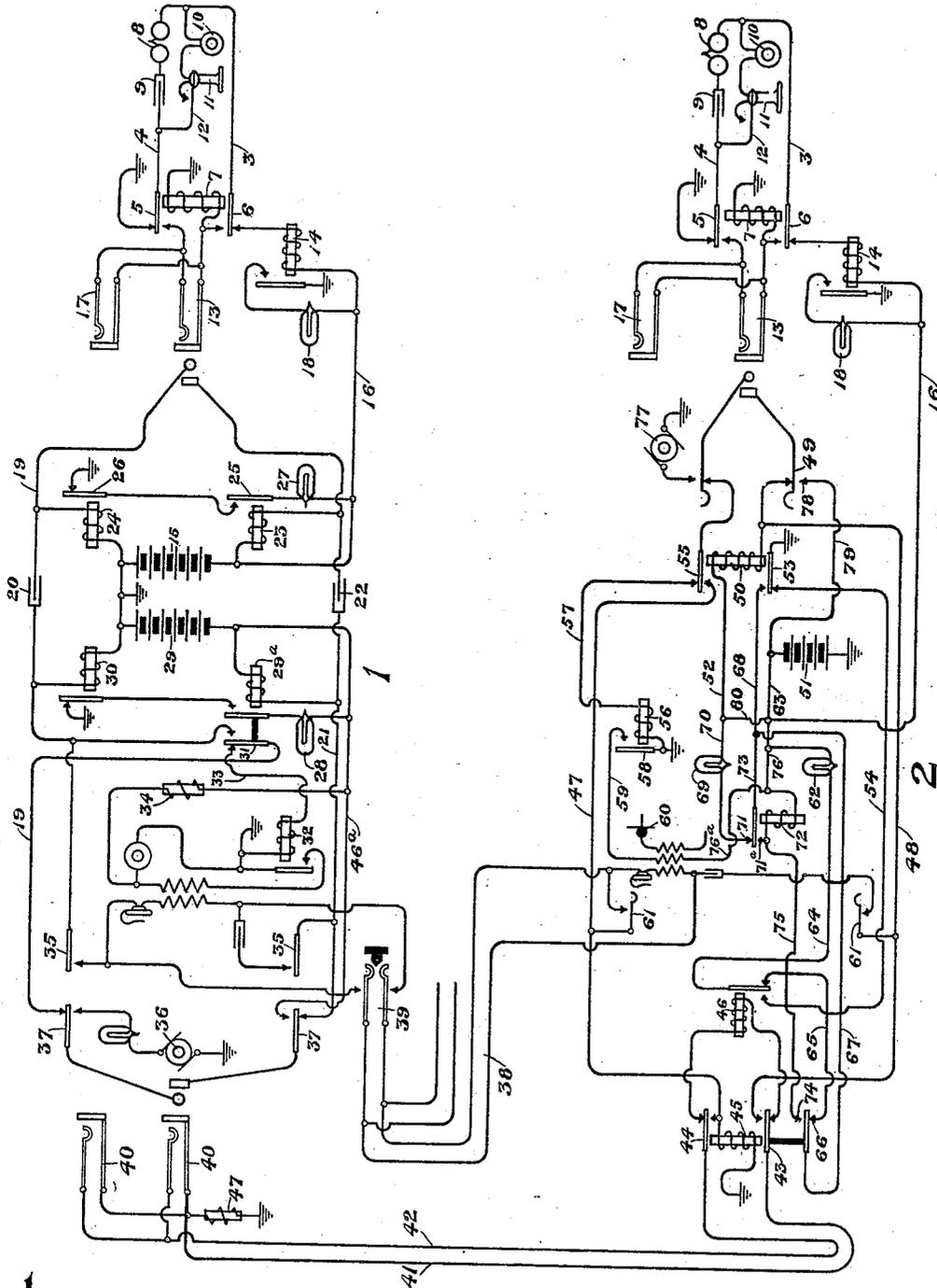


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H. M. POST.
INCOMING TRUNK LINE.
APPLICATION FILED MAR. 14, 1906.



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INCOMING TRUNK-LINE.

No. 841,339.

Specification of Letters Patent.

Patented Jan. 15, 1907.

Application filed March 14, 1906. Serial No. 305,993.

To all whom it may concern:

Be it known that I, HOWARD M. POST, a citizen of the United States, residing in Chicago, county of Cook, and State of Illinois, have invented a new Improvement in Incoming Trunk-Lines, of which the following is a specification.

My invention relates to telephone trunk systems for making connection between subscribers whose lines terminate at different switchboards and usually at switchboards located in different central offices or exchanges and to signaling means between the operators and subscribers by means of which such a connection is made and the connection supervised during conversation.

In such systems the operator's cord-circuit is usually employed for answering the calls coming in at the initiatory or A station, and in case a subscriber is desired whose line terminates at another exchange the calling end of the operator's cord-circuit is connected with the outgoing end of a trunk-line which terminates in spring-jacks at the A station and in a calling-plug at the incoming end of the trunk-line or B station. It is usual to provide a battery at each of the exchanges for controlling the signals between the operators in making and supervising the connection, the battery at the A exchange being used to furnish current over the line to energize the transmitter of the calling subscriber and the battery at the B exchange to furnish current to the substation-transmitter of the called subscriber. Due to the fact that the battery at each exchange is furnishing current over the line terminating at that exchange for talking purposes it is usual in such systems to sever the metallic trunk connection between the subscribers to the flow of direct current and to inductively unite the circuit for the transmission of voice-currents by means of a repeating coil or by the use of condensers inserted in the talking-strands of the trunk-line. The use of condensers or repeating coils to inductively unite the sides of the trunk-circuit for conversation add to the cost of installation and reduce the efficiency of the talking-circuit. In such systems also it is necessary to use a twenty-four-volt battery at both exchanges for energizing the transmitters of the respective subscribers.

In my invention a complete metallic circuit is provided for the voice-currents over the trunk-line from one exchange to the other without the use of intervening inductive means, such as repeating coils or condensers, and the battery at the A exchange is adapted to furnish current to the transmitters of both the calling and the called subscriber. The cost of installation is therefore materially reduced and the talking-circuit is coincident with the battery-circuit from the A exchange over the trunk-line to the called subscriber's station.

In the accompanying drawings I have shown two subscribers' lines terminating at different central offices with an operator's cord-circuit at the A exchange and a form of trunk-circuit embodying my invention, which I have worked out for commercial purposes, extending between the A exchange 1 and the B exchange 2.

At the A exchange the subscriber's line is shown consisting of limbs 3 and 4, terminating in contact-springs 5 and 6 of the cut-off relay 7. A call-bell 8 and condenser 9 are located in a permanent bridge of the line conductors, and a transmitter 10 and receiver 11 are located in a bridge of the line normally open at the switch-hook 12 when the subscriber's telephone is not in use. The sleeve-contact of the answering-jack 13 is connected with one side of the winding of the cut-off relay, the other side of this winding being connected with ground. Both the sleeve and tip contacts of the answering-jack are adapted to be connected with the respective line conductors at the front contacts of the cut-off relay when said relay is energized. The line conductor 4 is normally connected with ground by a back contact of the cut-off relay, and the line conductor 3 is normally connected with one side of the winding of the line-relay 14 at another back contact of the cut-off relay, the other side of the winding of the line-relay being connected with the central-office battery 15 by means of conductor 16. Multiple jacks 17 are provided at the different switchboard-sections. The line-relay is adapted to control through its normally open contacts the circuit of the line-signal 18 in the usual manner.

The subscriber's line entering the B exchange and its switchboard-section is shown

in the same manner as that described with reference to the A exchange, and the same reference-numerals have been used to indicate like parts. It will be understood that the trunk-circuit may be adapted for use with different common-battery line-circuits without departing from the spirit of the invention.

The operator's cord-circuit at the A exchange consists of a tip-strand 19, extending between the tip-contacts of the plugs and containing an interposed condenser 20, and a sleeve-strand 21, extending between the sleeve-contacts of the plugs and containing an interposed condenser 22. A pair of supervisory relays 23 and 24 have their windings connected between the opposite poles of the battery 15 and the sleeve and tip strands of the cord-circuit, respectively. These relays jointly control, the former through its normally open contacts 25 and the latter through its normally closed contacts 26, the circuit of a supervisory lamp 27, said lamp being connected with the live side of the battery 15 by means of conductor 16 and with the grounded side of battery through the normally closed contacts of relay 24. The supervisory lamp 28 upon the opposite side of the cord-circuit is similarly associated with the battery 29 and is adapted to be controlled in the same manner by the normally open contacts of the sleeve supervisory relay 29^a and the normally closed contacts of the tip supervisory relay 30. A second armature 31 is provided for the sleeve supervisory relay 29^a, the tip cord-strand 19 being normally severed at the front contact of this armature, said armature being normally connected with one side of a test-relay 32 by means of conductor 33, the other side of the winding of said relay being connected with ground. This arrangement provides a ground connection for the tip-contact of the calling-plug through the test-relay 32, which connection is broken by the energization of the supervisory relay 29^a, and the severed tip-strand of the cord-circuit is united for conversation. Current from the battery 29 to the transmitter of the operator's set is preferably cut down by means of the impedance-coil 34, the operator's head-receiver, secondary to her induction-coil, and a condenser being bridged across the cord-circuit by means of the listening-key contacts 35. A suitable ringing-generator 36 is provided for the calling end of the cord-circuit adapted to be connected with the limbs of the telephone-line by means of a ringing-key 37. The sleeve ringing-key contact is adapted to make connection with a conductor 46^a when the ringing-key is operated to maintain the cut-off relay 7 of a called line energized during ringing. An impedance-coil 47 is connected to ground from the sleeve side of the trunk-line through which the supervisory relay 29^a is energized when a connection is made.

The usual order-wire circuit 38 extends between the two exchanges and is adapted to be connected with the A operator's telephone by means of the order-key 39, the said circuit being permanently connected with the B operator's head-receiver.

The trunk-line at its outgoing end extends from the tip and sleeve contact springs of the jacks 40 in two limbs 41 and 42 to the contact-springs 43 and 44 of a relay 45 at the B exchange or incoming end of the trunk-line. The contact-springs 43 and 44 normally close the circuit through back contacts of said relay of a preferably high-resistance trunk-relay 46. One side of the winding of the relay 45 is connected with ground, and the other side of said winding is connected with the tip-strand 47 of the trunk-cord. The tip-strand 47 and the sleeve-strand 48 of the trunk-cord are normally severed from the limbs of the trunk-circuit at the normally open front contacts of the relay 45. The sleeve-strand 48 is connected with the corresponding contact of the calling-plug at the normally closed contacts of a ringing-key 49 and with one side of the winding of a relay 50, the other side of said winding being connected with the battery 51 by means of conductors 52, 80, and 63. The grounded contact-spring 53 of relay 50 is normally connected at the back contact of said relay with conductor 54, the circuit of said conductor being normally open at the front contact of the trunk-relay 46. The contact-spring 55 of the relay 50 is normally connected with the winding of a test-relay 56 by means of a conductor 57, the opposite side of said test-relay and its armature 58 being connected with ground and being adapted to close a path from the battery 51 through the tertiary winding of the operator's induction-coil when the test-relay is energized. The operator's transmitter 60 may be supplied with energy from any suitable source, and her head-receiver is adapted to be bridged across the trunk-circuit by listening-key contacts 61. The armature 55 of the relay 50 when said relay is energized is adapted to sever the connection of the tip-strand with the test-relay 56 and unite the normally-severed portions of said strand for conversation at the front contact of relay 50.

A guard or disconnect lamp 62 is connected with the live side of the battery 51 by conductor 63, the circuit of said lamp including conductor 64, normally closed contacts of the trunk-relay 46, conductor 65, normally closed back contact 66 of the relay 45, and conductors 67 and 68, said circuit being normally open at the contact-spring 53 of the relay 50. A ringing lamp-signal 69 is connected with the battery 51 by means of conductors 63, 80, and 70, the normally closed back contact 71 of relay 72, and conductors 73 and 68, the circuit of said signal being also normally broken at the contact-spring 53 of

the relay 50. The relay 72 has its circuit normally open at the front contact 74 of the relay 45 and has one side of its winding connected with said contact by means of conductor 75 and the other side of its winding connected with the battery 51 by means of conductors 76 and 63. A ringing-generator 77 is adapted to be connected between ground and the tip side of the line by the operation of the ringing-key 49 to signal the subscriber, a normally open contact 78 of the ringing-key being connected with the live side of battery 51 by means of conductor 79 to maintain the cut-off relay 7 actuated during the operation of ringing.

In the operation of the system a subscriber whose line terminates at exchange 1 signals the operator by removing his telephone from the hook, a path for current being thereby closed from the battery 15 over conductor 16 through the line-relay 14, the limbs of the telephone-line, including the substation apparatus, and to ground at the normally closed contact 5 of the cut-off relay 7. The line-relay responsive to current in this path will attract its armature and light the line-lamp 18. Upon seeing the signal the operator will insert a plug of her cord-circuit in the answering-jack of the line closing a path for current from the battery 15, through the winding of supervisory relay 23, the sleeve-contacts of the inserted plug and jack, through the cut-off relay 7 to ground. The cut-off relay will attract its armature 5 and 6, removing the ground from the tip side of the line and retiring the line-signal by breaking the connection with the line-relay upon the sleeve side of the line, at the same time connecting the external limbs of the telephone-line with the jack-section thereof at the front contacts of said relay. The circuit of the supervisory lamp 27 will be closed at the contacts of relay 23 by current in this path; but due to the fact that the subscriber's receiver is off its hook a path for current is completed through the substation talking apparatus over the tip side of the line, the tip-contacts of the jack and plug, tip-strand 19, and through the winding of the supervisory relay 24 to battery, thus opening a circuit of the supervisory lamp 27 at the normally closed contacts of said relay and preventing the operation of said signal. The operator will then throw her listening-key 35 to ascertain the number of the subscriber desired. Upon learning that a subscriber whose line terminates at station 2 is desired the operator will depress her order-wire key 39 and communicate the number of the subscriber desired to the B operator, who will tell the A operator what trunk-line to use in making the connection. The A operator will then insert her calling-plug in a jack of the designated line. A path for current will then be closed from the battery 29 through

the supervisory relay 29^a, sleeve-strand 21 of the cord-circuit, the sleeve-contacts of the inserted plug and jack, and the winding of the impedance-coil 47 to ground. The energization of the sleeve supervisory relay 29^a will close the circuit of the supervisory lamp 28 and will connect the normally severed portions of the tip-strand for conversation by means of its armature 31, severing the connection of the calling end of the tip-strand with the test-relay 32. A portion of this current will also flow from the branch containing the impedance-coil 47, over trunk-conductor 41, armature 43 of relay 45, through the winding of the high-resistance trunk-relay 46, armature 44 of relay 45, trunk-conductor 42, tip-contacts of the plug and jack, tip-strand 19 of the cord-circuit, and the winding of the tip supervisory relay 30 to battery. The tip supervisory relay 30 does not attract its armature by current in this path, due to the high-resistance of the trunk-relay 46, the trunk-relay being preferably of fifteen-thousand ohms resistance and the tip supervisory relay of one-hundred ohms. The supervisory signal 28 would therefore be lighted through the closed contacts of both supervisory relays to notify the A operator that the called subscriber has not yet responded. The trunk-relay 46 is energized by this flow of current attracting its armature and closing the circuit of the guard or disconnect lamp 62 from the live side of battery 51 over conductor 63, through the lamp 62, conductor 64, and front contact of relay 46, conductor 54, and the armature 53 of relay 50 to ground. The signal 62 will therefore be lighted to notify the B operator that the A operator has inserted her calling-plug in a jack of the proper trunk-line. The B operator, if she has not previously done so, will then test the condition of the wanted line in the usual manner. If the line is busy, a potential above that of ground would exist at the sleeve contact of the jack due to a flow of battery current through the cut-off relay 7 of the line at the switchboard-section where such connection exists. As the tip-strand of the operator's testing-terminal is normally grounded through the test relay 56, a flow of current will result over the tip-strand 57 and the winding of the test-relay 56 to ground. The armature 58 of the test-relay will close a path for current from the battery 51 through the tertiary winding of the operator's induction-coil, including conductors 63, 76, 76^a, and 59. Current in this path will produce an inductive click in the operator's head-receiver to notify her that the line is busy. If the line is not in use, no flow of current will result and the operator will insert her calling-plug into the jack of the desired line. Current will then flow from battery 51 over conductors 63, 80, and 52, through the winding of relay 50, sleeve-contacts of the plug and jack, and

through the winding of the cut-off relay 7 to ground. The relay 50 will attract its armatures, severing the connection of the test-relay with the tip-strand and uniting said strand for conversation at its armature 55, and opening the circuit of the guard-lamp 62 and closing the circuit of the ringing-lamp 69 at its armature 53. The guard-lamp 62 will thereby be effaced and the ringing-lamp 69 lighted, the circuit of the latter signal being traced from battery 51 over conductors 63, 80, and 70, through the lamp 69, normally closed back contact 71 of relay 72, conductors 73 and 68, and contact-armature 53 of the relay 50 to ground. The flow of current through the cut-off relay will remove the connection of the line-relay 14 with line conductor 3 at contact-spring 6 of the cut-off relay to prevent the operation of the line-signal 18 and will remove the ground connection from line conductor 4 at contact-spring 5 of said relay. The operator will then signal the subscriber by operating her ringing-key 49, signaling-current flowing from the generator 77 over the tip-contacts of the plug and jack, line conductor 4 through the substation signaling apparatus, line conductor 3, sleeve-contacts of the jack and plug, sleeve-strand 49, back contact 78 of the ringing-key, conductor 79 and to ground through the battery 51. During the process of ringing the cut-off relay 7 is maintained actuated by current from the battery 51 over conductor 79, contact 78 of the ringing-key, sleeve-contacts of the plug and jack, and through the winding of said relay to ground.

Upon the response of the called subscriber the relay 45 is operated over a path for current which may be traced from battery 51 over conductors 63, 80, and 52, the winding of relay 50, sleeve-contacts of the plug and jack, line-conductor 3, the substation talking apparatus, line conductor 4, the tip-contacts of the jack and plug, tip-strand 47, and through the winding of the relay 45 to ground. The relay 45 attracts its armatures, opening the circuit of the high-resistance trunk-relay 46 and extending the circuit of battery 29 at the A exchange from the armature 43 of the relay 45 to the armature 44 of said relay, over the sleeve-strand 48 of the trunk-cord, sleeve contacts of the plug and jack, limb 3 of the telephone-line, substation talking apparatus, limb 4 of the telephone-line, the tip-contacts of the jack and plug, and cord-strand 47 to the armature 44 of the relay 45. It will thus be seen that the telephone-line of the called subscriber is substituted in the path of current from the battery 29 at the A exchange for the high-resistance trunk-relay 46 and that the battery 29 is thus utilized for furnishing energy to the transmitter at the called-subscriber's station over a metallic line free from inductive devices or repeating-coils of any kind and free from impedance, the conduc-

tivity of said line from the called-subscriber's station to the A exchange being the same for voice-currents as for direct battery-current. The decreased resistance in this path due to the removal of the fifteen-thousand-ohm trunk-relay permits the operation of the tip supervisory relay 30 at the A exchange, which opens the circuit of the supervisory lamp 28 at the normally closed contacts of said relay, retiring said signal and notifying the A operator that the called subscriber has responded.

The operation of the relay 45 opens the circuit of the guard-lamp 62 at the back contact 66 of said relay and closes the circuit of the relay 72 at its front contact 74. The guard-lamp 62 is therefore prevented from lighting when its circuit is closed at the back contact of the trunk-relay 46, and said signal remains dark. The ringing-lamp 69 is extinguished by the operation of the relay 72, due to current from the battery 51 over conductors 63 and 76, the winding of the relay 72, conductor 75, contact 74 of relay 45, conductors 67 and 68, and armature 53 of relay 50 to ground. The circuit of the ringing-lamp 69 is broken at the back contact 71 of relay 72 and the ringing-lamp extinguished. A locking-circuit is also completed for the relay 72 from the battery 51 over conductors 63 and 76, the winding of said relay, front contact 71^a, conductors 73 and 68, and armature 53 of the relay 50 to ground.

At the termination of the conversation, when the subscriber at the A exchange hangs up his receiver, the circuit through the supervisory relay 24 is opened, deenergizing said relay and permitting its armature 26 to drop back, closing the circuit of the supervisory lamp 27, thus notifying the operator that this subscriber has returned his receiver to its hook. The return of the subscriber's telephone to its hook at the B exchange opens the circuit through the relay 45, permitting its armatures 43 and 44 to drop back, inserting the high-resistance trunk-relay in the path of current from battery 29 at the A exchange. As previously stated, the resistance in this path is sufficient to prevent the operation of the tip supervisory relay 30, which releases its armature, closing the circuit of the supervisory signal 28, which is illuminated to notify the operator that the subscriber at the B exchange has returned his receiver to its hook.

It will be noted that the ringing-lamp 69 will not be lighted when the B subscriber hangs up his receiver, due to the locking-circuit of the relay 72 above described. The disconnect-lamp 62 will also remain dark, due to the fact that its circuit is opened at the back contact of the trunk-relay 46. When the A operator receiving the signal for disconnection from both subscribers removes the plug from the trunk-jack, the trunk-re-

lay 46 will be deenergized, closing the circuit of the disconnect-lamp 62 at the back contact of said relay, and said signal will be illuminated to indicate this fact to the B operator over a path from battery 51, conductor 63, disconnect-signal 62, conductor 64, back contacts of the trunk-relay 46, conductor 65, back contact 66 of relay 45, conductors 67 and 68, and armature 53 of relay 50 to ground. Noticing this signal, the B operator will remove the plug of the trunk-line from the jack of the called subscriber, restoring all parts to normal condition.

It will be understood that the several grounds mentioned in connection with the exchanges may be one and the same or the common office return and that the ground connection between the exchanges is to be considered the equivalent of a metallic conductor. Where a metallic conductor is used, the danger of disturbing earth-currents, which in some localities might be present in the exchange, due to the ground connection, will be obviated.

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

1. The combination with a trunk-line, of a cord-circuit at the A exchange to connect with the outgoing end thereof, and a called-subscriber's line terminating at the B exchange with which its incoming end is adapted to be connected, a supervisory relay associated with the cord-circuit energized over a circuit local to the A exchange when a connection is made with the trunk-line, a signal having its circuit closed by said relay, a second relay for controlling the circuit of said signal at another point, a trunk-relay in series with said second relay and of sufficiently high resistance to prevent its operation, and means when the called-subscriber answers for substituting the called-subscriber's line in the circuit in place of said trunk-relay, whereby said second relay is actuated and said signal extinguished, substantially as described.

2. The combination with a trunk-line, of a cord-circuit at the A exchange to connect with the outgoing end thereof, and a called-subscriber's line terminating at the B exchange with which its incoming end is adapted to be connected, a supervisory relay associated with the cord-circuit energized over a circuit local to the A exchange when a connection is made with the trunk-line, a signal having its circuit closed by said relay, a second relay for controlling the circuit of said signal at another point, a trunk-relay in series with said second relay and of sufficiently high resistance to prevent its operation, a relay at the B exchange energized by current over the called-subscriber's line, said relay being adapted to remove said trunk-relay from the circuit and substitute the resistance

of the called-subscriber's line therefor, to energize said second relay and extinguish said signal, substantially as described.

3. The combination with a trunk-line, of a cord-circuit at the A exchange to connect with the outgoing end thereof, and a called-subscriber's line terminating at the B exchange with which its incoming end is adapted to be connected, a supervisory relay associated with the cord-circuit energized over a circuit local to the A exchange when a connection is made with the trunk-line, a signal having its circuit closed by said relay, a second relay for controlling the circuit of said signal at another point, a trunk-relay in series with said second relay and of sufficiently high resistance to prevent its operation, and means when the called subscriber answers for substituting the called-subscriber's line in the circuit in place of said trunk-relay, whereby said signal is extinguished, and a path for direct current is closed from one exchange to the other including the called-subscriber's line, substantially as described.

4. The combination with a trunk-line, of a cord-circuit at the A exchange to connect with the outgoing end thereof, and a called-subscriber's line terminating at the B exchange with which its incoming end is adapted to be connected, a supervisory relay associated with the cord-circuit energized over a circuit local to the A exchange when a connection is made with the trunk-line, a signal having its circuit closed by said relay, a second relay for controlling the circuit of said signal at another point, a trunk-relay in series with said second relay and of sufficiently high resistance to prevent its operation, and means when the called subscriber answers for substituting the called-subscriber's line in the circuit in place of said trunk-relay, whereby said signal is extinguished, and a path for direct current is closed from one exchange to the other including the called-subscriber's line, the path for voice-currents from the A exchange to the called-subscriber's station being coincident with said direct-current path, substantially as described.

5. The combination with a trunk-line, of a cord-circuit at the A exchange to connect with the outgoing end thereof, and a called-subscriber's line terminating at the B exchange with which its incoming end is adapted to be connected, a supervisory signal associated with the outgoing end of the trunk, means for closing the circuit of said signal when a connection is made with the trunk, a supervisory relay for opening the circuit of said signal, a trunk-relay of sufficiently high resistance to prevent the operation of said supervisory relay when connected in series therewith, and means when the called subscriber answers for connecting the called-subscriber's line in the path of current from

the A exchange and removing said trunk-relay therefrom to actuate said supervisory relay and extinguish said signal, substantially as described.

5 6. The combination with a trunk-line, of
a cord-circuit at the A exchange to connect
with the outgoing end thereof, and a called-
subscriber's line terminating at the B ex-
10 change with which its incoming end is
adapted to be connected, a supervisory signal
associated with the outgoing end of the
trunk, means for closing the circuit of said
signal when a connection is made with the
trunk, a supervisory relay for opening the
15 circuit of said signal, a trunk-relay of suffi-
ciently high resistance to prevent the opera-
tion of said supervisory relay when connected
in series therewith, and means when the
called subscriber answers for connecting the
20 called-subscriber's line in the path of cur-
rent from the A exchange and removing said
trunk-relay therefrom, whereby said super-
visory relay is energized and said signal is
extinguished, and a path for voice-currents
25 is closed between the A exchange and the
called-subscriber's station coincident with
the path for direct current, substantially as
described.

30 7. The combination with a trunk-line, of
a cord-circuit at the A exchange to connect
with the outgoing end thereof, and a called-
subscriber's line terminating at the B ex-
change with which its incoming end is
adapted to be connected, a supervisory signal
35 associated with the outgoing end of the
trunk, means for closing the circuit of said
signal when a connection is made with the
trunk, a supervisory relay for opening the
circuit of said signal, a trunk-relay of suffi-
40 ciently high resistance to prevent the opera-
tion of said supervisory relay when connected

in series therewith, and a relay energized
over the called-subscriber's line for connect-
ing said line in the path of current from the
A exchange and for removing said trunk- 45
relay therefrom, whereby the resistance of
the path is reduced, and said supervisory
relay actuated to extinguish said signal, sub-
stantially as described.

8. The combination with a trunk-line, of 50
a cord-circuit at the A exchange to connect
with the outgoing end thereof, and a called-
subscriber's line terminating at the B ex-
change with which its incoming end is
adapted to be connected, a supervisory signal 55
associated with the outgoing end of the
trunk, means for closing the circuit of said
signal when a connection is made with the
trunk, a supervisory relay for opening the
circuit of said signal, a trunk-relay of suffi- 60
ciently high resistance to prevent the opera-
tion of said supervisory relay when connected
in series therewith, a relay energized over
the called-subscriber's line for connecting
said line in the path of current from the A 65
exchange and for removing said trunk-relay
therefrom, whereby the resistance of the path
is reduced and said supervisory relay actu-
ated to extinguish said signal, and a discon-
nect-lamp having its circuit normally closed 70
at the contacts of said trunk-relay, and at
the contacts of said relay adapted to be
energized over the called-subscriber's line,
substantially as described.

Signed by me at Chicago, county of Cook, 75
and State of Illinois, in the presence of two
witnesses.

HOWARD M. POST.

Witnesses:

C. B. CAMP,
C. C. BRADBURY.