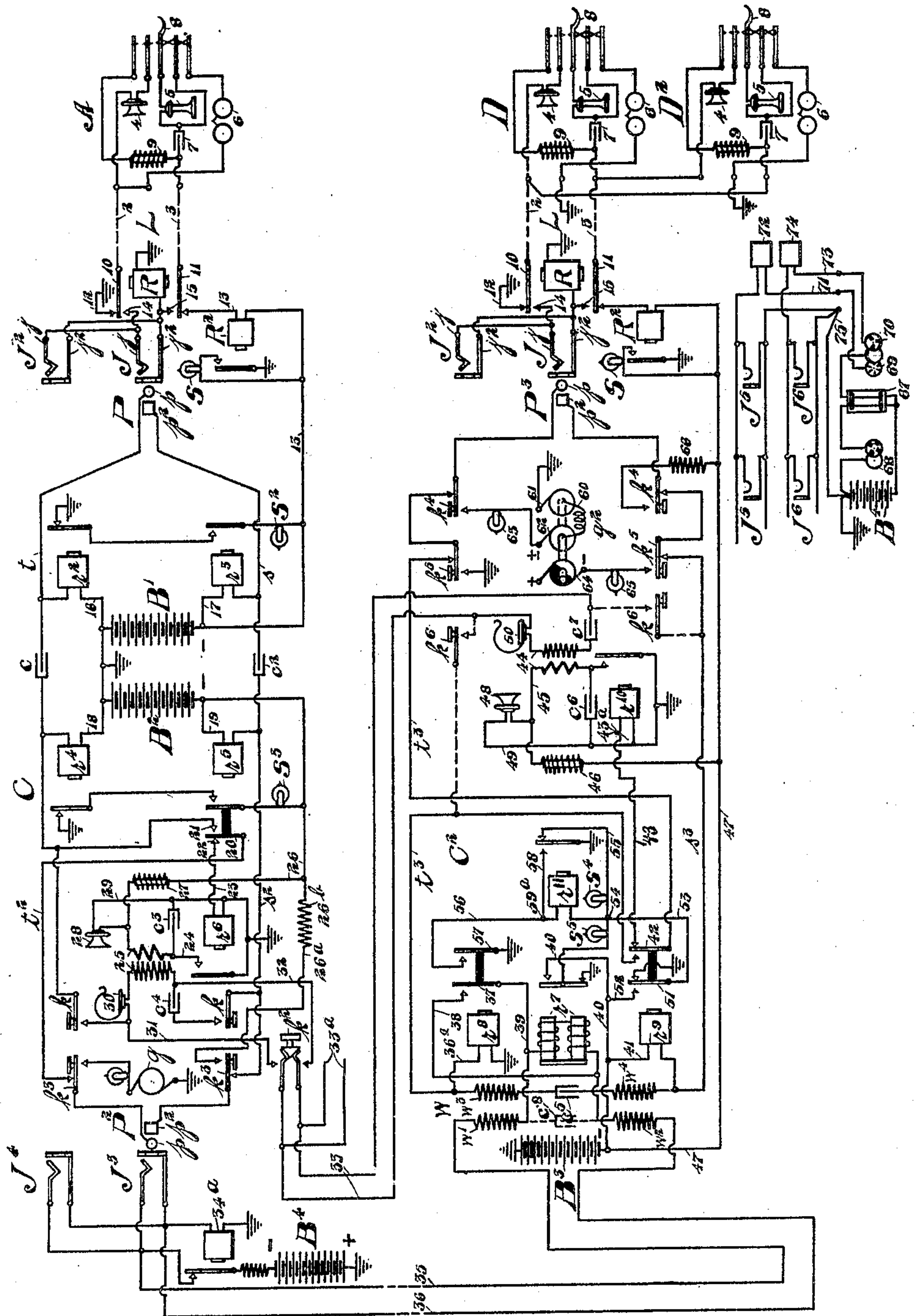


No. 818,527.

PATENTED APR. 24, 1906.

W. W. DEAN.  
TELEPHONE TRUNKING SYSTEM.  
APPLICATION FILED JULY 14, 1902.



Witnesses.  
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# UNITED STATES PATENT OFFICE.

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## TELEPHONE TRUNKING SYSTEM.

No. 818,527.

Specification of Letters Patent.

Patented April 24, 1906.

Application filed July 14, 1902. Serial No. 115,406.

*To all whom it may concern:*

Be it known that I, WILLIAM W. DEAN, a citizen of the United States, residing at Chicago, in the county of Cook, State of Illinois, have invented new and useful Improvements in Telephone Trunking Systems, of which the following is a specification.

In an application filed by me June 28, 1902, Serial No. 113,581, I have shown, described, and claimed a trunking-circuit and apparatus for connecting together subscribers' lines of the well-known "Dunbar" or "two-wire" type.

The present invention relates to the same general subject-matter as that of the above-mentioned application, and while many of its features may be employed in other relations it is intended particularly for the inter-connection of subscribers' lines of the above-mentioned type.

In the present invention one object is to provide a trunk-relay which is actuated when the connection is established at the outgoing end of the trunk in a manner to prevent the operation of the disconnect-signal at the incoming end and to operate the guard-signal at said end in case the called-subscriber's line has not been connected with by the incoming end of the trunk and to still maintain the armature of said relay in actuated condition during conversation, although its winding is deprived of operating-current.

A further object is to provide, in connection with a trunking system of the kind described, a polarized trunk-relay and means whereby when a connection is established with the trunk-circuit at the outgoing end the trunk-relay armature is actuated in one direction and when the connection is severed at said end the trunk-relay is actuated in the reverse direction. Further objects will be apparent from the description and claims.

My invention is illustrated in the accompanying drawing, in which the same reference characters designate like parts throughout, and in which the figure is a diagram showing two subscribers' lines leading to two different central offices and the trunking connection between said offices to enable the subscribers to be connected together for conversation.

In the figure, L designates one of the number of subscribers' lines terminating at the

central office C. This line extends in two limbs 2 and 3 from the subscriber's station A to the said central office C, where it is fitted with suitable answering and multiple jacks or connection-terminals J J<sup>2</sup>. At the subscriber's station the usual telephone instruments are provided and consist of a transmitter 4, a receiver 5, a ringer or call-bell 6, and the condenser 7. The switch-hook 8 is adapted in its normal position and when the receiver is placed thereon to open the circuit through the transmitter 4 and receiver 5 and to close it through the call-bell 6 and condenser 7. A retardation-coil 9 is connected at the substation when the hook is raised in parallel with the receiver 5 and condenser 7 to provide a path transparent to steady currents, but opaque to voice-currents. The line conductors 2 and 3 include, respectively, the armatures or springs 10 and 11 of the cut-off relay R, which is permanently legged to ground from the sleeve-contacts j<sup>2</sup> j<sup>2</sup> of the jacks J J<sup>2</sup>. The armature or spring 10 is normally connected with ground through the conductor 12, while the opposite armature 11 is normally connected with conductor 13, containing the line-relay R<sup>2</sup> for the line, said conductor leading to the live or ungrounded pole of the central battery B', the opposite pole of which is grounded. The line-relay R<sup>2</sup> controls, through its armature, the circuit of the line-signal S. The forward contacts 14 and 15 of the cut-off relay R are adapted to connect the jacks and the switchboard-section of the line with the external line-circuit when the said cut-off relay is energized. This, it is to be understood, is a typical two-wire line-circuit and is the particular kind with which I prefer to use my trunk-circuits, although I do not wish to so limit the use of the invention in all respects.

At the central office C the usual operator's cord-circuit is provided, said cord-circuit having an answering-plug P and a calling-plug P<sup>2</sup>, each being provided with a tip-contact p and a sleeve-contact p<sup>2</sup>, adapted to register with like contact-surfaces j and j<sup>2</sup> in the jacks of the line when the plug is inserted therein. The tip-contacts of the plugs are connected together by means of the tip-strands t and t<sup>2</sup> of the cord-circuit and the interposed condenser c, while the sleeve-contacts are likewise connected by the sleeve-strands s and s<sup>2</sup>



and the interposed condenser  $c^2$ . A conductor 16 extends from the grounded pole of the battery  $B'$  to the tip-strand  $t$  and contains the winding of the tip-supervisory relay  $r^2$ , associated with the answering-plug  $P$ , while the live pole of the battery is connected, by means of conductor 17, with the answering sleeve-strand  $s$  and includes the winding of the sleeve supervisory relay  $r^3$ . These relays  $r^2$  and  $r^3$  serve to control the circuit of the supervisory lamp  $S^2$ , associated with the answering-plug  $P$ , the former relay serving to normally close said circuit of the lamp, while the latter relay normally opens the same. The battery  $B^2$  is associated with the opposite or calling end of the cord-circuit and is connected by conductors 18 and 19 with the tip and sleeve strands  $t^2$  and  $s^2$ , respectively, the former conductor including the winding of the supervisory relay  $r^4$ , while the latter conductor includes the similar relay  $r^5$ . These relays serve in a manner similar to the relays  $r^2$  and  $r^3$  to control the circuit of the supervisory lamp  $S^3$ , associated with the calling-plug  $P^2$ . The relays  $r^2$  and  $r^4$  are conveniently referred to as the "tip-relays" and relays  $r^3$  and  $r^5$  as the "sleeve-relays," since they are connected with and operated by current flowing over the corresponding strands of the cord-circuit. The tip-strand  $t^2$  of the calling and testing plug  $P^2$  is normally open through the extra spring or movable contact 20 of the sleeve-relay  $r^5$ , but is adapted to be closed by the said spring and its forward contact 21 when the relay is energized. The back contact 22 of this extra spring 20 is connected, through the medium of conductor 23, with one side of the high-resistance and high-impedance relay  $r^6$ , known as the "test-relay," the other side of which is grounded. The armature of this relay is likewise grounded, and its forward contact is connected with the primary winding of the operator's induction-coil 25 by means of conductor 24. The other end of the said primary winding is connected, through the medium of conductor 26, to the live pole of the battery  $B^3$ , a retardation-coil 27 being included in this circuit. The operator's transmitter 28 is joined on one side to conductor 26, intermediate her primary coil and the coil 27, and on the other side through conductor 29 to ground. A condenser  $c^3$  is included in the operator's local circuit to facilitate talking and is connected as shown. The secondary winding of her induction-coil 25 is adapted to be included, together with her receiver 30 and a condenser  $c^4$ , in a bridge between the strands of the cord-circuit by means of any suitable key and indicated diagrammatically by  $k k$ . Branch connections 31 and 32 lead from opposite sides of the receiver and secondary to an order-key  $k^2$ , connected with an order circuit or wire 33, leading to the office  $C^2$ . A grounded alternating-current ringing-generator  $g$  is adapted to be

connected through a resistance-lamp with the tip-strand  $t^2$  of the cord-circuit by means of the tip-ringing key-spring  $k^3$ , the sleeve contact  $k^3$  of said key being connected with battery-lead 26 through wire  $26^a$  and resistance  $26^b$ .

A trunk-circuit is shown extending between the central offices  $C$  and  $C^2$ , said trunk-circuit being fitted at the outgoing end with multiple jacks, such as  $J^3$  and  $J^4$ , with a relay  $34^a$ , legged to ground from the sleeve side of the circuit. The battery  $B^4$ , which may be either a separate battery, as shown, or the same battery as  $B'$  or  $B^2$ , is connected, through a resistance and the normal contacts of said relay  $34^a$ , to the tip side of the trunk. At the opposite end of the trunk a polarized trunk-relay  $r^7$  of high resistance is connected between the windings  $w'$  and  $w^2$  of the repeating-coil  $W$ , which are connected with the opposite trunk-limbs 35 and 36. Battery  $B^4$  is so connected as to maintain the armature of the polarized relay  $r^7$  in the position shown and connected to ground. The opposite windings  $w^3$  and  $w^4$  of the repeating-coil  $W$  are connected together with an interposed condenser  $c^5$  between the tip-strand  $t^3$  and the sleeve-strand  $s^3$  of the trunk-cord, which strands terminate in the corresponding contacts  $p$  and  $p^2$  of the trunk-plug  $P^3$ . The tip-relay  $r^8$  is legged to ground from the tip-strand  $t^3$  of the trunk-circuit by conductor  $36^a$  and controls, through its forward contacts, a short circuit composed of conductors 38 and 39 of the high-resistance polarized trunk-relay  $r^7$ . A sleeve-relay  $r^9$  is connected on one side with the live pole of the battery  $B^3$  by means of conductors 40 and 41 and on the other side with sleeve-strand  $s^3$ . This incoming end of the trunk-circuit is provided with a testing apparatus similar to that described for the cord-circuit at the central office  $C$ . The forward portion of the tip-strand  $t^3$  is connected with spring 42 of the sleeve-relay  $r^9$ , while the other portion is connected with the forward contact of said spring. The back contact of spring 42 is joined by conductor 43 with the common high-resistance and impedance test-relay  $r^{10}$ , the opposite terminal of which is grounded. The armature of this test-relay serves when actuated to ground one side of the primary winding of the operator's induction-coil 44, which winding is connected on the other side with a conductor 45, containing the resistance and impedance coil 46 and joined to conductor 47, leading directly to the live pole of the battery  $B^3$ . The operator's transmitter 48 is in a conductor 49, leading from conductor 45 to ground. A condenser  $c^6$  is connected between conductor 49 and the side of the primary that is adapted to be grounded. The operator's receiver 50, together with the secondary of her induction-coil and condenser  $c^7$ , are connected permanently with the order circuit or wire



33, leading to the central office C. The forward contact of spring 51 of sleeve-relay  $r^9$  is connected by conductor 52 with the conductor 40, leading from the live pole of generator  $B^3$ . The spring 51, which is normally grounded, is connected by conductor 53, leading to point 54, and thence by conductor 55 through the ringing-lamp  $S^4$  to the normal contact of the grounded armature of locking-relay  $5^{11}$ . The locking-relay  $r^{11}$  is connected in a conductor 56, extending from point 54 to the forward contact of grounded spring 57 of tip-relay  $r^8$ . The forward contact of the locking-relay armature is joined by conductor 58 with conductor 56 at point 59<sup>a</sup>. The guard and disconnecting-lamp  $S^5$  are connected between the point 54 and the armature of polarized trunk-relay  $r^7$ , the lower and normal contact of which is grounded, as shown, and the upper and normally open contact of which is connected, by means of conductor 40, to the live pole of the battery  $B^3$ . This incoming end of the trunk is equipped for selectively ringing subscribers upon a party-line. It comprises the ringing-key contacts  $k^4 k^4$  and  $k^5 k^5$ , placed in the strands of the trunk-cord and adapted when actuated to suitably connect the alternating-current generator  $g^2$  with the plug  $P^3$ . This ringing-generator comprises the armature 60, the grounded brush 61, the brush 62, from which the alternating current is directed through resistance-lamp 63 to tip-key spring  $k^4$  when depressed, and brush 64 from the split commutator-ring, which is adapted to deliver a current of negative pulsations only through lamp 65 to the sleeve-key  $k^5$  when the key is operated. The sleeve-contact of key  $k^4$  when operated connects the sleeve of the plug to battery-lead 47 through resistance-coil 66 to maintain the cut-off relay of the line operated during ringing. The subscriber's line shown in connection with this office is of the party-line type and is connected to subscribers D and D<sup>2</sup>. The apparatus at these stations is similar to that at the station A and are likewise indicated, except that the bell 6 at station D is connected between the sleeve-conductor 3 and ground, while at station D<sup>2</sup> the bell is connected between the tip-conductor 2 and ground. The same type of normally disconnected jacks J J<sup>2</sup>, line-relay R<sup>2</sup>, cut-off relay R, and the line-signal S are employed and are designated by the same reference characters. The battery  $B^3$  furnishes current for the operation of these various relays and signals, as well as for talking.

J<sup>5</sup> J<sup>5</sup> and J<sup>6</sup> J<sup>6</sup> are respectively "busy-back" and "don't-answer" jacks associated with the incoming trunks. These circuits comprise an induction-coil 67, having its primary in circuit with a rapidly-rotating circuit-breaker 68 and the battery  $B^4$ , this battery being preferably the same battery as  $B^3$ , though shown separately for convenience.

The secondary of the induction-coil 67 is connected in circuit with the rapid circuit-interrupter 69 and the more slowly operating interrupter 70. From interrupter 69 a conductor 71 leads to the tip-contacts of busy-back jacks J<sup>5</sup> J<sup>5</sup> through a fifty-ohm resistance-coil 72, while interrupter 70 connects by conductor 73 through resistance-coil 74 to the tips of the don't-answer jacks. The sleeves of both sets of jacks are united by conductor 75 with the grounded pole of the battery. The circuit-breaker 68 causes induced currents in the secondary circuits which are interrupted at short intervals by breaker 69 and at longer intervals by breaker 70 to cause distinctive tones at the jacks J<sup>5</sup> and J<sup>6</sup>, whereby when a trunk-plug is inserted in one or the other jack a corresponding signal is transmitted to the waiting subscriber.

In tracing the circuits hereinafter the plan for pointing out the path for current from the live or ungrounded pole of the battery to the ground only will be followed for convenience, it being understood that the return-current will seek the grounded pole of the battery and that the circuit will therefore be complete.

The operation is as follows: The A subscriber desiring a connection with a subscriber located at another exchange removes his receiver from the hook, and thereby closes a path for current between the limbs 2 and 3 of his line through the transmitter 4 and retardation-coil 9, the condenser 7 and receiver 5 being connected in parallel with the retardation-coil. The closing of this circuit permits current to flow from the battery B' through conductor 13, line-relay R<sup>2</sup>, spring 11 of cut-off relay R, limb 3 of the telephone-line, through retardation-coil 9 and transmitter 4 at the substation, and thence over limb 2 back to the central office and spring 10 of cut-off relay R, through conductor 12 to ground. The line-relay R<sup>2</sup> is thus operated and closes the circuit of the signal-lamp S to ground from the conductor 13. The operator upon seeing the line-signal exposed inserts the answering-plug P into the answering-jack J of the subscriber's line and connects her telephone 30 with the cord-circuit by depressing the listening-key  $k k$  to receive the order from the subscriber. The insertion of the plug P closes a circuit through the cut-off relay R from the live pole of the battery B' through conductor 17, sleeve supervisory relay  $r^3$ , sleeve-strand  $s$ , sleeve-contacts  $p^2$  and  $j^2$  of the plug and jack, thence through the winding of the cut-off relay R to ground. The operation of this relay disconnects the armatures 10 and 11 from the ground-wire 12 and from the battery-lead 13 and connects them through the forward contacts 14 and 15 of said armatures to the normally disconnected jacks J J<sup>2</sup>. The operation of the supervisory relay  $r^3$  over the



path just traced serves to close, through its armature and front contact, the circuit of the supervisory signal  $S^2$ , which is associated with the plug  $P$ ; but it is prevented from glowing by the operation of the tip supervisory relay  $r^2$ , which is connected in the conductor 16 and receives current over telephone-line and the tip-strand  $t$  of the cord-circuit and through conductor 16 to the grounded pole of the battery  $B'$  as soon as the cut-off relay  $R$  is operated. The supervisory signal  $S^2$  therefore remains inert while the battery  $B'$  furnishes current over the metallic telephone-line for the operation of the supervisory relays and for conversational purposes. The operator's transmitter 28 is receiving current at this time from the battery  $B^2$  over the conductor 26, through retardation-coil 27, thence through the transmitter 28 and over conductor 29 to ground. When sound-waves strike the transmitter 28, the current flowing therethrough is varied, which causes a variation of the charge in the condenser  $c^3$  and a corresponding surge of current through the primary of her induction-coil 25. These induce voice-currents in the secondary, which are transmitted to the line, and the operator is therefore able to converse with the calling subscriber. Upon learning that a subscriber in the exchange  $C^2$  is desired, the A operator depresses the order-key  $k^2$  to connect her telephone with the order wire or circuit 33 and repeats the number of the wanted subscriber to the B operator, whose head telephone 50 is permanently connected with the said order-wire. The latter operator designates to the A operator the trunk to be used for the connection and proceeds to test the condition of the wanted line with the tip of the plug of the incoming trunk named. If the line is idle, no "click" will be received, but if busy the sleeve-contacts of the jacks of the line will be connected with the live pole of a battery through the sleeve contact and strand of the inserted plug. A complete circuit will therefore be established from the sleeve-contact of the tested jack, which it is assumed is connected with the live pole of the battery, through the tip of the plug  $P^3$ , tip-strand  $t^3$ , spring 42, and back contact of sleeve-relay  $r^9$  to conductor 43, through the common high-resistance and impedance test-relay or responsive device  $r^{10}$  to ground. This test-relay will therefore operate and ground, through its armature and front contact, one side of the primary of the operator's induction-coil 44, the other side of which is connected by conductor 45 through resistance 46 and conductor 47 to the live pole of the battery  $B^3$ . The completion of this circuit will permit a flow of current therethrough which will induce a current in the secondary of the said induction-coil and produce a click in the receiver 50 of the operator's set.

The operator's receiver will respond to this click at all times, even though the order-circuit should be open at the A exchange, since the electrostatic capacity of her circuits and that of the order-circuit is ample for the purpose of producing the click.

In the three-wire systems, where the test-circuits are insulated from the subscriber's line, there is no danger of varying the current flowing in the line to the annoyance of the subscriber during testing; but in the two-wire systems, where the testing contacts are connected directly with the talking-circuit, some means is necessary, or at least desirable, to prevent noticeably varying the current upon lines connected for conversation when testing their condition at other sections of the switchboard. This is accomplished in the circuit described by means of the test-relay  $r^{10}$ , which is of such high resistance as to vary the current upon the tested line but slightly and which is also of high impedance, so that its current will build up slowly, to thereby prevent a sudden variation of current on the line. The subscriber or subscribers whose lines are tested are therefore undisturbed by a sudden or large variation of current through their instruments. It is apparent that any other suitable test-responsive device or indicator than the relay  $r^{10}$  can be employed and that the operator's telephone can be used in place of the same or in the circuit with a retardation-coil; but the arrangement described is preferred. This relay is preferably common to all the incoming trunks at one operator's position, as indicated by the branching lines at 43<sup>a</sup>. Upon finding the line idle the plug  $P^3$  is inserted in one of the multiple jacks of the wanted subscriber's line.

The A operator having received the number of the trunk to be used inserts the calling-plug  $P^2$  of her cord-circuit in the jack  $J^3$  of the trunk at her section. The insertion of the plug  $P^2$  closes the circuit from the live pole of the battery  $B^2$ , through the sleeve-strand and through the relay 34<sup>a</sup>, to ground, thus operating the same and cutting off the battery  $B^4$  from the tip side of the trunk-circuit and at the same time permitting the negative current to flow over the sleeve side of the trunk and through the trunk-relay  $r^7$  in the usual way. The trunk-relay is therefore reversed; but on account of its high resistance the tip supervisory in the A-cord circuit is not at this time operated, for which reason the supervisory signal  $S^3$  is operated. The insertion of the incoming trunk-plug into the jack of the wanted line closes a circuit from the live pole of the battery  $B^3$ , over conductors 40 and 41, through sleeve-relay  $r^9$ , and thence over the sleeve-strand  $s^3$  of the trunk-cord, and thence through the sleeve-contacts of the plug and jack to ground, operating the cut-off relay. The sleeve-relay is also oper-



ated and disconnects the test-relay  $r^{10}$  and completes the tip-strand  $t^3$  of the trunk-cord. This relay also completes the circuit of the ringing-lamp  $S^4$  from the battery  $B^3$ , over conductor 40, conductor 52, forward contact and spring 51 of sleeve-relay, conductor 53, to point 54, and thence through the ringing-lamp  $S^4$ , over conductor 55, to the back contact and armature of locking-relay  $r^{11}$ , to ground. This lamp is therefore lighted and indicates to the operator that the called subscriber has not removed his telephone from its hook. The operation of the trunk-relay  $r^7$  at this time opens, through its armature and back contact, the circuit of the guard and disconnecting-lamp  $S^5$  to thereby prevent its operation. Upon the insertion of the trunk-plug  $P^3$  the B operator rings the wanted subscriber. If the subscriber D is the one desired, the ringing-key  $k^5$  is depressed, which throws ringing-current upon the sleeve-strand connected with the plug  $P^3$  and operates the subscriber's bell over the following path: from ground at the generator  $g^2$ , brush 61, armature 60 of the generator, brush 64, through resistance-lamp 65, key  $k^5$ , thence over the sleeve-strand of the cord to the plug  $P^3$ , over the sleeve-limb 3 of the telephone-line to the station D, and thence through condenser 7 and bell 6 to ground, the receiver 5 being at this time upon the hook 8, and therefore completing the circuit between the condenser 7 and bell 6.

It will be noticed that just previous to the depression of the ringing-key  $k^5$  the cut-off relay R was receiving a negative current through its coils from the battery  $B^3$ . At the instant the ringing-key  $k^5$  is depressed this path of current from the battery  $B^3$  is broken; but a new path is immediately established through the relay R from the negative source of pulsating ringing-current. The relay R is so constructed as to be maintained in continuous operation when this negative pulsating current is passing through its windings, and as pulsations are used of the same direction as the current furnished by the battery  $B^3$  the relay R is prevented from even momentarily releasing its armatures at the moment the ringing-key was depressed.

The bell 6 at the subscriber's station may be of the ordinary polarized type, as the presence of the condenser 7, which is connected directly in the ringing-circuit, permits the operation of such a bell from the pulsating source of ringing-current. The tip-spring of ringing-key  $k^5$  is grounded at this time to provide a path to ground for the return-current if the subscriber should respond during ringing. Should the subscriber  $D^2$  be the one desired, the ringing-key  $k^4$  is depressed, which serves to connect the generator  $g^2$  with the tip-strand of the cord-circuit to operate the bell at the station  $D^2$ . The ringing-circuit may be traced as follows: from ground at the

generator  $g^2$ , brush 61, armature-winding 60 of the generator, brush 62, through resistance-lamp 63, spring  $k^4$  in the tip-strand of the cord-circuit, thence over the tip-strand and tip conductor 2 of the line to the station  $D^2$ , and thence through condenser 7 and normally closed contacts of the hook 8, and through bell 6 to ground. The bell is thus operated. To maintain the cut-off relay R operated during ringing, the inner contact of the sleeve-spring  $k^4$  is connected through a resistance-coil 66 with the battery-lead 47, extending to the live pole of the battery  $B^3$ . This prevents the deenergization of cut-off relay R while ringing.

It is apparent that the arrangement of the ringing-keys is such that either key may be used to call a subscriber at whose station the apparatus is connected in the manner shown at A, which shows the arrangement which I preferably use where but one subscriber is placed upon the line. In this case the ringing-circuit would be complete over the subscriber's metallic circuit, the current returning to the grounded side of the ringing-generator by means of the grounded key  $k^5$  or battery-contact of the ringing-key  $k^4$ .

The subscriber having been called responds by taking up his receiver, and thereby closes a path for current between the limbs of his line from the main battery  $B^3$  over conductors 40 and 41, sleeve-strand  $s^3$  of the incoming end of the trunk-line 3 of the telephone-line, thence through retardation-coil 9 and transmitter 4 at the substation, thence over limb 2 of the telephone-line back to the central office and over tip-strand  $t^3$  of the incoming end of the trunk including spring 42 and its forward contact of sleeve-relay  $r^9$ , through conductor 36<sup>a</sup> and tip-relay  $r^8$  to ground. This relay responds to the current now flowing through it and closes through its contact 37 the short circuit of the high-resistance polarized relay  $r^7$ , consisting of conductors 38 and 39. This relay being polarized, however, the armature thereof does not return to normal position, but remains in position with its upper end against the back contact. The resistance of the trunk-relay  $r^7$  being now removed, the tip-relay  $r^4$  of the A cord receives sufficient current from the battery  $B^2$  to operate the same, and thereby open the circuit of the supervisory signal  $S^3$ , thus indicating to the operator that the wanted subscriber has responded to the call and that the parties are in condition to converse. The closing of spring 57 of tip-relay  $r^8$  upon its forward contact, however, completes the circuit of the locking-relay  $r^{11}$ , as follows: from the live pole of the battery  $B^3$ , conductors 40 and 52, front contact and armature 51 of sleeve-relay  $r^9$ , conductor 53 to point 54, thence through the winding of locking-relay  $r^{11}$  and over conductor 56 to the forward contact of spring 57 of tip-relay  $r^8$



and to ground. The locking-relay  $r^{11}$  therefore operates and opens through its armature and back contact the circuit of the ringing-lamp  $S^4$ , which is extinguished and indicates to the operator that the called subscriber has responded to his ring. The closing of the armature of the locking-relay  $r^{11}$  upon its forward contact completes a locking-circuit for said relay from the point 59<sup>a</sup>, through conductor 58, the forward contact, and armature of the relay to ground. This circuit and relay are therefore locked and the ringing-lamp  $S^4$  locked out during the remainder of the connection and can only be released when the sleeve-relay  $r^9$  is deenergized, which occurs when the plug  $P^3$  is pulled out. Should the tip and sleeve contacts of the plug be crossed when the plug is inserted in a jack and the locking and other relays operated, they will be immediately released by the opening of the sleeve-strand in ringing and no confusion would result therefrom. The subscribers are now connected together for conversation and the supervisory signals at both exchanges are extinguished. The battery  $B'$  is furnishing current over the answering end of the A-cord circuit to the A subscriber's line for talking purposes and for the operation of the supervisory relays, the battery  $B^2$  is furnishing current over the trunk-line for the operation of the supervisory relays associated with the answering end of the A-cord circuit, and the battery  $B^3$  is sending current over the incoming end of the trunk and to the substation D to furnish current for talking and for the operation of the several relays. The voice-currents are transmitted inductively from the subscriber's line L to the trunk-circuit through the condensers  $c$  and  $c^2$  in the A-cord circuit and from the trunk-circuit to the incoming end thereof and the subscriber's line connected therewith through the medium of the repeating-coil W. The condenser  $c^5$  between the windings  $w^3$  and  $w^4$  of the repeating-coil at the incoming end of the trunk prevents the flow of steady current therethrough, but permits a free passage of the voice-currents. The relay 34<sup>a</sup> by its retardation prevents leakage of voice-currents.

At the termination of the conversation the subscribers return their receivers to the hooks, with the result, in the case of subscriber A, that the tip supervisory relay connected with the A cord is deenergized and closes through its armature and back contact the circuit of the supervisory signal  $S^2$ , thus indicating that fact to the operator. When the subscriber D hangs up his telephone, current is cut off from the metallic line in the same way, and the tip-relay is therefore deenergized and the short circuit about the trunk-relay is opened. The current in the trunk-circuit must now flow through the high-resistance trunk-relay, which permits the tip-relay  $r^4$  in the A cord

to return to normal position, thus lighting the signal-lamp  $S^3$ . The A operator observing that both subscribers have hung up their receivers takes down the connection, thus restoring all parts at her office to normal position and permitting the battery  $B^4$  to put negative current upon the tip side of the trunk, as at first described, to thereby cause the trunk-relay  $r^7$  to throw its armature into normal position. It therefore closes the circuit of the disconnecting-lamp  $S^5$ , which circuit includes conductors 40, 52, and 53, to the point 54, thence through the limb and armature of the trunk-relay to ground. The lighting of this lamp indicates to the B operator that the A operator has disconnected her cord-circuit from the trunk and that the plug  $P^3$  should be withdrawn. Upon withdrawing this plug the sleeve-relay  $r^9$  is deenergized and the circuit of the signal-lamp  $S^5$  is opened at the front contact of the armature 51. The opening of this circuit also deprives the locking-relay of current, the armature of which returns to normal position. The disconnecting-signal  $S^5$  serves also as a guard-signal in case the A operator inserts the calling-plug  $P^2$  of her cord-circuit into a wrong jack, for the reason that the trunk-relay armature will be thrown to its abnormal position, thus closing a circuit from the said lamp, as follows: from battery-lead 40 through the said armature and lamp and thence over conductor 53 to spring 51 and back contact of sleeve-relay  $r^9$  to ground. This will indicate to the B operator that a mistake has been made.

In case the wanted subscriber's line is found busy or in case the subscriber having been called does not respond the plug  $P^3$  is inserted in one of the jacks  $J^5$  or  $J^6$  and the corresponding signal is transmitted to the waiting subscriber. Upon inserting the plug  $P^3$  in one of the jacks  $J^5$  a path for current is provided from the battery  $B^3$  through the sleeve-strand of the trunk-cord, sleeve-contacts of the plug and jack, and over conductor 75 to ground. This will serve to operate the sleeve-relay  $r^9$  to complete the continuity of the tip-strand  $t^3$  of the trunk-cord through its spring 42 and the front contact. Upon the completion of the strand at this point the tip-relay  $r^8$  is provided with current from the live pole of the generator  $B^4$ , through the secondary winding of the induction-coil 67, through circuit-breaker 69, and thence over conductor 71 through resistance 72 and the tip-contacts of the jack and plug and over the tip-strand and through the relay  $r^8$  to ground. This circuit is interrupted at the breaker 69, so that the relay  $r^8$  is alternately energized and deenergized to correspondingly make and break the short circuit of the trunk-relay  $r^7$ , which is therefore simultaneously removed from and inserted in the circuit of the outgoing end of the trunk. This causes the intermittent operation of the tip-relay  $r^4$  in



the A-cord circuit to effect the flashing of the supervisory signal  $S^3$ , whereby the A operator is notified that the called subscriber's line is busy. The flashing of this light of course  
 5 corresponds to the rapidity of the breaking of the circuit at breaker 67 or 70, which indicates to the operator whether the line is busy or does not answer. The subscriber is also notified by the tone caused in his receiver.

10 The order-circuit 33, as is indicated by the branching lines 33<sup>a</sup>, connects the B operator with several A operators either at the same or different exchanges. The A operator is also provided with a plurality of keys  $k^2$  to  
 15 connect herself with the different B operators. The busy-back or don't-answer apparatus is common to the various sections of the incoming trunk-board, as is indicated by the branching lines.

20 Although I have described the method of making connections through the medium of the order-circuit, I do not wish to so confine the invention, for it is apparent that the A operator is able by means of her testing apparatus to test the condition of the several  
 25 trunks before her until an idle trunk is found. Upon so testing and finding an idle trunk she may insert the calling-plug  $P^2$  of her cord-circuit, with the result that the trunk-relay  $r^7$  operates and lights the lamp  $S^5$ , which lamp has  
 30 been previously termed the "guard-lamp;" but in this method of operation it would act as a calling-signal from the A operator to the B operator. The B operator upon seeing the signal  $S^5$  would depress her listening-key  $k^6$   
 35  $k^6$ , which would connect her receiver in series with the repeating-coil windings  $w^3$  and  $w^4$ , these receiver connections being indicated in dotted lines in Fig. 1. She is therefore able  
 40 to communicate with the A operator. Upon learning the desired connection the B operator completes the same, as before described. It will also be understood that had the subscriber A called for a connection with another  
 45 subscriber in the same exchange the line of that subscriber would have been tested in the ordinary manner by means of a cord-plug  $P^2$  and the test-relay  $r^6$ , and the subscriber would have been called by the ringing-generator  $g$ .

50 The ground connections heretofore referred to, it will be understood, may and in practice usually are one and the same, or they may be the common office-return, although it is found  
 55 by experience that it is practically necessary to place a dead-ground upon one side of the common battery. It is also apparent that the other pole of the batteries may be grounded, so far as the operation of the system is  
 60 concerned, the only variation necessary from that shown in the drawings being to remove the present ground connections and replace them by other conductors and replace the ground upon the opposite pole of the battery.

65 While I have described several forms and

several different ways of carrying out my invention, I would have it understood that the invention is not so limited, as it is apparent that various changes and substitutions may be made therein and still come within its  
 70 scope and principle; but

What I do claim as my invention, and desire to secure by Letters Patent, is—

1. The combination with a trunk-line adapted to connect with a calling telephone-  
 75 line at its outgoing end and with a called telephone-line at its incoming end, a signal at the incoming end of the trunk, a trunk-relay at said end actuated by current over the trunk  
 80 when connection is established at the outgoing end for preventing the operation of said signal, means actuated when the called subscriber responds for entirely depriving said relay of operating-current, and means where-  
 85 by said relay still remains in operated position although deprived of operating-current through any of its windings and prevents the actuation of said signal during conversation, substantially as described.

2. The combination with a trunk-line  
 90 adapted to connect with a calling telephone-line at its outgoing end and with a called telephone-line at its incoming end, of a polarized relay at the incoming end of the trunk, a signal at said incoming end whose actuation de-  
 95 pends upon said relay, and means to direct current through said relay in one direction when connection is severed at the outgoing end and in the opposite direction when connection is established at said end to effect the  
 100 desired operation of the relay, substantially as described.

3. The combination with a trunk-line, of a calling telephone-line with which its outgoing  
 105 end is adapted to connect and a called telephone-line with which its incoming end is adapted to connect, of a polarized relay at the incoming end of the trunk, a signal at said incoming end whose actuation depends upon  
 110 said relay, and means to direct current through said relay in one direction before connection is established at the outgoing end and to direct current through the same in the opposite direction after the connection is es-  
 115 tablished, substantially as described.

4. The combination with a trunk-line, of a calling telephone-line with which its outgo-  
 120 ing end is adapted to connect and a called telephone-line with which its incoming end is adapted to connect, of a polarized relay at the incoming end of the trunk, a signal at said incoming end whose actuation depends upon  
 125 said relay, and means for normally sending current through said relay in one direction and to send it through the same in the opposite direction by the act of making the connection at the outgoing end of the trunk, substantially as described.

5. The combination with a trunk-line, of a calling telephone-line with which its outgo-  
 130



ing end is adapted to connect and a called telephone-line with which its incoming end is adapted to connect, of a polarized relay at the incoming end of the trunk, a signal at  
 5 said incoming end whose actuation depends upon said relay, and means for sending current through said relay in one direction when connection is established with the outgoing end of the trunk and for sending it through  
 10 said relay in the opposite direction when the said connection is severed, substantially as described.

6. The combination with a trunk-line, of a calling telephone-line with which its outgoing end is adapted to connect and a called  
 15 telephone-line with which its incoming end is adapted to connect, of a source of current normally connected with the trunk, a trunk-relay connected between the trunk conductors at the incoming end, a signal whose actuation depends upon said relay, and means  
 20 for reversing the connections of the said current source with the trunk when connection is established at the outgoing end of the trunk, substantially as described.

7. The combination with a trunk-line, of a calling telephone-line with which its outgoing end is adapted to connect and a called telephone-line with which its incoming end is  
 30 adapted to connect, of a polarized trunk-relay connected between the trunk conductors at the incoming end, a signal whose actuation depends upon said relay, and means for connecting the live pole of a current source with one of the conductors before connection  
 35 is established and for connecting the same pole with the other conductor after connection is established, substantially as described.

8. The combination with a trunk-line, of a  
 40 calling telephone-line with which its outgoing end is adapted to connect and a called telephone-line with which its incoming end is adapted to connect, of a polarized trunk-relay at the incoming end of the trunk, a signal  
 45 whose actuation depends upon said relay, a source of current connected with said trunk before connection is established therewith at the outgoing end, and a relay actuated when connection is established at said end for disconnecting said source, substantially as described.  
 50

9. The combination with a trunk-line, of a calling telephone-line with which its outgoing end is adapted to connect and a called  
 55 telephone-line with which its incoming end is adapted to connect, of a polarized trunk-relay connected at the incoming end of the trunk, a signal whose actuation depends upon said relay, a source of current at the  
 60 outgoing end of the trunk connected therewith before connection is established with said end, and a relay actuated when connection is established for disconnecting said source, substantially as described.

65 10. The combination with a trunk-line, of a

calling telephone-line with which its outgoing end is adapted to connect and a called telephone-line with which its incoming end is adapted to connect, of a polarized trunk-relay at the incoming end of the trunk, a signal  
 70 at said end whose actuation depends upon said relay, a source of current connected with the outgoing end before connection is established and adapted to send current in one direction through said relay, a relay also connected with the outgoing end of the trunk actuated when connection is established for disconnecting said source, and means for directing current through said trunk-relay in the reverse direction when connection is established at the outgoing end, substantially as described.  
 80

11. The combination with a trunk-line, of a calling telephone-line with which its outgoing end is adapted to connect and a called  
 85 telephone-line with which its incoming end is adapted to connect, of a polarized trunk-relay at the incoming end of the trunk, a signal whose actuation depends upon said relay, a source of current connected with said trunk before connection is established and adapted to send current through said relay in one direction, a relay connected at the outgoing end of the trunk, and means for sending an operating-current through said relay to disconnect said source and to also send a current in the reverse direction through said polarized relay when connection is established with the outgoing end of the trunk, substantially as described.  
 90 100

12. The combination with a trunk-line, of a calling telephone-line with which its outgoing end is adapted to connect and a called telephone-line with which its incoming end is adapted to connect, of a polarized trunk-relay at the incoming end of the trunk, a signal whose actuation depends upon said relay, a source of current normally connected with one side of said trunk, a relay connected with the other side of the trunk, said relay presenting sufficient retardation to prevent short-circuiting of the voice-currents during conversation, a cord-circuit to connect with the outgoing end of the trunk, a source of current associated therewith and means for  
 110 115 sending an operating-current from said source through said relay to open the connection of the first-named source and to direct current in the opposite direction through said trunk-relay, substantially as described.  
 120

13. The combination with a trunk-line, of a calling telephone-line with which its outgoing end is adapted to connect, and a called telephone-line with which its incoming end is adapted to connect, of a polarized trunk-relay at the incoming end of the trunk, a signal whose actuation depends upon said relay, a normal connection with a source of current to actuate said relay in one direction, a relay connected with the other side of said trunk  
 125 130



to sever the said connection from said source, said relay presenting sufficient retardation to prevent the short-circuiting of the voice-currents during conversation, a cord-circuit connected with the outgoing end, a supervisory signal associated therewith, and means for placing said supervisory signal in condition to operate by current flowing over one side of the talking-circuit and through said relay, said relay being actuated at the same time to open said connection, and current being simultaneously directed through said polarized relay in the reverse direction to correspondingly actuate it, substantially as described.

14. The combination with a trunk-line, of a calling telephone-line with which its outgoing end is adapted to connect and a called telephone-line with which its incoming end is adapted to connect, of a high-resistance polarized relay at the incoming end of the trunk connected in the metallic circuit thereof, a signal at the incoming end whose actuation depends upon said relay, a supervisory signal associated with the outgoing end of the trunk placed in condition to operate when connection is established therewith, and means for removing the high resistance of said relay from the trunk when the called subscriber responds, whereby a sufficient flow of current is permitted therein to render the supervisory relay inoperative, substantially as described.

15. The combination with a trunk-line, of a calling telephone-line with which its outgoing end is adapted to connect and a called telephone-line with which its incoming end is adapted to connect, of a high-resistance polarized trunk-relay at the incoming end of the trunk connected in the metallic circuit of the outgoing end, a signal at the incoming end whose actuation depends upon said relay, a supervisory relay associated with the outgoing end of the trunk placed in condition to operate by current flowing over the metallic trunk-line and through said high resistance, and means for removing said high resistance from the trunk when the called subscriber answers to permit a sufficient flow of current therein to render the supervisory signal inoperative, substantially as described.

16. The combination with a trunk-line, of a calling telephone-line with which its outgoing end is adapted to connect and a called telephone-line with which its incoming end is adapted to connect, of a high-resistance polarized trunk-relay connected between the trunk-conductors at the incoming end, a source of current connected with the trunk and adapted to send current through said relay in one direction, a signal at the incoming end whose actuation depends upon said relay, a supervisory signal associated with the outgoing end of the trunk placed in condition to operate by current flowing over a portion of the

talking-circuit and through said high-resistance relay and means for removing the resistance of said relay from between the trunk-conductors when the called subscriber responds, whereby a sufficient flow of current in the trunk is permitted to render the supervisory signal inoperative, substantially as described.

17. The combination with a trunk-line, of a calling telephone-line with which its outgoing end is adapted to connect and a called telephone-line with which its incoming end is adapted to connect, of a high-resistance-polarized trunk-relay at the incoming end of the trunk-circuit thereof, a signal whose actuation depends upon said trunk-relay, means for causing current to flow through said relay in one direction before connection is established with the outgoing end of the trunk to operate it in one direction, a cord-circuit to connect with said end, a supervisory signal associated therewith and placed in condition to operate by current flowing over one side of the trunking-circuit, said latter current flowing in the reverse direction through said trunk-relay to operate it in the reverse direction, said high-resistance relay serving to limit the flow of current in the trunk, and means for cutting out said high resistance when the called subscriber responds to permit an increased flow of current in the trunk to render said supervisory signal inoperative, substantially as described.

18. The combination with a trunk-line adapted to connect with a calling telephone-line at its outgoing end and with a called telephone-line at its incoming end, of a disconnect-signal at the incoming end placed in condition to operate when connection is established with the called line, a polarized relay at the incoming end, and means to operate said polarized relay in the proper direction when connection is established at the outgoing end of the trunk to prevent the operation of said signal, substantially as described.

19. The combination with a trunk-line adapted to connect with a calling telephone-line at its outgoing end and with a called telephone-line at its incoming end, of a disconnect-signal at the incoming end of the trunk, means to place said signal in condition to operate when connection is established with the called line, a polarized relay at the incoming end of the trunk and means to direct current through said relay in one direction before connection is established at the outgoing end and in the reverse direction when connection is established, the latter current being in the proper direction to prevent the operation of the signal, substantially as described.

20. The combination with a trunk-line adapted to connect with a calling telephone-line at its outgoing end and with a called telephone-line at its incoming end, of a disconnect-signal at the incoming end of the trunk,



and means actuated by current flowing over said trunk in one direction when connection exists with the called line to prevent the operation of said signal and by current in the reverse direction to actuate said signal when the connection is severed at the outgoing end, substantially as described.

21. The combination with a trunk-line adapted to connect with a calling telephone-line at its outgoing end and with a called telephone-line at its incoming end, of a disconnect-signal at the incoming end, a polarized relay at said end and means to direct current through said relay in the proper direction to prevent the operation of said signal when a connection is established at the outgoing end, and further means when connection is severed at the outgoing end to direct current through said relay in the reverse direction to suitably operate the same, substantially as described.

22. The combination with a trunk-line adapted to connect with a calling telephone-line at its outgoing end and with a called telephone-line at its incoming end, of a disconnect-signal at the incoming end of the trunk, a relay actuated over a portion of the talking-circuit when connection is established with the called line to place said signal in condition to operate, a polarized relay at the incoming end and connected with the outgoing end of the trunk, said relay being actuated by current sent through the same in the proper direction when connection is established at the outgoing end to prevent the operation of said signal, substantially as described.

23. The combination with a trunk-line adapted to connect with a calling telephone-line at its outgoing end and with a called telephone-line at its incoming end, of a disconnect-signal at the incoming end of the trunk, a relay actuated over a portion of the talking-circuit when connection is established with the called line to place said signal in condition to operate, a polarized relay at the incoming end and connected with the outgoing end of the trunk, and means to direct current through said polarized relay when connection is established at the outgoing end, said current being in a direction to actuate the relay so as to prevent the said signal from operating, and further means actuated upon severing the connection at the outgoing end, said current being in a reverse direction to actuate said relay so as to cause said signal to operate, substantially as described.

24. The combination with a trunk-line adapted to connect with a calling telephone-line at its outgoing end and with a called telephone-line at its incoming end, of a disconnect-signal for the incoming end of the trunk, a relay actuated over one side of the talking-circuit when connection is established

with the called line to place said signal in condition to operate, a polarized trunk-relay at the incoming end of the trunk and connected with the outgoing end, a source of current connected with said trunk to normally send a current through the relay in a direction to actuate the same so as to permit said signal to operate and means for directing current over the trunk in the reverse direction when a connection is established at the outgoing end to operate said relay in the reverse direction and prevent said signal from operating, substantially as described.

25. The combination with a trunk-line adapted to connect with a calling telephone-line at its outgoing end and with a called telephone-line at its incoming end, of a disconnect-signal at the incoming end of the trunk, a relay actuated over one side of the talking-circuit to place said signal in condition to operate, a polarized trunk-relay at the incoming end of the trunk and connected with the outgoing end, a source of current associated with the outgoing end and connected with the trunk when a conversational circuit is established to direct current through said polarized relay in a suitable direction to prevent the operation of said signal, and a relay responsive to current in the called line adapted to deprive said trunk-relay of operating current during conversation, the armature of said polarized relay remaining in the position to which it was last moved during the time the trunk-relay is deprived of operating-current whereby the said signal is maintained inert, substantially as described.

26. The combination with a trunk-line adapted to connect with a calling telephone-line at its outgoing end and with a called telephone-line at its incoming end, of a disconnect-signal at the incoming end of the trunk, a relay actuated over one side of the talking-circuit when connection is established with the called line to place said signal in condition to operate, a polarized relay at said incoming end adapted to receive current in a suitable direction when a connection is first established at the outgoing end to actuate the armature thereof in such manner as to prevent the operation of said signal, means for depriving the same of operating-current upon the response of the called subscriber, the armature of said trunk-relay remaining in the position to which it was last moved during the time the relay is deprived of operating-current whereby the said signal remains inert, substantially as described.

27. The combination with a trunk-line adapted to connect with a calling telephone-line at its outgoing end and with a called telephone-line at its incoming end, of a guard-signal at the incoming end and connected at the outgoing end, a source of current normally connected with the trunk to direct cur-



rent through said relay so as to actuate it in such manner as to prevent the normal operation of said signal, and means to disconnect said source and direct current through said relay in the reverse direction when a connection is established at the outgoing end to actuate said relay in the proper direction to operate said signal, substantially as described.

28. The combination with a trunk-line adapted to connect with a calling telephone-line at its outgoing end and with a called telephone-line at its incoming end, of a signal at the incoming end of the trunk, a relay adapted to be actuated over one side of the talking-circuit when connection is established with the called line, a polarized trunk-relay at said incoming end, said signal being actuated to give a guard indication when the first-named relay is deenergized and the polarized relay is actuated in one direction by current sent over the trunk when the connection is established at the outgoing end, substantially as described.

29. The combination with a trunk-line adapted to connect with a calling telephone-line at its outgoing end and with a called telephone-line at its incoming end, of a signal at the incoming end of the trunk, a relay actuated over one side of the talking-circuit when connection is established with the called line, a polarized relay at the incoming end of the trunk, said signal being controlled by said two relays so as to give a guard indication when a connection exists at the outgoing end and before connection is established at the incoming end and to give a disconnect indication when connection exists at the incoming end and is severed at the outgoing end, substantially as described.

30. The combination with a trunk-line adapted to connect with a calling telephone-line at its outgoing end and with a called telephone-line at its incoming end, of a signal at the incoming end of the trunk, a relay actuated over one side of the talking-circuit when connection is established with the called line, a polarized relay at the incoming end of the trunk, said signal being entirely controlled by said two relays to operate the same to give a guard indication when the first-named relay is deenergized and the second is actuated by current over the trunk when the connection exists at the outgoing end only and to give a disconnect indication when the first-named relay is energized and the polarized relay is actuated by current flowing over the trunk when the connection has been severed at the outgoing end, substantially as described.

31. The combination with a trunk-line, of a cord-circuit to connect with its outgoing end and a subscriber's line with which its incoming end is adapted to be connected, a supervisory signal associated with the cord-circuit and placed in condition to operate by

current flowing over a portion of the talking-circuit when the cord is connected with the trunk, a relay associated with the incoming end of the trunk and adapted to be operated over a portion of the talking-circuit when the trunk is connected with the called line, a testing-circuit for said incoming end of the trunk normally completed over one strand thereof and through the normal contacts of said relay, said testing-circuit being severed and the trunk-circuit being placed in condition for talking by the actuation of said relay, a ringing signal for the incoming end of the trunk placed in condition to operate by the actuation of said relay, means for rendering inert and for locking out said ringing-signal during the remainder of the connection, a polarized trunk-relay at the incoming end of the trunk actuated in one direction by current over the trunk from the cord-circuit when the cord-circuit is connected with the trunk, means to permit the flow of current over the metallic trunk-line to render said supervisory signal inert when the called subscriber responds, a second signal at said incoming end of the trunk placed in condition to operate by the actuation of the first-named relay, means for operating said signal when the cord-circuit is disconnected from the trunk and the trunk is connected with the subscriber's line, whereby a disconnect indication is given, and further means for actuating said signal when the cord is connected with the trunk and the trunk is disconnected from the trunk-line, whereby a guard indication is given, a source of current to furnish current for the operation of the relays and signals and to charge the transmitters for talking purposes, substantially as described.

32. The combination with a trunk-line adapted to connect with a calling telephone-line at its outgoing end and with a called telephone-line at its incoming end, a trunk-relay at the incoming end of the trunk of relatively high resistance and connected in series in the metallic circuit of the outgoing end, a source of current and a relay normally connected in series in said metallic circuit at the outgoing end, the resistance of said trunk-relay being such as to prevent a sufficient flow of current in said metallic circuit to operate said second relay, substantially as described.

33. The combination with a trunk-line adapted to connect with a calling telephone-line at its outgoing end and with a called telephone-line at its incoming end, a trunk-relay at the incoming end of the trunk of relatively high resistance and connected in series in the metallic circuit of the outgoing end, a source of current and a relay normally connected in series in said metallic circuit at the outgoing end, the resistance of said trunk-relay being such as to prevent a sufficient flow of current in said metallic circuit to operate said second relay, said second relay being operated dur-



ing a connection at the outgoing end of the trunk to open the normal connection to said source, substantially as described.

34. The combination with a trunk-line adapted to connect with a calling telephone-line at its outgoing end and with a called telephone-line at its incoming end, a polarized trunk-relay at the incoming end of the trunk of relatively high resistance and connected in series in the metallic circuit of the outgoing end, a source of current and a relay normally connected in series in said metallic circuit at the outgoing end, the resistance of said trunk-relay being such as to prevent a sufficient flow of current in said metallic circuit to operate said second relay, said second relay being operated during a connection at the outgoing end of the trunk to open the normal connection to said source, substantially as described.

35. The combination with a trunk-line, of a cord-circuit to connect with its outgoing end and a subscriber's line with which its incoming end is adapted to be connected, a relay legged to ground from one side of the talking-circuit established by the connection of the cord-circuit with the trunk, said relay having sufficient impedance to prevent the passage of voice-currents, a supervisory signal associated with the cord-circuit and placed in condition to operate by current flowing over a portion of the talking-circuit and through said relay when the cord is connected with the trunk, a source of current normally connected with the other side of the trunk-circuit at the outgoing end and adapted to be disconnected by the operation of said relay, a polarized trunk-relay at the incoming end of the trunk connected with said outgoing end and actuated in one direction by current from said source under normal conditions and in the opposite direction by current from the cord-circuit when the latter is connected with the trunk, a source of current at the incoming end, a relay also associated with the incoming end of the trunk and adapted to be operated by current from said source over one strand when connection is established with the called line, said relay serving when actuated to place the

trunk in condition for conversation, a ringing-signal for the incoming end of the trunk placed in condition to operate by the actuation of said relay, a second relay responsive to current in the trunk from said source when the called subscriber answers his call, said latter relay serving to render the said ringing-signal inert, means for locking out said ringing-signal during the remainder of the connection, means operated by the said second relay to permit a flow of current over the metallic trunk-line to render said supervisory signal inert when the called subscriber responds, a second signal at said incoming end of the trunk placed in condition to operate by the actuation of the first-named relay, said signal being actuated when the cord-circuit is disconnected from the trunk, and the trunk is connected with the called-subscriber's line and the called-subscriber's line is not in use, whereby a disconnection indication is given, said signal being also operated when the cord-circuit is connected with the trunk and the trunk is disconnected from the called line to give a guard indication, said source serving also to charge the transmitters for talking as well as for the operation of said relays and signals, substantially as described.

36. The combination with a trunk-circuit extending between different switchboard sections and adapted to interconnect telephone-lines for conversation, of a polarized relay bridged across the circuit and having a high resistance, a signal associated therewith whose actuation depends upon said relay, a source of current normally connected at the opposite end of the trunk and adapted to send current through said relay to operate it in one direction, a cut-off relay for said end of the trunk, and means when connection is established therewith to sever said connection and to send current in the reverse direction through said relay, substantially as described.

Signed by me at Chicago, county of Cook, State of Illinois, this 12th day of June, 1902.

WILLIAM W. DEAN.

Witnesses:

ROBERT LEWIS AMES,  
G. BEDER.