

No. 636,872.

T. C. WALES, JR.

Patented Nov. 14, 1899.

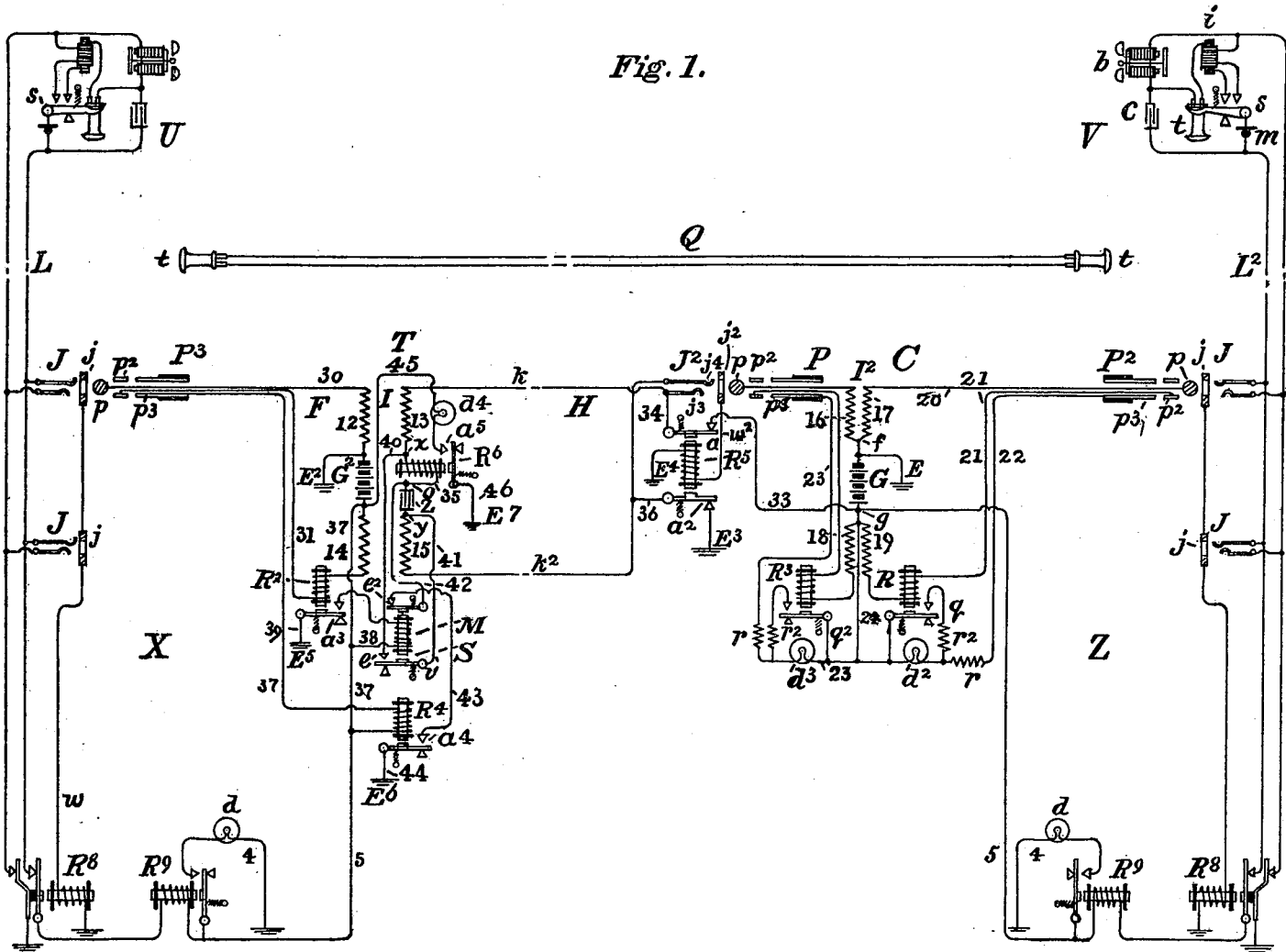
TELEPHONE TRUNK LINE SIGNALING.

(No Model.)

(Application filed Aug. 17, 1899.)

2 Sheets—Sheet 1.

Fig. 1.



Attest,
Joseph O. Sattly
Scribe

Thomas A. H. Leaf,
Inventor,

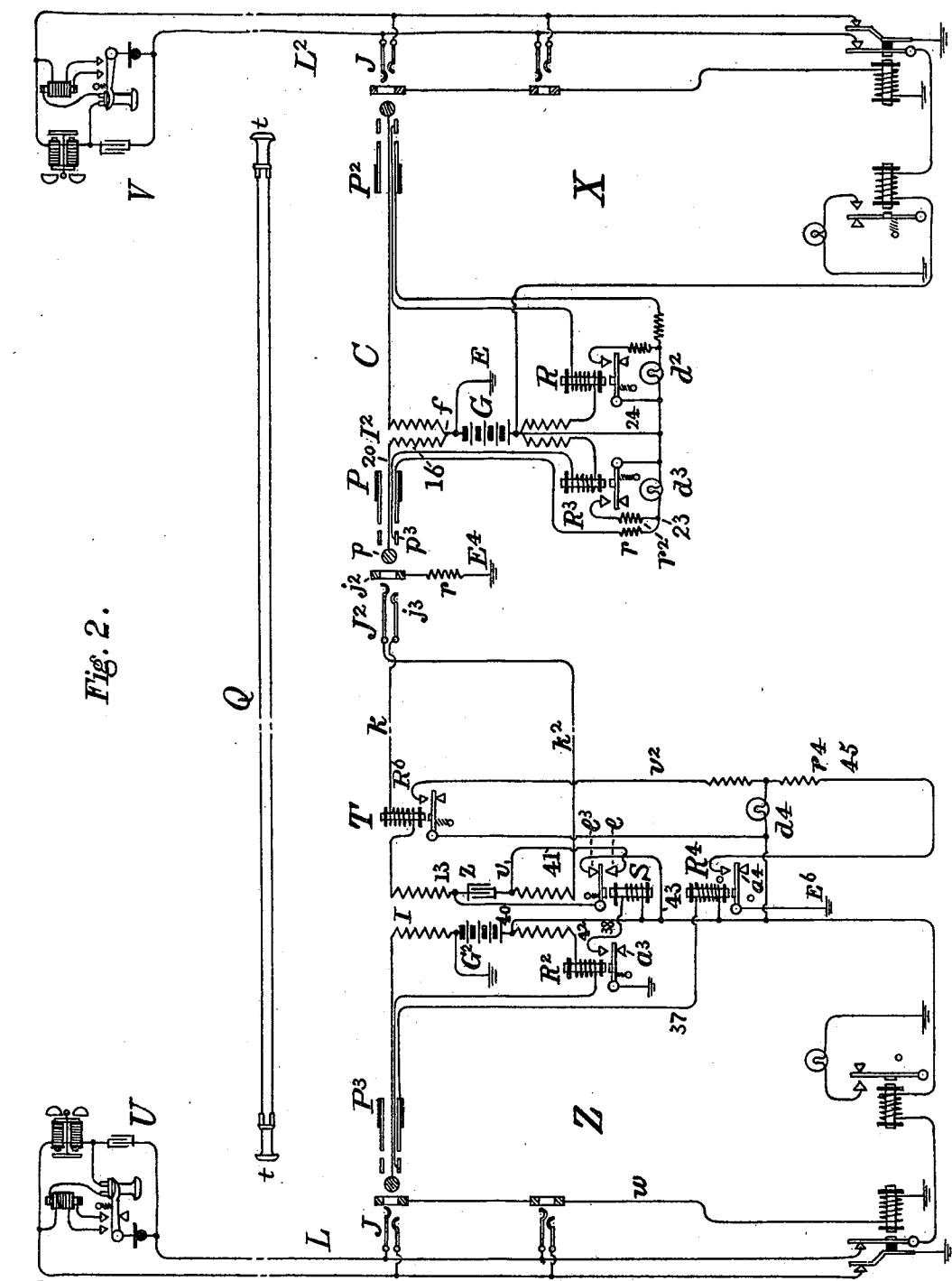
T. C. WALES, JR.
TELEPHONE TRUNK LINE SIGNALING.

(No Model.)

(Application filed Aug. 17, 1899.)

2 Sheets—Sheet 2.

Fig. 2.



Attest,
Joseph A. Bately
Sw. William Pierce

Thomas C. Wales, Jr.

Inventor,

UNITED STATES PATENT OFFICE.

THOMAS C. WALES, JR., OF NEWTON, MASSACHUSETTS, ASSIGNOR TO THE
AMERICAN BELL TELEPHONE COMPANY, OF BOSTON, MASSACHUSETTS.

TELEPHONE TRUNK-LINE SIGNALING.

SPECIFICATION forming part of Letters Patent No. 636,872, dated November 14, 1899.

Application filed August 17, 1899. Serial No. 727,579. (No model.)

To all whom it may concern:

Be it known that I, THOMAS C. WALES, JR., residing at Newton, in the county of Middlesex and State of Massachusetts, have invented certain Improvements in Telephone Trunk-Line Signaling, of which the following is a specification.

This invention relates to the central-station switching and signaling appliances of a telephone-exchange, and more particularly concerns the arrangement and operation of trunk-lines extending between different switchboards at which different sets of substation-lines terminate.

It has for its object to improve the service in communications involving the employment of the said trunk-lines in such manner that the trunk-line conductors may be made available in common for a talking-circuit and a signaling-circuit and so that ground or earth connections may be used to complete the latter without unbalancing the talking-circuit and without introducing disturbances therein. Until recently such trunk-lines when used for signaling, as well as for the transmission of speech, have had one or more ground connections at both ends of the trunk-conductors attached permanently, so as to produce an unbalanced condition of the talking-circuit, and while in some cases this has not produced harmful results in other localities where heavily-operated trolley-lines of electric street-railroad occur serious disturbance of the talking-circuit has been the result.

Experience has demonstrated that where but a single earth connection is attached to the trunk-line conductors when the trunk is employed as a link in a talking-circuit the unbalanced condition is greatly ameliorated and the disturbance disappears, or at any rate is so materially reduced that it no longer interferes with the transmission and reception of conversation.

My invention contemplates the use of a permanent earth connection attached to the trunk-circuit at one end only, but provides one or more complementary ground connections at the other end also, which, normally detached, can be automatically attached to the trunk-conductors when their presence becomes desirable to complete a signaling-cir-

cuit through the said conductors, which are automatically detached while the trunk is in use as a portion of a talking-circuit, which, again, are automatically attached for the transmission of the requisite signals at the close of a conversation, and which, finally, resume their normally-detached condition when disconnection is fully effected, all of these several changes being, moreover, dependent upon and actuated by the normal operation of the switching devices and requiring no special act for their accomplishment.

The invention involves any two substation-circuits (those of the relay-controlled type being preferred) terminating at different switchboards, which, of course, may either be in different central stations or in different parts of the same central station, and the usual trunk-line extending between the said switchboards, suitable switching devices being provided at each end for the interconnection of the two ends of the trunk with the substation-circuits, respectively.

It is customary to have one set of trunks at each switchboard for service in connections initiated at such board and a separate set for service initiated at other boards. Thus at any board the trunk-service, generally speaking, is arranged on a double-track basis, the trunk-lines of the former class being designated as "outgoing" trunks and those of the latter class as "incoming" trunks; but since the outgoing trunk at one board is always an incoming trunk at some other board it becomes possible to use a single-trunk circuit to illustrate and describe both classes. At the outgoing end of the trunk-circuit the ordinary and convenient practice is to provide a switch-socket termination therefor and to switch the trunk to a substation-circuit which has called for a number at another switchboard by means of the regular switch-cord connection, provided at each end with a switch-plug, one of the said plugs being placed in the subscriber's-line switch-socket and the other in the trunk-line socket; but the incoming trunk—that is, the other end of the trunk under consideration—terminates in a switch-plug and hence at the switchboard of the line called for. The trunk may be switched directly to such line by thrusting the plug-ter-

minal of the trunk into the switch-socket of the said desired line. I prefer to place the plug or incoming end of the trunk in a conductively-separated portion united to the main portion of said trunk by means of a repeating induction-coil, and the two portions of the trunk-line I designate, respectively, the "switch-plug" and "line-sections" thereof. The latter is normally open, a condenser being interposed therein.

The trunk-line is provided with two supervisory signals, one of which, placed in the plug-section, is responsive directly to the telephone-switch of the called substation, while the other, placed in the switch-cord connection at the outgoing end, is, when the trunk is connected between the two lines for intercommunication, introduced into the line-section thereof and is indirectly responsive to the operation of the switch of the said called subscriber, there being interposed between the said two relays an automatic switch actuated by an electromagnet, which magnet is controlled by the plug-section supervisory relay and when operated acts to short-circuit the condenser, and thus close the circuit and excite the supervisory relay in the line-section.

I find it convenient to designate the supervisory relay in the plug-section as the "primary" supervisory relay, the relay in the line-section as the "secondary" supervisory relay, and the magnet-actuated switch as the "electromagnetic" switch.

At the incoming end of the trunk there is also a special disconnecting-signal controlled by another relay, which may under certain conditions be placed either in series with the condenser, to be in conjunction therewith shunted by the electromagnetic switch, or directly in the main circuit of the trunk, and the said relay may, as will be hereinafter more fully described, control its signal either by closing and opening the circuit thereof or by opening and closing a shunt-circuit around it. The conductors of the trunk are grounded, preferably, at the outgoing end by a ground attached to the battery associated with the switch-cord connection, and this ground is maintained while the trunk is being employed as a portion of the talking-circuit; but the said conductors are common also to a signaling-circuit, and when operated as such depends in part upon the attachment of one or more other ground connections, which are uniformly detached or disconnected during the use of the trunk for conversation. The most important of these is adapted to complete a circuit for the disconnecting-signal at the incoming end of the trunk—that is to say, it may be employed either to complete the circuit directly of the said signal or of the relay controlling the same. Means are provided for automatically controlling the said complementary ground and may consist either of a special or supplementary relay contained in the cut-off-relay or test circuit

of the called line when the trunk-plug is placed in the switch-socket thereof or of the said special relay operating conjointly with the electromagnetic switch. In either case the said means is potentialized by the establishment of a switch connection between the trunk at its incoming end and the wanted line, is made active by the initial disconnection effected at the outgoing end of the trunk, and remains in action until the final disconnection at the incoming end of the trunk is made, whereupon it resumes its normal state of dormancy.

In the drawings which accompany this specification, Figure 1 is a diagram illustrating a circuit arrangement embodying the invention, and Fig. 2 is a similar diagram of an arrangement modified in certain respects.

In the drawings similar letters and figures of reference are used to indicate similar parts.

U and V are substations or subscribers' stations. X and Z are switchboards. L and L² are substation-circuits connecting the said substations with the said switchboards, respectively.

T is a trunk-line between the switchboards X and Z, by means of which substation-circuits terminating at the two switchboards, respectively, may be united.

C is a switch-cord connection at switchboard Z, provided with switch-plugs P and P².

Q is an order or instruction circuit, over which the operators at the two switchboards may communicate by means of telephones *t*.

At each substation is the outfit of telephonic appliances usually furnished, comprising the call-bell *b*, microphone *m*, receiving-telephone *t*, induction-coil *i*, and automatic telephone-switch *s* and a condenser *c* is also supplied, which, being together with the bell in circuit while the telephone is hung on the switch-hook, keeps the line-circuit open while in a state of disuse. When the telephone *t* is removed from the hook, the condenser is short-circuited and the main circuit closed.

The substation-circuits L L² are at their switchboard ends fitted with the usual switch-sockets J, having socket-rings *j*, and also with the standard cut-off relay R⁸, the signal-relay R⁹, and the line-signal *d* in a local circuit 4 controlled by the latter relay, which is itself placed in an extension-conductor 5, leading from any suitable source of current through one of the cut-off-relay contacts to one of the substation-circuit conductors. The cut-off relay R⁸ is placed, as usual, in a ground branch conductor uniting the switch-socket rings *j* of the line concerned, which branch when a plug is placed in any of the said sockets becomes a part of a local circuit, including a current-generator, which circuit may be termed the "cut-off-relay" circuit, or in the case of a multiple switchboard the "test-circuit."

The trunk-line T is an outgoing trunk at

switchboard Z and an incoming trunk at switchboard X. It terminates at its outgoing end in a switch-socket J^3 and its incoming end in a switch-plug P^3 , and it is therefore evident that it is adapted to form a connection with a substation-circuit at switchboard X directly by the insertion of its plug P^3 into a socket J thereof, while at switchboard Z it requires the intermediation of a switch-cord connection C in order to establish communication with a substation-circuit. At its incoming end the trunk is associated with a repeating induction-coil I, which divides it conductively into two portions, which I term a "plug-section" F and a "line-section" H.

The plug and cord connection C at the outgoing end of the trunk is of ordinary construction, having its terminal plugs P and P^2 each formed with a tip-contact surface p and with front and rear sleeve contact surfaces p^2 and p^3 . The tip and front-sleeve contacts register with appropriate main contacts of the substation-circuit and trunk-sockets J J^2 , respectively, and the rear-sleeve contact registers with the frame or ring contacts of the said sockets. The cord uniting these plugs comprises main conductors 20 and 21 and local-circuit conductors 22 and 23, one for each plug. The conductor 20 unites the tip and the conductor 21 the front-sleeve contacts of the two plugs, the inductively-related windings 16 and 17 of a repeating-coil I^2 being arranged in series in conductor 20 and the remaining windings 18 and 19 of the said coil, also inductively related, being connected in series in conductor 21. A suitable source of current G is bridged between the said conductors at points fg and has an earth connection E at the point f . The local conductors 22 and 23 of the plugs P^2 and P, respectively, branch from the ungrounded pole of the said source and, leading through supervisory signals d^2 and d^3 and any suitable regulating resistances r , extend to the rear sleeves p^3 of their respective plugs. The conductor 22 of plug P^2 is thus on the insertion of said plug in a socket J enabled to complete and close the cut-off-relay circuit of such line. The main-line conductors 20 21 of the cord connection include relays R R^3 , controlling the signals d^2 d^3 by means of shunt-circuits q q^2 , which may include regulating resistances r^2 . The relay R, not being a factor in my invention, requires no further description; but the supervisory relay R^3 being connected in the trunk-circuit as soon as the plug P is inserted in the trunk-socket J^2 becomes thereby indirectly responsive to the operation of the switch s of the called circuit L and is that which I term the "secondary" supervisory relay.

Referring now more particularly to Fig. 1, it will be seen that the plug-section F of the trunk-line T forms conductively a loop from the tip p to the front-sleeve-contact surface p^3 of the plug P^3 by way of conductor 30, repeating-coil windings 12 and 14 and the in-

terposed battery, and conductor 31, the said battery being grounded at E^2 . Associated with the loop is a local-circuit conductor 37, extending from the ungrounded pole of battery G^2 to the rear-sleeve conductor p^3 of plug P^3 , so that on the insertion of the plug the said conductor becomes a portion of and completes the cut-off-relay and test circuit w of the called-for substation-circuit L. The line-section of the said trunk is inductively connected with the plug-section thereof, the two remaining windings 13 and 15 of the repeating-coil being included in its circuit; but when not in use the said line has its two main conductors k and k^2 united at switchboard Z or (which amounts to the same thing) both grounded, one at E and the other at E^3 , and separated at switchboard X by the interposed condenser z . Tracing the said conductors from the normal ground connections at the outgoing end of the trunk, we find conductor k to lead from ground E, through the generator G, and by way of point g , conductor 33, armature-contact a , conductor 34, main conductor k , winding 13 of repeating-coil I, and conductor 35 to one plate of the condenser z , while conductor k^2 passes from ground E^3 , through armature-contact a^2 , branch 36, main conductor k^2 , and repeating-coil winding 15 to the other plate of the condenser. The two contact-springs j^3 and j^4 of the trunk switch-socket J^2 are branched from the conductors k k^2 , respectively. The socket-ring j^2 of the trunk-socket J^2 is in a conductor w^2 , leading to ground E^4 .

R^2 is the primary supervisory relay in the main circuit of the trunk-plug section F, and when the plug P^3 is in the line-socket J the said relay is of course under the direct control of the substation-telephone switch s . The said relay controls the continuity of a local circuit containing the magnet M of the electromagnetic switch S, which circuit is shown as extending from the battery G^3 , by wires 37 and 38, the armature-points a^3 of the said relay R^2 , and wire 39 to ground at E^5 .

The electromagnetic switch S controls two independent circuits by means of two separate sets of contact-points e and e^2 . One of these is a shunt v , which can be closed by the switch around the condenser z , which normally maintains the discontinuity of the line-section of the trunk-circuit. The said shunt v is controlled by the contacts e of said switch and extends from point x on one side of the condenser via conductor 40, contact-points e , and conductor 41 to point y on the other side of the condenser. Obviously when the points e make contact the trunk-line section is closed by thus cutting out the condenser, and assuming that the plug P of the switch-cord connection C has been placed in the trunk-socket J^2 it is evident that the secondary supervisory signal-relay R^3 is included in the said line-section of the trunk and is in position to respond to the operations of the switch-lever s at substation U as conveyed

to it by means of the primary relay R^2 and the electromagnetic switch S . The said secondary relay R^3 controls the display of the supervisory signal d^3 by closing or opening the shunt q^2 around it.

R^5 at the outgoing end of the trunk is a trunk-cut-off relay controlling by its two sets a^2 of armature-contacts the normal ground connections $E E^3$ of the trunk main conductors $k k^2$, respectively. The magnet of this relay is included in the circuit of conductor w^2 , leading to ground from the socket-ring j^2 of trunk-circuit J^2 . It is consequently operated as soon as the plug P is inserted in the said socket, and its circuit leads from earth at E , through the generator G , conductor 24, conductor 23, signal-lamp d^3 , included therein, contact-surface p^3 of plug P , wire w^2 , and magnet-winding of relay R^5 to ground E^4 . The relay R^5 acts immediately on the insertion of the plug P and removes the grounds from both of the trunk-line conductors.

R^4 is a supplementary relay at the incoming end of the trunk and is contained in the local conductor 37, associated with the trunk-plug P^3 , to form the cut-off relay and test-circuit w . This circuit is closed as soon as the plug P^3 is inserted and remains closed until the said plug is again withdrawn. The relay R^4 therefore operates as soon as the plug is placed in its socket and continues to hold its armature in a forward position until the said plug is again withdrawn. It controls in part a complementary ground connection E^6 , capable of being and adapted to be attached to the trunk-circuit conductor or conductors at a point o of the extension 35 of trunk-conductor k . When so attached, it is traceable from the said point o by wire 42 through the contact-points e^2 of the electromagnetic switch S , by wire 43 to the contact-points a^4 of the supplementary relay R^4 , and by wire 44 to earth at E^6 ; but the relay R^4 is excited when the plug P^3 is inserted, and the electromagnetic switch is excited when, the plug P^3 being so inserted, the telephone at substation U is removed from its switch. Thus the ground E^6 is detached from the circuit until the plug P^3 is inserted, is attached thereto by relay R^4 on the insertion of the said plug, is detached therefrom by the opening of the ground-conductor at e^2 when the electromagnetic switch S is excited pursuant to the removal of the telephone at U , remains detached during the use of the line for talking, is reattached thereto when the substation-receiver at U is again hung up by the reunion of the points e^2 , and is finally disconnected by the ultimate withdrawal of the plug, which opens the circuit of relay R^4 and permits its relay to fall away. This complementary ground is therefore controlled in part by the relay R^5 and in part by the electromagnetic switch S .

R^6 is a relay controlling the display of the disconnecting-signal. It is placed in the line-section H of the trunk at the incoming end and is connected between the condenser z

and winding 13 of the repeating-coil. It is included with the said condenser z in the shunt v , controlled by contacts e of the switch S , and is, with the said condenser, thus short-circuited while talking is going on. Since, however, the complementary ground-conductor is attached to the trunk-conductor at the point o , it follows that the withdrawal of the plug P at switchboard Z brings relay R^6 into a grounded circuit of the generator G , which circuit is about the same time closed at contacts e^2 by the reverse operation of switch S when the subscriber at U hangs up his receiver. The said circuit proceeding from ground E at switchboard Z is traceable by generator G , point g , wire 33, contact-points a , wire 34, line k , repeating-coil winding 13, relay R^6 , point o , wire 42, switch-points e^2 , wire 43, relay-points a^4 , and wire 44 to ground at E^6 . The closure of this signaling-circuit excites relay R^6 , which operates, attracting its armature and closing at points a^5 the local circuit of the disconnecting-signal d^4 . This circuit is from ground E^2 , through battery G^2 and wire 45, to the signal d^4 , and thence through the relay-points a^5 and wire 46 to earth at E^7 , and being thus closed the signal is displayed and remains displayed until the withdrawal of the plug P^3 , which, opening the circuit of the relay R^4 , causes the said relay to remove the complementary ground connection of the circuit through relay R^6 , whose excitement then ceasing allows the retraction of its armature and the consequent disappearance of signal d^4 . The complementary ground connection acts on the signal d^4 in this instance through a relay; but it may under varying conditions be so placed as to act on the circuit thereof directly without departing from the spirit of the invention.

In operation we assume that the subscriber at substation V has sent a call to switchboard Z and has indicated his desire to speak with substation U , whose line connects with switchboard X . The answering operator informs the operator at X of the call by means of instruction-circuit Q , and having already inserted plug P^2 of the cord C into a socket of the calling-line now inserts the plug P of said cord into the trunk switch-socket J^2 . This action closes a circuit of the generator G through the signal-lamp d^3 , which is displayed, and through relay R^5 , which operates and removes the normal grounds from the trunk-conductors. The operator at X inserts the trunk-plug P^3 into a switch-socket of the desired line, and thus closes the cut-off-relay circuit thereof, operating relay R^4 and establishing a supplementary ground on the trunk-conductors. When the subscriber at U , having been called by the operator at X , removes his receiver from the switch-hook, the primary relay R^2 operates, actuating the switching-magnet, which establishes the shunt around the disconnecting-signal relay and the condenser, thereby closing the trunk-circuit line-section and enabling relay R^3 at the other

end to operate and to shunt the signal d^3 , thus indicating there that the wanted subscriber has been connected and has responded. At the same time the switch-magnet has also detached the supplementary ground. The two lines being now connected, conversation may be proceeded with, and it is to be observed that there is but one ground connection attached to the trunk—viz., the ground E at the outgoing end. The talking-circuit is therefore not subject to disturbance. When now, on conclusion of the conversation, V hangs up his telephone, the signal d^2 is operated; also, when U replaces his telephone the primary relay R^2 releases its armature and opens the circuit of the electromagnetic switch. The said switch in turn releases its armatures, opening the trunk line-section and closing the complementary ground connection. The opening of the trunk-section causes relay R^3 to release its armature, which being retracted permits the display of signal d^3 and authorizes the withdrawal of the plug P. The operation of the switch S has, however, also introduced the disconnecting-signal relay R^6 at the incoming end of the trunk and has included the same in a circuit of the generator G, between the permanent ground E and the complementary ground E^6 , over conductor k . This relay R^6 therefore now operates, causing the display of the disconnecting-signal d^4 . In obedience to this signal the operator at X withdraws the plug P^3 . The relay R^4 is thereupon discharged and releasing its armature detaches the complementary ground, thus causing the discharge of relay R^6 , the consequent retraction of its armature, and the disappearance of a signal d^4 . The normal conditions are thus entirely restored.

The construction or arrangement illustrated by Fig. 2 does not differ in any material sense. The trunk-line conductors k k^2 are not normally grounded at the outgoing end. Hence no relay is required for the removal of such ground. The disconnecting-signal relay R^6 , instead of being placed in series with the condenser z and between the said condenser and the main line, is permanently in the main conductor k , and it operates to control the display of the disconnecting-signal d^4 by closing and opening a shunt around it instead of by closing and opening the actual circuit wherein it is connected. Moreover, the electromagnetic switch S does not assist the supplementary relay R^4 in the control the latter exercises over the complementary ground, but operates one set of back and front contacts e e^3 , acting when its armature is attracted to short-circuit the condenser by conductors 40 and 41 and contact-point e and when the armature is again retracted to reintroduce the condenser, thereby opening the line-section of the trunk, and to connect the main conductor, including the disconnecting-signal relay R^6 , in a circuit of generator G^2 , leading by conductors 42 and 43, switch-points e^3 , and shunt-conductor 40, to keep the

lamp d^4 from being displayed prior to the moment when the subscriber at U removes his telephone. The complementary ground E^6 , controlled by relay R^4 , in this case is concerned directly with the circuit of the disconnecting-signal d^4 instead of with the relay which controls the same, and, finally, the trunk switch-socket ring at the outgoing end thereof is connected directly to earth through such reducing-resistance as may be necessary. The arrangement, though modified, is still in all essential respects the same.

When subscriber V calls, desiring to converse with substation U, the plug P^2 , as before, is inserted in socket J of the line concerned, and the call is answered. The necessary information is conveyed to X by the order-line Q, and the plug P is placed in the trunk-socket J^2 . A circuit for generator G is thus established by way of conductor 24, signal d^3 , conductor 23, plug contact-surface p^3 , and the socket-ring j^2 to earth, suitable reducing-resistances r being included, and the lamp-signal d^3 is lighted. Another circuit at the same time is established for the battery G^2 at the incoming end of the trunk, which leads by way of conductors 40 and 43, switch-points e^3 , conductor 40, winding 13 of repeating-coil I, winding of relay R^6 , line-conductor k , socket-contact j^3 , tip p of plug P, conductor 20, winding 16 of coil I^2 , and point f to earth at E. The relay R^6 operates, establishes a shunt v^2 around the disconnecting-signal, and prevents the untimely display thereof. The plug P^3 at the incoming end of the trunk being now inserted in socket J of the desired line, the circuit w of the cut-off relay of such line is closed, as in Fig. 1, through conductor 37 and includes the supplementary relay R^4 , which attaches the complementary ground E^6 to the circuit-conductor 45 of the disconnecting-signal d^4 , at the same time including any suitable or appropriate resistance r^4 in such circuit. When the subscriber at U, having been rung up in the usual way, answers by removing his telephone from his switch and by thus operating the latter, the primary supervisory relay R^2 is excited and, closing at contacts a^3 the local circuit of the automatic switch S, enables the said switch to close the shunt v around the condenser z , thus closing the line-section of the trunk and at the same time detaching the battery and ground connection 43 therefrom. When this occurs, the relay R^3 at the outgoing end of the trunk becomes excited and, closing the shunt around the signal d^3 , withdraws the said signal, while the relay R^6 in the main conductor k maintains its excitement and the continuity of the shunt v^2 around signal d^4 , for the reason that though the battery and ground connection 43 has been removed a metallic circuit for the battery G, including the coils of said relay, has been substituted therefor. Disconnection, when required, is brought about in the following manner: When V restores his receiver to the switch-hook,

signal d^2 is displayed and authorizes the withdrawal of plug P^2 . When the receiver at U in like manner is replaced, the primary relay R^2 releases its armature, which opens the circuit of electromagnetic switch S. The said switch permits its armature to resume its normal position, and thus opens the line-section of the trunk, so that the secondary relay R^3 included therein no longer attracts its armature, which accordingly is released, permitting the display of the signal d^3 , which authorizes the withdrawal of plug P. The armature of relay R^6 , which thus far has been continuously attracted from the beginning of the operation, is, however, released as soon as the plug P is withdrawn, because it then can receive no current from either battery. The shunt v^2 is thereby opened and the disconnecting-signal d^4 displayed, and by this means the operator at X is authorized to complete the disconnection by withdrawing the trunk-plug P^3 . When this is done, the signal d^4 is extinguished, its circuit being opened at the points a^4 of relay R^4 .

It is of course to be understood that I have referred to several distinct ground connections at the same switchboard purely as a matter of convenience and that in practice a single ground connection or a common return-conductor may readily be substituted.

I claim as my invention—

1. In a telephone-exchange system, the combination of two substation-lines terminating at different switchboards; a trunk-circuit comprising a switch-plug section wholly at one of the said switchboards and a normally-open line-section in inductive relation therewith, and extending therefrom to the other switchboard; switch devices for uniting the said substation-lines to the respective ends of said trunk; and a primary and secondary supervisory signal-relay in the main circuit of the said trunk when so connected, the primary relay being at the switch-plug end of the trunk, and the secondary relay at the socket end thereof; with an electromagnetic switch actuated by the primary supervisory relay, and adapted to close and control the said normally-open trunk-section, and thereby operate the said secondary relay; a disconnecting-signal at the incoming end of the trunk-circuit; a complementary ground connection controlling a circuit for the operation of the said signal, detached while the trunk is in use for conversation; and means as indicated for attaching the same and for displaying the said signal at the said incoming end of the trunk in response to the disconnection effected at the other end thereof; substantially as set forth.

2. The combination with a trunk-line be-

tween two telephone-switchboards, having conductors common to a metallic talking-circuit, and a grounded signaling-circuit; of a ground connection for the said signaling-circuit at one end of the trunk; a supervisory relay in the talking-circuit, a complementary ground connection for the signaling-circuit, and a supplementary relay in a local circuit adapted to be closed through the trunk-circuit switch devices, all at the other end of said trunk; and means controlled in part by the said supervisory relay, and in part by the said supplementary relay for attaching and detaching the said complementary ground connection, as required; substantially as and for the purposes set forth.

3. In a telephone-exchange system, the combination of two switchboards, and substation-circuits terminating at each; a trunk-line extending from one to the other, having conductors common to a normally-open metallic talking-circuit, and a grounded signaling-circuit, and terminating at its outgoing end in a switch-socket, and at its incoming end in a switch-plug, the said trunk being switched directly to a substation-circuit at its switch-plug or incoming end, and through a switch-cord and double-plug connection to a substation-circuit at its socket or outgoing end; with a source of current, a ground connection, and a signal-operating relay in the talking-circuit, all connected to the said trunk-line at the outgoing end thereof; a supervisory relay in the talking-circuit, a disconnecting-signal relay in the signaling-circuit, an electromagnetic switch actuated by the supervisory relay and operating to close and open the talking-circuit of the trunk-line, a shunt around the said disconnecting-relay as required, and a supplementary relay in a local circuit containing the cut-off relay of the substation concerned, and adapted to be closed through the trunk-circuit switch devices, all at the switch-plug or incoming end of said trunk; and a complementary ground connection for the trunk signaling-circuit, detached while the talking-circuit is in operation, and controlled in part by the said supplementary relay, and in part by the primary supervisory relay acting through the electromagnetic switch; substantially as and for the purposes specified.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 14th day of August, 1899.

THOMAS C. WALES, JR.

Witnesses:

GEO. WILLIS PIERCE,
JOSEPH A. GATELY.