

(No Model.)

M. G. KELLOGG.
MULTIPLE SWITCHBOARD.

No. 592,301.

Patented Oct. 26, 1897.

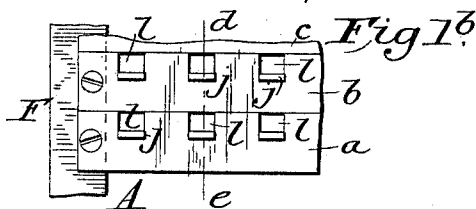
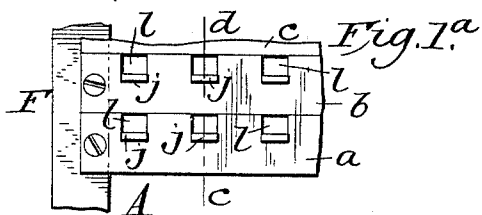
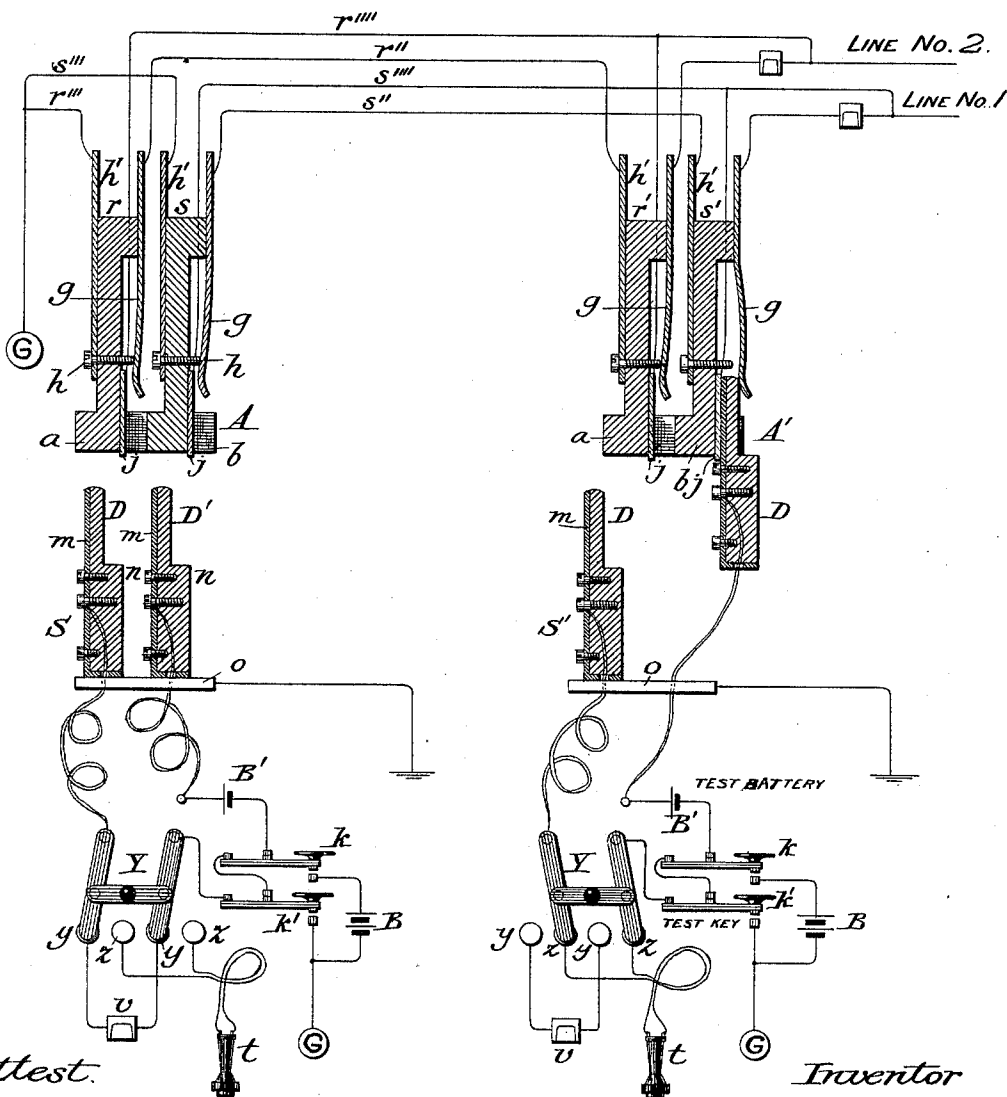


Fig. 2.



Attest.
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Inventor
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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. 592,301, dated October 26, 1897.

Original application filed April 27, 1887, Serial No. 236,279. Divided and this application filed November 12, 1890. Serial No. 371,225. (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 specification.

My invention relates especially to a telephone-exchange system in which the subscribers' lines or talking-circuits are single lines, each grounded at one end, which may be at the subscriber's station, and at the other end after passing through its spring-jacks or switches on the boards either grounded or open, according to the class or classes of lines centering in the exchange.

It consists, first, of a multiple-switchboard system of operating an exchange and testing at any board to determine whether any given line is in use, which system I shall hereinafter describe and claim in detail.

It consists, secondly, of an operator's central-office system of cords with plugs, switches, keys, clearing-out annunciator, operator's telephone, calling generator or battery, and circuits for answering, calling, testing, switching, and clearing out subscribers' lines, which system I shall hereinafter describe and claim in detail, said system being applicable to said multiple-switchboard system mentioned above and to other systems of telephone-exchange switchboards.

In my multiple-switchboard system I place as many switchboards in the central office as are found necessary or desirable in order to properly answer the calls and connect and disconnect the subscribers' lines. On each board I place for each telephone-line which centers at the office a spring-jack or similar switch having three suitable contact-points, two of which are normally in contact, each switch being adapted to receive a plug, and when the plug is inserted to disconnect the points which are normally in contact and connect the other contact-points to the flexible cord attached to the plug, and when the plug is withdrawn to again connect the contact-points as above. The contact-point which comes in contact with the metal piece of the plug should never be in contact with the other metal parts of the apparatus except through

the circuit connections or wire, as hereinafter described. The switches of a line on the different boards may be called a "series" of switches. I also use the contact-point last mentioned as a test-bolt of its line, and these points on the different boards belonging to a line may be called a "series" of test bolts or pieces.

Figures 1^a and 1^b of the drawings are front views of sections of two multiple switchboards to which the same wires are connected. Fig. 2 shows a complete diagram of the boards with their connections and with all the central-office apparatus, circuits, and connections necessary to operate them according to my invention.

In Fig. 2, A is a horizontal sectional view of the switchboard shown in Fig. 1^a, as indicated by line *de*, and A' is a like view of the switchboard shown in Fig. 1^b, as indicated by line *de*.

a b represent rubber strips on which the metal parts of the spring-jack switches are mounted. These strips may be long enough to receive any convenient number of spring-jack parts.

ll are square holes through the fronts and at the edges of the strips adapted to receive the switch-plugs. The contact-springs *g g* are mounted in the rear of and are parallel to the holes *ll* to which they belong, as shown. The contact-points *h h* (on which the springs normally bear) pass through the rubber strips and have connecting-pieces *h' h'*, as shown. The contact-pieces *j j* are placed on one of the faces of their respective holes, as shown. They project in the front to or beyond the edge of the holes or so that a test-plug can be applied to them, but do not extend far enough back to come in contact with the points *h h*. The switch-plugs are substantially as shown and as will hereinafter be described. The several parts mentioned above are so organized that when a plug is inserted into any of the holes it raises the spring-lever in the rear of the hole from the contact-point on which it bears, and the cord belonging to the plug is connected to the contact-piece *j* only (except by wires, which connect this piece to other parts of the apparatus.) Each section of a rubber strip, with

its spring-lever contact-point and contact-piece and the hole, all arranged and operating, as shown, may be called a "spring-jack switch." The rubber strips are placed one above the other, as shown. The lower edge of one strip therefore provides the upper edges of the holes in the strip which is below it. It is not necessary that these holes should be square. They may be of any shape adapted to the shapes and arrangements of the parts used.

Two subscribers' lines are shown in the drawings. They are marked line No. 1 and line No. 2. $s s'$ are the switches of line No. 1 on the two boards shown, and r and r' are the switches of line No. 2. The lines shown are single-circuit wires grounded at the subscribers' stations and passing through their series of switch-points $g h$ on the boards and to ground, as shown. Other boards might be added to the exchange, and the circuits of the lines through their respective series of switches on the different boards would be similar to the above and such as is usual. w is the calling-annunciator for line No. 1, and x that for line No. 2. There may be one for each line and they may be distributed at the several boards, so that the operators may conveniently answer the calls of the exchange. Each annunciator is placed in the circuit of its line after the line enters the office and before it goes to any pair of switch-points $g h$ of any of its series of switches. From each line, after it enters the office and before it goes to its annunciator, a wire or wires runs to each of its series of contact-pieces or test-bolts $j j$. Wire s'''' and its branches thus connect line No. 1 with the contact-pieces $j j$ of switches s and s' , and wire r'''' and its branches thus connect line No. 2 with contact-pieces $j j$ of switches r and r' .

$S S'$, Fig. 2, are operators' systems of cords, with plugs, keys, switches, clearing-out annunciators, test-batteries, operator's telephone, calling generator or battery, and circuits. Only one pair of cords, with its plugs, keys, switch, clearing-out annunciator, and test-battery, is shown in each system. Others would be added in a manner which will be apparent to those skilled in the art. Only one calling-generator and one operator's telephone are needed for each operator's cord system, as shown. $D D'$ are the two switch-plugs connected to the pair of cords.

$m m$ are the metal pieces of the plugs, adapted when a plug is inserted in a switch to bring the cord of the plug in connection with the piece j of the switch.

$n n$ are the rubber insulations of the plugs. The smaller ends of the plugs are adapted to be inserted in the switch. When a plug is inserted into a switch, as shown at s' , the rubber portion of its point should press against the spring g and move it away from the contact-point h and the metal piece of the plug should be in contact with the piece j and not in contact with the spring g . The pieces $m m$ are at-

tached to the flexible cords and are so made as to normally rest on a metal strip o , connected to the ground. Weights may be used in the usual manner or similar devices employed to bring the pieces m of the plugs on the ground-strips o and establish a good connection.

Y is a looping-in switch.

$y y$ and $z z$ are contact-bolts of the switch, on which the operator may at will place the pair of switch-levers. The cross-piece between the levers of switch may be of rubber or similar material.

k is a calling-key, and k' a test-key, both constructed, connected, and operating as shown. A switch or similar device might be used in their place.

v is a clearing-out annunciator; B' , a test-battery; B , an operator's signaling generator or battery, and t her telephone.

Each pair of plugs has an individual test-battery B' , an individual clearing-out annunciator v , and an individual looping-in switch Y . The contact-piece m of one of the switch-plugs D' of a pair is connected to one side of the test-battery B' . The other side of this test-battery is connected successively through the normally-closed pairs of contacts of the two keys $K K'$ and thence to one of the levers of the switch Y . The contact-piece m of the other plug of the pair of plugs is connected to the other lever of the switch Y . The two levers of the switch Y are adapted to be placed at will on either the two bolts $y y$, which are connected, respectively, to the two sides of the clearing-out annunciator v , or on the two bolts $z z$, which are connected, respectively, to the two sides of the operator's telephone t . Thus whether the switch Y is in position so that the clearing-out annunciator is in the circuit between the contact-pieces of the two plugs or the operator's telephone is in this circuit the test-battery B' is in the circuit between the two plug contact-pieces. Thus the test-battery is always in circuit between the two contact-pieces of the plugs whatever may be the position of the switch Y .

The circuits are substantially as shown. The clearing-out annunciator and the test-battery of a pair of cords should be constructed and adjusted to each other, so that the annunciator will not operate when they are included in the circuit of any subscriber's line. This result can be obtained in a variety of ways either with polarized or with non-polarized annunciators. I prefer, however, to employ a non-polarized annunciator, and to employ with it a battery so weak that it will not actuate the annunciator when closed through the circuit above described, but yet to have the battery strong enough to actuate the test receiving instrument to be employed and used in a manner hereinafter to be described. A telephone may be conveniently used as the test receiving instrument, as it is delicate enough to indicate a current which will not actuate the annunciator. It will be found

that with the annunciators which are ordinarily used in telephone-exchanges one cell of Daniel or gravity battery will answer the purpose indicated above.

5 When one switch-plug of a pair is inserted into any spring-jack switch of a line, the line is opened at the contact-pieces $g h$ of the switch, and is therefore disconnected from the ground, and the flexible cord attached to the
10 plug is connected to the line through the contact-piece j of the switch and the branch wire. The annunciator of the line will not be in the circuit of the cord and the line, it having been switched from the circuit of the
15 line by the opening of the points $g h$ of the switch, (the point g remaining open or disconnected,) and by the establishment of the circuit from the metal part of the plug through the contact-piece j of the switch and the
20 branch wire connected to the line between the annunciator and the subscriber's station. When the other switch-plug of the pair is inserted into the spring-jack switch of another line, that line is also opened at the contact-
25 points $g h$ of its switch, its annunciator is cut out, and the line is disconnected from the ground, and the flexible cord attached to the plug is connected to the line through the contact-piece j of the switch and the branch wire,
30 as described. The two wires are thus disconnected from the ground and connected together for conversation and the line-annunciators are switched from the circuit of the lines thus connected, but either the operator's tele-
35 phone or the clearing-out annunciator v is in their circuit, according as the levers of the switch Y are on the bolts $z z$ or $y y$. It will be seen that the test-battery B' of the pair of
40 cords which is being used is in the circuit of the lines thus connected whether the levers of the switch Y are on $y y$ or $z z$ and that all the contact-pieces $j j$ of the two lines are in electric connection with it. If the key k' is
45 depressed when the levers of the switch are on $z z$, the two plugs corresponding to the switch are disconnected from each other, and the plug D is grounded through the operator's telephone. If the key k is depressed, the two
50 plugs are disconnected from each other, and the plug D is grounded through the calling generator or battery B . It will be noticed that the battery B' is not in the telephone-circuit of its pair of cords when the test-key k' is depressed. The levers of the switches Y
55 should remain on bolts $y y$, except when the operator desires to use her telephone with a pair of cords, in which case the levers of the corresponding switch are temporarily moved to $z z$. It is intended that the plugs marked
60 D' shall be used in connecting with lines from which calls originate and that the plugs marked D shall be used in testing and switching the lines which are wanted.

65 The operation of the test system is as follows: If an operator at any board wishes to find out whether a line is in use at another board, she presses on the test-key k' of a pair

of cords, the levers of the switch Y of the cords being placed on $z z$, and while pressing on the key places the metal piece of plug D 70 of the pair of cords on a contact-piece j of the switch of the line to be tested, and if a click is heard in the telephone she knows that there is a battery at one of the boards in circuit with the line and that the line is in use; but, 75 hearing no click, she knows that the line is not connected for use.

The operation of the whole system is as follows: When a subscriber sends a calling-current over his line, the annunciator at the office 80 indicates a call, and the operator to whom the annunciator is assigned places the plug D' of a pair of her cords in the spring-jack switch of the line and moves the levers of the switch Y corresponding to the plug to bolts $z z$. Her 85 telephone is thus looped into circuit with the line, and she finds out by conversation what other subscriber's line is wanted. She then tests to see whether the line wanted is busy at another board by pressing on key k' of the 90 cords used and placing the metal part of plug D on the contact-piece j of the line. If it tests not in use, the plug is placed in the switch, and key k is pressed down to send a signaling-current to the line. The operator 95 may then move the levers of the switch to the bolts $y y$, and the clearing-out annunciator v is in the circuit between the lines, and the operator may at any time move the levers back to bolts $z z$ and listen to see whether 100 the subscribers are through conversation. When an operator has observed a call on the annunciator of a line and places one of her plugs D' into the switch of the line with the looping-in switch Y in the position in which 105 its levers are on the contact-bolts $z z$, the operator's telephone is in closed circuit with the line, and the test-battery B' is in this closed circuit and will therefore give the test indication that the line is switched for use. 110 An operator at another board will therefore not connect with the calling-line while the operator and subscriber are conversing. This closed circuit is from ground through the plate o to the contact-piece m of the plug D , 115 and thence to contact m of plug D' , through the switch Y , the operator's telephone t , and the test-battery B' , and thence to the line, and thence to ground at the subscriber's station. When the line is in this condition and an 120 operator at another board tests the line to find out whether it is in use, the test-circuit, which is established and which contains the test receiving instrument and battery, is as follows: from the ground through the test- 125 ing-operator's telephone, thence to the test-plug used, thence to the contact-piece j of the line to which the plug is applied for testing, thence to the contact-piece j of the switch at which the line is switched, thence from 130 the contact-piece m of the plug inserted into the switch to ground through the test-battery B' and the other operator's telephone. The testing operator will therefore hear a click in

her telephone and know that the line is in use. It frequently happens that when two lines are connected together by an operator into a complete circuit for conversation the operator will loop her telephone into the circuit to find out whether they are through conversation, although the circuit is provided with a clearing-out annunciator on which a clearing-out signal may be indicated. She thus loops her telephone into the circuit because it has been found out in practice that subscribers frequently forget or neglect to send the clearing-out signal, and did she not do this the lines might remain switched and thus test busy after conversation had ceased. By the position of the test-batteries in the cord-circuit of my system any line will always test busy whenever and as long as it is switched into a closed circuit for conversation, even though the connection is through an operator's telephone to ground at the central office. The operator at the board where the line is switched may have temporarily looped her telephone into the closed circuit of which the line forms a part. The lines will therefore always test busy when switched and in a closed circuit for conversation. It will be noticed that all the pieces $j j$, which belong to the switches of a given line, are connected to it before it goes to any of its switch-points g , and that the points $j j$ are always connected with their line whether the line is switched for conversation or not. is desirable both in the arrangement of switching the line-annunciator from the line-circuit and for the operation of the test system. It is evident that when a test is made, should the point to which the test-plug is applied be temporarily disconnected from the line, (by switching or otherwise,) the proper signal would not be given, even though the line were switched for conversation at another board and a test-battery were in the circuit, as indicated. By having the test-bolts or test contact-pieces of a line on all the boards connected to the line directly or by branch wires at a point between its switch-contact-opening points and the subscriber's station, I avoid the liability of a test bolt or piece of a line being cut off from the line when the line is switched for conversation at another board, and, therefore, of any failure to indicate at any board when a line is in use at another board.

I prefer to use a telephone as the test receiving instrument, as it is delicate enough to indicate a current of the strength mentioned above and can be conveniently used for this purpose and at the same time for the other operations of the attendant. A galvanometer or other suitable test receiving instrument might, however, be used. When no clearing-out annunciator is used, or when the clearing-out annunciator is constructed or adjusted for it, a comparatively strong battery might be used for the test-battery and

an electric bell or a similar test receiving instrument be employed.

I do not limit myself to the peculiar forms of keys and switches shown in the operator's cord system, as it is evident that there are other forms which would accomplish practically the same purpose and which could be substituted for those shown.

I have stated that the invention is specially applicable to single-circuit lines grounded at one end, and I have shown and described closed-circuit lines grounded at the subscribers' stations. My system of testing, however, is applicable to any system of telephone-exchange or character of telephone-lines where either the circuit of any two subscribers' lines connected for conversation is grounded at one or more places or where a test-circuit, whether through the ground or all metallic, may be completed at any of the boards through the test-battery in the circuit of two lines connected for conversation at any of the boards.

It will be noted that in my system of testing the test-battery B' is in the circuit of the line whenever it is in closed circuit with an operator's telephone or with the telephone of another subscriber. The line will therefore, as soon as the plug is inserted into its switch and the line is in closed circuit with the operator's telephone, be in condition to indicate the test.

No claim is made herein to the spring-jack switch, *per se*, as such subject-matter is claimed in my original application, Serial No. 236,279, filed April 27, 1887, of which this case is a division.

I claim as my invention—

1. In a telephone-exchange system, the multiple switchboards of the exchange to which the same telephone-lines are connected, two of said lines temporarily connected together at either of said boards into a closed circuit for conversation, and an electric battery in the central office connected in the circuit of said lines whenever and as long as they are so connected, in combination with test receiving instruments—one at each board—each instrument being grounded on one side and connected to a switch testing device on the other side, and test-bolts or contact-pieces—one bolt on each board for each line—each bolt being connected to its line, between the subscriber's station and the separable contacts of the line on all the boards, and the testing device at each board being adapted at the will of the operator to be brought into connection with any test-bolt at its board, whereby an operator at any board may connect her test receiving instrument to the circuit of either line and determine that said line is in use for conversation.

2. In a telephone-exchange system, the multiple switchboards of the exchanges for the lines which center at the office, each board being provided with switching devices whereby the operator may connect any two sub-

scribers' lines together into a closed circuit, an electric battery in the closed circuit of said lines whenever and as long as so connected, in combination with test bolts or pieces—one at each board for each line—each test-bolt being connected to its line, between the subscriber's station and the separable contacts of the line on all the boards, and test receiving instruments—one at each board—each instrument being grounded on one side and connected to a switch testing device on the other side, whereby the operator at any board may connect her test receiving instrument to the circuit of any line and always receive a test indication if the line is connected with the circuit of any other line.

3. In a telephone-exchange system, the multiple switchboards of the exchange for the lines which center at the office, each board being provided with switching devices whereby the operator may connect any two of said lines together into a closed circuit for conversation, said lines having normally or when they are not connected for conversation, no battery in their circuit, two of said lines temporarily connected for conversation and an electric battery in the circuit of the lines, whenever and as long as they are so connected in closed circuit, in combination with test bolts or pieces—one at each board for each line—each bolt being connected to its line whether the line is switched for conversation on any board, or not, and test receiving instruments—one at each board—each instrument being grounded on one side and connected to a switch testing device on the other side, whereby the operator at any board may determine that either of said lines is so connected.

4. In a telephone-exchange system, subscribers' lines centering at an exchange office, said lines being grounded at the subscribers' stations and normally grounded at the exchange office, and the multiple switchboards at that office—each board being provided with switching devices whereby the operator may disconnect any two lines from the ground and temporarily connect them together into a closed circuit for conversation, an electric battery in their circuit whenever and as long as they are so connected, in combination with test bolts or pieces—one at each board for each line—each bolt being connected to its line, when the lines are connected for conversation, between the subscriber's station and the separable contacts of the line on all the boards, and test receiving instruments—one at each board—each instrument being grounded on one side and connected to a switch testing device on the other side, whereby the operator at any board may determine whether or not any of the lines are switched for conversation.

5. In a telephone-exchange system, the combination of normally closed ground-circuit lines with switches at the central office—one switch for each line—and annunciators—one

annunciator in each line placed in the central office and located in the circuit of the line between the switch and the subscriber's station—branch wires—one wire branching from each line between the annunciator and the subscriber's station to an insulated piece of its switch—a pair of switch-plugs and flexible cords, and a clearing-out annunciator, said clearing-out annunciator being in a circuit which connects the contact-points of the plugs and each of said plugs being adapted, when inserted into a switch, to disconnect the line which belongs to the switch from the ground and to connect the contact-point of the plug to the line through the insulated contact-piece of the switch and its branch wire, and not through the line-annunciator, whereby, by the insertion of the plugs into the switches belonging to any two lines, the lines are disconnected from the ground and are connected together through their insulated pieces and branch wires, and the clearing-out annunciator is in the circuit of the lines so connected and the line-annunciators are switched from the circuit of the lines.

6. In a telephone-exchange system, the combination of normally closed ground-circuit lines with switches at the central office—one switch for each line—annunciators—one annunciator in each line placed in the central office and located in the circuit of the line between its switch and the subscriber's station—branch wires—one wire branching from each line between its annunciator and the subscriber's station to an insulated piece of its switch—the switch-plug with a flexible cord attached, said plug being adapted, when inserted into a switch, to disconnect the line which belongs to the switch from the ground and to connect the contact-point of the plug to the line through the insulated contact-piece of the switch and branch wire, and not through the annunciator, whereby, by the insertion of the plug into the switch of any line, the line is disconnected from the ground and is connected, through its insulated piece and branch wire, into a circuit in which a flexible cord and its annunciator are switched from the circuit of the line.

7. In a telephone-exchange system, a pair of switch-plugs with their flexible cords normally connected together and with a test-battery in their circuit, in combination with an operator's telephone and a test-key, also in the circuit of the plugs, said key being adapted, on being depressed, to disconnect one cord from the other and from the battery, and to ground that with the operator's telephone in its circuit, substantially as and for the purpose set forth.

8. In a telephone-exchange system, two subscribers' lines, temporarily connected together for conversation with a test-battery and an operator's telephone in their circuit, in combination with a test-key in their circuit between the test-battery and the operator's telephone, said key being adapted, at the will

of the operator, to open said circuit and to ground one of said lines with the operator's telephone in its circuit, substantially as and for the purpose set forth.

5 9. In a telephone-exchange system, a pair of switch-plugs with their flexible cords normally connected together, one of said plugs being assigned for connections with the switches of calling subscribers and the other one for
10 connections with the switches of subscribers wanted, in combination with a test-battery, an operator's telephone and a test-key in the circuit between said plugs, said battery being in the circuit nearest said first-mentioned
15 plug, said telephone being in the circuit nearest the other plug and said test-key having contact-points to open the circuit between said plugs and ground that part of the circuit which is connected with said last-mentioned
20 plug, substantially as set forth.

10. In a telephone-exchange system, the combination with a pair of switch-plugs and their flexible cords of a test-battery, a test-key and a telephone included in series in the
25 circuit between the plugs and operating substantially as set forth, and a calling-key also included in said circuit and adapted, on being depressed, to disconnect the test-battery from the calling-plug and throw in a calling-
30 battery.

11. In a telephone-exchange system, the combination with a pair of switch-plugs and their flexible cords one of said plugs (D') being designed for the switches of calling subscribers, and the other (D) for the switches
35 of subscribers to be called, of a telephone, test-battery, and key included in the circuit between said plugs, and a ground connection O upon which the plug D normally rests.

12. In a telephone-exchange system, multiple switchboards, telephone-lines connected to the boards, said lines being grounded at their outer ends and having normally no battery in their circuit, in combination with
45 switching devices, on the several boards, to temporarily connect any two of said lines together in a closed circuit for conversation, an electric battery in the circuit of the two lines whenever and as long as they are thus
50 connected in closed circuit, test bolts or pieces, one at each board for each line, all the bolts of a line being connected to it when it is switched for conversation on any board, and test receiving instruments one at each board
55 each instrument being grounded on one side and connected to a switch testing device on the other side, whereby the operator at any board may connect to the test-bolt of any line, and determine whether or not the line
60 is in use.

13. In a telephone-exchange system two subscribers' lines, each normally grounded at the central office, an annunciator at the central office located in each line between the
65 line-switches at the central office and the subscriber's station, switch devices for each line by which the lines may be disconnected from

the ground and connected together for conversation, and branch wires through which the lines are connected together, said branch
70 wires being united with the line between their calling-annunciators and the subscribers' stations, in combination with a clearing-out annunciator in the combined circuit of the two connected lines, substantially as set forth. 75

14. In a telephone-exchange system, two subscribers' lines, each normally grounded at the central office, an annunciator at the central office located in each line between the
80 line-switches at the central office and the subscriber's station, and switches for each line whereby they may be disconnected from the ground at the central office and connected together for conversation, in combination with
85 branch wires which unite with the lines between their calling-annunciator and subscriber's station, and through which the lines are connected together when switched for conversation.

15. In a telephone-exchange system, multiple switchboards, a ground-circuit line, a test-terminal for the line on each board permanently connected to the line and adapted to form contact with a contact of a switch-
90 plug when a plug is inserted into the line-switch for switching at its board, two plugs of a pair, one of which is inserted into the switch of the line at its board and the other of which has its contact grounded, an operator's telephone and test-battery, and circuit
95 connections to include them in circuit with each other between the contacts of the two plugs, in combination with test receiving instruments, one at each of the other boards, each grounded on one side and connected on
100 its other side to a test plug or device adapted to be brought for testing into connection with the test-terminal of the line at its board, whereby the line tests busy when and as long as it is connected for conversation with the
105 operator's telephone in circuit with it.

16. In a telephone-exchange, multiple switchboards, and a telephone-line permanently connected to a test-terminal on each
110 of said boards, in combination with test-battery to one side of which said line is connected as long as switched for conversation, the other side of the battery being then connected to ground, and test receiving instruments, one
115 at each board, each connected on one side to ground, and on the other side to a test plug or device adapted to be brought into connection with said test-terminal at its board, substantially as set forth.

17. In a telephone-exchange, multiple switchboards, and a ground-circuit telephone-line permanently connected to a test-terminal
120 on each of said boards, in combination with an operator's telephone switched for conversation in closed circuit with the line, a test-battery to one side of which said line is connected as long as thus switched for conversation, and test receiving instruments, one at
125 each board, each connected on one side to the

other side of said test-battery when the line is thus switched, and on the other side to a test plug or device adapted to be brought into connection with said test-terminal at its board, substantially as set forth.

18. In a telephone - exchange, multiple switchboards, and a telephone-line permanently connected to a test-terminal on each of said boards, in combination with an operator's telephone switched for conversation in closed circuit with the line, a test-battery to one side of which said line is connected as long as thus switched for conversation, the other side of the battery being then connected to ground, and test receiving instruments, one at each board, each connected on one side to ground, and on the other side to a test plug or device adapted to be brought into connection with said test-terminal at its board, substantially as set forth.

19. In a telephone - exchange, multiple switchboards, a subscriber's partly-ground talking circuit or line permanently connected to a test-terminal on each of said boards, in combination with test-battery, to one side of which said line is connected as long as switched for conversation, and test receiving instruments, one at each board, each connected on one side to the other side of said battery and on the other side to a test plug or device adapted to be brought into connection with said test-terminal at its board, substantially as set forth.

In testimony whereof I have hereunto subscribed my name.

MILO G. KELLOGG.

Witnesses:

A. C. OWEN,
FRANCES D. KELLOGG.