

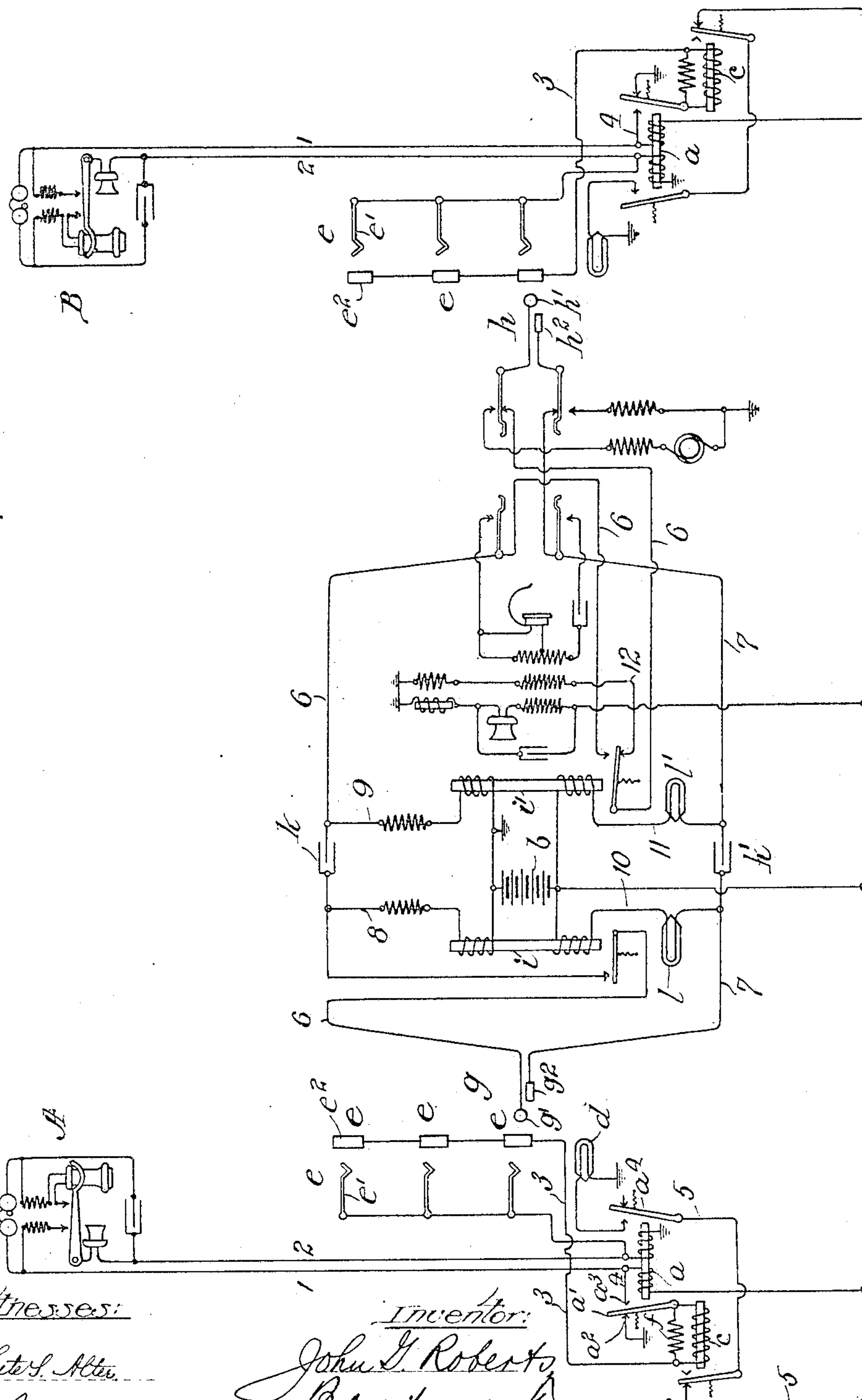
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APPARATUS FOR TELEPHONE EXCHANGE SYSTEMS.

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APPARATUS FOR TELEPHONE-EXCHANGE SYSTEMS.

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To all whom it may concern:

Be it known that I, JOHN G. ROBERTS, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Apparatus for Telephone-Exchange Systems, of which the following is a full, clear, concise, and exact description.

My invention relates to telephone-exchange systems of the class in which the spring-jacks associated with the lines are constructed each with only two contact-pieces, the connecting-plugs being correspondingly provided each with but two contact parts, these forming the terminals of link conductors by which lines may be temporarily switched together.

The object of my invention is to provide means for establishing a busy-test condition at the multiple spring-jacks of a line whenever the telephone at the substation of such line is removed from its switch-hook and also to provide improved and simplified apparatus for controlling the operation of the signal apparatus in the switchboard.

I will describe my invention particularly by reference to the accompanying drawing, which is a diagram illustrating two telephone-lines extending from substations to a central office, with a pair of plugs and their plug-circuit for uniting said lines, the system being organized and equipped in accordance with my invention.

The two telephone-lines illustrated extend in two limbs 1 2 from the substations A B to the poles of a central-office battery *b*. A line-relay *a* is permanently connected with the line, said relay being preferably provided with two windings, one in each of the limbs 1 2. Each line is provided with multiple spring-jack terminals *c c* upon the several sections of the switchboard, each spring-jack comprising a line-spring *c'* and test-piece *c''*. The line-springs *c'* of the several spring-jacks are permanently connected with limb 2 of the telephone-line, while the thimbles or test-pieces *c''* of said spring-jacks form the terminals of a conductor 3, extending to earth through the winding of a cut-off relay *e* and the armature

a' and back contact *a''* of said line-relay *a*. The alternative or front contact *a'''* of said line-relay is connected with a conductor 4, which extends to limb 1 of the line and is united therewith at a point between the winding of line-relay *a* and the substation. A local circuit 5, extending from the free pole of battery *b* to earth and including a line signal-lamp *d* and the armature and back contact of cut-off relay *e* is controlled by the armature *a'* of said line-relay. When, therefore, said line-relay is energized, the connection of conductor 3 with earth is broken by armature *a'*, and said conductor is connected instead with limb 1 by way of conductor 4, the line signal-circuit 5 being also completed by armature *a'* of said relay. The winding of cut-off relay *e* may be shunted by a non-inductive resistance *f*.

Conductors 8 9 are led from the link conductor 6 of said plug-circuit through the windings of impedance-coils *i i'*, respectively, to the grounded pole of battery *b*, a condenser *h* being located in said link conductor 6 between the points of connection of said conductors 8 9 therewith. In a similar manner conductors 10 11 extend from link conductor 7 through other windings of impedance-coils *i i'* and supervisory signal-lamps *l l'*, respectively, to the free pole of said battery. A condenser *h'* is likewise included in link conductor 7 between the points of juncture of said conductors 10 11 therewith. It will be understood, of course, that repeating-coils could be substituted for the impedance-coils and condensers.

The circuit of link conductor 6 is normally interrupted at the armatures and front contacts of the magnets of impedance-coils *i i'*. The tip of plug *g* is thus normally disconnected from the grounded pole of battery *b*, and so prevents any annoying clicks in the subscriber's telephone caused by the tip of plug *g* touching the test-piece *c''* of spring-jack *c* and shunting the line while said plug is being inserted. The tip *h'* of plug *h* is also normally disconnected from battery *b*, being connected to earth by way of the armature

and back contact of the magnet of impedance-coil i' and a branch 12 for the purposes of the busy-test, said branch 12 including the tertiary winding of the induction-coil associated with the operator's telephone set. When, however, the magnets of impedance-coils i' and i'' are energized, the tips of plugs g and h are connected with the grounded pole of battery b , and the continuity of link conductor 6 is established.

The usual listening and ringing keys are provided, whereby the operator may bring her telephone into connection with the plug-circuit and connect a source of signaling-current in circuit with the contacts of plug h .

The operation of the system is as follows: Subscriber A upon removing his telephone from its hook to transmit a call closes the line-circuit 1 2. The line-relay a thus becomes energized and draws up both of its armatures a' and a'' , completing the local circuit 5 to display the line-signal d and breaking the connection of conductor 3 with earth, uniting it instead with limb 1 by way of conductor 4. The limb 1 being connected with battery, a test potential is thus caused to exist at the test-piece e^2 of each of the spring-jacks e of that line as soon as said line-relay is excited. The operator observing the signal inserts her answering-plug g into spring-jack e of the line. The impedance-coil i , included in conductor 10, will now be in a circuit extending from battery b to earth through the substation apparatus and a winding of line-relay a , so that its magnet will become energized and connect the tip g' of plug g with the grounded pole of battery b , thereby completing a metallic circuit extending from the positive pole of battery b through conductor 8, a winding of impedance-coil i , link conductor 6, tip of plug g , line-spring e' of spring-jack e , limb 2 of the telephone-line, through the substation apparatus, and back by way of limb 1, branch conductors 4 3, and winding of cut-off relay c , test-ring e^2 of jack e , sleeve g^2 of plug g , link conductor 7, branch 10, supervisory signal-lamp l , and a second winding of impedance-coil i to the negative pole of battery b . The winding of cut-off relay c being included in this circuit becomes energized and draws up its armature, thereby opening the local circuit 5 and extinguishing the line-signal d . By reason of the large amount of resistance included in circuit with supervisory signal-lamp l said lamp will not receive sufficient current for its illumination.

The operator upon learning the number of the party with whom subscriber A desires connection (and we will assume that subscriber B is the wanted party) tests the line of that subscriber by touching the tip h' of plug h to the test-piece e^2 of the spring-jack of said line located upon her section of the switch-board. If the line is free, there will be no

click produced in her telephone. If, however, the line should be in use, either by reason of a connection at a spring-jack of the line upon some other section of the switch-board or by reason of the subscriber at the station of said line having taken his telephone from its hook, as in initiating a call or in response to a call from some other subscriber, a click will be produced in the operator's telephone, the testing-current flowing to earth through branch 12, including the tertiary winding of the induction-coil in the operator's telephone set, and thus indicating to her that the line is busy. If the line is found to be free, the operator inserts plug h into the spring-jack e of the line leading to station B and depresses her ringing-key to signal the subscriber at said station. The first impulse of ringing-current flows to earth through a winding of line-relay a , which becomes energized and draws up both its armatures, thus providing a complete metallic circuit for the ringing-current through the call-bell at the substation. The winding of cut-off relay c being included in a closed circuit from battery b during the closure of the ringing-key and the consequent energization of the line-relay, said cut-off relay becomes energized and prevents the display of the line-signal. When the ringing-key is released and until subscriber B responds to the call, the line-relay of the called line will remain inert and will complete at its back contact a circuit from the free pole of grounded battery b through branch conductor 11, a winding of impedance-coil i' , supervisory signal-lamp l' , link conductor 7, sleeve h^2 of plug h , test-ring e^2 of spring-jack e , and conductor 3 to earth through winding of cut-off relay c , whereby the supervisory signal-lamp l' will be illuminated and the magnet of impedance-coil i' and the cut-off relay c energized. The magnet of impedance-coil i' thereupon draws up its armature, breaking the connection of tip h' of plug h with earth and connecting it instead with the grounded pole of battery b . The cut-off relay c also draws up its armature, preventing the display of the line-signal when the line-relay shall be energized upon the response of the called party. When the subscriber at station B responds to the call by removing his telephone from its hook, the line-relay associated with his line becomes energized, breaking the grounded circuit previously traced and completing a metallic circuit similar to that traced in connection with plug g and the line to station A. By reason of the resistance thus introduced into the circuit, including supervisory signal-lamp l' , said signal is extinguished. When upon the termination of conversation both subscribers replace their telephones upon the switch-hooks, the line-relays associated with said lines become deenergized and allow their

armatures to fall back, again completing the grounded circuits previously traced, which include the supervisory signal-lamps *l* /, so that said signals are displayed, thereby informing the operator that she may take down the connection.

I claim—

1. The combination with a telephone-line and a substation-switch controlling its circuit, of a central source of current and a line-relay in the circuit controlled by said switch, multiple spring-jacks for the line each having a test-piece normally disconnected from the line, a normally open conductor adapted to form an extension of the talking-line circuit, leading from one of the line conductors to the several test-contacts of the spring-jacks, and contacts of said line-relay adapted to close said conductor, whereby the line-circuit is extended to the spring-jack and a test potential applied to the test-pieces thereof upon the closure of the substation-switch.

2. The combination with a telephone-line extending from a substation to a central office, of a source of current and a line-relay connected with the line at the central office, a switch at the substation controlling the flow of current in the line, spring-jacks for the line having contact portions normally disconnected therefrom, a conductor extending from said contact portions and including a cut-off relay, contacts of said line-relay adapted when the same is excited to connect said conductor with the line, means adapted to actuate said cut-off relay when connection is made with the line, a line-signal, and a circuit therefor controlled in contacts of said line-relay and said cut-off relay.

3. The combination with a telephone-line extending from a substation to a central office, of a switch in the circuit of the line at the substation, a line-relay responsive thereto at the central office, connection-terminals for the line normally disconnected therefrom, a plug and plug-circuit for making connection with the line at said connection-terminals, a source of current and a supervisory signal connected with the plug-circuit, a conductor extending from said connection-terminals to switch-contacts of said line-relay, and circuit connections associated with said switch-contacts adapted to complete the connection of the plug-circuit with the line when the relay is excited, and to complete a local circuit to actuate said supervisory signal when the relay is inert.

4. The combination with a telephone-line extending from a substation to a source of current at a central office, of a switch at the substation controlling the circuit of the line, a line-relay having a winding in the circuit of the line at the central office, a line-signal controlled thereby, a cut-off relay coöperating in the control of the line-signal, said cut-off relay being normally disconnected from the line, a circuit for the cut-off relay completed

to the line in contacts of the line-relay when the same is actuated, and means made operative in making connection with the line adapted to actuate said cut-off relay.

5. The combination with a telephone-line extending in two limbs from the poles of a central battery to a substation, of a switch at the substation controlling the circuit of the line, a line-relay having its magnet-winding in the line-circuit, extensions of the line conductors from points between the line-relay and the substation to the respective contacts of a two-part spring-jack, a switch-contact of the line-relay normally interrupting one of said extensions 3, a cut-off relay included in said normally interrupted extension 3, a signal jointly controlled by the line-relay and cut-off relay, a plug for making connection with the spring-jack, and connections of said plug adapted to establish a metallic circuit through both of said line extensions, and a local circuit for said extension 3 which includes the cut-off relay, said local circuit being controlled in a normally closed contact of the line-relay.

6. The combination with a telephone-line and a substation-switch controlling its circuit, of multiple spring-jacks for the line each having a line-contact adapted to serve also as a test-contact, a plug-circuit having a conductor adapted to extend the circuit from said contact when the plug is inserted in the jack, a battery and a supervisory signal connected with said plug-circuit conductor, a line-relay responsive to the substation-switch, a conductor leading from said test-contacts to the switch-contacts of said line-relay, said line-relay switch normally disconnecting said test-contacts from the line and connecting the same in a local circuit to the return-pole of the battery, and an alternate switch-contact for said line-relay adapted when the relay is excited to transfer the connection of said test-contacts to the line, the resistance of the line being too high to permit the operation of the supervisory signal when the latter is in circuit therewith.

7. The combination with a telephone-line and a substation-switch controlling its circuit, of multiple spring-jacks for the line each having a line-contact adapted to serve also as a test-contact, a plug-circuit having a conductor adapted to extend the circuit from said contact when the plug is inserted in the jack, a battery and a supervisory signal connected with said plug-circuit conductor, a line-relay responsive to the substation-switch, a conductor leading from said test-contacts to the switch-contacts of said line-relay, said line-relay switch normally disconnecting said test-contacts from the line and connecting the same in a local circuit to the return-pole of the battery, an alternate switch-contact for said line-relay adapted when the relay is excited to transfer the connection of said test-

contacts to the line, the resistance of the line
being too high to permit the operation of the
supervisory signal when the latter is in cir-
cuit therewith, a cut-off relay between the
5 test-contacts and the line-relay switch, and a
line-signal jointly controlled by said line-
relay and cut-off relay.

In witness whereof I hereunto subscribe my
name this 30th day of November, A. D. 1903.

JOHN G. ROBERTS.

Witnesses:

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