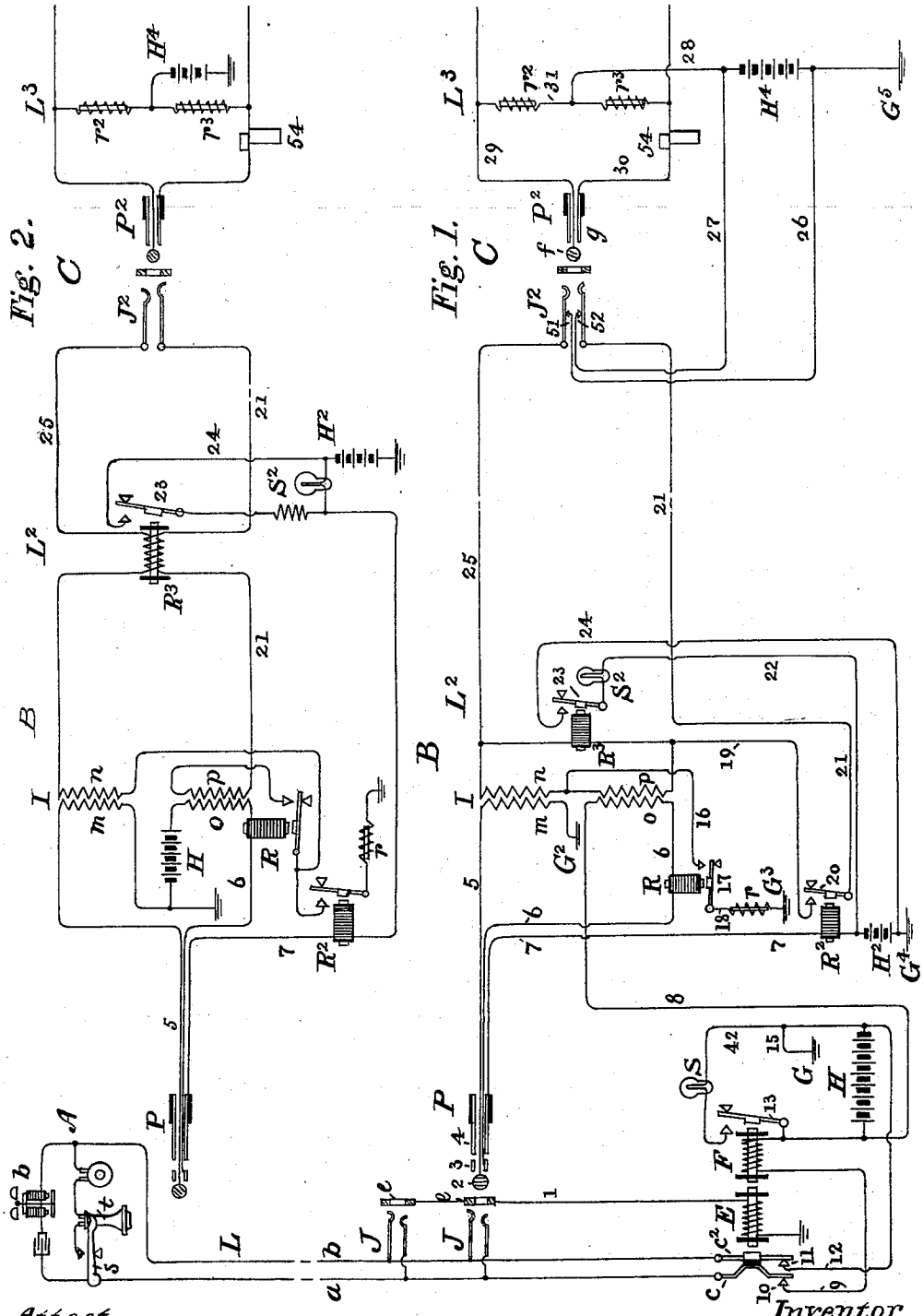
No. 628,567. Patented July 11, 1899.

T. C. WALES, JR.

TELEPHONE SWITCH APPARATUS, SIGNAL, AND CIRCUIT.

(Application filed Apr. 17, 1899.)

(No Model.) 2 Sheets—Sheet 1.



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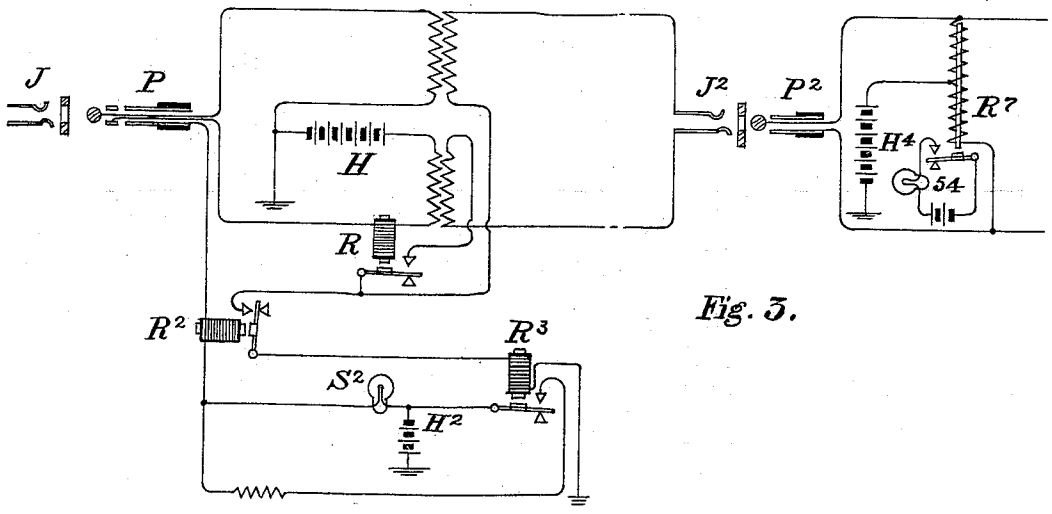

Fig. 3.

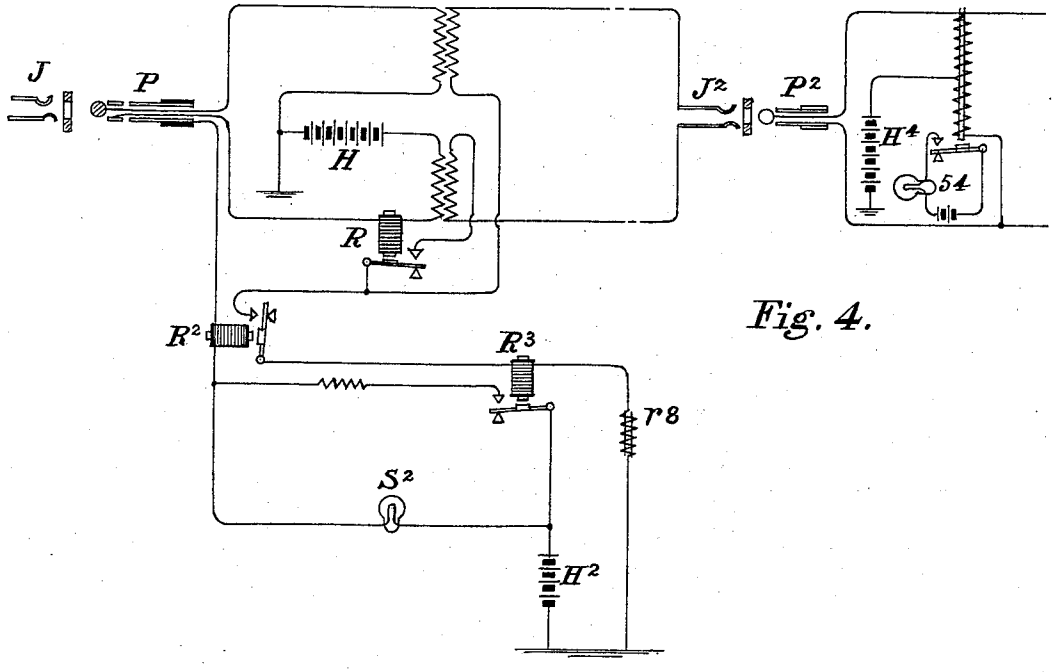

Fig. 4.

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UNITED STATES PATENT OFFICE.

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TELEPHONE SWITCH APPARATUS, SIGNAL, AND CIRCUIT.

SPECIFICATION forming part of Letters Patent No. 628,567, dated July 11, 1899.

Application filed April 17, 1899. Serial No. 713,338. (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 Switch Apparatus, Signals, and Circuits, of which the following is a specification.

In the development of telephone business various classes of circuits have been devised for the different kinds of service to be rendered, and the majority of telephone-circuits in use are now associated in some way with one or more central or terminal stations where is located a switching apparatus or switchboard by means of which the various circuits are linked together for conversational purposes and the different central stations are connected to each other by trunk-circuits, by means of which through connections are made. In pursuance of the relatively recent evolution of substation-telephone-circuit arrangements results which were formerly obtained by manual operations are now automatically produced, utilizing for the transmission of signals the common and centralized source of current in association with relay-controlled-circuit terminals, and it becomes necessary to provide interconnecting trunk-circuits adapted to such substation and relay circuit conditions.

The object of the present invention is to provide an improved trunk-circuit especially adapted for use between two central or terminal stations, one of which is equipped with a relay-switchboard, upon which are located the terminal sockets and automatic line lamp-signals of a series of substation-circuits and provided with linking cord-circuits having associated automatic supervisory signals, preferably glow-lamps, and a common source of electrical energy, while the second central station is the terminal station of a series of long-distance or toll lines and is provided with switching apparatus whereby the said lines can be connected to the trunk-circuits.

In the operations of connecting up and disconnecting a through-circuit consisting of a substation-circuit, of a relay-switchboard, a trunk-circuit, and a long-distance or toll circuit a very important part consists in the automatic operation of signals whereby information is given to the several operators at the different terminals of the circuits as to connections desired and connections made and also of the necessity for making disconnections. The special features of the present invention are that when the through-circuit is made up the supervisory signal before the operator at the long-distance or toll office is controlled by the telephone hook-switch at the substation, and also that when the operator at the long-distance office takes down the connection a disconnecting-signal will be shown before the trunk-line operator at the relay-switchboard.

In the arrangement of circuits comprising the invention there are a series of substation relay-circuits multiplied to the switchboard-sections and a series of trunk-circuits, each divided by a repeating-coil with four windings, two of which at the relay-switchboard end are connected to the common source of current, which is adapted to be connected to a substation-circuit by a terminal plug, the other two windings (those belonging to the second part of the trunk-circuit) being connected to the springs of the terminal switch-sockets at the long-distance office and multiplied to the switchboard-sections thereat.

The cord-circuits at the long-distance office have each a bridge between their conductors, including electromagnetic resistance or impedance coils, and from a point between the said coils extends an earth branch containing a battery. There is also a supervisory signal in the cord-circuits adapted to be operated by the hook-switch at a connected substation. A disconnecting-signal is located at the relay-switchboard, which is adapted to be operated when the cord-circuit at the long-distance office is disconnected from the trunk-circuit.

I have shown a preferred form of trunk-circuit and of cord-circuits located at the long-distance office, and also several modifications thereof, which I will now proceed to describe.

Referring to the drawings, which illustrate the invention, Figure 1 is a diagram showing the substation and central-station arrangement of a relay-controlled substation-circuit

L, a trunk-circuit L^2, and a portion of a cord-circuit L^3; and Figs. 2, 3, and 4 are diagrams showing modifications of the trunk-circuit L^2 and of a cord-circuit L^3.

Referring to Fig. 1, the substation-circuit L extends from substation A to central station B by the two conductors *a* and *b* and at the former station continues normally through the condenser and bell, being provided there with the hook-switch *s* and telephones in a branch controlled by the said hook-switch. At the central station the conductors *a* and *b* are provided with branch terminals in spring jacks or sockets J at the switchboard-sections and terminate in the respective armatures *c* and c^2 of the cut-off relay E, the contacts 10 and 11 of which are united by the wires 9 and 12 to the opposite poles of the battery H, the wire 9 including the helices of the line-signal relay F and being branched to the armature 13 of said relay. The line-signal S is in a wire 42, which connects one pole of the battery with the front contact of the armature 13 and has a branch 15 to ground G. The test-rings *e* of the sockets J are connected by wire *l* to the cut-off relay E and to ground. The trunk-circuit L^2 has a plug-terminal P at the relay-switchboard whose tip 2 is connected by conductor 5 with winding *m* of repeating-coil I (which divides the circuit into two inductive parts) and to a ground, while the forward sleeve 3 is connected by conductor 6, including relay R, to winding *o* of the coil I and by conductor 8 to one pole of the battery H, and the rear sleeve 4 is connected by conductor 7, including relay R^3 and battery H^2, to ground G^4. The armature 17 of relay R has a branch 18 to ground G^3 through an electromagnetic resistance *r*, and its front contact connects by wire 16 to a point between the windings *n* and *p* of the coil I, the former winding being joined to the short or tip spring of socket J^2 by conductor 25, while the latter winding is joined to conductor 19, which branches to the helices of relay R^3 and extends to the front contact of armature 20 of relay R^2, the armature connecting by conductor 21 with the long or sleeve spring of the socket J^2. Armature 23 of relay R^3 is adapted when attracted to its front contact to close a circuit through conductor 24, battery H^2, and conductor 22 and light the lamp-signal S^2. The tip *f* of the plug P^2 of the cord-circuit L^3 at the long-distance office C connects with cord conductor 29 and the sleeve *g* with the cord conductor 30, which includes the electromagnetic signal 54.

r^2 and r^3 are electromagnetic resistances or impedance-coils in the bridge 31, which has a branch 28 to ground, in which is located the battery H^4. The conductors 26 and 27 connect the opposite poles of the battery H^4 with the respective contacts 51 and 52, upon which the springs of the socket J^2 normally rest.

In the operation of the invention when a call is to be made from substation A the telephone *t* is removed from the hook-switch *s*, which thereupon moves and closes the telephones in a shunt-circuit around the bell *b* and condenser and also closes the main circuit through the battery H, causing the attraction of armature 13 of relay F to its front contact and the lighting of the line lamp-signal, all in a well-known manner. In response to this signal the operator at B answers, and the subscriber asks for a long-distance or toll connection. Then by means of a call-circuit (not shown) the operator states the connection required to the long-distance operator at C, who selects the trunk-circuit to be used, informs the trunk operator at the relay-switchboard B of the fact, and proceeds to put up the connection with the long-distance circuit by inserting plug P^2 of the connecting cord-circuit L^3 into the socket J^2 of the trunk L^2, while the operator at B substantially at the same moment inserts the plug P of the trunk into the socket J of the circuit L. With the plug P inserted in the socket J current flows from battery H^2 and ground G^4 through relay-magnet R^2, over conductor 7, rear sleeve 4 of plug P, conductor 1, and cut-off relay E to ground. This current sets the busy-test and operates both relays. The operation of cut-off relay E then disconnects the extensions 9 and 12 of the line conductors *a* and *b* at contacts 10 and 11 and causes the lamp-signal S to be extinguished, and the operation of relay R^2 causes the attraction of the armature 20 to its front contact and the completion of a circuit from battery H^4 through conductor 27, jack-contact 52, conductor 21, armature 20, conductor 19, relay R^3, conductor 25, jack-contact 51, and conductor 26 to the opposite pole of said battery. The operation of relay R^3 tends, of course, to close the local circuit of battery H^2 through the lamp-signal S^2; but if the said lamp is illuminated at this time it is only for a moment, for the insertion of plug P^2 into socket J^2, which should occur at about the same time with that of plug P into socket J, removes battery H^4 from the circuit (the springs in socket J^2 being by the insertion of said plug separated from their contacts) and causes relay R^3 to promptly release its armature. It will be seen that current now flows from the battery H between ground connections G^2 and G by way of winding *m* of coil I, conductors 5 and *a* to substation A, returning by conductors *b* and 6, relay R, (causing the latter to attract its armature 17 to its front contact,) winding *o*, and conductor 8. A circuit is now formed (the armature 17 being, as stated, attracted to its forward position) from G^5 for battery H^4 by way of conductor 28 to the center of bridge 31, then over the two trunk conductors 25 and 21 in parallel, one side of the circuit by conductors 29 and 25 and winding *n* to conductor 16, and the other side of the circuit by conductors 30 21, armature 20, conductor 19, and winding *p* to the said conductor 16, thence by armature 17 and resistance or impedance *r* to ground G^3, and the current in this circuit

operates the signal 54. It will be seen that the flow of current in the said circuit depends upon the closure thereof by the relay R, which in turn is controlled by the switch-hooks at substation A, so that the circuit can be opened and closed by oscillating the hook-switch, and the operator at C can thereby readily be signaled. The non-illumination of lamp-signal S^2 as the plug P is inserted indicates to the trunk operator at B that the operator at C has completed the connection, and the operation of signal 54 is evidence to the latter operator that the former operator at B has performed her portion of the operation. At the close of a conversation the long-distance operator withdraws plug P^2 from socket J^2 and the springs in the socket close upon their contacts 51 and 52. Current from battery H^4 will flow over the circuit, which, as previously described, contains the relay R^3, and will light the lamp-signal S^2, this indicating to the trunk operator at B the said disconnection of plug P^2, and then the plug P is also withdrawn from the socket J and all circuits and connections resume their normal condition.

Fig. 2 shows another, albeit similar, arrangement for a trunk-circuit. In this case the insertion of plug P into socket J allows current from battery H^2 to flow through lamp-signal S^2, relay R^2, and cut-off relay E to ground, and relay R^2, attracting its armature, places a ground connection on one side of the trunk through impedance-coil r. The other side of the line is likewise grounded through impedance-coil r when relay R attracts its armature, which it does when the subscriber removes his telephone from the hook-switch. This being the case, when plug P^2 is inserted in socket J^2 current from battery H^4 flows over both sides of the line in multiple to ground. Relay R^3 is differentially wound, so as to be non-inductive to telephone-currents. Therefore this current flowing through the two windings of relay R^3 in the same direction causes the said relay to attract its armature, thus short-circuiting and extinguishing the signal S^2. The relay R is controlled by the hook-switch at the substation, as is also the signal 54 at the long-distance-office switch-cord L^3. At disconnection when the operator at C removes plug P^2 from socket J^2 current ceases to flow through relay R^3 and its armature is released, and the disconnecting lamp-signal S^2 becomes lighted as a signal to the trunk operator at B that disconnection should be made there also.

Fig. 3 exhibits a third specific plan for accomplishing the desired results. With plug P inserted into jack J current from battery H^2 flows through lamp-signal S^2, relay R^2, and cut-off relay E to ground. This current tends to cause signal S^2 to light and causes relay R^2 to attract its armature. The relay R attracts its armature when the telephone at the substation is removed from the hook-switch, and there then exists a connection to ground through impedance-coil relay R^3 from both sides of the trunk-line. Hence when plug P^2 is in jack J^2 current from battery H^4 flows over both sides of the line in multiple to earth, and impedance-coil relay R^7 does not attract its armature, owing to the fact that the current flows equally and in opposite directions through its equal windings, and as long as current flows through relay R^3, which also serves as an impedance-coil, its armature is attracted and the lamp-signal S^2 is shunted and remains for the present unilluminated. When the telephone at A is replaced upon its hook-switch, relay R releases its armature. This removes the ground connection from one side of the line, and current flows through but one winding of relay R^7, which attracts the armature, and the signal 54 (which here takes the place of the main-line electromagnetic signal of Figs. 1 and 2) is displayed; and when to disorganize the circuit the plug P^2 is removed from the socket J^2 current ceases to flow through relay R^3, and the shunt is removed from signal S^2, which lights as a disconnect-signal for the trunk operator, who thereupon removes plug P from socket J.

Another arrangement of circuits for accomplishing the required results is shown in Fig. 4. In this diagram when the plug P is in the socket J current flows from battery H^2, through lamp-signal S^2, relay R^2, and cut-off relay E, and the operation of relay R^2 places a ground connection on one side of the line through relay R^3 and impedance-coil r^8. When relay R operates, as it does on the removal of the telephone from the hook-switch at A, the other side of the line is similarly connected to earth through relay R^3 and impedance r^8, and when plug P^2 is in socket J^2 current flows from battery H^4 over both sides of the line in multiple to earth, and this current operates relay R^3, causing its armature to shunt the signal S^2. In the manner already described the release of the armature of relay R causes the signal 54 to be displayed, and when the plug P^2 is withdrawn from socket J^2 current ceases to flow through relay R^3 and lamp-signal S^2 is lighted. The taking down of plug P causes the circuits to resume their normal condition.

The invention and its operation having now been fully described, it is hereby claimed as follows:

1. The combination in a telephone-exchange, of a source of current at the central station; a substation telephone-circuit represented on the switchboard by switch sockets or jacks, having its conductors extended to the said source of current, and provided at the substation with a circuit-controlling switch; a local trunk-circuit at the central station having a switch-plug and a switch-socket at its terminals respectively, and being conductively separated into two inductively-united divisions by an induction-coil with four windings, two of which are included with the said source of supply and a circuit-closing relay in the switch-plug division, and the remain-

ing two in the switch-socket division; a test-battery and local circuit, and a second circuit-closing relay, associated with the said switch-plug division; a third circuit-closing relay and a lamp-signal controlled thereby, associated with the said switch-socket division; and a linking or switch cord connection circuit, having a bridge between its main conductors and a branch to a grounded battery extending from the center of said bridge, and having also a signal included in one of the said main conductors; whereby when the said circuits are switched to form a through-circuit the said cord-signal may be operated from the substation, and the lamp-signal of the trunk-line-socket division operated by the removal of the cord-connection plug from the trunk-line socket, substantially as set forth.

2. The combination in telephone exchange and switchboard circuits, of a main circuit extending between a switchboard at a central station, and a circuit-controlling switch at a substation; a battery or like generator at the said central station, supplying current to the said circuit; a trunk-circuit terminating at one end in a switch-plug, and at the other in a switch-socket and comprising two divisions, conductively separated but inductively united by an interposed induction-coil with four windings, two in series in each division; a test-conductor and a battery connected therewith, associated with the switch-plug division; a ground branch extending from a point between the two induction-coil windings of the switch-socket division; a relay in the circuit of the plug division controlling the continuity of said ground branch; a second relay in the circuit of said test-conductor, controlling the continuity of said switch-socket division; a third relay controlling a lamp-signal in a bridge of the said switch-socket division; and a link or switch cord connection circuit at the switch-socket end of the trunk-circuit having a bridge between its main conductors, impedance-coils contained therein, and a battery branch extended to earth from a point on said branch between the said coils, and having also a disconnecting-signal included in one of its main conductors; substantially as specified, and for the purposes set forth.

3. The combination in telephone exchange and switchboard circuits, of a relay substation-circuit extending between a central-station switchboard and a substation hook-switch; a common source of current-supply at the relay-switchboard; a trunk-circuit; and a linking cord-circuit; the substation-circuit conductors provided with terminal sockets at the switchboard-sections and extending to the poles of the common source of supply; the trunk-circuit provided with a plug and a switch-socket at its terminals and divided into two normally open inductive circuits by an induction-coil with four windings, the switch-plug division including two of said windings in series with a relay and the said source of supply, and having an associated conductor containing a second relay controlling the switch-socket division and a test-battery; and the switch-socket division including the remaining two said windings and provided with a circuit-closing relay controlling a lamp-signal; a branch extending to earth from a point on the switch-socket division between its two induction-coil windings through the armature and front contact of the plug division or first relay; and the linking cord-circuit having a bridge between its strands with a grounded-battery branch, and a signal associated with one of said cords; whereby when the said circuits are switched to each other and the telephone at the substation is off its hook-switch, a signaling-circuit is formed from ground at the relay-switchboard over both conductors of the switch-socket portion of the trunk-circuit and over the two conductors of the linking cord-circuit through the said grounded-battery branch, including the signal in said cord-circuit; which signaling-circuit is opened when the said telephone is restored to its hook-switch as set forth.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 12th day of April, 1899.

THOMAS C. WALES, JR.

Witnesses:
GEO. WILLIS PIERCE,
JOSEPH A. GATELY.