circuit, two local signal circuits at a station thereof each including a visible signal, a switch socket for the said main circuit, and a switch plug therefor; a relay contained in the said main circuit and adapted to respond diversely to current impulses of opposite direction circulating therein; and circuit opening and closing switches at two points of each signal circuit so arranged that the signals of either of the said circuits can only be displayed when such circuit is closed at both points, one switch of both circuits being controlled by the said relay, and the other by the switch socket and plug, substantially as described.

2. The combination with a telephone circuit extending between a substation and a central station, a switch socket and plug therefor, and a signal receiving main circuit relay; of two local signaling circuits, each including a visible signal responsive to the passage of an electric current through its respective circuit, and adapted to disappear on the cessation of such current; two circuit controllers for each signal circuit, one associated with the switch socket, and operated by the insertion and withdrawal of the plug, and the other operated by the main circuit relay, the said signaling circuits being so arranged that one of them is normally closed in the switch socket and open at the relay, while the other is open at the switch socket and closed at the relay, whereby the relay is enabled to display the signal of the former only when the plug is not in its socket and the signal of the latter only when the plug is in its socket, substantially as described.

3. In a telephone switchboard apparatus the combination of a main telephone circuit extending to a substation; a polarized relay permanently connected therewith, and adapted to respond to currents of opposite sign traversing the said main line; a switch socket containing terminals of the said main circuit adapted for interconnection with other main circuits, and a switch plug associated therewith for the establishment of such interconnections; normally inert local signal circuits each including a glow lamp for call and disconnecting signals respectively, and a current generator therefor, the call signal circuit having a normally closed switch, and the disconnecting signal having a normally open switch within the switch socket, to be opened and closed respectively by the insertion of the plug, and to be restored to their normal condition on the withdrawal thereof; the said signal circuits being also controlled by the armature of the polarized relay, so that either one if closed within the switch socket may have its signal made operative when concurrently closed by the relay armature, in response to a main line current of appropriate sign, substantially as described.

4. The combination with a telephone circuit extending between a central station and a substation, of a substation apparatus comprising an automatic switch lever adapted to be actuated by the removal and replacement

of the telephone, a battery, an induction coil having a primary winding in circuit with the said battery, and a secondary winding in the main telephone circuit; a circuit or current changing switch actuated by the movements of the said automatic switch lever and transposing the relation of the main circuit and induction coil; and circuit closing and breaking springs and contact stops also actuated by the said switch lever in both directions, and adapted to close and open the circuit of the battery through the primary winding; whereby the stronger induced current due to the opening of the primary circuit is established at different times in opposite directions in the secondary winding and main line; substantially as and for the pusposes specified.

5. The combination with a telephone circuit extending between a central and a substation, of central station apparatus comprising a polarized relay permanently connected therewith, responsive to changes of direction in main line currents, a switch socket and its plug; and independent local call signal and disconnecting signal circuits including each a self-restoring visible signal, the said circuits being controlled jointly by the said polarized relay, and the switch socket and plug, so that the call signal circuit may be closed by the said relay and the signal given when the plug is withdrawn, while the disconnecting signal circuit may be closed and the signal given when the plug is inserted; and substation apparatus comprising the automatic switch lever actuated by the removal and replacement of the telephone, a battery, an induction coil, a circuit closing and breaking mechanism actuated by the movement of the automatic switch lever in both directions and adapted to close and open the circuit of the battery through the induction coil primary, and to develop induced currents thereby in the secondary winding and main line, and a circuit changing or current changing switch also actuated by the switch lever, and adapted to reverse the relations of the main circuit with the induction coil, and thereby select the stronger induced currents consequent on the opening of the primary circuit, and to cause them to circulate in the main line in opposite directions, whereby the central office relay is enabled to operate the call signal on the removal of the telephone, and the disconnecting signal on its replacement, substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 8th day of May, 1895.

JOSEPH J. O'CONNELL.

Witnesses:
ANNA B. RAYMOND,
A. S. FOX.