

No. 689,903.

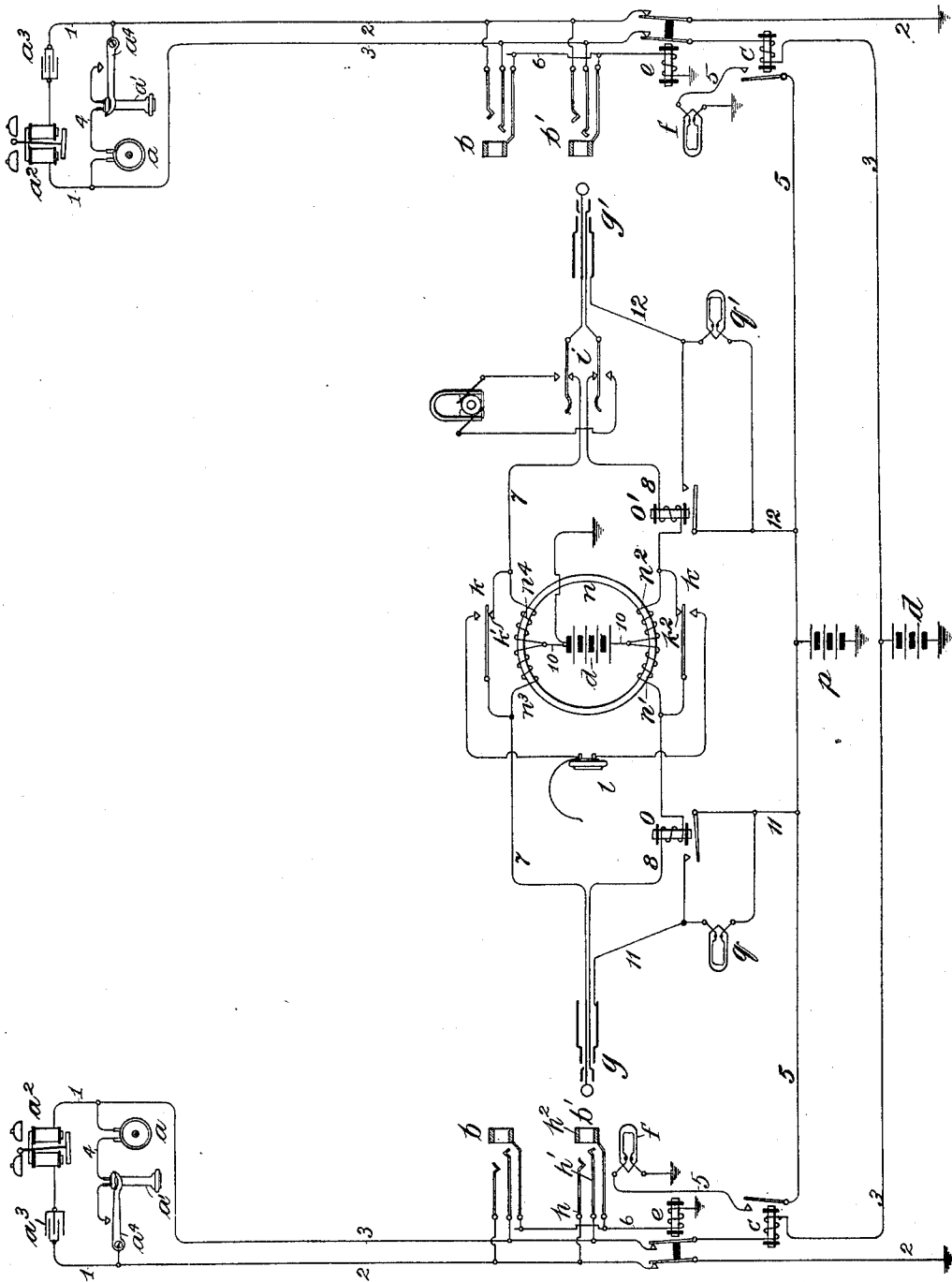
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J. L. McQUARRIE.

TESTING APPLIANCE FOR MULTIPLE SWITCHBOARDS.

(Application filed Mar. 22, 1897.)

(No Model.)



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TESTING APPLIANCE FOR MULTIPLE SWITCHBOARDS.

SPECIFICATION forming part of Letters Patent No. 689,903, dated December 31, 1901.

Application filed March 22, 1897. Serial No. 628,585. (No model.)

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 Testing Appliances for Multiple Switchboards, (Case No. 3,) of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

My invention concerns means for testing a line at one section of a multiple switchboard to determine whether it be already in use at some other section of the switchboard. It applies particularly to switchboards equipped with automatic signals associated with the lines and with a central source of current permanently connected with the lines to operate the signals, and it is designed to obviate certain conditions which give rise to false test-signals in such switchboards. In the type of telephone-switchboard mentioned each line is provided with a test-ring whose electrical condition becomes changed when connection is made with the line in the switchboard, and the connecting-plugs and their plug-circuit are provided with supervisory signals controlled by magnets interposed in the plug-circuit and responsive to currents through the lines determined by the use of the telephones at the substations, together with a source of current in a bridge of the plug-circuit intermediate of the signal-controlling magnets and an impedance-coil in the bridge with the source of current. In a system of this type a false test-signal will be produced when a test is made in the usual way with a plug whose mate has been employed in answering the call on account of current from the central source returning through the circuit of the calling-line and changing the electrical condition of the testing-plug.

My invention aims to avoid this condition; and it consists in switch-contacts associated with the operator's listening-key constructed to break the continuity of the plug-circuit during the act of testing, leaving the tip of the testing-plug without immediate electrical

connection with the remainder of the plug-circuit, so that it shall not be affected by changes in the condition of the plug-circuit.

In a form of my invention suitable for practical employment the impedance-coil before mentioned is divided into two helices, which are placed in inductive relation to each other after the manner of a repeating-coil and which are connected together and to earth at one point. The switch-contacts upon the listening-key are arranged to unite the other extremities of the two windings while the telephone is disconnected from the circuit, leaving them separated and in position to exercise their function as a repeating-coil while the telephone is in use. The parts are arranged in duplicate for use in metallic circuits.

The invention is shown in the attached drawing in connection with the switching system before described. Therein two substations are represented connected by line-circuits with switching and signaling appliances in a switchboard. The latter is shown equipped with a single pair of connecting-plugs and their plug-circuit, with the usual accessory appliances, and with the circuits and mechanism for testing which constitute my present invention.

The apparatus at the substation may comprise a transmitting-telephone a and a receiving-telephone a' , a polarized signal-bell a^2 , a condenser a^3 , and a switch a^4 . The bell a^2 and the condenser a^3 may be connected in a permanently-closed bridge 1 of the line-circuit 2 3, the telephones being included in a bridge 4, which is closed through the action of the telephone-switch when relieved from the weight of the telephone. At the central office the line conductors 2 3 are connected with spring-jacks b and b' in two different sections of a multiple switchboard. Conductor 2 is led directly to earth, while conductor 3 is connected with the relay c , and thence through a battery d to earth. Interposed in the extensions of each of these conductors 2 and 3 is a pair of normally-closed switch-contacts of a second relay e . The latter when excited breaks the connection of the one line

conductor with the earth and of the other with the relay and battery. The switch-contacts of the relay *c* control a local circuit 5, which includes a subsidiary signal-lamp *f*, associated with the spring-jack *b'* in one of the switch-boards, together with a source of current suitable for illuminating the lamp. The relay *e* is included in a portion 6 of a second local circuit, which becomes closed, as will be hereinafter described, when a connection is made with the line.

The apparatus of the two lines is of course alike. The signal-lamps *f* and the answering-jacks with which they are associated may be assumed to be located upon different sections of the switchboard, however, so that calls from the different lines are answered by different operators.

The plugs *g* and *g'* are of usual construction, each having three contact portions adapted to make connection with the two line-contacts *h* and *h'* and the local contact or test-ring *h²* of the spring-jacks. The like line-contacts of the two plugs are normally united through conductors 7 and 8, which constitute the plug-circuit. The usual calling-key *i* is interposed in these conductors, constructed to loop a generator of signaling-current into circuit with plug *g'*, and a listening-key *k* is provided for bringing the operator's telephone *l* into a bridge of the plug-circuit. A permanently-closed bridge 10 of the plug-circuit includes the common source of current *d* for actuating the signals of the line, together with the windings of an impedance-coil *n*. One pair of windings *n¹* *n²* of this coil are interposed in parallel in conductor 10 between the battery *d* and the conductor 8 of the plug-circuit. Two other windings *n³* and *n⁴* are interposed in the same bridge conductor, between the source of current and the strand 7 of the plug-circuit. The terminals of the windings *n¹* and *n²* are connected together during the normal use of the plug-circuits through the agency of an auxiliary-switch contact *k²* of the listening-key *k*, which becomes closed to the switch-spring of the key when the key is in position to interrupt the connection of the operator's telephone with the plug-circuit. The other windings *n³* *n⁴* are similarly brought into multiple through the agency of another anvil *k'* in the key. Thus while the operator's telephone is not in connection with the plug-circuit the conductors 7 and 8 of the plug-circuit are practically continuous. While the key is in position for the use of the telephone, however, the circuit of conductor 7 is from the tip of plug *g* through coil *n³* to ground and from the tip of plug *g'* through coil *n⁴* to ground. The circuits from the ring-contacts of plugs *g* and *g'* are through the helices *n¹* and *n²*, respectively, to the free pole of battery *d*. Hence while the telephone is in use the tip of the testing-plug *g'*, being grounded through winding *n⁴*, is free from disturbance by the

varying electrical conditions of the remainder of the plug-circuit.

Two relays *o* and *o'* are interposed in conductor 8 of the plug-circuit, one in the conductor between each of the plugs and the point of connection with the source of current. These relays should, of course, be of low resistance and may be shunted by suitable non-inductive resistances. The sleeves of the plugs *g* and *g'*, which make contact with the thimbles *h²* of the spring-jacks, form the terminals of conductors 11 and 12, respectively, which are led to the free pole of a grounded source of current *p*. These conductors include supervisory signal-lamps *q* and *q'*, which are associated, respectively, with plugs *g* and *g'*, each of which is controlled through the agency of a shunt including the contact-points of the corresponding relay *o* and *o'*. The battery *p* thus serves when a plug is inserted into the spring-jack to excite the cut-off relay *e* of the corresponding line to electrify the test-rings *h²* of that line to produce the test and to illuminate either of the supervisory lamps *q* or *q'* whose shunt may be interrupted in its controlling-relay.

The operation in general of the system is, briefly, as follows: The removal of the receiving-telephone from its switch-hook at the substation closes the line-circuit at the station and causes the excitement of the relay *c*, whereby the circuit 5 becomes closed and the corresponding line-lamp *f* is lighted. Responding to the signal, the operator inserts an answering-plug *g* into the answering-jack *b'* of the line, at the same time placing her listening-key *k* in position to bring her telephone into connection with the plug-circuit. The act of inserting the plug into the spring-jack causes the cut-off relay *e* to break the normal ground connections of the line, and thus to render relay *c* inert and to extinguish the line-signal *f*. The same act changes the electrical condition of test-rings *h²* of the line, so that they shall test "busy" subsequently. The supervisory lamp *q* does not become lighted, because of the current from source *d* through relay *o* to the substation, which causes the relay to close the shunt about the supervisory lamp. Having learned the order for the corresponding line, the operator touches the tip of plug *g'* to a test-ring *h²* of the required line. If no connection exists with the line tested, the test-contacts *h²* of the spring-jacks *b* and *b'* are merely connected to earth and become a part of a circuit leading from earth through the test-contact, the tip of the plug *g'*, a portion of conductor 7 of the plug-circuit, the winding *n⁴* of the impedance-coil, and a portion of conductor 10 to earth, and since this circuit includes no source of current no electrical change takes place in the circuit when closed. If, however, a connection already exists with the line, the battery *p* is connected with the test-contacts by way of conductor

12 and the sleeve-contact of a plug g' , by means of which connection has been made, whereby the potential of the test-contacts of the line is raised above that of the earth, so that a current will then flow through the tip of the test-plug at each application of the test-ring, which, acting inductively upon the winding n^3 , will produce a current in the circuit made up of a portion of the bridge 10, winding n^3 , a portion of the conductor 7, the operator's telephone-bridge, a portion of conductor 8, and winding n' , which will cause a click in the operator's telephone.

In the early stages of the development of the central-battery relay-switchboard it was customary to supply battery to the connecting-cord circuit through a bridged retardation or impedance coil. With a circuit so arranged, however, trouble was experienced on account of a false busy test which was obtained when an operator undertook to test while the answering-plug of her pair of connecting-cords was inserted in the jack of a metallic-circuit line. The cause of this difficulty lay in the current which, flowing out over one side of the metallic circuit through the bridge at the substation and returning over the other side of the circuit, raised the potential at the tip of the calling-plug sufficiently to cause a busy click in the operator's telephone. Whenever the tip of the calling-plug was touched to the test-ring of a jack, whether the line associated with that jack were busy or not, a current would find path back to the grounded side of the battery, through the grounded connection of the busy-test ring, as well as through the connection from the tip side of the plug-circuit to the grounded side of the battery through the impedance-coil, enough current being diverted to the test-ring to produce the click. By the use of my invention it is obvious that such a false test-signal is avoided, because when the key is depressed for testing the direct connection between the tips of the two plugs is broken, and current returning from the calling-station by way of the tip of the answering-plug would not find path to the tip of the test-plug, since the grounded pole of the battery is connected between the windings $n^3 n^4$, and the normal short circuit of said windings is broken.

Having tested the line and found it free for use, the operator disconnects her telephone by means of the listening-key k and inserts the plug g' into the spring-jack of the line called for. The change of position of key k necessary to disconnect the telephone incidentally closes the switch-springs of the key upon the contacts $k^1 k^2$, respectively, and thus unites the severed portions of conductor 7 and of conductor 8, leaving the bridge 10 complete and including a pair of windings in multiple at each side of battery d .

The connection of plug g' with the line called for effects the cutting off of the line-

relay c of that line and changes the condition of the test-rings to make the line test busy. Until the response of the called subscriber no current flows through relay o' . Hence the supervisory lamp q' , being as yet not shunted, remains lighted. The response of the called subscriber is indicated to the operator by the extinction of this lamp.

The replacement of the telephones at both stations causes the lighting of both supervisory lamps q and q' , which may be taken as signifying the discontinuance of conversation.

I claim as my invention—

1. The combination with a plug and a plug-circuit, said plug having a contact adapted for testing lines to determine the electrical condition thereof connected through a helix with earth, of a key adapted to disconnect the said test-contact from its normal connection with the remainder of the plug-circuit and simultaneously to bring the operator's telephone into connection with a winding in inductive relation to the said helix, substantially as described.

2. The combination with a pair of plugs and the plug-circuit thereof, a contact-piece of one of the plugs being adapted to test the electrical condition of lines, of a bridge of the plug-circuit, and a source of current included therein, an impedance-coil with two windings between said source of current and the conductor of the plug-circuit terminating in said test-contact, said windings being connected in multiple, an operator's listening-key for connecting a telephone with the plug-circuit, and switch-contacts of the said key adapted to break the multiple connection between the said two windings and thereby to interrupt the normal connections of the plug-circuit, substantially as described.

3. The combination with a metallic-circuit telephone-line closed at the substation, and extensions of the line conductors terminating in the contact-pieces of a connecting-plug, one of said contact-pieces being adapted for testing the electrical condition of lines, of two helices in inductive relation interposed serially in the conductor leading to the test-contact, a bridge of the line connected with the point of junction of the helices, said point of junction being grounded, a key adapted to connect the said helices in multiple, and a test-indicating appliance in association with the conductor terminating in the test-contact to respond to currents therein; whereby interference with the test by current in the line-circuit is prevented, substantially as described.

4. The combination with a metallic-circuit telephone-line and a double plug having its contact-pieces connected with the line conductors, one contact-piece of the plug being adapted for use in testing, and an operator's listening-key, of a bridge of the line includ-

ing a source of current, said bridge being
divided into multiple branches, a winding of
an impedance-coil in each of the branches,
switch-contacts in the listening-key adapted
5 to break or close each conductor of the line-
circuit between the points of connection of
the said branches therewith, and a ground
connection from that portion of the source of

current which is connected with the test-con-
tact, as described. 10

In witness whereof I hereunto subscribe my
name this 21st day of November, A. D. 1896.

JAMES L. McQUARRIE.

Witnesses:

ELLA EDLER,

DUNCAN E. WILLET.