(No Model.)

M. G. KELLOGG.

MULTIPLE SWITCHBOARD.

No. 592,306. Patented Oct. 26, 1897.

Fig. 1a.

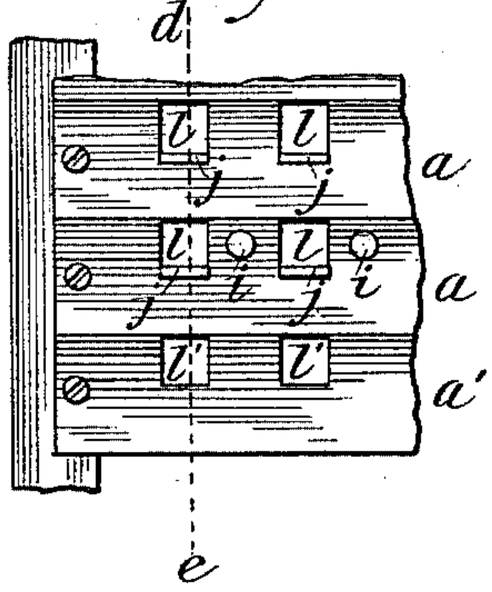


Fig. 1b.

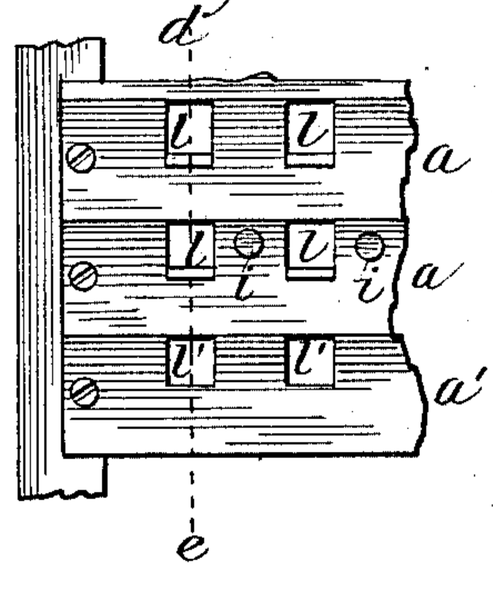


Fig. 2.

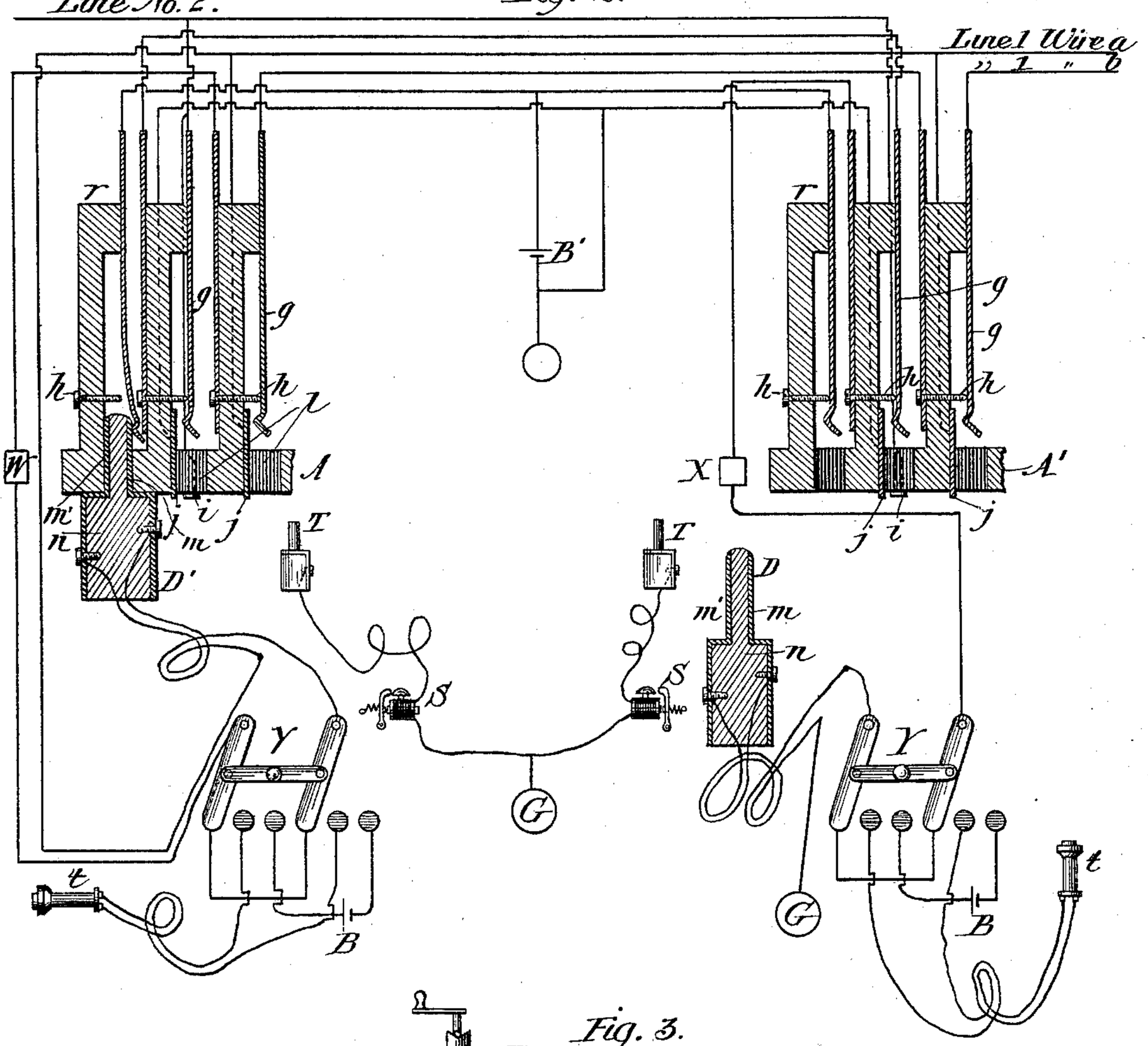
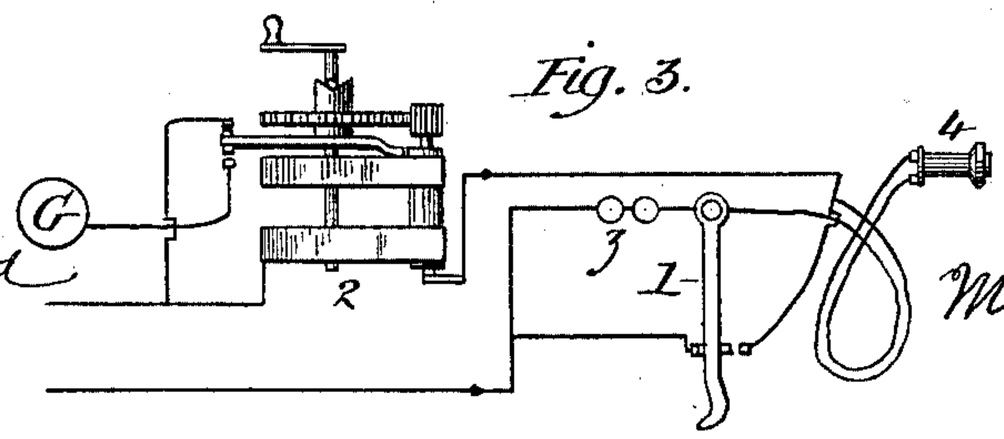


Fig. 3.



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UNITED STATES PATENT OFFICE.

MILO G. KELLOGG, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF SAME PLACE.

MULTIPLE SWITCHBOARD.

SPECIFICATION forming part of Letters Patent No. 592,306, dated October 26, 1897.

Application filed February 1, 1888. Serial No. 262,664. (No model.)

To all whom it may concern:

Be it known that I, MILO G. KELLOGG, of Chicago, Illinois, have invented certain new and useful Improvements in Multiple Switchboards for Telephone-Exchanges, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to a telephone-exchange system in which parts of the subscribers' lines are single or ground circuit lines and part of the lines are metallic-circuit lines; and it consists of apparatus and a system of testing such lines to determine at one board whether a line is in use at another board, which requires of the operator practically the same operations, whether the line tested be a single ground-circuit line or a metallic-circuit line.

In the drawings illustrating my invention, Figures 1^a and 1^b represent sections of two multiple switchboards of the exchange to which the same lines are connected. Fig. 2 shows a complete diagram of the boards with all the central-office apparatus, circuits, and connections necessary to operate them according to my invention. Fig. 3 shows a diagram of the subscriber's-station apparatus adapted for use on the metallic-circuit lines of the system.

In Fig. 2, A is a sectional view of the switchboard shown in Fig. 1^a, and A′ is a sectional view of the switchboard shown in Fig. 1^b, each as indicated by the line *d e*. I place as many boards in the central office as are found necessary or desirable in order to properly answer the calls and make the necessary connections. On each board is a suitable switch for each line. Each switch has a contact-spring which normally bears on an insulated contact-point and has a contact-piece insulated from the rest of the switch (except by the connections as indicated) and is adapted to receive a loop-switch plug, and when the plug is inserted to disconnect the spring from the contact-point (on which it normally bears) and connect the two contact-pieces of the plug with the spring and said insulated contact-piece, respectively.

In Fig. 2, *g g* represent the springs of the different switches, *h h* the contact-points on which the springs normally rest, and *j j* the insulated contact-pieces of the switches. *l l* are the switch-holes. *a a* are the rubber strips on which the spring-jack parts are mounted, as shown, and through the fronts of which are the switch-holes *l l*. These holes are adapted to receive the switch-plugs, (shown in the figure and marked D D′,) and when a plug is inserted in a switch it operates the switch as above described. The insulated contact-pieces *j j* of the switches, which are used for metallic-circuit lines, should be so placed that a test-plug or other switch testing device may be readily applied to them. For the single-circuit lines I use test contact-pieces separate from the line-switch contact-points and holes, but which may be adjacent to the holes. I use one such test contact-piece for each line on each board. These pieces are marked *i i*.

I use a loop-switch plug with double flexible cord for each line on the board where its calls are to be answered. These plugs are marked D D′, the construction of the plugs being the same whether they are for single-circuit or metallic-circuit lines, but the connections to the plugs being different for the different kinds of lines.

In Fig. 2, D is for a single-circuit line, and D′ is for a metallic-circuit line.

For each loop-switch plug at the board where it is located I provide a switching device adapted to receive the plug and into which the plug is normally placed and which normally connects one of the contact-pieces of the plug with the ground wire or connection of the lines, as shown and as will hereinafter be described.

r r are the switching devices for the two lines shown, one device on each board.

l′ l′ are the holes in which the plugs are normally placed, and *g′ g′* are contact-springs of the devices with which one of the contact-pieces of the plugs connects when the plugs are inserted.

m m′ are the two insulated contact-pieces of a plug, and *n* is the rubber insulation of the plug.

All the springs g' g' of the several switching devices connect to a ground wire or connection in which is a battery B', as shown.

For each line there is a looping-in switch (marked T) connected in the line-circuit as shown and by which the operator attending the line may at will loop either her telephone or calling-generator in its circuit. The looping-in switch of a line is located at the board where the looping-in plug of the line is located and where the calls of the line are to be attended to. It should be conveniently mounted and placed so that the operator can readily make the connections.

In the subscriber's-station apparatus for metallic-circuit lines, shown in Fig. 3, 1 is the telephone-switch. 2 is the calling-generator. 3 is the signal-receiving bell, and 4 is the subscriber's telephone. G is the ground connection. These parts may be the usual forms of apparatus and are connected as shown or in other known ways. The calling-generator is, however, modified, as will hereinafter be described.

The generator has an automatic device (shown in the drawings) by which, when the crank is not in motion, the wire of the armature is shunted and the line is disconnected from the ground at the subscriber's station, and when the generator is turned or operated the shunt is automatically removed and the line is connected to the ground. The automatic device shown is a modification of a form very generally used, the modification being substantially in the arrangement of the contact-points. It contains a V-shaped attachment to the hub of the driving-wheel, a pin in the shaft which engages in the V-shaped arrangement, and a spring which presses against the wheel and brings the pin normally in the center of the V arrangement. The contact-points are substantially as shown and as will produce the switching operations described above.

w and x are calling-annunciators, one for each line shown, and each located in the circuit of its line at the board where its calls are to be answered. Two lines are shown, one a metallic-circuit line and marked line No. 1 and the other a single-circuit line and marked line No. 2. The two sides or branches of the metallic-circuit line are marked wire a and wire b.

The circuit of the single-circuit line is as follows: from the subscriber's ground through his station apparatus, (which may be of the usual style for such lines,) through the pairs of contact-points, successively, of its switches on the several boards, going in each case to the spring first, thence through its line-annunciator to one of the conductors of its double cord and thence to the contact-piece m of its double plug, and, when the plug is inserted into its switching device, to the ground through the contact-spring g' and the battery B'. The looping-in switch is in the circuit of the line, as shown, before it is connected to the plug. The other contact-piece m' of the plug of a single-circuit line is connected through the other conductor of its cord to the ground or to the common ground-wire, but the battery B' should not be in its ground-circuit. All the contact-pieces j j' of the switches of a single-circuit line should be connected together and to the ground or to the common ground-wire, but the battery B' should not be in their ground-circuit. All the test contact-pieces i i of a single-circuit line should be connected together and to the line, the connection to the line being between its switches and the subscriber's station. The drawings show the connections of a single-circuit line and its switch parts and apparatus as described above.

The circuit of a metallic-circuit line is as follows: One side or branch of the line, say wire a, is connected with all the contact-pieces j j of its switches on the several boards and also to the contact-piece m' of its loop-plug through one of the conductors of the double cord. The other side or branch of the line passes successively through the pairs of contact-points g h of its switches on the several boards, going in each case to the spring first, thence through its annunciator to the other conductor of the cord, and to the contact-piece m of its double plug, and, when the plug is inserted into its switching device, through the contact-spring g' and the battery B' to ground. The looping-in switch is in the circuit of this side of the line, as shown, before it is connected to the plug. The two sides of the line unite at the subscriber's station, and the subscriber's-station apparatus is so connected into the circuit that when the generator is operated the ground connection thereby established is between the wire of the armature and the contact-pieces j j of the switches. In each case in the switching when a plug is taken from its normal position in its switching device and placed in a line-switch it is so placed in the switch that the contact-piece of the plug (marked m) makes connection with the spring-lever g of the switch. To insure this, the piece m may be suitably marked. The metallic-circuit lines are normally grounded only at the central office and as indicated.

The switching between the various lines of the exchange is as follows: When an operator receives a call from a metallic-circuit line assigned to her board to be answered, she finds out by testing, as will hereinafter be described, whether the line called for is in use. If it is not in use, she takes the plug of the line calling from its normal position and places it, as indicated, in the switch at her board of the line wanted. By so doing she removes the ground connection, through the battery B', from both lines. If the line wanted is also a metallic-circuit line, the two lines are connected together in an ungrounded metallic circuit. The annunciator and the looping-in switch of the line which called is

in that circuit, and the annunciator and looping-in switch of the other line is not in that circuit. If the line wanted is a single-circuit line, the two lines are connected together into one circuit with the annunciator and looping-in switch of the calling-line in the circuit and the annunciator and switch of the other line not in the circuit. The combined circuit is thus: from the ground of the single-circuit line at the subscriber's station through the line to the contact-piece of the loop-plug which is in connection with the spring-lever of the switch used, thence through the metallic-circuit line to the other contact-piece of the plug, and through it to the contact-piece *j* of the switch used, and thence to ground. When an operator receives a call on a single-circuit line assigned to her board to be answered, she finds out by testing whether the line called for is in use at another board. If it is not in use, she takes the plug of the line calling from its normal position in its switching device and places it, as indicated, in the switch at her board of the line wanted. By so doing she removes the ground connection, through the battery B′, from both lines. If the line wanted is a metallic-circuit line, the two lines are connected together with the looping-in switch and annunciator of the calling-line in their circuit and the others not in the circuit. The combined circuit is thus: from the ground of the single-circuit line at the subscriber's station through the line to the contact-piece *m* of its loop-plug, thence through the spring-lever of the switch used and the metallic-circuit line to the contact-piece *j* of the switch, thence to the contact-piece *m′* of the plug and to the ground through its flexible conductor. If the line wanted is a single-circuit line, the lines are also connected together in a circuit in which are the annunciator and looping-in switch of the calling-line only. The combined circuit is from the ground at the subscriber's station of the calling-line, through the line to the contact-piece *m* of its plug, thence to the spring-lever of the switch, and through the line wanted to its ground at the subscriber's station. The other contact-piece of the plug is in this case connected with the contact-piece *j* of the switch. Both are connected with the ground only, and the operation of the system is not affected thereby.

For each operator at her board I provide a test receiving instrument, grounded at one side or connected to the ground connection, (but the ground-circuit of the instrument must not be through the test-battery B′,) said instrument being connected on its other side to a test-plug with a flexible cord or other suitable test arrangement, by which the operator may connect her test receiving instrument on that side at will to any of the contact-pieces *j j* at her board of the metallic-circuit lines and to any of the contact-pieces *i i* at her board of the single-circuit lines. The test receiving instruments are marked S and the test-plugs are marked T. In each case in the drawings, G represents the ground connection.

The test is applied for any line to determine whether or not it is in use by connecting the test-plug to the contact-piece *j* or *i* of the switch of the line at her board, as the case may be. The test-circuit of a metallic-circuit line when not in use is from the ground of the test instrument through the instrument to the contact-piece *j* of the line, thence through the circuit of the line, the pairs of contact-points of the line-switches, and the flexible cord, plug, and switching device of the line to the ground through the battery B′, and her instrument will respond to the battery. If the line is switched, either by its switch-plug being withdrawn from its normal position or by a plug being inserted in any of its line-switches, this test-circuit is interrupted, and as no battery will then pass through the instrument it will not respond. The test-circuit of a single-circuit line when not in use is from the ground of the test instrument through the instrument to the contact-piece *i* of the line, thence through the pairs of contact-points of the line-switches and the flexible cord, plug, and switching device of the line to the ground through the battery B′, and her instrument will respond to the battery. If the line is switched, either by the switch-plug being withdrawn from its normal position or by a plug being inserted in any of its line-switches, this test-circuit is interrupted, and as no current will pass to the instrument it will not respond. In either case the operator may tell whether a line is in use or not by the fact that her test receiving instrument does not or does respond.

It will be seen from the description of the system as above described that the operators can make all the necessary connections and testing for a telephone system with combined single and metallic circuit lines, and that the operations they go through with for each connection are the same whichever kind of lines are switched. The confusion which would result from having two systems of testing and switching for the two kinds of lines is avoided. This result is obtained by the combination of apparatus I have shown.

The system herein described varies from that of my Reissue Patent No. 11,388, being a reissue of my Patent No. 393,508 for which application was filed November 14, 1887, as far as the same relate to the test system for metallic-circuit lines, especially in the fact that in the system of said patent the test-battery is in the test-wire from ground to the test-plug, in which is also the test receiving instrument, and is therefore always in the circuit with the test receiving instrument, whereas in the system of this application the test-battery is the normal ground connection of the lines at the central office from which the lines are disconnected when they are

switched for conversation, and the battery is therefore in circuit with the test receiving instrument only while the test of a line is being made and when the line is not then switched for conversation. This difference in the relative position of the test-battery to the test receiving instruments and the circuits produces a system which in various ways has advantages over the system of said patent. In the system of this application the line will not test "free" or unswitched, when already switched for use from any current passing from the test-battery through the test receiving instrument when the test of a line is made, from any accidental ground or escape which may exist on the line, because the battery in this system is then entirely out of circuit with the line. It is, moreover, well known that telephone-lines have in practice a static capacity, varying in amount with their character and general construction, and that on account of such static capacity when a grounded test-wire containing a test receiving instrument and battery is connected to such a line the line becomes charged from the battery, and during the period of charging current passes through the test receiving instrument, and precautions must be observed that a false test is not thereby indicated. With the test-battery related to the test receiving instruments and located as described in this application there can be no static charge of the line from the battery through the test receiving instrument when the test is made, and therefore no liability from this source of false test-signals.

I claim as my invention and desire to secure by Letters Patent—

1. In a telephone-exchange system, multiple switchboards, a single-circuit line grounded at its outer end, a switch on each of said boards for said line, each switch containing a pair of contact points or pieces normally in contact and a third contact-piece normally insulated from the rest (except by the line connections), the line passing successively through said pairs of contact-pieces of its switches and thence normally or while the line is not switched for conversation to a ground wire or connection and a battery in said ground wire or connection, said normally-insulated contact-pieces of its switches being also connected to ground, but not through a battery, and a loop-switch plug, the two contact-pieces of which are connected to the two sides or branches of a metallic-circuit line, said plug being adapted to be inserted into one of the switch-holes and when inserted to disconnect the pair of contact-points which are normally in contact and connect the two contact-pieces of the plug, one with said normally-insulated contact-piece of the switch and the other with that contact-piece of the pair of contact-pieces which is then connected with the line, in combination with test-bolts for the line, one on each board, each test-bolt being apart from the switch-hole of the line and connected to the line, and test receiving instruments, one at each board, each test receiving instrument being grounded on one side but not through a battery and connected on its other side to a test-plug or other test device adapted to be brought into connection with the test-bolt at its board, substantially as set forth.

2. In a telephone-exchange system, multiple switchboards, single and metallic circuit lines connected to said boards, a ground connection for said lines at the central office, a battery in said ground connection, one branch of each of said metallic-circuit lines and said single-circuit lines being normally or while they are not switched for conversation connected to said ground connection, the other branch of each of said metallic-circuit lines being normally open at each of the switchboards, and said metallic-circuit lines being normally and while the subscriber's generator is not operated ungrounded at the subscribers' stations, and switching devices at each board for each of the lines to disconnect the lines from the ground when they are switched for conversation, in combination with test receiving instruments, one at each board, each instrument being grounded on one side (but not through a battery) and connected on its other side to a switch testing plug or device adapted at the will of the operator to connect the instrument to any single-circuit line and to the normally open branch of any metallic-circuit line at her board, substantially as set forth.

3. In a telephone-exchange system, a loop-switch plug, the two insulated contact-pieces of which are connected to the two sides or branches, respectively, of a metallic-circuit line, in combination with a spring-jack switch for a single or ground circuit line, said switch having two contact-pieces normally in contact and a third contact-piece, normally insulated from the rest (except by the circuit connections), one of said contact-pieces which are normally in contact being connected with the line and the other being normally or while the line is not switched for conversation connected with a ground wire or connection, and a battery in said ground wire or connection, said third contact-piece being permanently connected to the ground, but not through a battery, said plug being adapted to be inserted into said switch and when inserted to disconnect the two contact-pieces of the switch which are normally in contact and connect the two contact-pieces of the plug, respectively, with that contact-piece of the switch which is connected to the line and with said third contact-piece of the switch, substantially as set forth.

4. In a telephone-exchange system, a spring-jack switch containing a contact-piece connected to the line, a contact-piece normally or while the line is not switched for conversation in connection with said other contact-piece and grounded, a battery in the

ground connection, and a third contact-piece insulated from the rest (except by the circuit connections) and grounded, but not through the battery in combination with a double or loop plug adapted to be inserted into said switch and when inserted to disconnect said contact-pieces which are normally in contact and connect one of the contact-pieces of the plug with said first-mentioned contact-piece of the switch and the other contact-piece of the plug with said third contact-piece of the switch, substantially as set forth.

5. In a telephone-exchange system, multiple switchboards, a telephone-line, a spring-jack switch on each board for said line, each switch containing a pair of contact-points which are normally in contact (and a third contact-piece which is placed along the surface of said switch-hole), said line normally or while the line is not switched for conversation passing successively through said pairs of contact-pieces of its switches and thence to a ground wire or connection, a battery in said ground wire or connection (and said third contact-piece being connected to ground but not through a battery), in combination with test-bolts, one for the line on each board, each bolt being placed apart from the switch-hole of the line and connected to the line, and test receiving instruments, one at each board each grounded on one side and connected on its other side to a test plug or device, adapted, at the will of the operator to be brought into connection with the test-bolt at its board, substantially as set forth.

6. In a telephone-exchange system, multiple switchboards, a telephone-line, a spring-jack switch on each board for said line, each switch containing a pair of contact-points which are normally in contact, said line normally or while the line is not switched for conversation passing successively through said pairs of contact-pieces of its switches and to a ground wire or connection, and a battery in said ground wire or connection, in combination with test-bolts, one for the line on each board, each bolt being placed apart from the switch-hole of the line and connected to the line, and test receiving instruments, one at each board, each grounded on one side but not through a battery and connected on its other side to a test plug or device adapted, at the will of the operator, to be brought into connection with the test-bolt at its board, substantially as set forth.

7. In a telephone-exchange system, a switchboard, a telephone-line, a switch on said board for the line, containing a pair of contact-pieces normally in contact and a third contact-piece normally insulated from the rest (except through the circuit connections), one of said contact-pieces which are normally in contact being connected to the line and the other normally or while the line is not switched for conversation connected to a ground wire or connection, a battery in said ground wire or connection, and said third contact-piece being also connected to the ground, but not through a battery, said switch being adapted to receive a switch-plug and said plug when inserted adapted to connect said third contact-piece with one end of another line, in combination with an insulated test-bolt connected to the line and a test receiving instrument grounded on one side and connected on its other side to a test plug or device adapted at the will of the operator to be brought into connection with said test-bolt.

8. In a telephone-exchange system, a metallic, circuit-line, the two sides or branches of which terminate in the two contact-pieces, respectively, of a loop-switch plug, a switching device for said plug in which it is normally placed, said switching device having a contact-piece which is connected to the ground through a battery, said plug having one of its contact-pieces in connection with said contact-piece of the switching device when in its normal position and adapted to be removed from said normal position and placed in the switch of another line, in combination with a test receiving instrument grounded on one side but not through a battery and connected on its other side to a test plug or device adapted, at the will of the operator, to be brought into connection with said line, substantially as set forth.

9. In a telephone-exchange system, two metallic-circuit lines, in combination with double or loop plugs, one for each line, in the two contact-pieces of which the two sides or branches of the line, respectively, terminate, switches, one for each line, each switch having two contact-points, normally in contact, in the circuit of one of the sides or branches of its line, a switching device for each plug, in which the plug is normally placed, each switching device having a contact-piece which, when the plug is inserted, is in connection with that side or branch of the line in which are said contact-points of its switch and which contact-piece is connected to the ground through a battery, said plugs being each adapted to be withdrawn from their normal position and placed in the switch of the other line and thereby disconnect the lines from their ground connection and connecting them together, in combination with a test receiving instrument grounded on one side but not through a battery and connected on its other side to a switch testing plug or device adapted to be brought into connection with either line, substantially as set forth.

10. In a telephone-exchange system, metallic-circuit lines normally grounded at the central office and there only, line-switching devices at the central office, one for each line, each switching device containing three contact-pieces, two of which are normally in contact, and one of said pieces which are normally in contact being connected to one side or branch of its line, and the third contact-piece being connected to the other side or branch of its line, double or loop plugs with

double flexible cords, one for each line, the two conductors of each cord being respectively attached to the two sides or branches of its line, and the other ends of the conductors being attached to the two contact-pieces of their plug, respectively, and ground switching devices, one for each plug in which the plug is normally placed, each of said switching devices having a contact-piece which is connected to the ground through a battery, and when its plug is in its normal position therein, connecting said contact-piece with that contact-piece of the plug which is connected to the same side or branch of the line as its said pairs of contact-points are in, said plugs being adapted to be withdrawn from their normal positions and placed in the switch of another line, and when so placed to disconnect the two lines from their ground connection through the battery and connect them together, in combination with a test receiving instrument grounded on one side but not through a battery, and connected on its other side to a switch testing plug or device adapted, at the will of the operator, to be brought into connection with either of said third contact-pieces of the switches, substantially as set forth.

11. In a telephone-exchange system, metallic-circuit lines normally grounded at the central office and there only, multiple switch-boards for said lines, line-switching devices for said lines, one for each line on each board, each switch containing three contact-pieces, two of which are normally in contact, the contact-pieces of the switches which are normally in contact being in the circuit of one side or branch of their line and the other contact-pieces of the switch being connected to the other side or branch of the line, double or loop plugs with double flexible cords, one for each line, the plugs being distributed among the several boards, the two conductors of each cord being attached to the two contact-pieces of its plug, respectively, and the other ends of the conductors being attached to the two sides or branches of their line, respectively, and ground switching devices at the several boards for said plugs, each ground switching device having a contact-piece which is connected to the ground through a battery, said plugs being normally placed in their ground switching device and when so placed grounding that side of their line in which are said pairs of contact-points, through the battery, each of said plugs being adapted to be withdrawn from its normal position and placed in the switch of another line and thereby disconnect the two lines from their ground connection through the battery and connect them together, in combination with test receiving instruments, one at each board, each instrument being grounded on one side, but not through a battery and connected on its other side to a switch testing plug or device, adapted, at the will of the operator, to be brought into connection with any of said third contact-pieces of the switches at its board, substantially as set forth.

12. In a telephone-exchange system, the combination of a metallic-circuit line, a switch-plug for the line, a switching device into which the plug is normally placed and on which it operates, a ground wire or connection with which one side or branch of the line is normally in connection, a battery in said ground wire or connection and contacts by which such normal connection of the line with the ground wire or connection is automatically broken when the plug is withdrawn from its normal position in the switching device, substantially as set forth.

13. In a telephone-exchange system, the combination of a telephone-line, a switch-plug for the line, a switching device into which the plug is normally placed and on which it operates, a ground wire or connection with which the line is normally in connection, a battery in said ground wire or connection and contacts by which such normal connection of the line with the ground wire or connection is automatically broken when the plug is withdrawn from its normal position in the switching device, substantially as set forth.

14. In a telephone-exchange system, a metallic-circuit line, a switch-plug for the line, a switching device into which the plug is normally placed and on which it operates, a ground wire or connection with which one side or branch of the line is normally in connection, a battery in said ground wire or connection and contacts by which such normal connection of the line with the ground wire or connection is automatically broken when the plug is withdrawn from its normal position in the switching device, in combination with a test receiving instrument grounded on one side and connected on its other side to a plug or device adapted to be brought for testing into connection with the line, substantially as set forth.

15. In a telephone-exchange system, a telephone-line, a switch-plug for the line, a switching device into which the plug is normally placed and on which it operates, a ground wire or connection with which the line is normally in connection, a battery in said ground wire or connection and contacts by which such normal connection of the line with the ground wire or connection is automatically broken when the plug is withdrawn from its normal position in the switching device, in combination with a test receiving instrument grounded on one side and connected on its other side to a plug or device adapted to be brought for testing into connection with the line, substantially as set forth.

16. In a telephone-exchange system, the combination of a metallic-circuit line, a switch-plug for the line having a contact-piece with which one side of the line is normally connected, a switching device into which the plug is normally placed, a contact-piece in

said switching device with which said contact-piece of the plug comes in contact when the plug is inserted into the switching device, a circuit wire or connection connected on one side to said contact-piece of the switching device and grounded on its other side, and a test-battery in said circuit-wire, substantially as set forth.

17. In a telephone-exchange system, the combination of a telephone-line, a switch-plug for the line having a contact-piece with which the line is normally connected, a switching device into which the plug is normally placed, a contact-piece in said switching device with which said contact-piece of the plug comes in contact when the plug is inserted into the switching device, a circuit wire or connection connected on one side to said contact-piece of the switching device and grounded on its other side, and a test-battery in said circuit-wire, substantially as set forth.

18. In a telephone-exchange system, a metallic-circuit line, the two sides or branches of which are normally open to each other at the central office, a ground connection through which one side or branch of the line is grounded there, and a battery in said ground connection, in combination with a switch for the line adapted to receive the switch-plugs of other lines, a pair of switch-contacts normally closed but open while a plug is in the switch, a switch-plug for the line, a plug switching device in which the plug is normally placed, and a pair of contacts which are closed while the plug is in the switching device and opened by the withdrawal of the plug from the device, said branch of the line which is normally grounded passing through said pair of switch-contacts and thence through said other pair of contacts to ground, substantially as set forth.

19. In a telephone-exchange system, a metallic-circuit line, the two sides or branches of which are normally open to each other at the central office, a ground connection through which one side or branch of the line is grounded there, and a battery in said ground connection, in combination with a switch for the line adapted to receive the switch-plugs of other lines, a pair of switch-contacts normally closed but open while a plug is in the switch, a switch-plug for the line, a plug switching device in which the plug is normally placed, a pair of contacts which are closed while the plug is in the switching device and opened by the withdrawal of the plug from the device, said branch of the line which is normally grounded passing through said pair of switch-contacts and thence through said other pair of contacts to ground, and a test receiving instrument grounded on one side and connected on its other side to a plug or device adapted to be brought for testing into connection with the other side or branch of the line, substantially as set forth.

20. In a telephone-exchange system, a metallic-circuit line the two sides or branches of which are normally open to each other at the central office, a ground connection through which one side or branch of which is normally grounded there, and a battery in said ground connection, in combination with switches for the line, one on each of the multiple switchboards, each switch being adapted to receive the switch-plugs of the other lines located at its board, a pair of contacts for each switch which are normally closed but opened while a plug is in the switch, a switch-plug for the line, a plug switching device in which the plug is normally placed and a pair of contacts which are closed while the plug is in the switching device and opened by the withdrawal of the plug from the device, said branch of the line which is normally grounded passing successively through said pairs of its switch-contact points, and thence through the other pair of contacts to ground, substantially as set forth.

21. In a telephone-exchange system, a metallic-circuit line the two sides or branches of which are normally open to each other at the central office, a ground connection through which one side or branch of which is normally grounded there, and a battery in said ground connection in combination with switches for the line, one on each of the multiple switchboards, each switch being adapted to receive the switch-plugs of the other lines located at its board, a pair of contacts for each switch which are normally closed but opened while a plug is in the switch, a switch-plug for the line, a plug switch device in which the plug is normally placed, a pair of contacts which are closed while the plug is in the switching device and opened by the withdrawal of the plug from the device, said branch of the line which is normally grounded passing successively through said pairs of its switch-contact points, and thence through the other pair of contacts to ground, and a test receiving instrument grounded on one side and connected on its other side to a plug or device adapted to be brought for testing into connection with the other side or branch of the line, substantially as set forth.

MILO G. KELLOGG.

Witnesses:
MILTON HEAD,
CALVIN DE WOLF.