

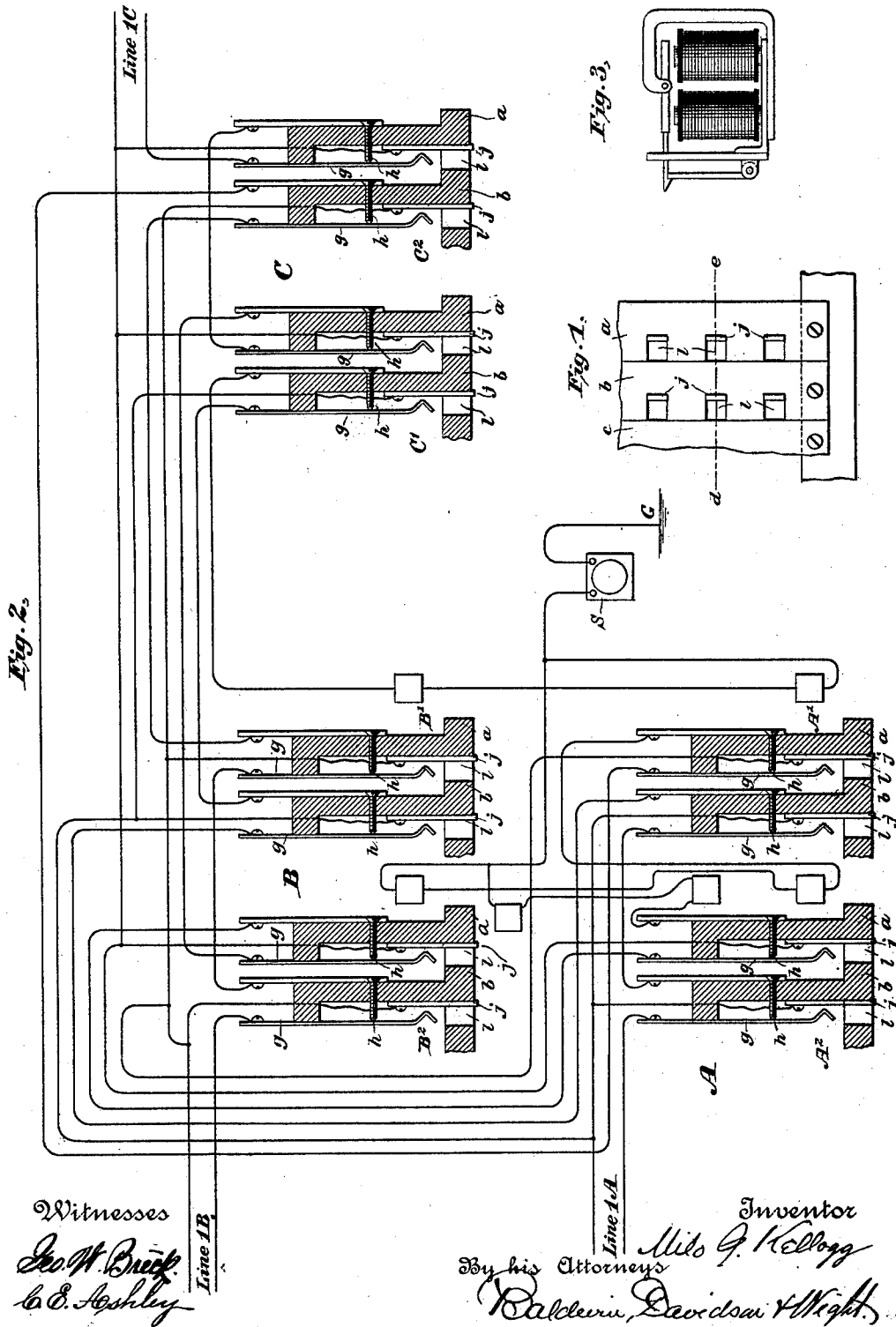
(No Model.)

2 Sheets—Sheet 1.

M. G. KELLOGG.
MULTIPLE SWITCHBOARD.

No. 592,362.

Patented Oct. 26, 1897.



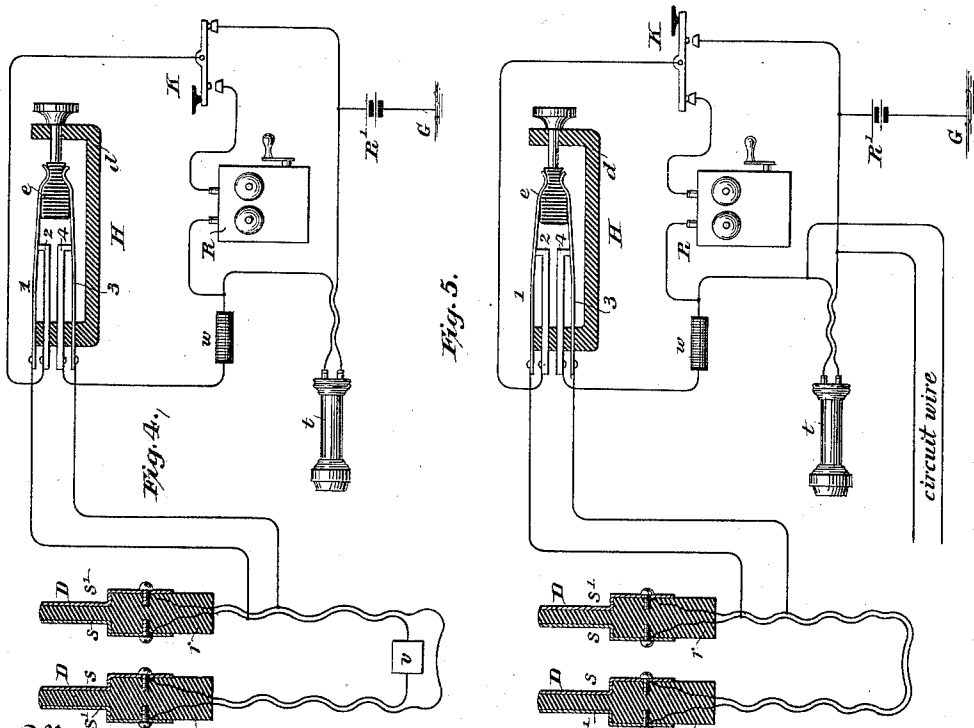
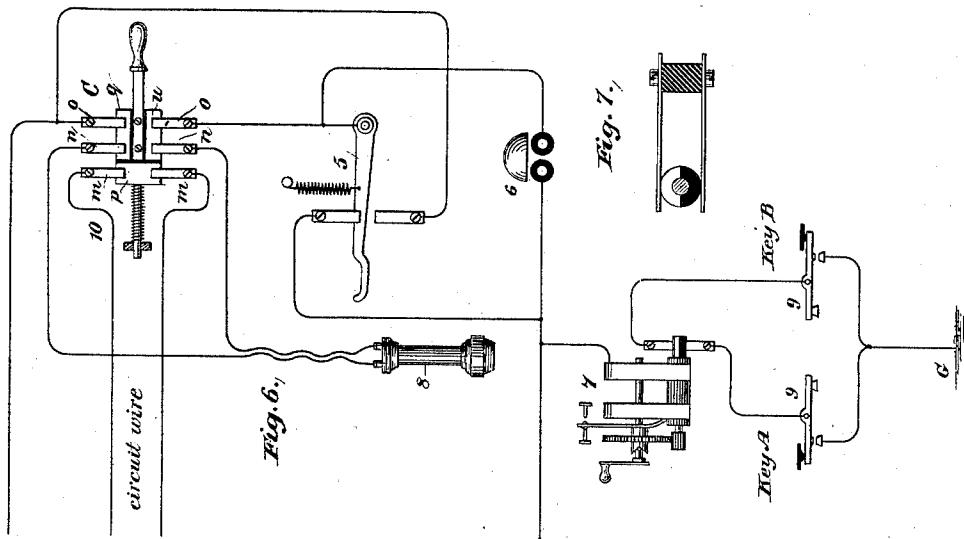
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2 Sheets—Sheet 2.

M. G. KELLOGG.
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No. 592,362.

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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. 592,362, dated October 26, 1897.

Application filed March 24, 1890. Serial No. 345,063. (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 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 especially to the telephone-exchange systems described in my Patents No. 424,310, dated March 25, 1890, and No. 427,087, dated May 6, 1890.

It also relates to a metallic-circuit system of telephone-exchanges and a system of testing, answering, and switching the various lines of such an exchange.

In said patents the lines of the exchange and the subscribers are divided into two classes or divisions, and the multiple switchboards of the exchange are also divided into two classes or divisions. On each board of one class or division of the boards there is a spring-jack switch or other switching connection for each of the lines of one of the classes, and each line has a switch or switching connection on one of the boards of the other class. Each subscriber can at will call to an operator at a board of either class or division and can request a connection with any line which is connected to all the boards of the operator's class. The operator can then switch or connect the subscriber's line with the line with which connection is requested. The advantages derived from the use of said system are set forth in said patents. The principal advantages are that it reduces, by approximately one-half, the number of spring-jack switches and the cost of the central-office switchboards for a given number of lines, and that as compared with other systems it doubles the number of lines which can be operated in one exchange. It may be approximately stated that with the other systems from ten to twelve thousand subscribers are all that can be conveniently served in one exchange, and that with ten thousand subscribers there would be ten thousand switches on each board of the exchange; also, that in the system described in my former patents from twenty to twenty-five thousand lines can be

conveniently operated in one exchange, and that with an exchange of ten thousand lines there would be required but five thousand switches on each board of the exchange.

It is now apparent that even a greater number of lines than twenty-five thousand could in the larger cities of the world be consolidated in one exchange if apparatus could be obtained at not too great an expense by which that number of lines could be economically and promptly served in one exchange. The invention herein described is designed to accomplish this result. Operating with the apparatus herein shown and described I estimate that as many as forty thousand subscribers can easily be operated in one exchange, and the average number of switches required are about one for each line for every three boards of the exchange instead of one for every two boards, as in my other system, and one for every board as is usually employed. I do not, however, limit myself to the organization by which these results are accomplished. The system can be still further developed, as I shall hereinafter point out, by which a still greater number of subscribers can be operated in one exchange and the apparatus required for each line in proportion to the number of boards used be still further decreased.

In carrying out the general feature of my invention I divide the subscribers' lines which center in an exchange into several classes or divisions, and I divide the multiple switchboards of the exchange into the same number of classes or divisions. The classes of lines I designate, for convenience, "Class A," "Class B," "Class C," &c. The lines which belong to "Class A" I designate "Line 1^A," "Line 2^A," &c. The lines which belong to "Class B" are designated "Line 1^B," "Line 2^B," &c. The lines which belong to the other classes are similarly designated. The switchboards which belong to one class are called "Section A," or "Division A," or "Class A." Those which belong to another class are designated "Section B," or "Division B," or "Class B." The other classes or divisions of the boards are similarly designated "Class C," &c. The names or designations of the various classes of lines and boards are imma-

terial so long as the division exists and is used as hereinafter indicated.

On each board of one class of boards—say class A—I place a switch for each line of one class of lines—say class A—and I place a switch for said line on one board of each of the other classes of boards. On each board of a second class of boards I place a switch for each line of a second class of lines, and I place a switch for said line on one board of each of the other classes of boards. On each board of a third class of boards I place a switch for each line of a third class of lines, and I place a switch for said line on one board of each of the other classes of boards. In a similar way would each line of a fourth class of lines be connected to a switch on each board of a fourth class of boards and on one board of each of the other classes of boards. If there were still further divisions of boards and lines, the connections would be made similar to that indicated for the other classes.

The operator or operators at each board have operators' answering and switching apparatus by which they can answer any calls received by them and connect together for conversation the lines of any two subscribers who have line-switches located on their board.

There is calling apparatus for each line, by which the subscriber can at will call an operator at a board in each section or class of boards, the board in each class being one at which a switch of the line is located. The calling apparatus and the switches of the lines in the various classes of boards will preferably be distributed in approximately equal numbers on the boards.

My invention as a whole is applicable to the various systems of lines, both metallic and single-circuit, and to the various systems of switching and testing which may be employed in a multiple-switchboard system. The system which I have shown in the drawings and which I shall now describe in detail is a metallic-circuit telephone-exchange system, certain features of which are new with me and will be herein claimed.

For each operator I provide test apparatus and connections by which, in connection with the line system and apparatus described, she may make a test for any line which has its switches located at her board and determine whether or not the line is in use. It is evident that she need not have testing apparatus for the other lines of the exchange, as she will never have occasion to switch to them.

In the accompanying drawings, illustrating my invention, Figure 1 represents a front view of a section of one of the multiple switchboards of the exchange. Fig. 2 shows a complete diagram of the main-line central-office apparatus, circuits, and connections of a telephone-exchange system, with three classes or divisions of switchboards, (designed to accommodate an exchange whose lines are divided into three classes,) with two switchboards for each class of boards and three lines, one line

for each class of lines. Fig. 3 shows in detail, the calling-annunciators used at the central office. Fig. 4 shows in diagram an operator's cord system or apparatus to be used with the switchboards of two of the classes or divisions of boards, as hereinafter indicated. Fig. 5 shows in diagram an operator's cord system and apparatus to be used with the switchboards of the other class, as will hereinafter be indicated. Fig. 6 shows in diagram a subscriber's station apparatus to be used at the subscriber's station of each line of the exchange. Fig. 7 shows an end view of the calling-generator shaft of the subscriber's station apparatus, with two commutator-springs, one bearing on each side of the shaft.

In the drawings like parts and apparatus are indicated by the same letters and figures of reference.

G in each case represents a ground connection.

In Fig. 2 $A^1 A^2$ represent the two boards of one class or division, $B^1 B^2$ the two boards of a second class or division, and $C^1 C^2$ the two boards of the third class or division. The three classes or divisions of boards are indicated by the letters A, B, and C, respectively, to correspond with the similar indications on the individual boards, as above indicated. Each board is indicated by a sectional view of a section of the board, as indicated by the line $d e$ in Fig. 1.

The two sides or branches of one of the metallic-circuit lines are indicated by the mark line 1^A . This line belongs to class A of lines. The two sides or branches of another line are marked line 1^B . This line belongs to class B of lines. The two sides or branches of the third line are marked line 1^C , and this line belongs to the class C of lines.

Each line of class A of lines has a spring-jack or other suitable switch on each switchboard of class A of boards and on one switchboard in each of the other classes of boards. Each line of class B has a switch on each board of class B of boards and on one switchboard of each of the other classes of boards. Each line of class C has a switch on each board of class C of boards and on one board of each of the other classes of boards.

Each switch has a contact-spring which normally connects with a contact-point and is separated from the contact-point while a switch-plug is inserted into the switch, and it has also a third or insulated contact-piece insulated from the other parts except by the circuit connections. This third or insulated contact-piece is placed along the surface of the switch-hole and so that a plug can be readily applied to it for testing and that one of the contact-pieces of a loop-switch plug will form connection with it when the plug is inserted into the switch. The switches are adapted to receive the switch-plugs shown in Figs. 4 and 5, and when a plug is inserted into a switch it raises the contact-spring of the switch from the contact-point of the switch

on which it normally rests 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* the third or insulated contact-pieces of the switches.

a b are rubber strips of the shape substantially as shown on which the metal parts of the switches are mounted and through the 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 its circuit.

Each line of the exchange has two polarized annunciators, one annunciator being located at a board of one of the classes of boards—say class A—and the other annunciator being located at a board of another class of boards—say class B. By the use of these annunciators, in connection with the subscriber's station apparatus and the circuit, as will hereinafter be indicated, any subscriber of the exchange may at will call an operator located at either of the two classes of boards. By means of the apparatus which I shall hereinafter describe he may also at will call an operator located at a board of the third class of boards.

The calling-annunciators of each line are located at boards where its spring-jack switches are located.

S is an electric rheotome or circuit-breaker which may be substantially of the form shown or of other forms by which an electric circuit may be alternately made and broken. In the rheotome shown there is a 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 switchboards and apparatus as follows: One side or branch of the 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 contact-points *g h* of said switches, passing in each case to the spring *g* first. It then passes successively through the two annunciators of the line and is then connected to a ground wire or connection which contains the contact-points of the rheotome between the connection and the ground. The two annunciators of a line are so connected into the line-circuit that one of them only will be operated to indicate a call when a current of one polarity

passes through them and the other one will indicate a call when a current of the opposite polarity passes through them.

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 on the boards, and when a plug is inserted into a switch to operate the switch 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 the two insulated contact-pieces. *H* is a switching device for the pair of plugs and cords. This switching device has a supporting-piece (marked *d*,) a commutator or movable piece of non-conducting material, (marked *e*,) and four contact-pieces insulated from each other, except by the circuit connections and contacts, as will hereinafter be pointed out. These pieces are marked 1, 2, 3, and 4, respectively. 1 and 3 are flexible or spring contact-pieces. The others may be rigid. The commutator-piece is adapted, at the will of the operator, to occupy two positions—its normal and inner position, as shown in the figure, and an outer position in which it may be placed by the operator while he leaves two subscribers connected together through the instrumentality of the pair of plugs and cords. When the commutator-piece is in inner and normal position, contact-pieces 1 and 2 are in contact and pieces 3 and 4 are also in contact, as shown in the figure. When the commutator-piece is placed in its other position, the contact between 1 and 2 and between 3 and 4, respectively, is broken.

v is a clearing-out annunciator for the pair of cords. *t* is the telephone; *R*, the calling-generator; *K*, the calling-key; *w*, a resistance-coil, and *R'* a test-battery for the operator who uses the pair of plugs and its apparatus. Each operator has one of each of said operator's parts and as many pairs of plugs and cords with their switching devices and clearing-out annunciators as she may require.

The operator's calling-key is a three-point key, having a lever which normally presses against one contact-point and which may be depressed by the operator away from said contact-point and into contact with another point.

The connections of the operator's cord system shown in Fig. 4 are as shown and as follows: The contact-pieces *s s* of the two plugs are connected together through an insulated conductor of each of the cords, as shown, and the clearing-out annunciator is placed in the circuit connecting them, as shown. The other contact-pieces of the plugs *s' s'* are connected together through the other conductors of the cords. The cord-circuit connecting the pieces *s s* is connected to contact-piece 1 of the switching device, and the cord-circuit connecting *s' s'* is connected to contact-piece 3 of the device. One side of the telephone is

connected through the resistance-coil to contact-piece 4 of the device, and the other side of the telephone is connected with that contact-piece of the key which is normally in contact with the lever and also with the ground through the test-battery. The calling battery or generator is connected on one side to the other contact-point of the key and on the other side to the first-mentioned side of the telephone, preferably between the telephone and the resistance-coil. The lever of the key is connected with contact-piece 2 of the switching device.

In the operator's cord system shown in Fig. 5 there are the same parts as in Fig. 4, and they are similarly illustrated and indicated. The clearing-out annunciator, however, is not shown and is not required, and the connections are different from those in Fig. 4. The connections are as follows: The contact-pieces *s s* and the contact-pieces *s' s'*, respectively, are connected together through the conductors of the double flexible cords, as in Fig. 4. The cord-circuits connecting the contact-pieces of the plugs are connected to the contact-pieces 1 and 3 of the switching device, as in Fig. 4. One side of the operator's telephone is connected to contact-piece 4 of the switching device and the other side of the telephone is connected to that contact-point of the key which is normally out of contact with the key-lever and also to the ground through the test-battery. The resistance-coil is connected in the circuit between the telephone and contact-piece 4. One side of the calling-generator is connected to the circuit-wire which connects the telephone and the resistance-coil and the other side of the generator is connected to contact-point of the key which is normally in contact with the lever. The key-lever is connected with contact-piece 2 of the switching device.

Only one pair of cords and plugs with their special apparatus is shown in the operator's cord systems in Figs. 4 and 5. The connection of other pairs, as may be required by the operator, will be apparent to those skilled in the art.

Special calling-circuits similar to those in the Law telephone system are connected to all the subscribers' stations of the exchange, and these circuits are distributed among the operators who are located at the class of boards which are not provided with the calling-annunciators, as heretofore indicated. The operator's cord system shown in Fig. 5 is designed for use at the boards of this class—say class C. The two sides of the calling-circuit assigned to one of the operators of this class are connected to the two sides of her telephone. The connection of this circuit is indicated in Fig. 5, and the two wires of the circuit are marked "circuit-wire." In the subscribers'-station apparatus shown in Fig. 6, 5 is the telephone-switch. 6 is the signal-receiving bell. 7 is the calling-generator. 8 is the telephone. 9 9 are two calling-keys. 10

is a looping-in switch. 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 spring contact-pieces, 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 connection with said insulated piece. The lever of one of the calling-keys is connected to one of said contact-springs of the generator and the lever of the other key is connected to the other spring of the generator. The contact-points of keys are connected to the ground.

The keys are open-circuit keys and the contacts are normally open, but closed by an operator when he presses on the lever.

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

The line is normally open to the ground at the subscriber's station, but is grounded there while the subscriber operates either of said calling-keys.

It is well known that when the magnetogenerators 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 of the armature. It is evident, therefore, that a subscriber may by closing the contact in one of said calling-keys send a current of one polarity through the circuit from the ground established to the office ground of the line, and that he may by closing the contact in the other key send a current of the opposite polarity through the circuit.

As the two annunciators of the line are connected normally in such circuit and are so connected as to be operated by currents of opposite polarity, it follows that the subscriber may at will by operating his generator and pressing on one or the other of the keys operate one or another of the annunciators, and thereby call an operator on a switchboard of either of the two classes of boards in which his annunciators are located. As heretofore described, one of the classes of boards is designated "Class A" and the other class of boards "Class B." I prefer to have the key which is operated to operate the annunciator located in class A of boards marked A or designated "Key A" and to have the other key marked B or designated "Key B."

10 in Fig. 6 indicates the usual hand-switch, employed for shifting the telephone in a subscriber's station from his private line to a call or signal wire, so as to permit him to

speak to the central-office operator and notify him of the connection desired. The switch contains a reciprocating block carrying three conducting-plates *p q u*, insulated from one another. Upon plate *p* rests a pair of springs *m m*, which complete the circuit for the call-wire, while upon plates *q u*, respectively, rest pairs of springs *n n*, *o o*, the first pair being connected, as indicated, to the two sides of the subscriber's telephone and the other pair being connected to the two sides of the subscriber's line, as indicated. The reciprocating block with its parts is held normally in the position shown, and in that position the calling-wire is complete through the subscriber's station and the telephone there is not in said calling-wire and is in the circuit of the subscriber's private line. The telephone is in that condition shunted by a wire of small resistance when the telephone is on its switch, and the shunt is removed by the operation of the switch when the telephone is taken off. When the subscriber pushes the reciprocating block so that contact-springs *m m* are out of contact with plate *p* and are in contact with plates *q u*, respectively, and said plates *q u* are out of contact with springs *o o*, the telephone is disconnected from the subscriber's private line and is looped into the circuit of the calling-wire which goes to the subscriber's station.

There should be as many calling wires or circuits as there are operators located at the class of boards, to which the calling-wires connect, as heretofore indicated—say at class C of boards. Each calling-circuit will pass and be connected, as described, to as many subscribers' stations as its operator is assigned to answer, the calls of which belong to her class of boards. In each case the calling wire or circuit which connects with any subscriber's station is connected with the operator's system, which is located at a board where a switch of the subscriber's individual line is located. Each subscriber's station of the exchange system is connected substantially as indicated to one of the calling-circuits which pass to the central office. As the switch 10 is used, as described, when a subscriber desires to call to a board of class C of boards to ask for a connection with some line among class C of lines I prefer to have the switch marked or designated C.

It will be noted that each subscriber's station has apparatus to operate at will its line-annunciators in either division of boards A or B and has also apparatus for looping its telephone into the circuit-wire, which is connected with an operator at division C of boards. Therefore, each subscriber can at will call an operator at either division A, B, or C.

The two keys which are designated A and B and said switch designated C will be conveniently mounted in the subscriber's-station apparatus, so that he can conveniently reach them. They may show as push but-

tons or knobs placed in a line on the front of the apparatus and their respective letters or indications may be engraved on the front of the knobs or indicated at one side of them.

In the exchange catalogue or list a subscriber's name will be indicated by a designation which will show to what class of lines his line belongs. For instance, the designation for one subscriber opposite his name will be "135A," that of another subscriber "28B," and that of another "2306C."

The operation of the system is as follows: When a subscriber wishes to talk with any other subscriber of the exchange, he finds out from the list the number and designation of the line wanted. If the line wanted is in class A of lines, he presses on key A at his station and operates his generator. This causes his annunciator located in class A of boards to indicate a call. If the line wanted is in class B of lines, he presses on his key B and operates his generator, and his annunciator located in class B of boards indicates his call. If the line wanted is in class C, he presses on his key C and, taking his telephone from its switch, talks through the special calling-circuit to his operator located at class C of boards. When a call is indicated by an annunciator of class A or B of boards, the operator at the board takes one switch-plug of a pair and places it in the switch of the line which has made the call. By so doing the line has been disconnected from the ground connection through the rheotome and the two sides or branches of the line are connected together through a circuit which contains the operator's telephone and resistance-coil. She then finds out by conversation what line is wanted and then tests the line wanted by placing the contact-piece *s'* of the other plug of the pair on the third or insulated contact-piece of the switch of the line. If the line tests "free," she places the plug with which she made the test into the switch, and by so doing disconnects this line also from the ground connection through the rheotome. The two lines are then in a metallic circuit which is bridged or cross-connected at the central office by a circuit which contains the operator's telephone and resistance-coil. She thereupon presses on her calling-key, and by so doing switches her telephone out and her calling-generator into said bridge or cross-circuit, and a calling-current goes in split circuit to both subscribers' lines. The bell of the subscriber wanted is thereby rung. The operator then moves the piece *e* of the switching device of the pair of cords used from its normal to its other position, and the bridge or cross-connection of the metallic circuit is open. This is done through the opening of the pairs of contact-points 1 2 and 3 4. Should the operator desire to listen into the circuit to determine whether the subscribers are through conversation, she moves the piece *e* of the switching device of the cords to its normal position and the bridge or

cross-connection containing her telephone is again established.

When an operator located at class C of boards receives an order for a connection with a certain line, she places a switch-plug of one of her pairs of plugs in the switch of the line wanting the call and with the contact-piece S' of the other plug of the pair tests the line wanted by placing it on the third or insulated contact-piece of the line. If the line tests "free," she places the plug in the switch. The two lines are then disconnected from their ground connection through the rheotome and are connected into a metallic circuit which is bridged or cross-connected by a circuit which contains her calling-generator. A calling-current thereby passes in split circuit to both lines, and the bell of the subscriber wanted is rung. The operator then removes the piece e of the switching device of the pair of cords used from its normal position to its other position. The bridge or cross-connection is thereby opened by the opening of the pairs of contact-points 1 2 and 3 4, and the subscriber's bell stops ringing. Should the operator desire to listen into the circuit to determine whether the subscribers are through conversation, she presses down on the lever of her key k, and while the key is in that position places the piece e of the switching device of the pair of cords used in its normal position. A bridge connection is thereby established which contains the operator's telephone, and she can hear any conversation which is passing over the circuit.

In each of the cases described above where an operator establishes a bridge connection when she listens to the circuit of a pair of subscribers' lines connected together her resistance-coil is also included in the bridge-circuit. This prevents an undue amount of any telephone-current from passing through her telephone.

When an operator at either of the classes of boards tests any line as heretofore described and the line is not switched at any board of the exchange and is thereby connected with the ground through the rheotome, a complete circuit, which contains her telephone and test-battery and the rheotome, is established as follows: from the ground through the battery and telephone to the tip of the plug used in testing, thence through the circuit of the line and the several pairs of its switch contact-points on the boards, and thence through the rheotome to the ground. The operator will then distinguish in her telephone that the circuit is being alternately made and broken and therefore that the line is still in connection with the rheotome and is not switched. If when the test is made the line is switched at any board, such test-circuit will be open at the pair of contact-points of the switch used in switching, and the operator, not distinguishing the operation of the rheotome, will know that the line is already switched.

In this application I use the expression

"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.

The system herein described is subject to still further development, so as to serve a still greater number of subscribers in one exchange.

The subscribers' lines and the switchboards may be divided into four or more classes, with a switch for each line on each board of one class and one board of each of the other classes in a manner like that herein indicated and calling apparatus provided by which any subscriber may at will call to his board in each class of boards. If one more division is made than that herein shown, a second calling-circuit system may be established from the subscribers' stations to the switchboards of the fourth class. If still greater divisions are desired and made, other calling-circuits may be established, so that any subscriber may, at will, call to any of the class of boards. Moreover other systems of calling may be employed than those herein described whereby any subscriber may, at will, in the operation of this system as described and indicated, make his call indicated on the several classes of boards which may be established.

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

1. In a telephone-exchange system, the combination of the telephone-lines divided into three classes, the switchboards divided into three classes, switches, one switch for each line of one class on each board of one class and on one board of each of the other classes, one switch for each line of a second class on each board of a second class and on one board of each of the other classes and one switch for each line of the third class on each board of the third class and on one board of each of the other classes, talking-circuits connected to all the subscribers' stations and to the boards of one class whereby any subscriber may transmit his orders to that class of the boards and connecting apparatus whereby the operators at that class of boards may connect together any two lines, substantially as set forth.

2. In a telephone-exchange system, the combination of telephone-lines divided into three classes, the switchboards divided into three classes, switches, one switch for each line of one class on each board of one class and on one board of each of the other classes, one switch for each line of a second class on each board of a second class and on one board of each of the other classes, one switch for each line of the third class on each board of the third class and on one board of each of the other classes, annunciators for said lines, two

for each line located in the line and so constructed and connected that the subscriber can at will operate either, one located in one class and the other in another class of boards, special talking-circuits connected to all the subscribers' stations and to the boards of the third class whereby any subscriber may transmit his orders to that class of boards, and connecting apparatus whereby the operator at any board may connect together any two lines which have their switches at her board, substantially as set forth.

3. In a telephone-exchange system the combination of telephone-lines divided into three classes, the switchboards divided into three classes, one class of boards for each class of lines, each line being connected to all the boards of its class and to one of the boards of each of the other classes, line-annunciators two for each line, so constructed and connected that the subscriber can at will operate either, one located at a board of one class where the line is connected and the other at a board of the other class where the line is connected, special talking-circuits connected to all the subscribers' stations and to the boards of the third class whereby any subscriber may transmit his orders to a board of that class to which his line is connected, and connecting apparatus whereby the operator at any board may connect together any two lines which are connected to her board substantially as set forth.

4. 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 each line located at a board in one class of boards where the line has a switch, electric calling apparatus whereby the subscriber may at will operate said annunciator, special calling-circuits connected to all the subscribers' stations whereby any subscriber of one class may send his call to a board of the other class where his line has a switch, and connecting apparatus whereby the operator at any board may connect together any two 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 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 each line located at a board in one class of boards where the line has a switch, electric calling apparatus whereby the subscriber may at will operate said annunciator, special talking-circuits connected to all the subscribers' stations whereby any subscriber of one class may transmit his orders to a board of the other class where his line has a switch,

and connecting apparatus whereby the operator at any board may connect together any two lines which have their switches at her board, substantially as set forth.

6. In a telephone-exchange system, a metallic-circuit line, one side or branch of which is normally grounded at the central office and the other side or branch of which is normally open at the central office, in combination with a subscriber's calling-generator, and ground-contacts, and two polarized annunciators connected in opposite polarity in said first-mentioned side or branch of the line, pole-changing switch apparatus, and connections by which the subscriber may at will send a current of either polarity from his ground connection through the circuit of said first-mentioned side or branch of the line to its ground connection at the central office to operate either of said annunciators, substantially as set forth.

7. In a telephone-exchange system, a metallic-circuit line, normally open to the ground at the subscriber's station, one side or branch of which is normally grounded at the central office and the other side or branch of which is normally open at the central office, in combination with a subscriber's calling-generator, and ground-contacts, and two polarized annunciators connected in opposite polarity in said first-mentioned side or branch of the line, pole-changing switch apparatus, and connections by which the subscriber may at will send a current of either polarity from his ground connection through the circuit of said first-mentioned side or branch of the line to its ground connection at the central office to operate either of said annunciators, substantially as set forth.

8. In a telephone-exchange system, a metallic-circuit line, one side or branch of which is normally grounded at the central office, and the other side or branch of which is normally open at the central office, in combination with a subscriber's calling-generator, a commutator-piece on the armature-shaft, two commutator-springs bearing alternately on said commutator-piece as the armature revolves, a ground connection for said line passing through the armature-coil to said commutator-piece, and alternately through said commutator-springs into two derived circuits connected respectively to the springs, and switch apparatus whereby the operator may at will close either of said derived circuits, and two polarized annunciators connected in opposite polarity in said normally-grounded side or branch of the line, substantially as set forth.

9. In a telephone-exchange system, a metallic-circuit line, normally disconnected from the ground at the subscriber's station, one side or branch of which is normally grounded at the central office, and the other side or branch of which is normally open at the central office, in combination with a subscriber's calling-generator, a commutator-piece on the armature-shaft, two commutator-springs

bearing alternately on said commutator-piece as the armature revolves, a ground connection for said line passing through the armature-coil to said commutator-piece, and alternately through said commutator-springs into two derived circuits connected respectively to the springs, and switch apparatus whereby the operator may at will close either of said derived circuits, and two polarized annunciators connected in opposite polarity in said normally-grounded side or branch of the line, substantially as set forth.

10. In a telephone-exchange system, a metallic-circuit line, one side or branch of which is normally grounded at the central office, and the other side or branch of which is normally open at the central office, in combination with a subscriber's calling-generator, a commutator-piece on the armature-shaft, two commutator-springs bearing alternately on said commutator-piece as the armature revolves, a ground connection for said line passing through the armature-coil to said commutator-piece, and alternately through said commutator-springs into two derived circuits connected respectively to the springs, and switch apparatus, whereby the operator may at will ground the line through either of said derived circuits, and two polarized annunciators connected in opposite polarity in said normally-grounded side or branch of the line, substantially as set forth.

11. In a telephone-exchange system, the combination of a metallic-circuit line, one of whose sides or branches is normally grounded at the central office the other side or branch being normally open at the central office, and two polarized annunciators connected in opposite polarity in said normally-grounded side or branch of the line, a calling-generator and commutator and switch apparatus and

connections by which the subscriber may at will send a current of either polarity through a circuit composed of said normally-grounded side or branch of the line and ground, substantially as set forth.

12. In a telephone-exchange system, a pair of loop-switch plugs, the two contact-pieces of one of which are connected to the two contact-pieces, respectively, of the other by flexible conductors, in combination with an operator's telephone, a special calling or talking circuit extending from the central office to one or more subscribers' stations and in which the telephone is connected, a bridge-circuit in which the telephone is connected, said bridge-circuit being normally connected on its two sides to the two cord-circuits, respectively, which connect the contact-pieces of the plugs, and a switching device by which the operator may at will disconnect the telephone from said cord-circuits, substantially as set forth.

13. In a telephone-exchange system, a pair of loop-switch plugs, the two contact-pieces of one of which are respectively connected to the two contact-pieces of the other by flexible conductors, in combination with an operator's telephone, a bridge-circuit between said flexible conductors in which is the telephone, a special talking or calling circuit extending from the central office to one or more subscribers' stations and which also includes the telephone, and a switching device by which the operator may at will open or close said bridge-circuit, 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.