

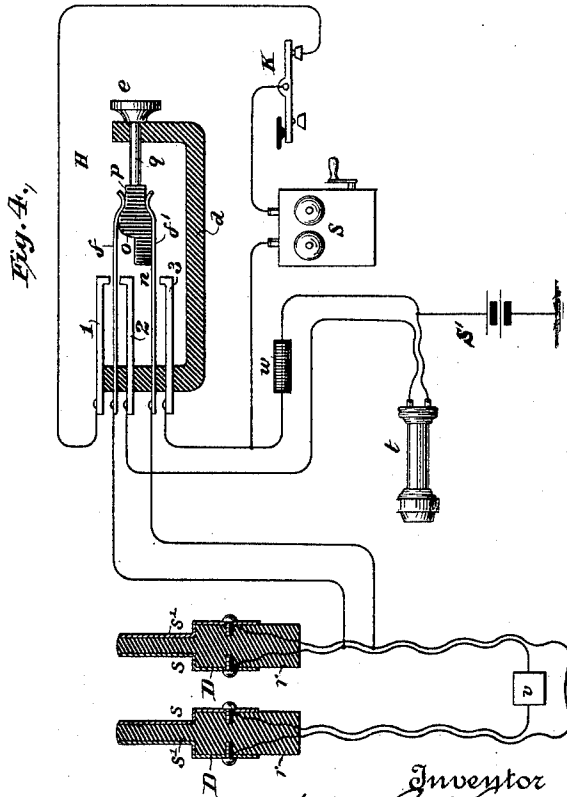
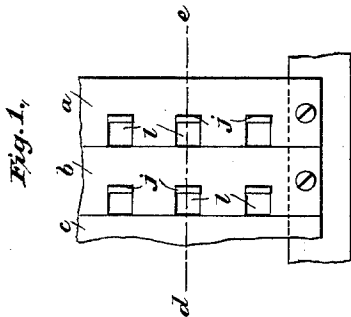
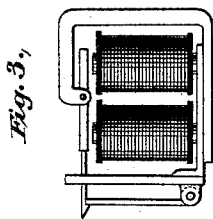
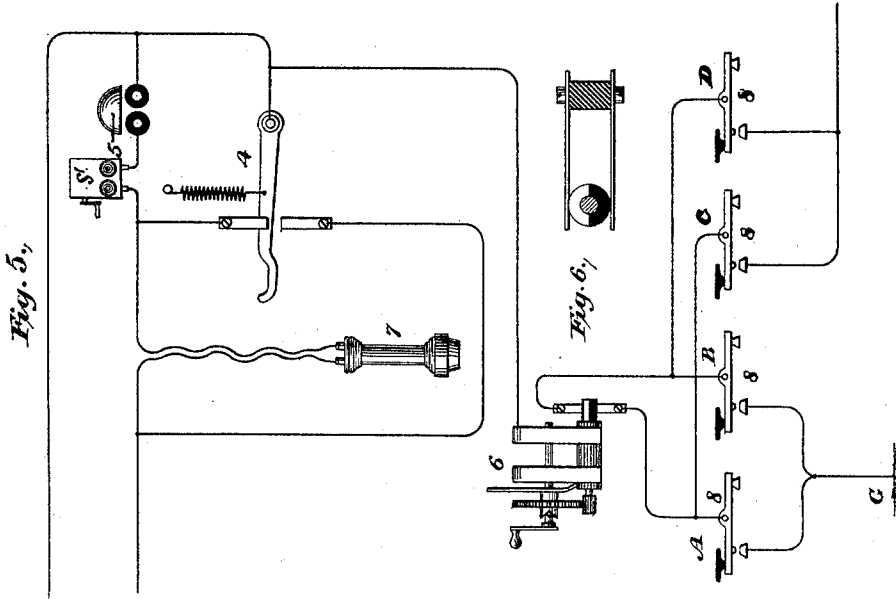
(No Model.)

2 Sheets—Sheet 1.

M. G. KELLOGG. MULTIPLE SWITCHBOARD.

No. 592,363.

Patented Oct. 26, 1897.



Witnesses
Geo. W. Beck
C. E. Ashley

Inventor
Milo G. Kellogg
 By his Attorneys
Bellevue, Davidson & Wright

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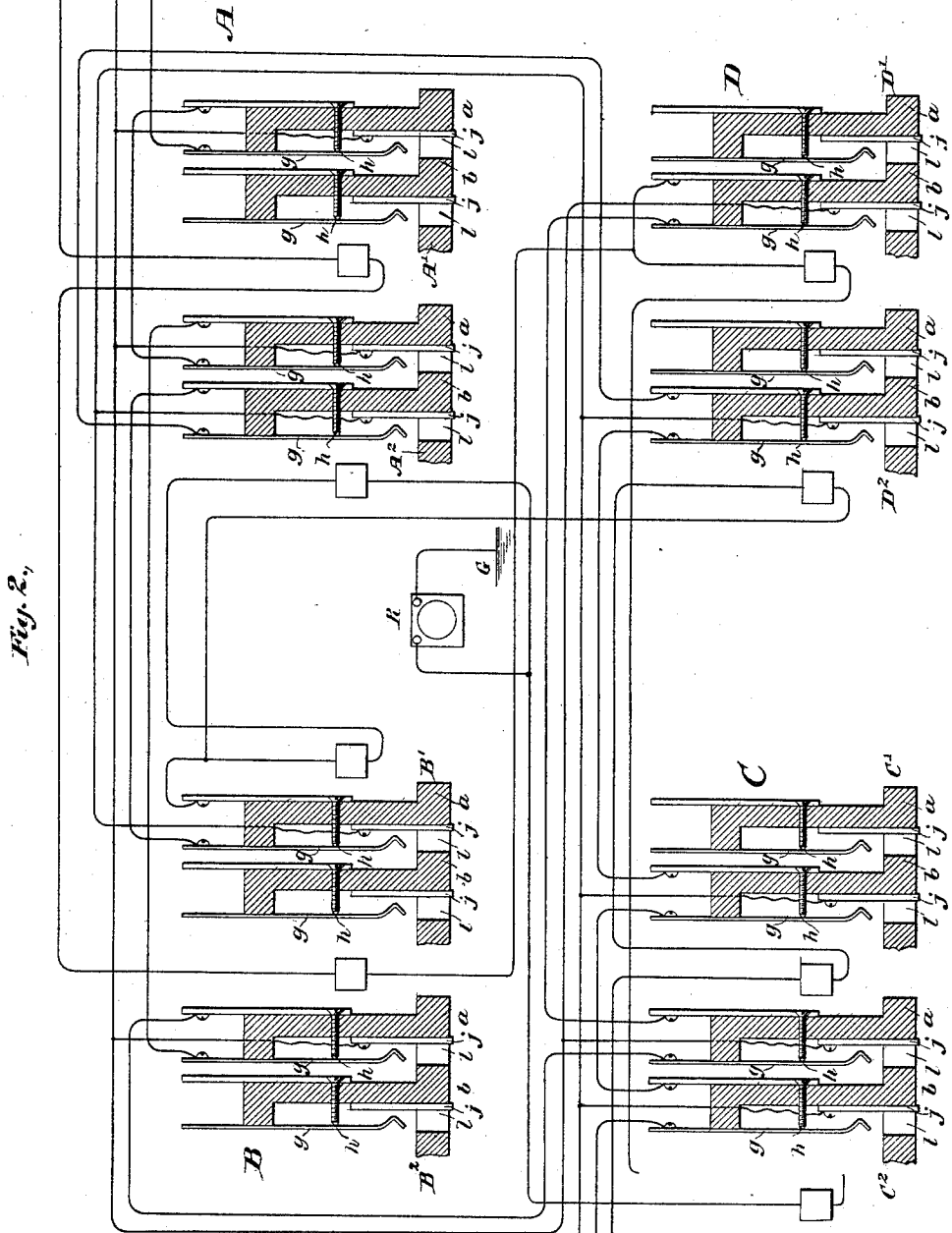


Fig. 2.

Witnesses

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Ralston Davidson & Wright

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. 592,363, dated October 26, 1897.

Application filed March 24, 1890. Serial No. 345,064. (No model.)

To all whom it may concern:

Be it known that I, MILO G. KELLOGG, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful
5 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.
10 My invention is related to the telephone-exchange system described in my Patents No. 424,310, dated March 25, 1890, and No. 427,087, dated May 6, 1890, and also to an application of mine, Serial No. 345,063, filed March 24,
15 1890. It also contains a metallic-circuit system of testing, answering, and switching the various lines of an exchange. In said patents the lines of the exchange are divided into two classes or divisions, and the multiple
20 switchboards of the exchange are also divided into two classes or divisions. On each board of one class is a switching device for each line of one class, and each line of that class has a switching connection on a board of the other
25 class. Each line of the other class has a switching connection on each board of the other class and also on some one board of the first class. In said application, Serial No. 345,063, the lines of the exchange are divided
30 into three or more classes, and the switchboards of the exchange are divided into three or more classes to correspond. Each line of one class has a switching connection on each board of one class of boards and on one board
35 in each of the other classes. Each line of a second class has a switching connection on each board of a second class and on one board in each of the other classes. Each line of a third class has a switching connection on each
40 board of a third class of boards and on one board in each of the other classes. In said application three classes of boards and lines are shown, but other divisions may be made, as therein indicated. In all of said applica-
45 tions the subscribers can at will call to the operator at a switchboard in each class of boards and to one at which his line has a switching connection, and the operators at any board can connect together any two lines
50 which have switching devices at their board

and may test any such line to determine whether or not it is in use.

In the invention which I shall now describe the switchboards are shown as divided into four classes, and the lines are described as divided
55 into four classes to correspond. Each line of one class has a switching connection on each board of its class and on one board of each of the other classes. The subscribers can at will call an operator on a board of each
60 class of-boards and at a board where his line has a switching connection, and the operators at any board can connect any two lines together which have switching connections at their board and test any such line to deter-
65 mine whether or not it is in use.

The invention relates especially to the calling system which I shall describe, whereby the subscribers may at will make their calls
70 to either class of boards. The calling system can be extended in the line shown and as will be indicated, so that the subscribers may at will make their calls to a board in each of six or eight or more classes of boards and the lines be correspondingly divided and con-
75 nected. By such system a very large number of lines can be operated in one telephone-exchange system and the service made as promptly and as satisfactorily to the subscribers as when the exchange consists of but few
80 subscribers.

In the accompanying drawings, illustrating my invention, Figure 1 represents a front view of a section of one of the switchboards.
85 Fig. 2 shows a complete diagram of the main-line central-office apparatus, circuits, and connections of a telephone-exchange system with four classes or divisions of switchboards (designed to accommodate an exchange whose
90 lines are divided into four classes) with two switchboards for each class of boards and two lines, one line for each class A and C of lines. Fig. 3 shows in detail the calling-anunciators used at the central office. Fig. 4
95 shows in diagram an operator's cord system or apparatus to be used with the boards. Fig. 5 shows in diagram a subscriber's-station apparatus to be used at the subscriber's station of each line. Fig. 6 shows an end view of the calling-generator shaft of the sub-
100

scriber's-station apparatus with two commutator-springs, one bearing on each side of the shaft.

G in each case in the drawings represents a ground connection.

In Fig. 2, $A' A^2$ represent the two boards of one class of division of boards; $B' B^2$, the two boards of a second class; $C' C^2$, the two boards of a third class, and $D' D^2$, the two boards of a fourth class. The four classes or divisions of boards are indicated by the letters A, B, C, and D, respectively, to correspond. Each board is indicated as a sectional view of a section of its board, as indicated by the line $d e$ in Fig. 1.

For convenience in designation I call one class of lines "class A," a second class "class B," a third "class C," and a fourth "class D" of lines. Each line of a class is indicated in the catalogue or list and elsewhere by the letter or designation of its class—as, for instance, one line is designated " 32^A ," another " 365^B ," a third " 376^C ," and a fourth " 4^D ."

The peculiar designations of the various classes of boards and lines and of the lines in each class are immaterial, so long as the division is made as indicated and the distinction is kept up.

Each line of class A, for example, has a spring-jack or other suitable switch on each board of class A and on one board of each of the other classes. Each line of class B has a switch on each board of class B and on one board of each of the other classes. Each line of class C has a switch on each board of class C and on one board of each of the other classes. Each line of class D has a switch on each board of class D and on one board of each of the other classes.

Each of the switches, as shown, has a contact-spring which normally bears on a contact-point and is separated from the point while a switch-plug is inserted into the switch, and has also a third or insulated contact-piece insulated from the rest, except by the circuit connections. This third or insulated contact-piece is placed along the switch-hole, so that a test-plug can readily be applied to it for testing and so that one of the contact-pieces of a loop-switch plug inserted into the switch will form connection with it. The switches are adapted to receive the loop-switch plugs shown in Fig. 4, and when a plug is inserted into a switch it raises the contact-spring of the switch from the contact-point on which it normally bears and the two contact-pieces of the plug form connection with the spring and the third or insulated contact-piece of the switch, respectively.

$g g$ are the contact-springs of the switches, $h h$ the contact-points on which the springs normally bear, and $j j$ their third or insulated contact-pieces.

$a b$ are rubber strips, of the shape substantially as shown, on which the metal parts of the switches are mounted and through fronts of which are the switch-holes $l l$. These holes

are rectilinear and are adapted to receive and guide the switch-plugs and cause them to operate the switches, as indicated.

The calling-annunciators shown in Fig. 2 and in greater detail in Fig. 3 are polarized annunciators of known construction. Each annunciator responds or indicates a call when an electric current of one polarity passes through its circuit, but will not respond or indicate when a current of the opposite polarity passes through it.

For each subscriber of the exchange there are four polarized annunciators, one annunciator being located at that board of the section of boards to each of which the line is connected where calls of the line are to be answered, and the other annunciators being located, respectively, one at each of the boards of the other sections of boards where the line-switching devices are located and where the calls of the line are to be answered.

R is an electric rheotome or circuit-breaker, which may be of substantially the form shown or of other forms, by which an electric circuit may be alternately made and broken. In the rheotome shown there may be a gear-movement actuated by a spring, which in its operation alternately makes and breaks the connection between two insulated contact-points.

The metallic-circuit lines are connected to the central-office switchboards and apparatus as follows: One side or branch of a line is connected to all the contact-pieces $j j$ of the switches of the line on the different boards of the exchange and the other side or branch of the line passes normally successively through the pairs of contact-points $g h$ of the line-switches on the different boards of exchange, passing in each case to the spring first. It then passes successively through two of the annunciators of the line, one of which is connected into the circuit, so that it will be actuated by a current of one polarity, and the other of which is so connected into the circuit as to be actuated by a current of opposite polarity. The line is thence connected to one of the contact-points of the rheotome, the other point of the rheotome being connected with the ground.

Each subscriber has also a special calling-wire in addition to his regular or talking line, as above indicated. This special calling-wire is connected at the central office with the subscriber's regular or talking line with the line-annunciators between the connection and the line ground, and it has in its circuit the other two annunciators of the subscriber connected into its circuit, so that one of the annunciators will be actuated by a current of one polarity and the other will be actuated by a current of the opposite polarity passing through their circuit.

In the operator's cord system shown in Fig. 4, $D D$ are a pair of loop-switch plugs adapted to be inserted into the spring-jack switches of the boards, and when a plug is

inserted into a switch it operates it, as heretofore described. The two contact-pieces of each plug are connected to the other apparatus by the two insulated conductors of a double or loop flexible switch-cord. r is the rubber insulation of a plug, and $s s'$ are its two insulated contact-pieces. H is a switching device for the pair of plugs and cords. This switching device has a rubber frame (marked d) which supports and insulates the various parts. $f f'$ are two contact-springs. 1, 2, and 3 are contact-points located and insulated substantially as shown and which form connections with said springs $f f'$, substantially as will be hereinafter described. q is a sliding rod which passes through the frame d . It terminates at one end in a button e , which is placed in a convenient position for the operator to manipulate to draw the rod in and out in order to carry on the intended switching operations. $n o p$ is an irregularly-shaped rubber placed at the end of the rod q . The different sections or divisions of this rubber piece are marked $n o p$, respectively, as indicated in the drawings. The rod q carries in its reciprocating movements the rubber piece $n o p$. These pieces, which move together, may be called the "commutator-piece" of the switching device. All the parts of the switching device are constructed, insulated, mounted, and adjusted to perform the switching operations which I shall now describe. The button e and the piece p furnish shoulders or stops for the commutator-piece, which limit its inward and outward motions. When the commutator-piece is pushed in until the outer stop is against or close to the standard of the frame, the two springs $f f'$ rest on piece p and are insulated from the contact points or pieces 1 2 3. When the commutator-piece is pulled out to its central position, so that the springs rest on piece o , spring f' is in contact with piece 3 and f is in contact with 1. When the piece is pulled still farther out, so that the springs rest on n , f' is still in contact with 3 and f has passed out of contact with 1 and into contact with 2.

k is a two-point key, the points of which are normally in contact, but are open while the operator depresses the key-lever.

t is the operator's telephone; S , her calling-generator; S' , a test-battery. w is a resistance-coil. Each operator has one of each of these parts.

v is a clearing-out annunciator. There is one such annunciator for each pair of cords.

The connections of the operator's cord system are as follows: The two contact-pieces $s s'$ of the pair of plugs are connected together by means of two flexible conductors of the two switch-cords, and the clearing-out annunciator may be placed in their circuit, as shown. The two other contact-pieces of the plugs $s' s$ are connected by the other conductors of the cords. The two cord-circuits which connect said pairs of plug contact-pieces are connected to the springs $f f'$, respectively. Con-

tact-pieces 2 and 3 are connected together through the operator's telephone and resistance-coil, and pieces 1 and 3 are connected together through the operator's calling-generator and the contact-points of her key. The test-battery is grounded on one side and is connected on its other side to the circuit which connects the telephone and piece 3.

Each operator has as many pairs of switch plugs and cords, with their switching devices and clearing-out annunciators, as she may need, and they are connected to her special apparatus, substantially as shown and described. The switch-cords should be long enough so that she can reach with any plug any switch at her board, and the cord apparatus should be conveniently mounted for her work. The commutator-piece of the switching device is placed normally, or when the pair of plugs are not in use for switching, in its outer position, so that the springs rest on piece n .

In the subscriber's-station apparatus shown in Fig. 5, 4 is the telephone-switch, 5 is the signal-receiving bell, 6 is the calling-generator, 7 is the subscriber's telephone, and 8 8 8 8 are four calling-keys. The calling-generator is a usual construction of magneto-generator modified as follows: There is an insulated contact-piece on the armature-shaft which is a half-circle and to which one end of the armature-coil is connected. The remaining part of the circle is an insulation, as shown. There are two stationary contact-springs, as shown, which bear on diametrically opposite parts of that part of the shaft of which the insulated piece is a part and which in the movement of the armature alternately make and break connection with said insulated piece. The levers of two of said calling-keys are connected to one of said contact-springs of the generator, and the levers of the other two keys are connected to said other contact-spring. The contact-points of two of the keys, whose levers are connected to the two contact-springs, respectively, of the calling-generator, are connected to the ground, and those of the two other keys are connected to the special calling-wire of the subscriber. The lever and point of each key are normally open to each other, but are closed to each other while the subscriber presses on the key when he sends in a call.

The subscriber's line is normally open to the ground at his station, but is grounded while he operates either of the two first-mentioned keys. His special calling-wire is normally open to his line at his station, but is connected with the line when he operates either of the other two keys.

When the subscriber's telephone is on its switch, the calling-generator is in the circuit of the line, with the armature-coil between said insulated contact-piece on the shaft and the normal ground connection of the line at the central office.

It is well known that when the magneto

calling-generators are operated a current of one polarity is generated during one half of the revolution of the armature and a current of the opposite polarity is generated during the other half of the revolution. It is evident, therefore, that a subscriber may by closing the contact of one of the calling-keys which has its contact-point connected to the ground send a current of one polarity through the circuit from the ground established to the office ground of the line, and that by closing the contact of the other key whose contact-point is connected with the ground he may send a current of the other polarity to the circuit, and that as the two annunciators are connected into this circuit, so as to operate by currents of opposite polarity, he may at will cause either one to indicate a call. It is also evident that when he operates one of the other keys he establishes a circuit which includes the special calling-wire of the subscriber and its two annunciators and the calling-generator and that branch of his line which is normally grounded at the central office, and on operating the generator and pressing on one of the keys one of the annunciators in his special calling-wire will be operated, and that by pressing on the other key and operating the generator the last annunciator will also be operated. The subscriber can, therefore, by pressing on the lever of one or other of his four calling-keys cause at will any of his annunciators at the central office to indicate a call.

I prefer to designate and mark the four keys A, B, C, and D, respectively, to correspond with the classes of boards at which are located the annunciators they operate, respectively.

The operation of the system is as follows: When a subscriber wishes to call for any other subscriber, he finds out from the exchange-list the number and designation of the line wanted. If the line wanted belongs to class A of lines, he presses on key A and operates his generator; if to class B, he presses on key B; if to class C, he presses on key C; if to class D, he presses on key D, each time operating the generator. He thereby calls the operator located at the board where both he and the subscriber wanted have a line-switch. The operator on observing the indication places one plug of a pair of her switch-plugs in his switch, and her telephone is thereby included in a closed circuit of the subscriber's line, and she can by conversation find out what line is wanted. The circuit is completed by the cords of the plugs used, the contact-springs $f f$ of the switching device of the cords, and the contact-pieces 2 3, which are connected to the two sides of the telephone. When the operator finds out what line is wanted, she tests it by placing the contact-piece s of the other plug of the pair on the third or insulated contact-piece of its switch. If the line tested is not switched at any board, a test-circuit is complete from the ground

through the test-battery and operator's telephone to the line, through the circuit of the line and the pairs of contact-points of its switches on the several boards, and thence to ground through the rheotome, and the operator will distinguish in her telephone the make and break of a rheotome in the circuit and know that the line is not switched. She then places the plug in the switch tested, and both lines, then disconnected from their ground connection through the rheotome, are connected into a metallic circuit, and this circuit is bridged at the central office by a circuit which contains the telephone and resistance-coil. She then pushes the commutator-piece of the switching device, so that the springs rest on piece o , when spring f' is still in contact with contact-point 3 and spring f is in contact with point 1. A bridge to the metallic circuit is thereby established which contains the calling-generator, and a calling-current will pass in split current to both lines and operate the signal-bell of the subscriber wanted. The operator then presses the commutator-piece, so that the springs rest on p and the two lines are in metallic circuit, which is not bridged by the telephone or generator and with which neither of them are connected.

If at any time the operator desires to listen to the circuit of the lines to determine whether conversation is finished, she presses on her key k , so as to open its contacts, and while the key is in that position pulls the commutator-piece of the switching device to the position where the springs rest on points 2 and 3. The metallic circuit is thus bridged by her telephone and resistance-coil and she can hear any conversation which may be passing through the circuit. The resistance-coil prevents an undue amount of any telephone-current from passing through the telephone, and the use of the key is to prevent a generator-current from passing to the metallic circuit while the springs are passing over the piece o .

In this application I use the expressions "bridge" and "cross-connect" with reference to a metallic circuit to describe a connection from one side or branch of the circuit to the other side or branch of the circuit, and an instrument in a bridge or cross-connecting circuit is not in the direct metallic circuit, but is in a circuit which bridges across the two sides or branches of the metallic circuit.

If when the test was made as described the line had been switched at any board, the circuit to the rheotome would have been open at the pair of contact-points of the switch used and the operator would not have distinguished the make and break of a rheotome and would thereby know that the line was already switched for use.

The operator at any board can only test the lines of the exchange which have their switching connections located at her board. She has no need to test any of the other lines.

More than one special calling-wire for each line of the exchange may be employed in very large exchanges, each calling-wire being equipped with annunciators and keys and connected to the other circuits, as described for the calling-wires shown, and the switchboards and lines of the exchange may be divided into as many classes as there are annunciators for each line, provided with switches, and connected to the various boards, substantially as indicated for the classes and boards herein described.

The special calling-wires may be connected (provided with switches and annunciators) in other ways from that herein described, so as to perform practically the same operation in providing calls for different classes of boards. They may be used in connection with single-circuit as well as in connection with metallic-circuit systems and serve in providing calls where the lines and boards are divided and operated in several classes, in the manner indicated above.

To operate the clearing-out annunciator *v*, a generator *s'* may be placed at the subscriber's station in the circuit connection containing the bell *5*, or suitable switch devices may be provided, whereby the generator *6* may be looped into the metallic circuit of two connected lines to send the clearing-out signal.

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

1. In a telephone-exchange system, the combination of telephone-lines divided into four classes, the switchboards divided into four classes, one class of boards for each class of lines, each line having a switch on each board of its class and on one board of each of the other classes, special calling-wires, one for each line and extending from the line-station to the central office, polarized annunciators, four for each line, two connected in opposite polarity in the line-circuit and two connected in opposite polarity in its calling-wire, one annunciator being located in each class of boards at a board where the line has a switch, electrical apparatus and switching connections at each subscriber's station by which he may at will send a current of either polarity to either his line-circuit or his special calling-wire circuit, and connecting apparatus at each board by which the operator may at will connect together any two lines which have their switches at her board, substantially as set forth.

2. In a telephone-exchange system, the combination of telephone-lines divided into four classes, the switchboards divided into four classes, one class of boards for each class of lines, each line connected to all the boards of its class and to one board of each of the other classes, special calling-wires, one for each line and extending from the line-station to the central office, polarized annunciators, four for each line, two connected in opposite polarity in the line-circuit and two connected in opposite polarity in its calling-wire, one

annunciator being located in each class of boards at a board where the line has a switch, electrical apparatus and switching connections at each subscriber's station by which he may send at will a current of either polarity to either his line-circuit or his special calling-circuit, and connecting apparatus at each board by which the operator may at will connect together any two lines which are connected to her board, substantially as set forth.

3. In a telephone-exchange system, the combination of telephone-lines divided into two classes, switchboards divided into two classes, one class of boards for each class of lines, switches for the lines, one switch for each line on each board of its class and on one board of the other class, an annunciator in the circuit of a line located at a board of one class of boards where the line has a switch, a special calling-wire for said line extending from the central office to the subscriber's station, an annunciator in said special calling-wire located at a board of the other class of boards where the line has a switch, electric calling apparatus whereby the subscriber may at will operate either of said annunciators, and connecting apparatus whereby the operator at any board where said line has a switch may connect the line with any lines which have their switches at her board, substantially as set forth.

4. In a telephone-exchange system, the combination of telephone-lines divided into three classes, switchboards divided into three classes, one class of boards for each class of lines, switches for the lines, one switch for each line on each board of its class and on one board of the other classes, two polarized annunciators connected in opposite polarity in the circuit of a line located at a board of each of two classes of boards where the line has a switch, a special calling-wire for said line extending from the central office to the subscriber's station an annunciator in said special calling-wire located at a board of the other class of boards where the line has a switch, electric calling apparatus whereby the subscriber may at will operate either of said annunciators and connecting apparatus whereby the operator at any board where said line has a switch may connect it with any lines which have their switches at her board, substantially as set forth.

5. In a telephone-exchange system, the combination of telephone-lines divided into three classes, switchboards divided into three classes, one class of boards for each class of lines, switches for the lines, one switch for each line on each board of its class and on one board of each of the other classes, an annunciator in the circuit of a line located at a board of one class of boards where the line has a switch, a special calling-wire for said line extending from the central office to the subscriber's station, two polarized annunciators connected in opposite polarity in said special calling-wire located at a board of each

of the other classes of boards where the line has a switch, electric calling apparatus whereby the subscriber may at will operate either of said annunciators, and connecting apparatus whereby the operator at any board where said line has a switch may connect the line with any lines which have their switches at her board, substantially as set forth.

6. In a telephone-exchange system, the combination of a telephone-line normally grounded at the central office, two polarized annunciators connected in the circuit of the line in opposite polarity, a special calling-wire extending from the subscriber's station to the central office and connected to said telephone-line with the said annunciators between said connection, and the normal ground connection of the line, two polarized annunciators connected in opposite polarity in the circuit of said wire, a calling-generator at the subscriber's station, and switch and commutator apparatus and connections by which the subscriber may at will send a current of either polarity through a ground-circuit from his ground to the central-office ground of his line or a current of either polarity through a metallic circuit composed of his line and his special calling-wire, substantially as set forth.

7. In a telephone-exchange system, the combination of telephone-lines divided into four classes, the switchboards divided into the same number of classes, one class of boards for each class of lines each line having a switch connection on each board of its class and on one board of each of the other classes, one of said telephone-lines normally grounded at the central office, two polarized annunciators connected in the circuit of the line in opposite polarity, a special calling-wire extending from the subscriber's station to the central office connected to said telephone-line with said annunciators between said connection and the normal ground connection of the line two polarized annunciators connected in opposite polarity in the calling-wire, said four annunciators being located at boards in the four classes where the line has a switching connection, a calling-generator and switch and commutator apparatus and connections by which the subscriber may at will send a current of either polarity through a ground-circuit from his ground to the central-office ground of his line or a current of either polarity through a metallic circuit composed of his line and his special calling-wire, substantially as set forth.

8. In a telephone-exchange system, the combination of a telephone-line normally grounded at the central office, an annunciator in the circuit of the line at the central office, a special calling-wire extending from the subscriber's station to the central office and connected to said line with said annunciator between said connection and said normal ground connection, an annunciator at the central office in said special calling-wire, a calling-gen-

erator at the subscriber's station and switch and commutator apparatus and connections by which the subscriber may at will send a calling-current from his ground through the line to the normal ground of the line at the central office or through a metallic circuit which includes the line and said special calling-wire, substantially as set forth.

9. In a telephone-exchange system, the combination of a telephone-line normally grounded at the central office, two polarized annunciators connected in opposite polarity in the circuit of the line at the central office, a special calling-wire extending from the subscriber's station to the central office and connected to said line with said annunciator between said connection and said normal ground connection, an annunciator at the central office in said special calling-wire, a calling-generator at the subscriber's station, and switch and commutator apparatus and connections by which the subscriber may at will send a calling-current of either polarity from his ground through the line to the normal ground of the line at the central office or a current through a metallic circuit which includes the line and said special calling-wire, substantially as set forth.

10. In a telephone-exchange system, the combination of a telephone-line normally grounded at the central office, two polarized annunciators connected in opposite polarity in the circuit of the line at the central office, a special calling-wire extending from the subscriber's station to the central office and connected to said line with said annunciators between said connection and said normal ground connection, an annunciator at the central office in said special calling-wire, a calling-generator at the subscriber's station and switch and commutator apparatus and connections by which the subscriber may at will send a calling-current from his ground through the line to the normal ground of the line at the central office, or a calling-current of either polarity, through a metallic circuit which includes the line and said special calling-wire, substantially as set forth.

11. In a telephone-exchange system, the combination of telephone-lines normally grounded at the central office and divided into two classes, switchboards divided into two classes, one class of boards for each class of lines, switches for the lines, one switch for each line on each board of its class and on one board of the other classes, an annunciator at the central office in the circuit of a line, a special calling-wire for the line extending from the subscriber's station to the central office and connected to the line with the annunciator between such connection and such normal ground connection, an annunciator in said special calling-wire at the central office, a calling-generator at the subscriber's station, and switch and commutator apparatus and connections by which the subscriber may at will send a calling-current from his

ground through the line to the normal ground of the line at the central office, or through a metallic circuit which includes the line and said special calling-wire, substantially as set forth.

12. In a telephone-exchange system, the combination of telephone-lines normally grounded at the central office and divided into three classes, switchboards divided into three classes, one class of boards for each class of lines, switches for the lines, one switch for each line on each board of its class, and on one board of each of the other classes, two polarized annunciators connected in opposite polarity at the central office in the circuit of the line, a special calling-wire for the line extending from the subscriber's station to the central office and connected to the line with the annunciators between such connection and such normal ground connection, an annunciator in said special calling-wire at the central office, a calling-generator at the subscriber's station; and switch and commutator apparatus and connections by which the subscriber may at will send a calling-current of either polarity from the ground through the line to the normal ground of the line at the central office, or a calling-current through a metallic circuit which includes the line and said special calling-wire, substantially as set forth.

13. In a telephone-exchange system, the combination of telephone-lines normally grounded at the central office and divided into three classes, switchboards divided into three classes, one class of boards for each class of lines, switches for the lines, one switch for each line on each board of its class, and on one board of each of the other classes an annunciator at the central office in the circuit of a line, a special calling-wire for the line extending from the subscriber's station to the central office and connected to the line with the annunciator between such connection and such normal ground connection, two polarized annunciators connected in opposite polarity in said special calling-wire at the central office, a calling-generator at the subscriber's station, and switch and commutator apparatus and connections by which the subscriber may at will send a calling-current from his ground through the line to the normal ground of the line at the central office or

a current of either polarity through a metallic circuit which includes the line and said special calling-wire, substantially as set forth.

14. In a telephone-exchange system, a telephone-line normally disconnected from the ground at the subscriber's station, another line or circuit connection normally open at the subscriber's station to the telephone-line, a calling-generator at the subscriber's station one side of the armature-coil of which is connected to said telephone-line and the other side of the coil of which is connected to a commutator-piece on the armature-shaft, two commutator-springs bearing alternately on said commutator-piece as the armature revolves, and four keys by which the subscriber may at will connect either of said springs with the ground or with said other line or circuit connection, substantially as set forth.

15. In a telephone-exchange system, a telephone-line, a ground connection and another circuit connection at the subscriber's station, a calling-generator at the subscriber's station one side of the armature-coil of which is connected to said line and the other side of the coil of which is connected to a commutator-piece on the armature-shaft, two commutator-springs bearing alternately on said commutator-piece as the armature revolves and switching devices by which the subscriber may at will connect either of said springs with either the ground connection or said other circuit connection, substantially as set forth.

16. In a telephone-exchange system, a telephone-line and two circuit connections at the subscriber's station, a calling-generator at the subscriber's station, one side of the armature-coil of which is connected to said line and the other side to a commutator-piece on the armature-shaft, two commutator-springs bearing alternately on said commutator-piece as the armature revolves, and switching devices by which the subscriber may at will connect either of said springs with either of said circuit connections, substantially as set forth.

In witness whereof I hereunto subscribe my name this 7th day of March, 1890.

MILO G. KELLOGG.

Witnesses:

R. J. PRESTON,
E. P. MACLEAN.