(No Model.) 2 Sheets—Sheet 1.

M. G. KELLOGG.

MULTIPLE SWITCH BOARD.

No. 424,310. Patented Mar. 25, 1890.

Fig. 1a'.

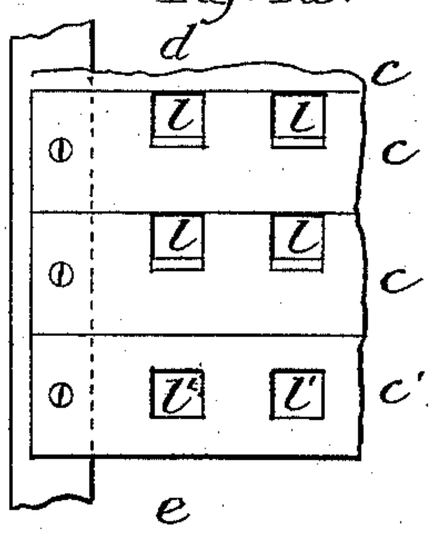


Fig. 1a².

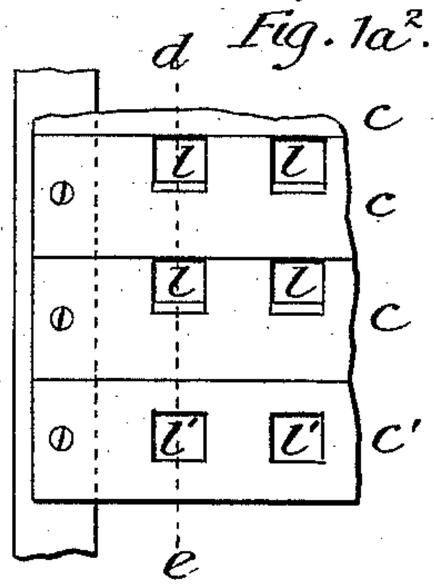


Fig. 1b'.

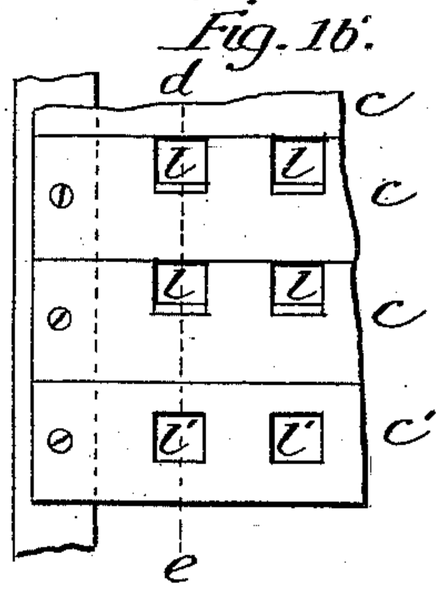
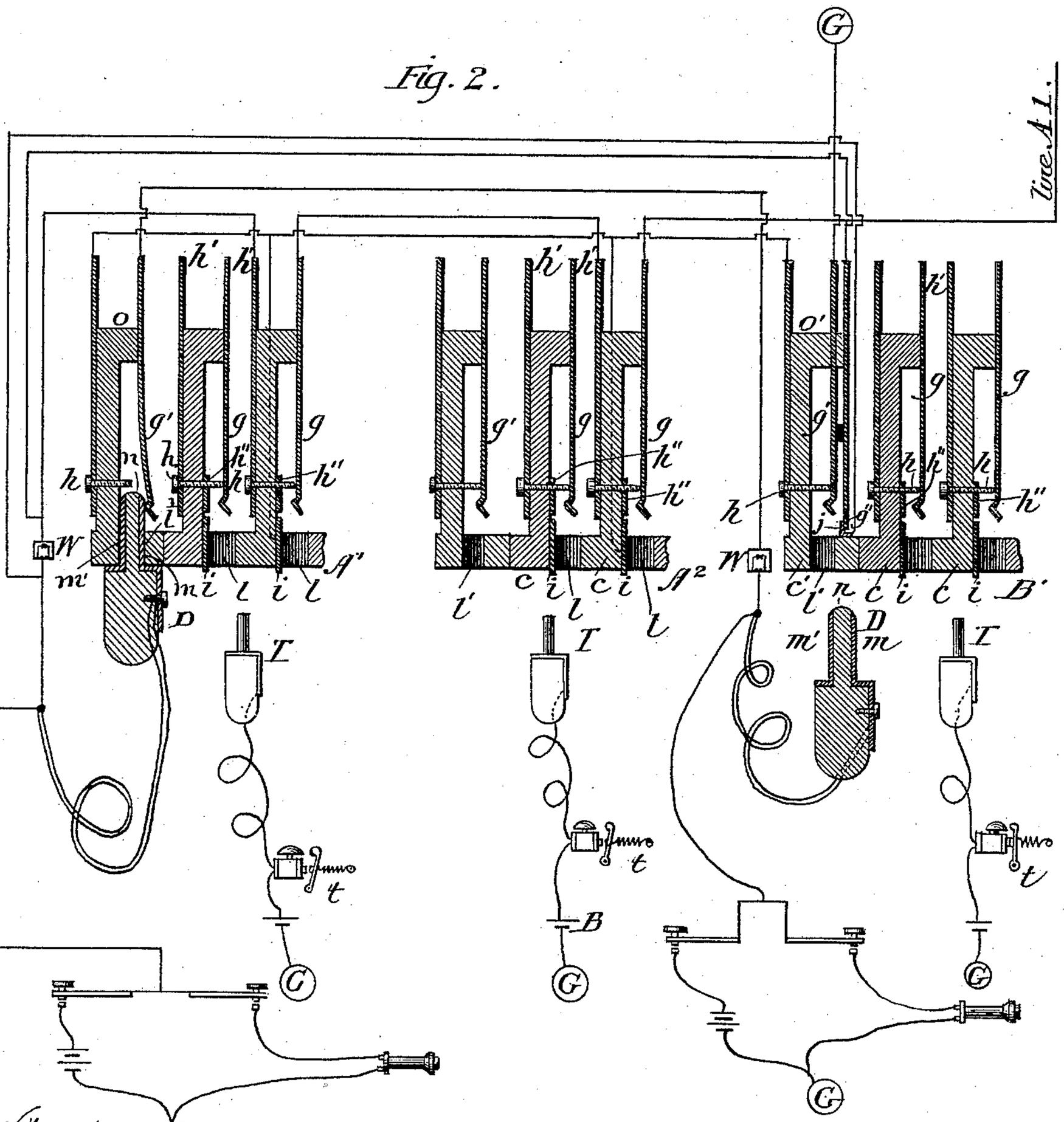


Fig. 2.



Witnesses:
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Milton Head

Inventor:
Milo G. Kellogg

(No Model.)

2 Sheets—Sheet 2.

M. G. KELLOGG.

MULTIPLE SWITCH BOARD.

No. 424,310. Patented Mar. 25, 1890.

Fig. 4.

Fig. 6.

Fig. 3.

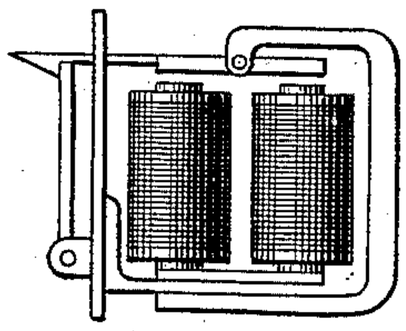
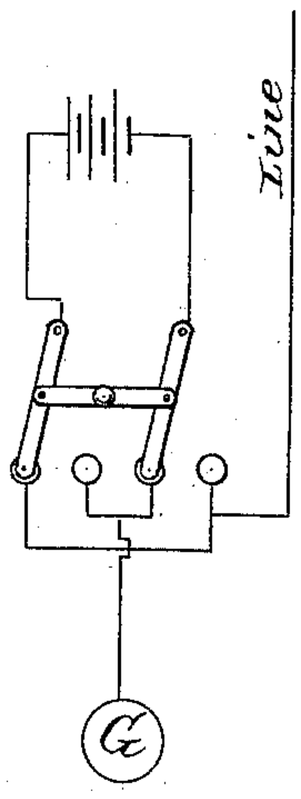


Fig. 5.



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Witnesses:
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UNITED STATES PATENT OFFICE.

MILO G. KELLOGG, OF HYDE PARK, ILLINOIS.

MULTIPLE SWITCH-BOARD.

SPECIFICATION forming part of Letters Patent No. 424,310, dated March 25, 1890.

Application filed December 8, 1887. Serial No. 257,317. (No model.)

To all whom it may concern:

Be it known that I, MILO G. KELLOGG, of Hyde Park, Illinois, have invented certain new and useful Improvements in Multiple Switch-Boards 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.

It is well known that multiple switch-board systems and apparatus as at present constructed and arranged become very expensive per line or subscriber where a very large number of subscribers' lines are operated in one multiple switch-board exchange. In these systems there is now provided one switch-board for about every one hundred and fifty subscribers' lines. The number of boards required may be more or less, according to the rapidity of the system used, the expertness of the operators, and the average use which subscribers make of their telephone-lines. On each board, as the multiple systems are at present organized and worked, there is one spring-jack or similar switch for each subscriber's line which belongs to the exchange. It is therefore evident that, as the number of boards used in an exchange is increased as the number of subscribers' lines is increased, the number of switches for each line is correspondingly increased, and consequently the cost of the switches for a line is correspondingly increased. The number of switches used in an exchange of five thousand subscribers' lines will be four times the number of switches used in an exchange of twenty-five hundred subscribers' lines, and the number used in an exchange of ten thousand lines will be four times as great as the number used in an exchange of five thousand lines and sixteen times as great as the number used in an exchange of twenty-five hundred lines. Where more lines are used, the number of switches used per line will increase in like ratio. The number of lines which can be operated in one multiple switch-board exchange is, moreover, limited by the number of the spring-jack or similar switches which may be grouped on one board within convenient reach of an operator. It may be stated, approximately, that as the systems are at present constructed the number of lines which can be operated in one exchange is limited to about ten thousand. It is evident that in the large business centers the number of subscribers of the exchange will reach and exceed this number if apparatus is devised and employed which will provide quick and satisfactory service to all, and the charges can be made reasonable by keeping within reasonable limits the cost of the plant and the service.

In my improvement in multiple switch-boards, which I shall now describe, I reduce by one-half the number of spring-jack switches which are required at each board, and at the same time I practically retain all the advantages which have heretofore been obtained in the multiple switch-board systems employed. I therefore reduce approximately by one-half the cost of spring-jack or switch apparatus required for a given number of lines, and double the number of lines which can be successfully operated at one exchange.

In carrying out my invention I divide the subscribers' lines which center at an exchange into two divisions or classes, which, for convenience, I designate "Class A" and "Class B." The lines which belong to Class A, I will designate "Line A′," "Line A^2," &c., or "A′," "A^2," &c. The lines which belong to Class B, I will designate "Line B′," "Line B^2," &c., or "B′," "B^2," &c. The switch-boards at the exchange I also divide into two divisions. Those boards which belong to one division I will designate as "Section A," and those which belong to the other division I will designate as "Section B."

On each board of Section A, I place a spring-jack or similar switch for each line of Class A, and on each board of Section B, I place a similar switch for each line of Class B. These switches are intended to be used when the line to which the switch belongs is asked for at the board where the switch is located. The line asked for is to be connected to the line which asks for the connection by means of a switch-plug or other suitable switching device connected to the line which asks for the connection.

On one of the boards of each of the two sections I place for each line of the exchange a signal-receiving instrument, whereby the operator at the board may know that the subscriber which belongs to the line has signaled

her, and switching apparatus whereby she may connect her telephone with his line may connect the line for conversation with any line belonging to her class by means of the switch of the line called for and the plug connected to the line which asks for the connection, and may signal to the line called for, receive clearing-out signals, &c. On each board I also provide test circuits and apparatus whereby the operator may know whether any line which belongs to the class to which her board belongs is switched for conversation at any other board of the exchange. When the signal has come to her from a line, she does not need to test that line, as the fact that the subscriber has called shows her that the line is not in use at another board. She needs testing apparatus only to test the lines which may be called for at her board, and consequently only for the lines which belong to her class.

I would divide the lines into approximately two equal classes. It is evident that with the organization I have described approximately only one-half the switches and only one-half the testing apparatus will be required for each line which is required in the usual organization.

The signal receiving and switching apparatus heretofore mentioned as provided for each line on two boards of the exchange, one board of each section, may be conveniently distributed among the several boards. I prefer to have the subscriber's signal apparatus and the signal-receiving apparatus of his line at the two boards so constructed and placed with reference to each other that the subscriber may signal to either board at will without attracting the attention of the operator at the other board.

My invention as a whole is applicable to the various systems of lines and of testing which may be employed in multiple switch-board systems. The systems of lines and testing which I have shown in the drawings, and which I will now describe in detail, are a system of single-circuit lines, normally grounded at the central office, and a system of testing which now seems to me, all things considered, the most applicable for such lines.

In the drawings, Figures $1^{a'}$, 1^{a2}, and $1^{b'}$ represent front views of sections of three multiple switch-boards of an exchange, Figs. $1^{a'}$ and 1^{a2} representing boards belonging to Section A of the exchange and Fig. $1^{b'}$ representing a board belonging to Section B of the exchange. Fig. 2 shows a complete diagram of the boards, with all the central-office apparatus, circuits, and connections necessary to illustrate my invention. Fig. 3 shows in detail the calling-annunciators used in the central office. Fig. 4 shows in diagram the subscriber's station apparatus. Fig. 5 shows a modification of the subscriber's signaling apparatus. Fig. 6 is an end view of the generator-shaft at the subscriber's station, with two contact-springs, bearing one on each side of the shaft, and of the insulated contact-piece of the shaft.

In the drawings like parts and apparatus are indicated by the same letters of reference. G in each case represents the ground-connection.

In Fig. 2, A′ is a sectional view of the switch-board shown in Fig. $1^{a'}$, A^2 is a sectional view of the switch-board shown in Fig. 1^{a2}, and B′ is a sectional view of the switch-board shown in Fig. $1^{b'}$, each as indicated by the line *d e*.

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

l l are the rectilinear holes through the fronts and at the edges of the strips adapted to receive the switch-plugs. The contact-springs *g g* are mounted to the rear of and are parallel to the holes *l l* to which they belong, as shown. The contact-points *h h*, on which the contact-springs or spring-levers *g g* normally bear, pass through the rubber strips, as shown. The contact-points have each a connecting-piece *h′*, and also a contact-piece or extension *h″*, as shown, along to the front of the point and along the lower face of the hole. Toward the front of the switch-holes and along their lower faces I place the contact-pieces *i i*, as shown. These pieces come in proximity with but do not touch the contact-pieces *h″*, and extend far enough to the front of their respective holes, so that test-plugs may be applied to them. The switch-plugs are substantially as shown and as will hereinafter be described.

The several parts mentioned above are so made, shaped, arranged, and adjusted that when a switch-plug is inserted into a switch-hole it raises the spring-lever in the rear of the hole from the contact-point on which it normally bears, and the flexible cord of the plug is connected with the spring-lever, while the contact-point and the contact-piece *i* are electrically connected through the medium of the piece *m′* of the switch-plug, which then touches both *i* and *h″* of the switch.

Each section of the rubber strip, with its spring-lever, contact-point, contact-pieces, and the hole, all arranged and operating as above and 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. The holes may be of any convenient shape adapted to the shape and arrangement of the parts used.

Spring-jack switches are provided and distributed among the different boards of the exchange, as heretofore indicated.

The calling-annunciators or signal-receiving instruments located at the central office, one for each line in each of the two sections of the exchange, are marked *w* in the drawings, and those which are shown are located

at the boards where the calls of the lines are to be answered. The annunciators are polarized annunciators, and their construction is shown in greater detail in Fig. 3. Each of these annunciators responds or indicates when one polarity of current passes over its line, and does not respond when the other polarity passes over the line. The two annunciators of any given line, one in each section of boards, are so constructed and connected into the circuit of their line that one of them will respond to one polarity of current and the other will respond to the other polarity.

In order to carry out the operation of the exchange system, I provide for each line at each board where its calls are to be answered a switch-plug with flexible cord adapted to be inserted into the spring-jack switches at the board where it is located. These plugs are marked D.

m m are the metal pieces of the plugs, adapted to come into contact with and move the spring-levers *g g* of the switches into which they are inserted and connect them with the cords of the plugs. *m' m'* are contact-pieces of the plugs, adapted to be in contact with the pieces *h''* and *i* of a switch when the plug is inserted and connect them together.

n n are the rubber insulations of the plugs.

I also provide for each line at each board where its calls are to be answered a switching device in which the plug of the line at that board is normally placed, and which completes the circuit of the line to the ground when the plug is in its normal position, and which disconnects the line from the ground when the plug is withdrawn and at the same time closes a test-connection which forms a part of the general test system of the line and of the exchange. One of these switching devices of a line (that one which, when the line is connected through to ground, is nearest the ground-connection) may also have contact-points which will shunt or switch the annunciator of the line in the other section from the circuit when the plug is withdrawn from the device. The reason for this will appear hereinafter. *o o'*, &c., represent these devices, *o'* being the device which has the contact-points last mentioned. In these devices *g' g'* represent contact-springs, with which the metal pieces *m* of the plugs are normally in contact, and *h h* represent contact-points on which the springs *g' g'* rest when the plugs are withdrawn.

In the devices, *o' g''* represent a second spring insulated from the other, and which comes in contact with the insulated piece *j* when the plug is withdrawn from the device, but is otherwise disconnected from it.

In the diagram of the subscriber's station apparatus shown in Fig. 4, 1 is the telephone-switch, 2 is the signal-receiving bell, 3 is the calling-generator, 4 is the operator's telephone, and *k k'* are two calling-keys. The generator is constructed with the usual automatic device, whereby it is shunted or switched from the line-circuit while not operated. The insulated contact-piece on the shaft of the armature, to which is connected one end of the armature-wire, and which conducts the generated current to line through the stationary spring contact (or contacts) provided for it is a half-circle, the remaining part of the circle being an insulation. I provide two stationary spring contact-pieces 5 5, as shown, each bearing on the diametrically-opposite part of the circle of the shaft of which said insulated contact-piece is a part. Into the circuit with each of said springs is the calling-key *k* or *k'*. These keys are normally open, as shown. The circuits from the two springs, after passing through their respective keys, unite, as shown. The circuit of the line while the generator is being operated is through the wire of the armature to its insulated contact-piece, and then through whichever of the calling-keys is depressed or closed. If neither key is closed, the circuit is open and no current goes to line.

It is well known that when magneto-generators are operated a current of one polarity is generated during one half of the revolution of the armature and a current of the other polarity is generated during the other half of the revolution of the armature. It is evident, therefore, that the subscriber may at will send currents of either polarity to his line by depressing either one or the other of his calling-keys when he operates his generator. When his line is provided with two calling-annunciators which respond to currents of opposite polarity and are located at two different boards, as heretofore indicated, he can therefore at will call the operator at either board and not disturb the other operator.

Various other arrangements may be employed whereby the subscriber may at will signal to either operator without disturbing the other. In Fig. 5 is shown an electric battery for signaling, with a pole-changing switch whereby the subscriber may send currents of either polarity to line.

It is preferable to use a signal-receiving bell at the subscriber's station, which will respond to either polarity of current. By having such a bell the subscriber can tell whether or not he has sent a signaling-current over his line. This will be a reminder should he forget to press one of the keys while signaling.

At each board of the exchange I place a test-receiving instrument in a normally-open circuit grounded at one end or connected to the common ground-connections of the lines, and connected at the other end to a test-plug with a flexible cord adapted to be brought into connection at the will of the operator with any of the contact-pieces *i i* at her board. In the circuit between the test-plug, on the one hand, and the contact-pieces *i i* at her board, on the other hand, I place a test-

battery. The test-receiving instruments may be the ordinary hand-telephones.

In Fig. 2 *t t* represent the test-receiving instruments. T T represent the test-plugs, and B B represent the test-batteries.

In the drawings I have illustrated the central-office apparatus and circuits necessary to connect the operator's telephones and calling-generators into the various line-circuits. Well-known apparatus and methods of connection may be employed for this purpose.

I have represented the main line and test-connections for one line only, and that for a line which belongs to what I have designated "Class A." From this the connections of the other lines of the exchange, as also the connections to all the boards of the exchange which may be employed, will be apparent to those skilled in the art.

The line represented as connected is marked A'. After entering the office it passes through its several spring-jack switches on the several boards of section A, as shown. From thence it passes through its annunciator located at one of the boards of section A, and thence to its flexible cord and plug located at that board. When the plug is in its switching device *o*, the circuit continues from the plug through the spring *g'* of that device, and thence to its annunciator located on a board in the other section, and through it to its flexible cord and plug located at that board. When the plug is in its switching device *o'* located at that board, the circuit continues from the plug through the spring of the device to the ground. All the contact-pieces *i i* of the switches of the line are connected with each other and with the contact-pieces *h h* of the two switching devices *o o'* of the line, as shown. The contact points or pieces *g''* and *f* of the switching device *o'* of the line are connected to the circuit of the line, one on one side of the line-annunciator located at the board which belongs to its class and the other on the other side of the annunciator, as shown.

The annunciators which are located in one section of the exchange may be all so constructed and connected as to be operated by the same polarity of current passing over their lines, and the annunciators in the other section to be operated by the other polarity.

The calling-keys at the subscribers' stations may be marked with the designations of the sections whose annunciators will be operated when they are depressed and their generator is operated—as, for example, A and B.

In the catalogue or list of the exchange may be placed each subscriber's name and opposite it the number of his line, with the letter or designation which indicates to what class his line belongs—as, for example, "John Adams, A1;" "Wm. Andrews, B6." The subscriber who wishes to talk with John Adams will, when in calling, press on his key marked A, and when the operator answers him at the board located in section A, state that he wishes A1. The operator will then test to see if line A1 is busy, and if it is not she completes the connection desired. If the subscriber, by mistake, presses on his calling-key marked B, and asks for A1, the operator at section B receiving the call will at once notice the mistake and inform the subscriber of it, who will then send the proper signal.

It will be seen that when an operator at any board takes a switch-plug from its normal position and places it in the spring-jack switch of any line at her board, she has disconnected both lines from the office-ground and has connected the two lines together for conversation. It will also be noticed that when she has so connected them the annunciator located at her board of the line in which the call originated is in the united circuit for clearing-out purposes, and that none of the other annunciators of the two lines are in that circuit.

It will be seen that when a line is switched at any board, either by one of its plugs being withdrawn from its normal position in one of its switching devices or by a plug being placed in one of its spring-jack switches, as indicated, the normally-open test-wire of the line to which is connected the contact test-pieces *i i* of its switches is connected with the local office-ground and with the test-receiving instruments connected therewith, as heretofore indicated. All the test-pieces *i i* of the line are therefore thereby connected to one side of each test-receiving instrument, and the other side of the instrument is connected to the test-plug of the instrument. When an operator connects a test-plug to a test-piece *i* of a line and it is switched, there is a complete local office-test circuit, as indicated and shown, and the test-receiving instrument will respond. If the line is not switched at any place when the test is made, the instrument will not respond.

When a plug is withdrawn from a switching device for switching, the test-wire is connected with the ground-connection by means of the spring-lever *g* of the switching device coming in contact with the point *h*. When a plug is inserted in the switch of a line, the test-wire of the line is connected with the ground-connection by means of the contact-piece *m'* of the plug pressing on both contact-pieces *i* and *h''* of the switch, the latter piece being connected with the office-ground through the main-line connections. Since the test-circuits for the subscribers' lines are local to the exchange-office and are not through the circuits of the lines, as is usually the case in exchanges where the multiple system is required, considerably less testing-battery is required and the uniformity and certainty of the test is greater. The telephone-exchange lines of a given exchange may vary in length from several hundred feet to many miles. A battery which gives a clear and satisfactory test-signal over a short line may not be strong

enough to give a clear signal over the long line; and if it is strong enough to give a clear signal over the long line, it may give too loud a signal over the short line. It is desirable to have the test-signals of the various lines of the exchange come as nearly uniform as possible, and all of them clear and distinct; otherwise the operator, in the rapidity of her work, may mistake the signals.

In the apparatus and system which I have described the test-circuits will not greatly vary and they are not greatly subject to induction and other extraneous interferences; hence the test-signals will come clear, distinct, and uniform.

In my applications Serial No. 238,728, filed May 19, 1887, and Serial No. 278,423, filed June 28, 1888, I have shown arrangements similar to part of the organization herein disclosed, and I disclaim herein any subject-matter claimed in said prior applications.

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 two classes, multiple switch-boards for said lines divided into two sections, the switches for said lines, one switch for each line of one class on each board of one section and one switch for each line of the other class on each board of the other section, annunciators for said lines, two for each line, one annunciator being located at a board of one section and the other annunciator being located at a board of the other section, and switching apparatus at each of the boards, whereby the operator at the board may connect any line which has its annunciator at her board with any line which has its switch at her board, substantially as set forth.

2. In a telephone-exchange system, the combination of telephone-lines divided into two classes, switch-boards for said lines divided into two sections, the switches for said lines, one switch for each line of one class on each board of one section and one switch for each line of the other class on each board of the other section, signaling apparatus whereby any subscriber may at will signal to either of the operators at two boards of the exchange, one board of each section, and switching apparatus at each of the two boards, whereby the operator at the board may connect the line of the subscriber with any line which has its switch at her board, substantially as set forth.

3. In a telephone-exchange system, the combination of telephone-lines divided into two classes, multiple switch-boards for said lines divided into two sections, signaling apparatus whereby a subscriber may at will signal to the operator at either of two boards, one board of each section, and switching apparatus whereby the operator at one of said boards may connect the line of the subscriber with any line of one of the classes and the operator at the other of said boards may connect the line with any line of the other class, substantially as set forth.

4. In a telephone-exchange system, the combination of two switch-boards, one board having switches for making connections with part of the lines of the exchange when wanted and with them only, and the other board having switches for making connections with other lines of the exchange when wanted and with them only, a telephone-line connected with the two boards, and switching apparatus at each board, whereby the operator at the board may connect said line with any line having a switch at her board, substantially as set forth.

5. In a telephone-exchange system, two switch-boards, a telephone-line connected with said boards, two polarized annunciators in the circuit of said line, one annunciator being located at each board, one annunciator indicating when a current of one polarity passes through it and the other indicating when a current of the other polarity passes, a signaling-generator at the subscriber's station, switching apparatus whereby the subscriber may at will send a current of either polarity to his line, and switching apparatus at each board, whereby the operator at the board may connect said line with other lines of the exchange, substantially as set forth.

6. In a telephone-exchange system, the combination of telephone-lines divided into two classes, multiple switch-boards for said lines divided into two sections, the switches for said lines, one switch for each line of one class on each board of one section and one switch for each line of the other class on each board of the other section, two polarized annunciators in the circuit of each line, one annunciator being located at a board of one section and the other located at a board of the other section, one annunciator indicating when a current of one polarity passes through it and the other indicating when a current of the other polarity passes, a signaling-generator at each subscriber's station, switching apparatus whereby the subscriber may at will send a current of either polarity to his line, and switching apparatus for each line at each board where one of its annunciators is located, whereby the operator at the board may connect the line with any line which has its said switches at her boards, substantially as set forth.

7. In a telephone-exchange system, the combination of the telephone-lines divided into two classes, the multiple switch-boards for said lines divided into two sections, connecting-switches on each board of one section to make connections with the lines of one class when wanted, and connecting-switches on each board of the other section to make connections with the lines of the other class when wanted, call-receiving apparatus for each line at two boards of the exchange, one board of each section, the call-receiving apparatus of

the lines being distributed among the several boards of the exchange, and switching apparatus at each board, whereby the operator at the board may connect any line which has its call-receiving apparatus at her board with any line which has its connecting-switch at her board, substantially as set forth.

8. In a telephone-exchange system, the combination of two switch-boards, one board having switches for making connections to part of the lines of the exchange when wanted and with them only, and the other board having switches for making connections to other lines of the exchange when wanted and with them only, a telephone-line connected to the two boards, and signaling apparatus whereby the subscriber may at will signal to the operator at either board, substantially as set forth.

9. In a telephone-exchange system, the combination of two switch-boards, a telephone-line connected to the two boards, a polarized annunciator in the circuit of the line at each board, one annunciator responding to a current of one polarity and the other annunciator responding to a current of the other polarity passing through the line, a signaling-generator at the subscriber's station, and switching apparatus for sending currents of either polarity through the line at the will of the subscriber, whereby the subscriber may at will signal either operator, substantially as set forth.

10. In a subscriber's station apparatus, a magneto-bell generator, two contact-springs for said generator, said springs bearing on diametrically-opposite segments of the armature-shaft, an insulated contact-piece on said shaft, on which said springs alternately bear when the generator is operated, and to which one end of the armature-wire is attached, two circuit-wires connected together at one end and connected at their other ends to the two contact-springs, respectively, and two normally-open keys, one in the circuit of each wire, in combination with a shunt-circuit which shunts the circuit in which is included the generator and keys, and a switching device with a pair of contact-points operated by the generator to open said shunt-circuit when the generator is operated and to close it when the generator is not operated, substantially as set forth.

11. In a telephone-exchange system, the two classes of lines and the two sections of switch-boards, in combination with the two calling-annunciators in each line, one in each section of the boards, the two annunciators being operated by opposite polarities of current, an electric calling-generator, and two keys at each subscriber's station to be used in calling for the two classes of lines, said keys on being depressed sending opposite polarities of current to line and being so marked or designated that the subscriber may know which key is to be used in calling for either class of lines, substantially as set forth.

12. In a telephone-exchange system, telephone-lines normally passing successively through their spring-jack switches on the boards of their section, (part of the lines having their switches in one section of the boards and the rest in the other section,) and thence through switch-plugs with cords and switching devices on two boards of the exchange, one plug with its cord and switching device on a board in each section and to ground, each plug being adapted to be withdrawn from its switching device and placed in any spring-jack switch at its board, substantially as set forth.

13. In a telephone-exchange system, telephone-lines normally passing successively through their spring-jack switches on the boards of their section, (part of the lines having their switches in one section of the boards and the rest in the other section,) and thence through calling-annunciators and switch-plugs with cords and switching devices on two boards of the exchange, one annunciator and one plug with its cord and switching device on a board in each section and to ground, the switching device nearest to the ground having a pair of contact-points in a circuit which shunts the annunciator at the other board, said points being normally open, but closed when the plug is withdrawn from the device, each plug being adapted to be withdrawn from its device and placed on any spring-jack switch at its board, substantially as set forth.

14. In a telephone-exchange system, two multiple switch-boards, a telephone-line normally grounded at the central office, spring-jack switches for said line, one on each board, each switch containing a pair of contact-points in the circuit of the line, one of said contact-points of each switch being connected to the line when switched, and which therefore may be designated as the line contact-point of the switch, and the other contact-point being connected to the normal ground when switched, and which therefore may be designated as the ground contact-point of the switch, test contact-pieces, one for each switch, the two test contact-pieces being connected together and normally insulated from the line and the other switch contact-points and switch-plugs, each with two insulated contact-pieces and a flexible conducting-cord, said cord being attached to one of said plug contact-pieces and said plugs being adapted to be inserted into said switches, and when a plug is inserted into a switch to open the pair of contact-points of the switch to connect the cord with the line contact-point of the switch and to connect the ground contact-point of the switch with its test contact-piece through the contact-piece of the plug which is not connected with the flexible cord, in combination with a test-receiving instrument at each board, each instrument being grounded on one side and connected on its other side to a test-plug

adapted to be brought into contact with the test contact-piece at its board, and a battery in the test-circuit between said plug and said test contact-piece, substantially as set forth.

15. In a telephone-exchange system, the switch-boards of the exchange divided into sections and the lines of the exchange divided into classes, each line of one class being connected to each board of one section and to a board of the other section, and each line of the other class being conected to each board of said other section and to a board of said first-mentioned section, in combination with switching apparatus for said lines at the boards to which they are connected, whereby the operators of the exchange may connect any two of said lines together for conversation, substantially as set forth.

16. In a telephone-exchange system, the switch-boards of the exchange divided into two sections and the lines of the exchange divided into two classes, each line of one class being connected to each board of one section and to a board of the other section and each line of the other class being connected to each board of said other section and to a board of said first-mentioned section, and switching apparatus for said lines at the boards to which they are connected, whereby the operators of the exchange may connect any two of said lines together for conversation, in combination with electric apparatus whereby an operator at any board may determine whether any line which is connected to all the boards of the section to which her board belongs is switched for conversation at any board of the exchange, substantially as set forth.

17. In a telephone-exchange system, the switch-boards of the exchange divided into two sections and the lines of the exchange divided into two classes, each line of one class having a switch on each board of one section and each line of the other class having a switch on each board of the other section, each switch being adapted to receive a switch-plug connected with a flexible conducting-cord and when the plug is inserted into the switch to connect the line to which the switch belongs with the conducting-cord to which the plug belongs, in combination with switch-plugs, two for each line, each plug being connected with its line by its flexible conducting-cord, the plugs of each line being located at boards in the two sections, whereby the operators of the exchange may by the insertion of a plug of one line into a switch of another line connect any two lines together for conversation, substantially as set forth.

18. In a telephone-exchange system, the switch-boards of the exchange divided into two sections and the lines of the exchange divided into two classes, each line of one class having a spring-jack switch on each board of one section and each line of the other class having a spring-jack switch on each board of the other section, each switch having two contact-points, which are normally in contact and adapted to receive a switch-plug connected with a flexible conducting-cord and when a plug is inserted into a switch to disconnect the contact-points of the switch, which are normally in contact and connect one of them with the flexible conducting-cord to which the plug belongs, in combination with switch-plugs with flexible conducting-cords, two for each line, the plugs of a line being located at boards in the two sections, and switching devices, one for each plug, and located at the board where the plug is located, each switching device being adapted to receive its plug, and when the plug is inserted to connect its conducting-cord with a contact-piece of the switching device, each line normally passing successively through each pair of contact-points of its switches, in each case going first to that contact-point of the switch which is in connection with the flexible cord when a plug, is inserted, said line also normally passing successively through its two flexible conducting-cords with plugs and said contact-pieces of their switching devices (into which the plugs are normally placed) and thence to ground, whereby the operators of the exchange may, by the withdrawal of a plug of one line from its switching device and its insertion into a switch of another line, disconnect any two lines from the office-ground and connect them together for conversation, substantially as set forth.

MILO G. KELLOGG.

Witnesses:
CALVIN DE WOLF,
MILTON HEAD.