

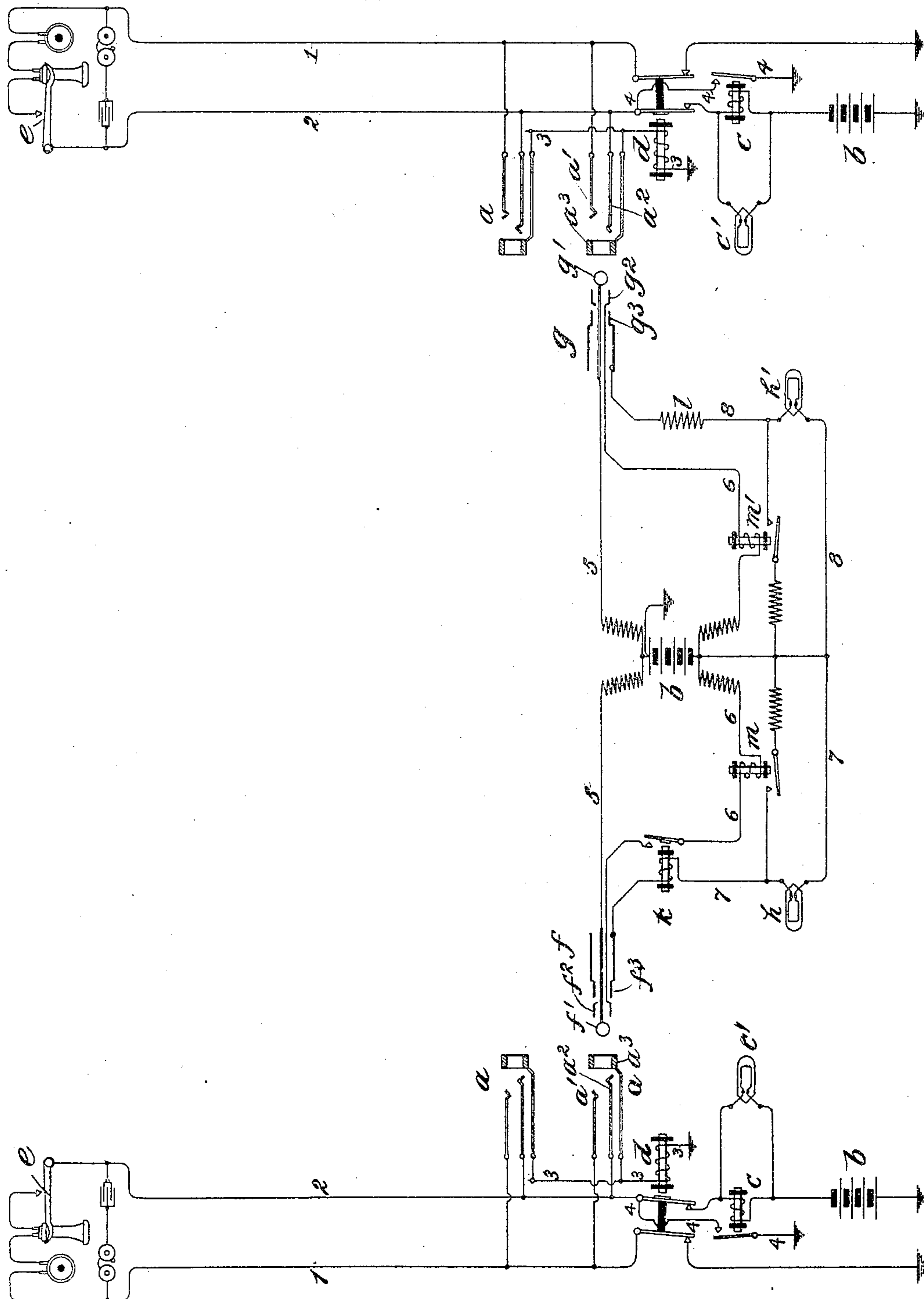
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J. L. McQUARRIE.

TELEPHONE EXCHANGE SWITCHBOARD APPARATUS.

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WITNESSES:

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# UNITED STATES PATENT OFFICE.

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## TELEPHONE-EXCHANGE SWITCHBOARD APPARATUS.

SPECIFICATION forming part of Letters Patent No. 778,599, dated December 27, 1904.

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*To all whom it may concern:*

Be it known that I, JAMES L. McQUARRIE, 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 Telephone-Exchange Switchboard Apparatus, of which the following is a full, clear, concise, and exact description.

My invention relates to apparatus for telephone-switchboards, and is applicable more particularly to a telephone-exchange system in which signals are automatically transmitted from the substation to the central office as the substation-telephone is taken for use or replaced on its switch-hook. In such systems a central battery is connected with all the lines through individual line-signaling apparatus operated by the flow of current in the line, which is determined by the open or closed condition of the telephone-switch at the substation. It has been common to provide a cut-off relay whose switch-contacts are interposed between the battery and line-signaling apparatus and the line conductors, this relay being excited by current in a local circuit which is established in registering contacts of the usual plug and spring-jack switch when connection is made with the line. A battery has been connected with the plug-circuit to furnish current to the substation-transmitter for telephonic purposes and also for operating a supervisory signal temporarily associated with the line, this battery being applied to the line when connection is made therewith by inserting the plug-terminal of the cord-circuit into the spring-jack of the line. An objectionable feature of this system has been that as the plug was inserted in the spring-jack the source of current would be rapidly connected and disconnected, due to the successive engagement of the different contact-pieces of the plug with the contacts of the spring-jack, the result being that a series of violent cracks or noises would be produced in the substation-telephone which the subscriber is holding to his ear. These noises have been produced not only by the mere current from the battery

itself, but also by the more violent induced currents caused by the induction of the repeating-coils in the plug-circuit.

My object has been to devise a system in which these noises produced in the substation-telephone as the connection is made with the line may be greatly reduced, the inductive disturbances heretofore caused by the discharge from the repeating-coil being entirely obviated. In my system when the subscriber takes his telephone to transmit a call a signal is automatically displayed at the central office, and simultaneously the whole line is short-circuited until the operator in answering the call has completed connection therewith, whereupon the short circuit will be removed and the battery in the plug-circuit applied. Very little noise is produced by the connection of the battery, the disturbances which have been most objectionable heretofore having been produced by the inductive action or "kick" of the coils in the circuit.

I will describe my invention in connection with the accompanying drawing, which illustrates the preferred embodiment thereof, and the features or combinations which I regard as novel will be pointed out in the appended claims.

The drawing illustrates diagrammatically two telephone-lines extending from substations to a central-office switchboard, the circuit of the operator's switching apparatus for uniting the lines being also indicated.

Each line has two limbs 1 2, between which the substation apparatus is bridged in the usual way, said limbs being connected at the central office with the poles of the central battery *b*. The usual multiple spring-jacks *a a* are provided for each line, the short and long line springs *a'* *a''* of each spring-jack being connected, respectively, with the limbs 1 2 of the telephone-line for which the spring-jack forms a connection-terminal. Each spring-jack is also provided with a ring contact or thimble *a'''* in accordance with the usual practice, and the thimbles of all the spring-jacks of each line are connected to earth by a con-



ductor 3, which includes the magnet-winding of the cut-off relay  $d$  of such line. The cut-off relay is provided with two armatures, each of which has a back contact against which it normally rests, these contacts being broken when the relay is excited. These contacts are interposed in the limbs 1 2 of the telephone-line between the spring-jacks of said line and the poles of the battery. The magnet-winding of the line-relay  $c$  is included in the circuit of limb 2 of the telephone-line between the free pole of the battery  $b$  and the contacts of the cut-off relay. When the cut-off relay is excited, therefore, the connection of the line with battery  $b$  and the line-signaling apparatus is broken. A line signal-lamp  $c'$  is connected in multiple with the line-relay  $c$ . A conductor 4 extends from that armature of the cut-off relay  $d$  which is connected with the limb 2 of the line to the grounded pole of the battery  $b$  through normally open switch-contacts, which are controlled by the line-relay  $c$ , said contacts being closed by said line-relay when excited.

The usual telephone-switch  $e$  is provided at the substation for controlling the line-circuit, and when this switch is once closed, as in transmitting a call, the line-relay  $c$  is excited and closes the circuit of conductor 4 directly to the grounded pole of the battery, shunting or short-circuiting the line. A local circuit is thus established, which includes the battery  $b$ , the line-relay  $c$ , and the signal-lamp  $c'$  in shunt thereof, the switch-contacts of the cut-off relay  $d$ , and the conductor 4, completed at the switch-contacts of said line-relay  $c$ . This local circuit is thus under the control of the cut-off relay  $d$  only and will remain closed and the signal-lamp  $c'$  lighted until the cut-off relay is excited.

The central-office operator is provided with the usual pair of plugs  $f$   $g$ , united by link conductors 5 6 of a cord-circuit, whereby any two lines may be connected together by inserting the plugs into the spring-jacks of such lines. Each plug is provided with the usual tip, ring, and sleeve contacts, which are adapted to engage, respectively, with the short and long line springs and the test-ring of the spring-jack, in which the plug may be inserted. The tip and ring contacts  $f'$   $f''$  of the answering-plug  $f$  are connected with the corresponding tip and ring contacts  $g'$   $g''$  of the calling-plug  $g$  by the conductors 5 6 of the plug-circuit, which include the windings of the usual repeating-coil. The central battery  $b$  is connected in a bridge of the plug-circuit between the windings of the repeating-coil, the grounded pole of the battery being connected with the tip-strand 5 of the plug-circuit. A conductor 7, including a supervisory signal-lamp  $h$  and the magnet-winding of a relay  $k$ , extends from the free pole of the battery  $b$  to the third contact or sleeve  $f^3$  of the answering-plug. A conductor 8,

including a supervisory signal-lamp  $h'$  and a resistance  $l$ , connects the free pole of the battery  $b$  with the third contact or sleeve  $g^3$  of the calling-plug  $g$ . When one of the plugs is inserted in the spring-jack of a line, a local circuit, including the supervisory signal-lamp of such plug, is thus temporarily established by the engagement of the third contact or sleeve of the plug with the ring-contact  $a^3$  of the spring-jack, this circuit including the conductor 3 of the line whose spring-jack is plugged into, so that the cut-off relay  $d$  in the circuit of said conductor is excited. The usual supervisory relays  $m$   $m'$  may be included in the ring-strand 6 of the plug-circuit between the battery  $b$  and the ring-contacts of the plugs  $f$  and  $g$ , respectively, said supervisory relays controlling shunts about the signal-lamps  $h$   $h'$ , respectively, in accordance with the usual practice.

In accordance with my invention the conductor 6 between the ring-contact  $f^3$  of the answering-plug and the free pole of the battery  $b$  is normally open at the switch-contacts of the relay  $k$ , so that the battery  $b$  will not be applied to the contact  $f^3$  until the relay  $k$  shall have been excited by current flowing in the circuit 7 3. This relay  $k$  should be adjusted to act sluggishly, so that the ring-contact of the plug will not be connected to the battery until after the cut-off relay  $d$  shall have been excited and the short circuit 4 broken.

To review briefly the operation of the system, the subscriber transmits a call in the usual way by taking his telephone from its hook. The circuit of the line is thus closed and the current flowing through the line-relay  $c$  causes the same to draw up its armature, whereby the local signal-circuit is completed by way of the conductor 4, which shunts or short-circuits the telephone-line and the substation apparatus thereof. Current flowing in this local circuit maintains the relay  $c$  excited and causes the illumination of the signal-lamp  $c'$ , indicating to the operator that a connection is desired. The instant after the subscriber removes his telephone from its hook his line is thus short-circuited and remains so until the cut-off relay  $d$  shall have been actuated. The operator perceiving the signal-lamp  $c'$  lighted responds to the call by inserting her answering-plug  $f$  in the answering spring-jack of the line. The ring-contact  $f^3$  of the plug being disconnected from the battery, current will not be applied to the test-ring  $a^3$  until the plug is inserted sufficiently to bring the sleeve  $f^3$  thereof into engagement with said test-ring. As soon as these two parts come into contact the circuit 7 3 is established, so that relays  $d$  and  $k$  are both actuated. The local circuit 4 is thus broken and the signaling apparatus disconnected from line, and the battery  $b$  in the plug-circuit is applied to the line by way of the spring-jack as soon as the relay  $k$  draws



up its armature. The only noise that the subscriber hears in his telephone, therefore, is the single click when the relay *k* responds.

As usually constructed cut-off relays act rather sluggishly, and if the battery should be connected at all times with the ring-contact of the plug there might be a discharge of current from the battery *b* in the plug-circuit through conductors 6 to the long-line spring of the jack, and thence through the conductor 4 to earth until the cut-off relay should respond. Then upon the breaking of this circuit by the cut-off relay the self-induction or kick of the repeating-coil in the plug-circuit would cause a violent disturbance on the line, making a disagreeable click in the subscriber's telephone. By providing the relay *k* the battery is disconnected from the ring-contact of the plug until the circuit through the cut-off relay is completed, and for the reasons above given I prefer that the relay *k* should be, if anything, a little more sluggish than the cut-off relay *d*, so that the grounded branch 4 will surely be broken before battery is applied to the ring-contact of the plug.

While I have for convenience of illustration shown three batteries in the drawing, each marked *b*, it will be understood that in accordance with the usual practice these may be one and the same battery.

Having thus described my invention, I claim as new, and desire to secure by Letters Patent, the following:

1. The combination with a telephone-line extending from a substation to a central office, of a source of current in circuit with the line at the central office, a switch at the substation controlling the flow of current in the line, a line-relay at the central office in the path of current so controlled, a local circuit including said relay closed by said relay when excited, a portion of said local circuit shunting or short-circuiting the substation apparatus, a signal controlled by the flow of current in said local circuit, a spring-jack for the line, a plug and plug-circuit for making connections therewith, means actuated upon the insertion of the plug in the spring-jack for breaking said shunt or short circuit of the substation apparatus, a source of current associated with the plug-circuit, a switch *k* adapted to connect said source of current between the line-terminals of the plug, and means controlled by the insertion of the plug in the spring-jack for actuating said switch, as described.

2. The combination with a telephone-line extending from a substation to a central office, of a source of current in the circuit of the line at the central office, a switch at the substation controlling the flow of current in the line, an

electromagnetic switch at the central office responsive to the flow of current controlled by the substation-switch and adapted when actuated to establish a short circuit of the line, a spring-jack for the line, a plug and plug-circuit for making connection therewith, mechanism actuated in establishing connection with the line for interrupting the short circuit, a source of current associated with the plug-circuit, and an electric switch controlling the connection of said last-mentioned source of current with the line actuated in establishing connection with the line, whereby the short circuit is interrupted before the application to the line of the source of current connected with the plug-circuit.

3. The combination with a telephone-line and a cord-circuit for making connections therewith, of the line-relay *c* adapted when actuated to provide a local circuit through the same to temporarily short-circuit or shunt the line, the cut-off relay *d* with the relay *k* of the cord-circuit adapted to be connected in series, said relay *k* being also adapted to act as a switch when actuated, to throw current onto the line, immediately after the cut-off relay has acted to open said local circuit.

4. In a telephone system, the combination with the cut-off relay of a line, of a sluggish relay *k* in the cord-circuit, and the centralized battery, said relay *k* acting as a switch to close said battery to line after the cut-off relay has acted, substantially as described.

5. The combination with a telephone-line extending from a substation to the poles of a central source of current, of a substation-switch controlling the flow of current in the line, a line-relay at the central office in the path of current so controlled, a line-lamp in shunt thereof, a local circuit including said line-relay and lamp in multiple branches thereof closed by said relay when excited, a portion of said circuit shunting the substation apparatus, a spring-jack for the line, a plug and plug-circuit for making connection therewith, means actuated upon the insertion of the plug in the spring-jack for breaking said shunt of the substation apparatus, a source of current in a bridge of the plug-circuit, an electromagnetic switch *k* controlling the application of said source to the line, and a circuit therefor completed in registering contacts of said plug and spring-jack.

In witness whereof I hereunto subscribe my name this 29th day of January, A. D. 1902.

JAMES L. McQUARRIE.

Witnesses:

D. E. WILLETT,

EDWIN H. SMYTHE.