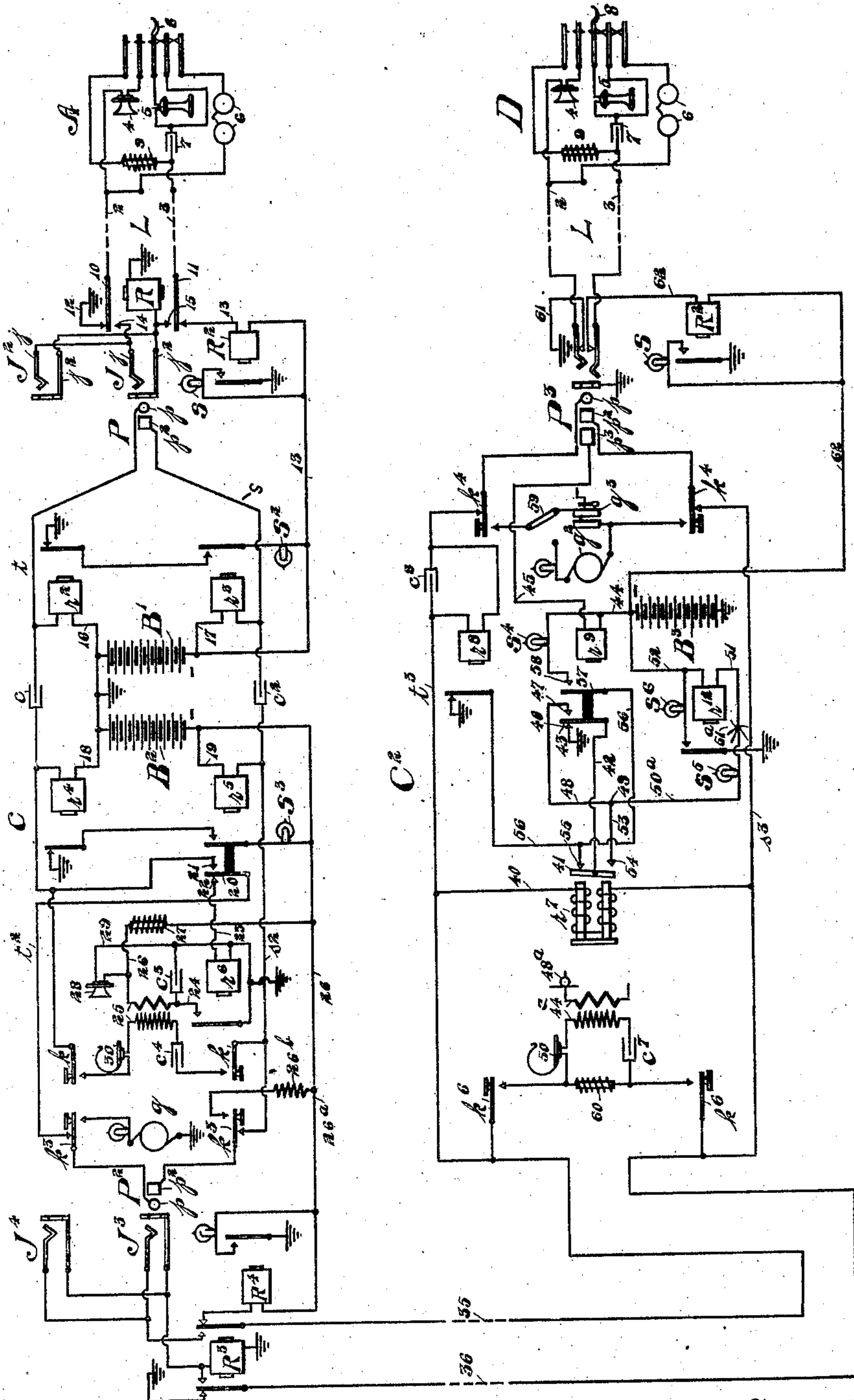


No. 850,470.

PATENTED APR. 16, 1907.

W. W. DEAN.
TELEPHONE TRUNKING SYSTEM.
APPLICATION FILED JULY 16, 1902.



Witnesses.
R. H. Burfield.
G. Beder.

Inventor:-
William W. Dean,
by Robert Lewis Ames,
Attorney.

UNITED STATES PATENT OFFICE.

WILLIAM W. DEAN, OF CHICAGO, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE TRUNKING SYSTEM.

No. 850,470.

Specification of Letters Patent.

Patented April 16, 1907.

Application filed July 16, 1902. Serial No. 115,764.

To all whom it may concern:

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

My invention relates primarily to telephone trunk-circuits and apparatus cooperating therewith, whereby telephone subscribers whose lines terminate at different central offices or central stations may be connected together for conversational purposes.

This trunking system is intended particularly for use between a main exchange and an auxiliary exchange in which the subscribers' lines terminating at the main exchange are of the distinctive "two-wire" or "Dunbar" type which, as is well known, are provided with cut-off relays actuated over a portion of the talking-circuit when the conversational circuits are established, whereby but two point-jacks are required for the lines and but two cables or wires extend throughout the switchboard. The connecting-plugs of the cord-circuits are also provided with only two contacts and the cord-circuit strands may be reduced to two in number. The supervisory signals associated with the cord-circuit are also actuated by current flowing over a portion of the talking-circuit and rendered inoperative by current over the telephone-line when the subscriber responds. In this type of line, moreover, the busy testing is accomplished on one of the main-line terminals of the spring-jacks or switch connections of the lines.

The auxiliary exchange is of the type commonly known as a "private-branch" exchange, in which a comparatively small number of lines terminate. These lines may be provided with a single switch connection, and it is desirable, owing to the few number of communications that may be desired between the two exchanges to adapt the trunk-circuit for reciprocal operation. It is also desirable to supervise the connection from the main exchange so that when the private-branch-exchange subscriber returns the receiver to the hook the operator at the main exchange will be notified of the fact and will sever the connection before her, the arrangement being

made to automatically signal the private-branch-exchange operator that such disconnection has been made, whereupon the circuit is disconnected at the branch exchange.

In accordance with my invention a main-exchange operator answers the call of a subscriber for a connection in the regular manner and upon finding that a subscriber in the private-branch exchange is wanted, she tests the condition of the trunk-circuit and upon finding the same idle a connection is made therewith which operates the calling-signal at the auxiliary exchange. The B operator at said exchange connects her telephone with the trunk-line and learns the subscriber desired and connects the incoming end of the trunk with the line of said subscriber. When the wanted subscriber responds, a visual indication before the B operator is given and at the same time the usual supervisory signal in the A operator's circuit is likewise rendered inoperative to indicate to her that the subscribers are in condition for conversation. When the private-branch subscriber desires a connection with the main exchange, he communicates the order to the B operator, who is provided with lines to operate a signal at the opposite end of the trunk-circuit to attract the attention of the A operator. The connection is then completed at the main exchange in the ordinary manner. At the termination of the conversation when both subscribers return their receivers to their hooks the supervisory signals associated with the connective circuits at the A exchange are operated, and when the connection is severed a signal is automatically given to the B operator, who takes down the connection at this end. In order to carry out these various operations, I provide in connection with the outgoing ends of the trunks an arrangement corresponding in all respects to the ends of the subscribers' lines, whereby the method of operation in connection with the trunks is similar to that with the subscribers' lines. Moreover, the installation of the trunk-circuits is the same as the subscribers' lines, whereby when it is desired to provide trunk-circuits extending to the auxiliary exchange it is merely necessary to send the wires to said exchange instead of to a subscriber's station.

For the proper operation of the supervisory signals at the B exchange I provide a

high-resistance and high-impedance polarized relay connected between the trunk-line conductors and adapted under normal conditions to be operated in one direction and during the connection to be operated in the reverse direction, whereby the desired actuation of the supervisory signals results. I further provide at the incoming end of the trunk a ringing-signal, which indicates to the B operator when the called subscriber has responded to his call. A pilot-signal is also provided which is common to a plurality of trunks and which operates whenever the calling-signal or disconnecting-signal is operated. Although I have described the invention as being particularly applicable to a special type of lines and in connection with a private-branch exchange, I do not wish to thus limit myself in all respects, as it is evident that certain features of the invention may be capable of use in other relations.

My invention is illustrated in the accompanying drawing, in which the figure is a diagram of a subscriber's line terminating at a main exchange, a cord-circuit and connecting apparatus at such exchange, and a trunk-circuit leading to a private-branch exchange, together with a subscriber's line terminating at said branch exchange.

In the diagram, L designates one of the plurality 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 J². 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 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 j² j² of the jacks J J². 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 R² 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 R² 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 P², each being provided with a tip-contact *p* and a sleeve-contact *p*², adapted to register with like contact-surfaces *j* and *j*² 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*² of the cord-circuit and the interposed condenser *c*, while the sleeve-contacts are likewise connected by the sleeve-strands *s* and *s*² 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 S², associated with the answering-plug P, the former relay serving to normally close said circuit of the lamp, while the latter normally opens the same. The battery B² 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 S³, associated with the calling-plug P². 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 P² 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^2 , 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 $k k$. 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 and resistance 26^b.

A trunk-circuit is shown extending between the central office C and the private-branch exchange C², said trunk-circuit being fitted at the outgoing end with multiple jacks, such as J^3 and J^4 , and with a cut-off relay R^3 , legged to ground from the sleeve-contacts of the jacks. The tip-spring of said relay is normally connected with a conductor 26^a, which includes the line-relay R^4 for the trunk and which in turn controls the circuit of a suitable signaling-lamp, as shown. The sleeve-contact of the relay is normally grounded also, as shown in the figure. At the incoming end of the trunk the flexible strands t^3 and s^3 are connected with the tip and sleeve conductors 35 and 36, respectively, and terminate in contacts p and p^2 of the connecting-plug P^3 . A polarized trunk-relay r^7 of high resistance is bridged across the circuit between the strands by conductor 40. The armature 41 of said relay is connected by conductor 42 with the spring-contact 43 of a relay r^9 , which is connected upon one side by conductor 44 with the battery B^3 and upon the other by conductor 45 with the third contact p^3 of the plug P^2 . A normal contact 46 of said spring 43 of relay r^9 is grounded, while the forward contact 47 is connected, by means of a conductor 48, to the point 49, from whence a branch 50^a extends to the calling-lamp S^5 . A conductor 51 extends from the other side of the lamp to the pilot-relay r^{12} , the other terminal of which is connected by a conductor 52 with the live pole of the battery B^3 . A second branch 53 extends from the point 49 to a contact 54 of the polarized relay r^7 , the other contact 55 of which is connected with the conductor 56, leading from the normally grounded spring of relay r^8 , which is included in the tip-strand t^3 of the trunk-cord to the spring-contact 57 of relay r^9 , the forward contact 58 of which is connected with the ringing-lamp S^4 , the op-

posite pole of which is connected with a conductor 44, leading to the battery B^3 . A power-generator g^2 and a hand-generator g^3 are provided for the trunk-cord, either of which may be connected by the switch 59 with the keys $k^4 k^4$ in the strands t^3 and s^3 of the cord, by means of which current is sent out over the line to the subscriber. The operator's receiver 50 may be connected in a bridge of the trunk by the listening-key $k^6 k^6$, while the transmitter is supplied by current in a suitable manner, said bridge including the condenser c^7 and the secondary of the operator's induction-coil 44^a. In parallel with the said receiver, secondary coil, and condenser a low-wound retardation-coil 60 is provided and which when connected by means of the key $k^6 k^6$ across the circuit serves to connect a low-resistance path in shunt of the relay r^7 . A condenser c^8 in the tip-strand shunts the tip-relay r^8 . The subscribers' lines terminating at this exchange comprise the usual substation-circuit; but at the exchange the springs of the switch-sockets are provided with normal contacts, of which the tip-contact is grounded by conductor 61, while the sleeve-springs normally connect with the conductor 62, leading to the line-relay R^2 and which is connected with the live pole of the battery B^3 . The line-relay R^2 controls the circuit of the line-signal S.

The operation is as follows: The A subscriber desiring a connection with subscriber D, located at the private-branch 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^2 , 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^2 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^3 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 J². 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 S², 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 the conductor 16 to the grounded pole of the battery B' as soon as the cut-off relay R is operated. The supervisory signal S² 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 B² 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 subscriber D, located in the private-branch exchange, is wanted, the A operator tests the condition of the trunk leading to that exchange by touching the tip of her calling-plug to the test-ring of the jack and if the trunk-line is busy the sleeve-rings are connected with the live pole of the battery B² through the sleeve-strand of the inserted plug, whereby when the tip of the testing-plug engages the ring of the testing-jack the circuit will be completed through the tip-strand of the testing-cord, contacts 20 and 22 of sleeve-relay r^3 , and through the test-relay r^6 to ground, thus operating the test-relay and causing a click in the operator's receiver. If the trunk is found idle, however, a plug is inserted, which closes the circuit from the sleeve side of the cord-circuit through the cut-off relay R³, which disconnects the grounded sleeve-spring of the relay and the tip-spring from the line-relay R⁴ and connects them with the corresponding contacts of the trunk-jacks. Under normal conditions current is flowing from the negative pole of the battery B² over conductors 26 and 26^a, through line-relay R⁴, and thence over the trunk-conductor 35 to the branch exchange C² and thence through the high-resistance polarized relay r^7 and back over the trunk-conductor 36 to ground. This serves to maintain the armature of the trunk-relay r^7 in the position shown, and on ac-

count of the resistance of the trunk-relay r^7 the line-relay R⁴ is not operated. The insertion of the plug P², however, causes current to flow from said battery in the opposite direction over the trunk and over the trunk-relay r^7 , which causes its armature to disconnect from contact 55 and make connection with contact 54, thereby closing a circuit from the live pole of the battery B³ over the conductor 52, through pilot-relay r^{12} , conductor 51, calling-signal S⁵, which is preferably a small incandescent lamp, conductor 50^a, point 49, conductor 53, contacts 54 and 41 of the trunk-relay, and thence from conductor 42 and contacts 43 and 46 of relay r^9 to ground. The lamp S⁵ is therefore lighted and indicates to the branch-exchange operator that a connection is desired. She therefore connects her telephone with the trunk-circuit by means of key $k^6 k^6$, and upon learning the order the connecting-plug P³ is inserted in a jack of the subscriber's line. The insertion of this plug closes the circuit from the live pole of the battery over conductor 44, relay r^9 , conductor 45, and through the sleeve-contact p^3 of the plug P³, and through the grounded ring of the subscriber's jack. This relay r^9 is therefore operated and opens the circuit of the calling-lamp S⁵ at its contacts 43 and 46, and at the same time closes its contacts 57 and 58, whereby a circuit is closed from the live pole of the battery B³ over conductor 44 to the ringing-lamp S⁴, contacts 57 and 58 of sleeve-relay r^9 , conductor 56 to the spring-contact of the relay r^8 , which is normally grounded. The subscriber is then called by depressing the ringing-key $k^4 k^4$, which connects the hand-generator g^3 or the large generator g^2 with the cord-circuit and apparatus of the subscriber D. Upon the response of the subscriber current flows from the battery B² at the main exchange over both sides of the cord-circuit, both sides of the trunk-circuit, the trunk-cord, and over both limbs of the telephone-line. Current flowing in this path operates the tip-relay r^8 to open the circuit of the ringing-lamp S⁴, which is extinguished. This circuit is also of low resistance as compared with the bridge containing the trunk-relay r^7 , which permits a sufficient flow of current to operate the supervisory relay r^4 in the A cord, thus retiring the supervisory signal S³ and indicating to the A operator that the subscribers are in communication. At the termination of the conversation, when the subscribers have returned their receivers to the hooks, the circuits from the batteries B' and B² are interrupted and the supervisory lamps S² and S³ in the main exchange are lighted, thus indicating that fact to the operator, while the lamp S⁴ is again lighted at the B exchange. The operator observing both signals lighted withdraws the plug P², thus permitting current to flow over the

trunk-line in the opposite direction as under normal conditions and operating the trunk-relay and causing its armature to disconnect the contact 54 and connect with contact 55, whereby a circuit through the disconnecting-lamp S^5 is provided from the live pole of the battery B^3 through the pilot-relay and lamp S^5 , conductor 50^a , point 49, conductor 48, contacts 47 and 43 of relay r^9 , conductor 42, contacts 41 and 55 of relay r^7 , conductor 56, to the spring of relay r^8 and ground. The operator observing both of these signals S^4 and S^5 withdraws the plug P^3 and all parts are restored to normal condition. In case the private-branch-exchange subscriber D wishes a connection with the main exchange he indicates a call in the usual way and is answered by the operator, who communicates with the main exchange by depressing listening-key k^6 , which connects a low-resistance retardation-coil 60 across the circuit in parallel with the trunk-relay r^7 . This permits sufficient current to flow over the circuit through the trunk-line relay R^4 to attract its armature and light the trunk-line lamp. The operator at the A exchange seeing the signal connects her cord with the trunk and completes the desired connection.

The ground connections hereinbefore referred to at the two exchanges may and in practice usually are the common office-return or office-ground. It is also apparent that the other poles of the batteries may be grounded so far as the operation of the system is concerned, the only variation being to remove the present ground connections, to replace them by other conductors, and to place a ground upon the opposite pole of the battery. It is also evident, in so far as some features are concerned, that the lines may terminate in single plugs and cords in place of the double cords shown and that the trunks may terminate in jacks in place of the plugs and cords.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The combination with a trunk-line extending in two limbs only between different switchboards and having switch-sockets only at one end and a connecting-plug only at the other to establish talking connections, of means at each end of the trunk operative from the other end thereof over the metallic circuit of the trunk, for attracting the attention of the operator, whereby the trunk is adapted for reciprocal operation, substantially as described.

2. The combination with a trunk-line extending in two limbs only between different switchboards and having a switch-socket only at one end and a connecting-plug only at the other for establishing talking connections through the trunk, of means actuated over the metallic circuit of the trunk to signal the

operator at the plug end of the trunk from the socket end, and a calling-signal at said socket end placed under the control of the operator at the plug end, whereby the trunk-circuit is adapted for reciprocal operation, substantially as described.

3. The combination with a trunk-line extending between different switchboards and having multiple-switch sockets at one end for establishing connection with the trunk, of a calling-signal at said end placed under the control of the operator at the other end of the trunk, said sockets being normally disconnected from the trunk but adapted to be connected therewith when the talking-circuit is established with one of said sockets, substantially as described.

4. The combination with a trunk-line extending between different switchboards and having normally disconnected switch connections at one end, of a signal at said end placed under the control of the operator at the other end of the trunk, a cut-off relay actuated when a connection is established with one of said switch connections to render said signal inoperative and to operatively connect the switch connections with the trunk-circuit, substantially as described.

5. The combination with a trunk-line extending between different switchboards and adapted for reciprocal operation, of switch connections for said trunk-line at one end normally disconnected from the trunk, a calling-signal at said end normally connected with the trunk, and means for disconnecting said signal and connecting the switch connections with the trunk when a talking-circuit is established with one of said switch connections, substantially as described.

6. The combination with a trunk-line extending between different switchboards and having switch-sockets at one end normally in inoperative relation with the line, of a signal associated with said end and having its operation controlled from the opposite end of the trunk, and a cut-off relay actuated over a portion of the talking-circuit when connection is established with the line to operatively connect said sockets with the trunk-line and to render said signal inoperative, substantially as described.

7. The combination with a trunk-line extending between different switchboards and having switch-sockets at one end, a signal associated therewith, said sockets being normally disconnected from the trunk-line, a cut-off relay permanently connected with one of the talking contacts of the switch-sockets, and means when a connection is established with one of the sockets to actuate the cut-off relay to render the signal inoperative and to connect the sockets with the line, substantially as described.

8. The combination with a trunk-line extending between different switchboards and

adapted to interconnect telephone-lines for conversation, of switch-sockets at one end, a line-signaling device and source of current normally connected therewith at said end, whereby the operator at the other end of the trunk is enabled to operate said signal by completing the circuit thereof, and means actuated over a portion of the talking-circuit for rendering said signal inoperative when connection is established with said sockets, substantially as described.

9. The combination with a trunk-line extending between different switchboards and adapted to interconnect telephone-lines for conversation, of switch-sockets at one end, a line-signaling device and a source of current normally bridged in series between the limbs of said line at said end a key at the other end whereby the operator at the other end is enabled to actuate the signaling device by completing the circuit of the same, and means for rendering said signal inoperative when the connection is established at that end, substantially as described.

10. The combination with a trunk-line extending between different switchboards and adapted to interconnect telephone-lines for conversation, of switch-sockets at one end, a line-signaling device and a source of current normally connected with the trunk at said end, a key to enable the operator at the opposite end of the trunk to complete the circuit of said source and said signaling device to operate the same, and means for disconnecting said signal from the trunk when connection is established with any of said sockets, substantially as described.

11. The combination with a trunk-line extending between different switchboards and adapted to interconnect telephone-lines for conversation, of spring-jacks for said trunk at one end, a line-signaling device and a source of current normally bridged in series between the limbs of the trunk-line at said end, whereby said signal may be actuated from the other end of the trunk and a cut-off relay actuated over a talking-strand of the trunk-line when a connection is established with one of said spring-jacks to render said signaling device inoperative, substantially as described.

12. The combination with a trunk-line extending between different switchboards and adapted to interconnect telephone-lines for conversation, a line-signaling device and a source of current normally connected with the trunk, whereby the operator at the other end of the trunk is enabled to operate said device by completing a path for current over the two limbs of the trunk-line in series, spring-jacks for said end of the trunk, a cut-off relay having its circuit closed through talking contacts of said jack when a connecting-plug is inserted therein, and means for directing current through said cut-off relay

when a connection is established at one of said jacks to cut off said line-signaling device, substantially as described.

13. The combination with a trunk-line extending between different switchboards and adapted to interconnect telephone-line circuits for conversation, of spring-jacks for said trunk-line at one end, a cut-off relay connected between one side of the talking-circuit and a third conductor, said jacks being normally disconnected from the trunk-line, a line-signaling device and a source of current normally connected with said trunk-line, and means for connecting a source of current between said third conductor and the contact of the spring-jack with which said cut-off relay is connected when the cord-circuit is connected with the jack, whereby said cut-off relay is operated to render the signaling device inoperative and to connect the spring-jacks with the trunk-line, substantially as described.

14. The combination with a trunk-line extending between different switchboards and adapted to interconnect telephone-lines for conversation, of a signal at one end of the trunk, a polarized relay of high resistance at said end connected with the trunk, a source of current normally connected with the other end of the trunk and sending current thereover and through said polarized relay to operate it in such direction as to prevent the operation of said signal, a signaling device at said other end of the trunk in the path of said current but not operated thereby owing to the resistance of said polarized relay, and means under the control of the operator at the first-named end of the trunk for closing a low-resistance path for said current to operate said signaling device, substantially as described.

15. The combination with a trunk-circuit extending between different switchboards and adapted to interconnect telephone-line circuits for conversation, of a signal located at one end, a high-resistance polarized relay bridged across the metallic circuit of the trunk-line at said end, a source of current and a signaling device connected between the line conductors at the opposite end, said source sending current over the trunk-line and through said high-resistance relay in the proper direction to prevent its operating said signal, the flow of said current being limited by the high resistance of said relay to prevent the simultaneous operation of the said signaling device at the opposite end of the trunk, means under the control of the operator for short-circuiting the polarized relay to permit the operation of the said signaling device from said current source, substantially as described.

16. The combination with a trunk-circuit extending between different switchboards and adapted to interconnect telephone-line

circuits for conversation, of a signal located at one end, a high-resistance polarized relay bridged across the metallic circuit of the trunk-line at said end, a source of current and a signaling device connected between the line conductors at the opposite end, said source sending current over the trunk-line and through said high-resistance relay to actuate it in the proper direction to prevent the operation of said signal, the flow of said current being limited by the high resistance of said relay to prevent the simultaneous operation of the said signaling device at the opposite end of the trunk, means under the control of the operator for short-circuiting the polarized relay to permit the operation of said signaling device by the increased current-flow, and means when a connection is established with the second-mentioned end of the trunk to disconnect said source and signaling device and to complete a path for current over the trunk-line in the opposite direction to operate the polarized relay in the reverse direction, whereby said signal at the latter end is operated, substantially as described.

17. The combination with a trunk-line extending between different switchboards and adapted to interconnect telephone-lines for conversation, of a signal at one end of the trunk, a polarized relay of high resistance at said end connected with the trunk, a source of current normally connected with the other end of the trunk and sending current thereover and through said polarized relay to operate it in such direction as to prevent the operation of said signal, a line-signaling device at the opposite end of the trunk in the path of said current but not normally operated thereby owing to the resistance of said polarized relay, means under the control of the operator at the first-named end of the trunk for closing a low-resistance path for said current to cause said signaling device at the opposite end of the trunk to operate, and means when a connection is established with said second-named end to render said signaling device inoperative, substantially as described.

18. The combination with a trunk-line extending between different switchboards and adapted to interconnect telephone-lines for conversation, of a signal at one end of the trunk, a polarized relay of high resistance at said end connected with the trunk, a source of current normally connected with the other end of the trunk and sending current thereover and through said polarized relay to operate it in such direction as to prevent the operation of said signal, a line-signaling device at the opposite end of the trunk in a path of said current but not operated thereby owing to the resistance of said polarized relay, means under the control of the operator at the first-named end of the trunk for closing a low-re-

sistance path for said current to cause said signaling device at the opposite end of the trunk to operate, and means when a connection is established at the second-mentioned end of the trunk to render the signaling device at said end inoperative, and to reverse current through said polarized relay to cause it to operate said signal, substantially as described.

19. The combination with a trunk-circuit extending between different switchboards and adapted to interconnect telephone-lines for conversation, of a source of current and a signaling device normally connected with one end of said trunk, switch-sockets for said end, a cut-off relay therefor, a polarized relay at the opposite end of the trunk, and a signal whose actuation depends upon said relay, the said current source serving normally to send current in one direction through said polarized relay, and means when a connection is established with one of said sockets to render said signaling device inoperative and to reverse the direction of current through said polarized relay, substantially as described.

20. The combination with a trunk-circuit extending between different switchboards and adapted to interconnect telephone-lines for conversation, of a polarized relay at the incoming end of the trunk, a calling-signal at said end operated by said relay when a connection is established at the outgoing end of the trunk, and a second relay at said incoming end actuated over a local circuit independent of the talking-circuit to render said signal inoperative when a connection is established with the called line, substantially as described.

21. The combination with a trunk-line extending between different switchboards and adapted to interconnect telephone-line circuits for conversation, of a polarized trunk-relay at the incoming end of the trunk, a disconnect-signal at said end, current being directed through said polarized relay in one direction during conversation to prevent the operation of said disconnect-signal, and means for reversing current through said polarized relay when the connection is severed at the outgoing end to actuate it in the reverse direction to cause said signal to operate, substantially as described.

22. The combination with a trunk-line extending between different switchboards and adapted to interconnect telephone-line circuits for conversation, of a disconnect-signal at the incoming end of the trunk, a polarized trunk-relay bridged across the trunk-circuit and receiving current in a direction to prevent it from operating said signal during conversation, a second relay energized over a local circuit independent of the talking-circuit when the incoming end of the trunk is connected with the called line to place said signal in condition to operate, and means for

reversing the current through said polarized relay when the connection is taken down at the outgoing end to cause the operation of the signal to give a disconnect indication, substantially as described.

23. The combination with a trunk-circuit extending between different switchboards and adapted to interconnect subscribers' lines for conversation, of a polarized trunk-relay bridged across the circuit at the incoming end and a second relay adapted to be actuated over a local circuit independent of the talking-circuit when the incoming end of the trunk is connected with the called line, a signal at said incoming end actuated when the second relay is deenergized and the trunk-relay is energized by current flowing there-through in one direction when the cord-circuit has been connected with the outgoing end of the trunk to give a call indication, said signal being actuated to give a disconnect indication when the second-named relay is energized and the trunk-relay is actuated by current in the reverse direction when the cord-circuit has been disconnected at the outgoing end, substantially as described.

24. The combination with a trunk-circuit extending between different switchboards and adapted to interconnect telephone-line circuits, of a ringing-signal for the incoming end of the trunk, and a relay actuated over a local circuit when the trunk is connected with a called line for placing said signal in condition to operate, and a second relay actuated by current in the line from the outgoing end when the called subscriber responds for rendering said signal inoperative, substantially as described.

25. The combination with a trunk-circuit between different switchboards and adapted to interconnect subscribers' lines for conversation, of a polarized trunk-relay bridged across the circuit at the incoming end, and a second relay adapted to be actuated over a local circuit independent of the talking-circuit when the incoming end of the trunk is connected with the called line, a signal at said incoming end actuated when the second relay is deenergized and the trunk-relay is energized by current flowing therethrough in one direction when the cord-circuit has been connected with its outgoing end to give a call indication, said signal being actuated to give a disconnect indication when the second-named relay is energized and the trunk-relay is actuated by current in the reverse direction when the cord-circuit has been disconnected at its outgoing end, and a pilot signaling device actuated whenever said signal is actuated, substantially as described.

26. The combination with a trunk-line extending between different switchboard-sections and adapted to interconnect telephone-lines for conversation, of a cord-circuit at the outgoing end of the trunk, and a source of

current associated therewith, a polarized trunk-relay at the incoming end of the trunk, a signal at said end whose actuation depends upon said relay, said source of current serving to actuate said relay in one direction during conversation, and to furnish current to the called-subscriber's line for conversation, and means when connection is severed at the outgoing end to actuate said relay in the reverse direction by current over the trunk-line, substantially as described.

27. The combination with a trunk-circuit adapted to interconnect telephone-lines for conversation, of a series of switch-sockets for one end of the trunk, a source of current normally impressed upon the trunk-line, testing-terminals for said sockets, normally disconnected from the line, whereby an idle test is secured when the trunk-line is not busy, and means for connecting said terminals with the trunk-line talking-circuit during conversation whereby their electrical condition is altered, and they are in condition to test busy, substantially as described.

28. The combination with a trunk-line extending between different switchboards, of a cord-circuit to connect with one end and having a source of current and supervisory signal associated therewith, said signal being rendered operative by current over a portion of the talking-circuit when connection is established with the line, a called-subscriber's line to connect with the other end of the trunk, the established circuit being such that current from said source flows over the trunk and called line to furnish current thereto for the operation of the transmitters, said supervisory signal being rendered inoperative by current over the metallic circuit of the called line and trunk when the called subscriber answers his call and completes his line for steady currents, substantially as described.

29. The combination with a trunk-line adapted to connect with a cord-circuit at its outgoing end and with a called line at its incoming end, a source of current associated with the cord-circuit and included in the through metallic circuit when connection is established and the called subscriber has responded, said source serving to charge the called-subscriber's transmitter for talking and to control the supervisory signals associated with the cord-circuit, a polarized relay bridged across the metallic circuit at the incoming end of the trunk, a signal at said end whose actuation depends upon said relay, said relay being of high resistance and impedance to prevent the short-circuiting of either the steady or voice currents, substantially as described.

30. The combination with a plurality of subscribers' lines terminating at a central office, each of said lines having a line-signal and a cut-off relay to render the line-signal

inoperative when a connection is established,
said cut-off relay being adapted to be actu-
ated over a portion of the talking-circuit
when a connection exists therewith, of a plu-
5 rality of trunk-lines also terminating at said
office and provided with switch connections,
signals and cut-off relays of the same type as
the subscribers' lines, whereby the apparatus
at said office and the method of establishing

connections is made uniform throughout, is
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.