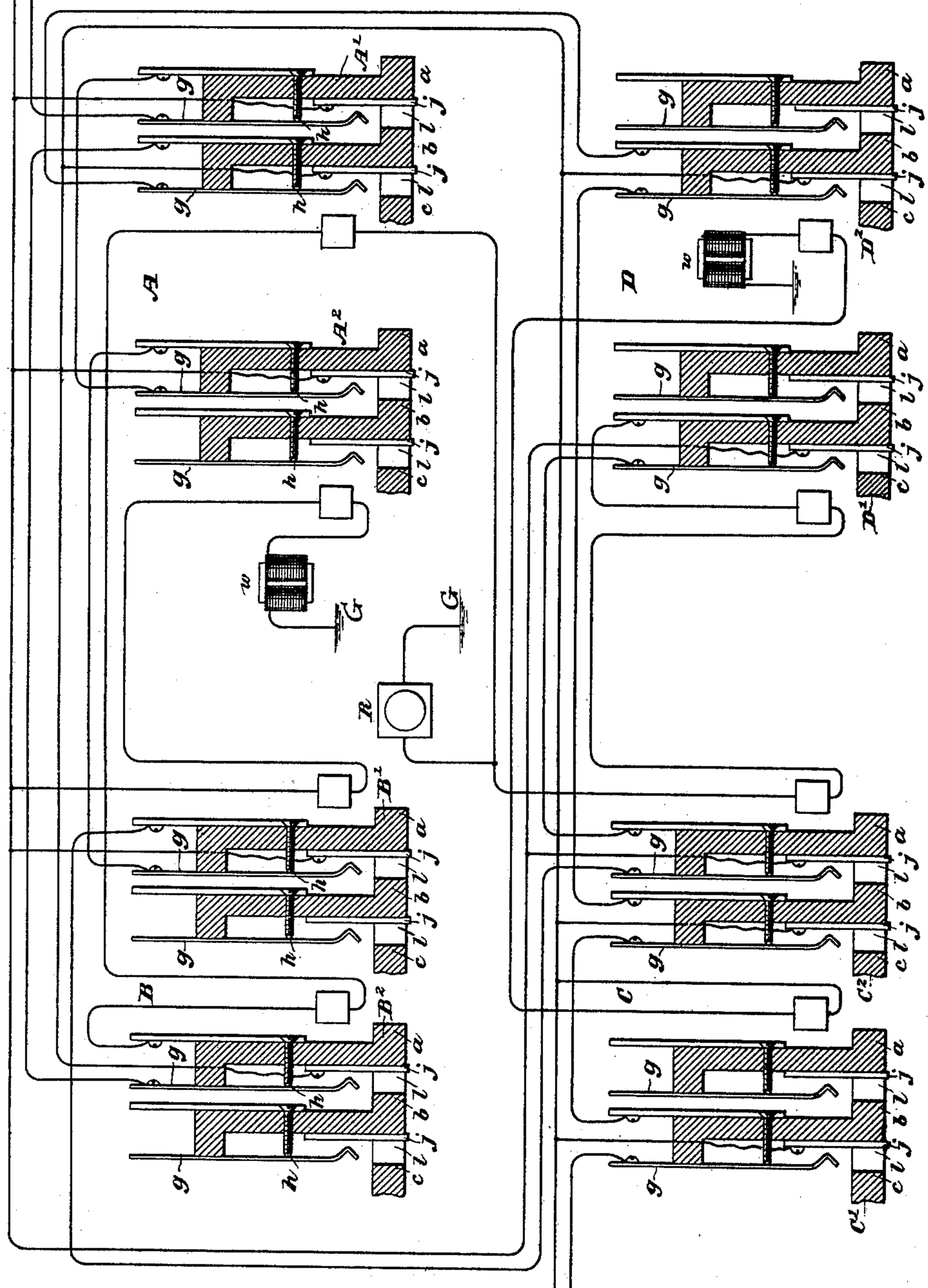
(No Model.) 2 Sheets—Sheet 1.

M. G. KELLOGG.

MULTIPLE SWITCHBOARD.

No. 592,364. Patented Oct. 26, 1897.

Fig. 2.



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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

(No Model.)

2 Sheets—Sheet 2.

M. G. KELLOGG.

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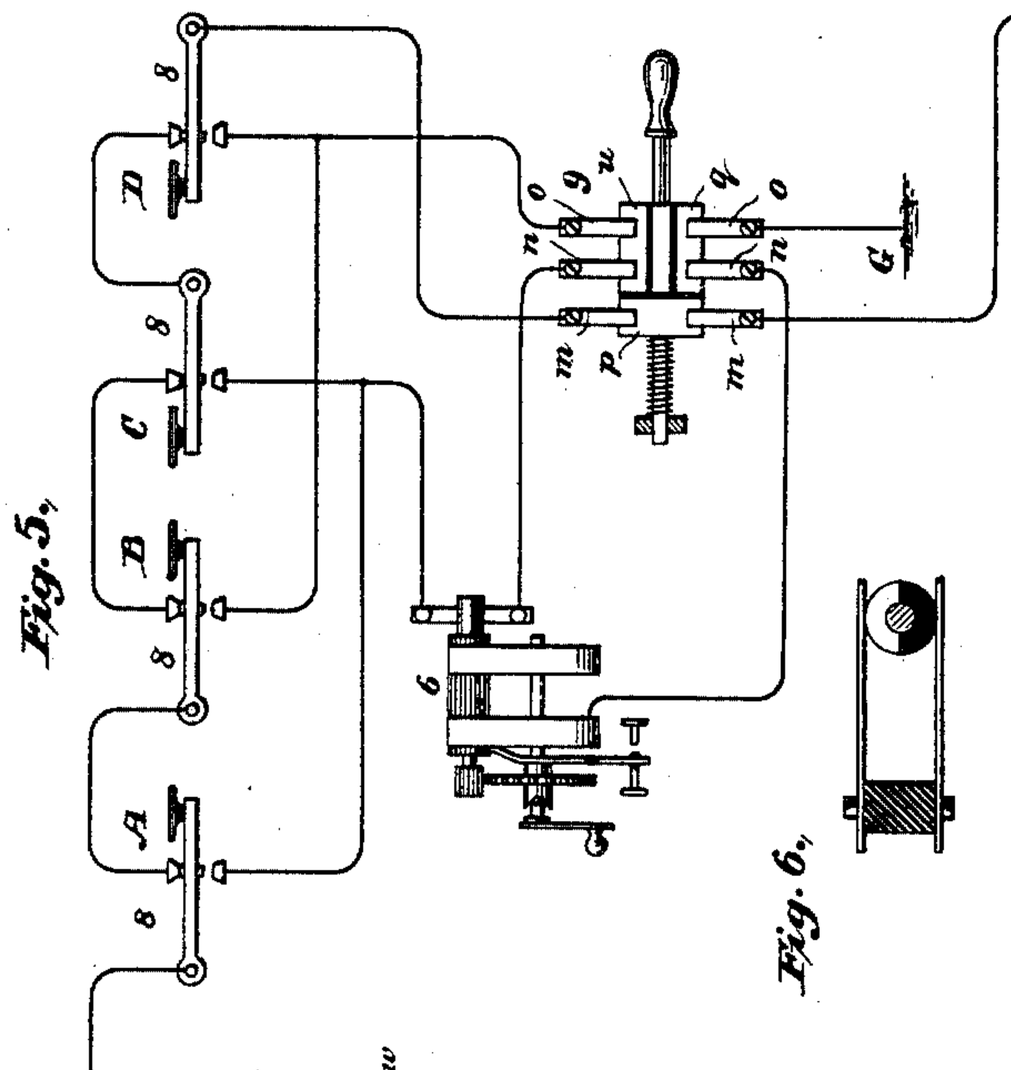
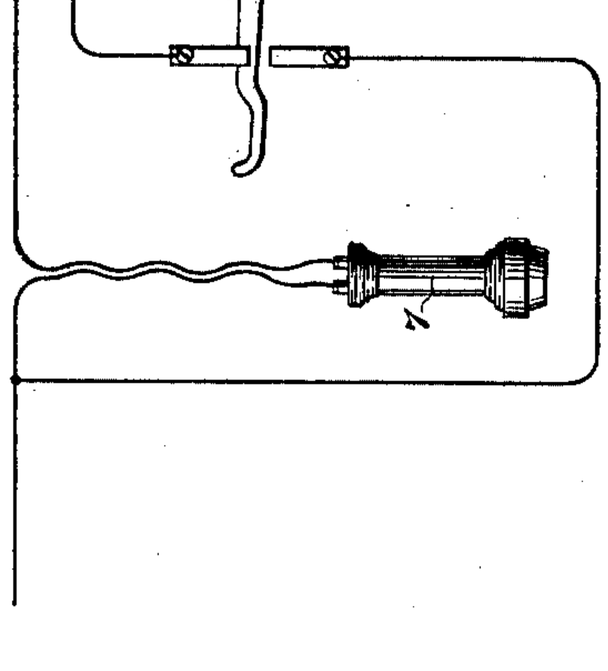


Fig. 5.

Fig. 6.



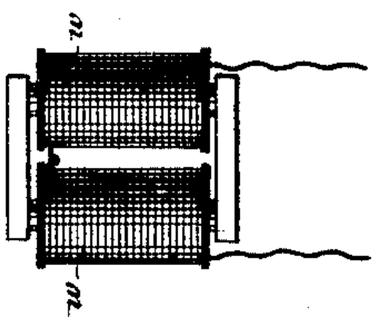


Fig. 4.

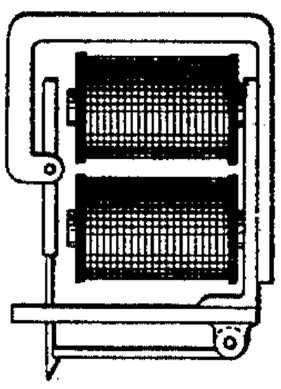


Fig. 3.

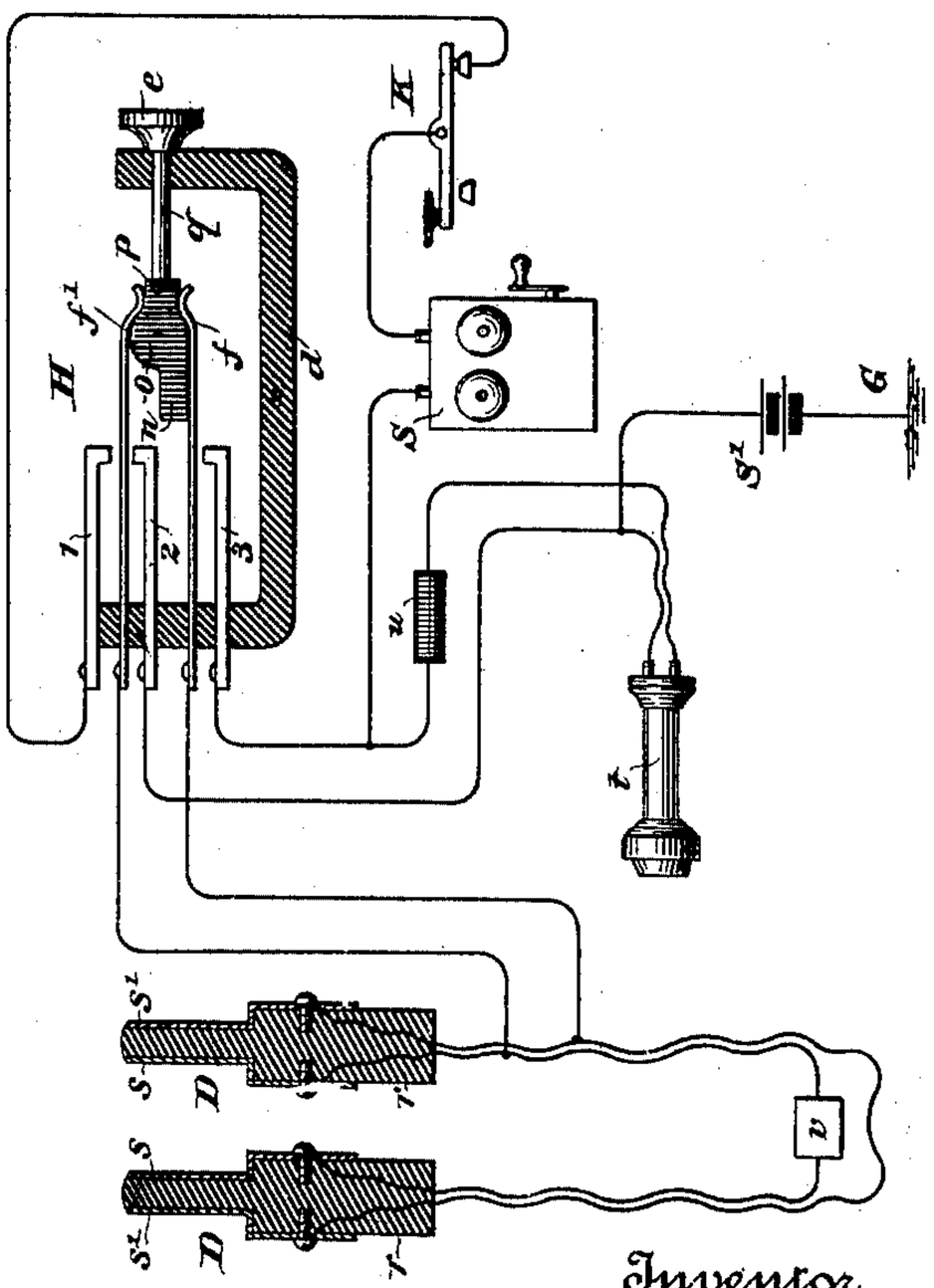


Fig. 7.

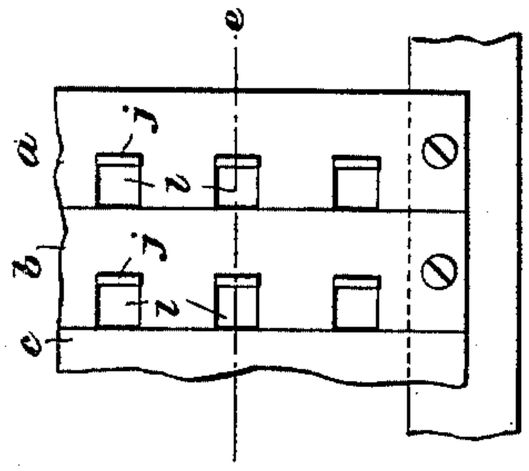


Fig. 1.

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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. 592,364, dated October 26, 1897.

Application filed March 24, 1890. Serial No. 345,065. (No model.) Patented in England March 25, 1890, No. 4,699, and in France March 25, 1890, No. 204,565.

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.

The invention herein described and claimed is in part comprehended in the foreign patents granted to me as follows: In the Kingdom of Great Britain, No. 4,699, dated March 25, 1890, and in the Republic of France, No. 204,565, dated March 25, 1890.

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 application, Serial No. 345,064, filed March 24, 1890.

It relates also to a metallic-circuit telephone-exchange system.

In said application, Serial No. 345,064, the lines of the exchange are divided into four classes or divisions and the switchboards of the exchange are divided into four classes to correspond. Each line of one class is provided with a switching device on each board of one class and on one board of each of the other classes. Each line of the second, third, and fourth classes is connected to each board of its own class of boards and to one board of each of the other classes. For each subscriber's line are four polarized annunciators, placed in the four classes of boards where the line has switching connection, and also a special calling wire or circuit. Two of the annunciators are connected in opposite polarity in the normal line-circuit and the other two annunciators are connected in opposite polarity in the special calling wire or circuit of the line. The calling-generator at the subscriber's station has commutator devices and keys or switches whereby the subscriber may at will send a current to either circuit, so as to operate either annunciator.

In the invention which I shall now describe the lines and the switchboards are divided into four classes and are connected in a manner similar to that described above for the other system. For each line also there are four polarized annunciators, connected with switches and apparatus so that the subscriber can, at will, call at a board in each class where he has switching connection. In this system, however, I do not require the special calling-wire for each line in order to make the required calls, but for the purpose of calling I use the two branches of the metallic circuit, as will hereinafter be described.

In the accompanying drawings, illustrating my invention, Figure 1 represents a front view of a section of one of the switchboards. Fig. 2 shows a complete diagram of the main-line central-office apparatus, circuits, and connections of the system, with four classes or divisions of boards and two lines and their necessary central-office apparatus, one line for each class A and C of lines. Fig. 3 shows in detail the calling-annunciators used at the central office. Fig. 4 shows a retardation-coil which may be used for each line. 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 subscriber's-station apparatus with two commutator-springs, one bearing on each side of the shaft. Fig. 7 shows in diagram an operator's cord system or apparatus to be used at the boards.

G in each case represents a ground connection.

In Fig. 2, A′ A^2 represent the two boards of one class 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 the fourth class of boards.

The four classes of boards are indicated by the letters A, B, C, and D, respectively, to correspond. Each board is shown in 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 the fourth "class D" of lines, to correspond with the designations of the different classes of boards. Each line of a class is indicated in the exchange 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 and the distinction kept up.

Each line of one class—class A, for example—has a spring-jack or other suitable switch on each board of class A of boards 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, but is separated from the point, while a switch-plug is inserted into the switch and has 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 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. 7, and when a plug is inserted into a switch it raises the switch-spring from the contact-point on which it normally bears and the two contact-pieces of the plug form connection with the spring and said 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 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 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.

One of the four annunciators for each line is located at that board of the class of boards on which the line has switches at each board where its calls are to be answered, and the other annunciators of the line are located at the boards of the other classes where the line has its switches and where also its calls are to be attended to.

w w are retardation-coils, one for each line of the exchange. These coils consist each of two spools or helices of insulated wire, each surrounding an iron core, and the two cores are connected at their two ends by cross-bars of iron. The coils of a retardation-coil are connected together in such a direction as to magnetize in the same direction the closed magnetic circuit made by the iron pieces of the coil.

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. It afterward passes successively through two of the polarized annunciators of the line and then passes through the circuit of the insulated wire of the retardation-coil of the line and is then connected to the ground, (but the rheotome should not be in this ground connection.) The other side or branch of the line passes normally successively through the several pairs of contacts *g h* of the switch-boards of the line on the different boards, passing in each case to the spring first and then successively through the circuit of the other two polarized annunciators of the line to one of said insulated contact-points of the rheotome. The other contact-point of the rheotome is connected to the ground. The two annunciators in the circuit of each of the branches of the line, as above described, are so connected into their circuit as to be actuated or operated by a current of the opposite polarity passing through them.

In the operator's cord system shown in Fig. 7, 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, as will be described, by the two insulated conductors of a double or loop flexible switch-cord. *r* is the rubber insulation of the plug, and *s s'* are its two insulated contact-pieces.

H is the 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 connection with the springs *f f'*, as will be described. *q* is a sliding rod which passes through the frame *d*. It terminates at one end in the knob *e*, which is placed in a convenient position for the operator to manipulate to draw the rod in and out to carry on the switching operations, as will be described. *n o p* is an irregularly-

shaped rubber piece placed at the end of the rod *q*. The different sections or divisions of the rubber piece are marked *n o p*, respectively, as indicated. The rod *q* carries them in its reciprocating movements, and they may altogether be called the "commutator-piece" of the switch. All its parts are constructed, insulated, mounted, and adjusted to perform the switching operations I shall 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 its outer stop is against or close to the standard of the frame, the springs *f f'* rest on piece *p* and are insulated from contact-points 1, 2, and 3. When the commutator is pulled out to its central position and the springs rest on *o*, spring *f* is in contact with piece 3, and *f'* is in contact with 1. When the commutator-piece is pulled still farther out and the springs rest on *n*, *f* is still in contact with 3, and *f'* (having passed from contact with 1) connects 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', her test-battery, and *w* a resistance-coil. Each operator has one of each of such parts.

v is a clearing-out annunciator which may be non-polarized and operated by a current of either polarity. 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 a flexible conductor of the pair of cords, and their clearing-out annunciator may be placed in the circuit, as shown. The other two contact-pieces of the plugs *s' s'* are connected by the other conductor of the cords. The two cord-circuits which connect said pairs of plug contact-pieces are connected to the springs *f f'*, respectively, spring *f* being in connection with *s' s'*. Contact-pieces 2 and 3 are connected together through the operator's telephone and resistance-coil, and 1 and 3 are connected together through her calling-generator and the contact-points of her key. The test-battery is grounded on one side and connected on its other side to the circuit which connects the telephone and piece 2.

Each operator has as many pairs of switch-plugs and cords, with their switching devices and clearing-out annunciators, as she may need for her work, and they are connected to her special apparatus substantially as shown and described. The cords should be long enough so that she can reach any switch at her board, and the apparatus should be conveniently mounted for her work.

The commutator-piece of the switching device stands normally, or when its cords are not in use for switching, in its outer position, so that the springs rest on *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. 8 8 8 8 are calling-keys, and 9 is a clearing-out switch.

The calling-generator is a usual construction of telephone calling-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 springs 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 contact-piece. These insulated contact-springs are so placed in relation to the armature that one of them is connected with said insulated piece on the shaft when a current of one polarity is generated in the coil and the other is connected to the insulated piece when a current of the other polarity is generated.

The calling-keys 8 8 8 8 are three-point keys, having one point on which the key-lever normally bears and another point normally insulated from the lever and with which the lever comes in contact when it is pressed or operated by the subscriber in calling.

The clearing-out switch 9 is the usual hand-switch employed to switch a telephone from one circuit to another. It contains a reciprocating block carrying three conducting-plates *p q u*, insulated from one another. Upon plate *p* normally rests a pair of contact-springs *m m*, while upon plates *q* and *u* rest pairs of contact-springs *n n o o*, respectively. The reciprocating block with its parts is held normally in the position shown by a spring. When the subscriber presses in the reciprocating block, *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* and are in contact with springs *n n*, respectively.

The circuits of the subscriber's-station apparatus are substantially as shown and as follows: One side or branch of the line is connected through the pairs of contact-points normally in contact of two of the calling-keys, passing in each case to the spring first, and then passes through the pairs of contact-points normally in contact of the two other keys, passing in each case to the point first. It then connects with the other side or branch of the line. The line is separated at a point which is in the circuit while the telephone is on the switch, and the two ends are connected to the two springs *m m*, respectively. One of the springs which bear, as described, on the armature-shaft is connected to one of the

springs *n* and the other spring *n* is connected to the other side of the armature-coil than that to which the insulated contact-piece is connected. This last spring *n* bears on plate *q*, and the spring *o*, which also bears on this plate, is connected to the ground. The two keys whose connection with the line-circuit was first described have their lower contact-points (those on which the levers may be pressed by the subscriber) connected to the two contact-springs, respectively, of the calling-generator, and the lower contact-points of the two other keys are also connected to the two springs, respectively. The connection between two of said contact-points and one of said springs is made through the contacts and connections of switch 10, as shown.

The lines are normally disconnected from the ground at the subscriber's station, but one branch is grounded through the calling-generator when a subscriber presses on any of his calling-keys. The telephone-switch connections are such that the calling-keys and the clearing-out switch are not switched or shunted from the line while the telephone is on the switch.

It will be seen from the drawings and the description above given of the connections and the construction of the apparatus that when a subscriber presses on one of the two keys whose connection was first described and operates his calling generator one side or branch of the line will be disconnected from the other and have a calling-current of one polarity sent over it, and when the other key of the pair is pressed and the generator operated a current of the opposite polarity will go to the circuit of that branch. The circuit is from the subscriber's ground connection to contact-spring *o*, thence through contact-plate to spring *n*, thence through the armature-coil and spring of the generator to the contact-point of the key connected with the spring and the key-lever to the branch of the line, and through its circuit and that of the annunciators connected in circuit with it to the ground connection of the branch heretofore described as being at the central office. The subscriber can therefore at will operate either of the two annunciators connected into this branch. In like manner he can by operating his generator and pressing on one or the other of the other keys operate either of the annunciators connected in circuit with the other branch of the line. The subscriber can therefore at will cause any of his annunciators at the central office to indicate a call.

I prefer to mark and designate the four keys of a subscriber's station A, B, C, and D, respectively, to correspond with the four classes of boards at which respectively are the annunciators which they operate. Key A is the one which operates the annunciator in class A of boards, key B that which operates the annunciator in class B of boards, &c.

The operation of the system is as follows: When a subscriber wants to converse with any other, he finds in 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, and if to class D he presses on key D, each time operating his generator. He thereby calls an operator located at a 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 the switch of the line in such way that its contact *s'* connects with contact *j* of the switch, and her telephone is thereby included in a closed circuit with the line, and she can by conversation find out what line is wanted. The circuit is completed by the cord used, the contact-springs *f f'*, connected to its flexible conductors, and contact-pieces 2 3, which are connected to the two sides of the telephone. When she finds out what line is wanted, she places contact-piece *s'* of the other plug of the pair on the third or insulated contact-piece of the switch of the line wanted. 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 will therefore know that the line is not switched at any board. She then places the plug in the switch of the line tested so that the plug-contact *s'* connects with the contact *j* of the switch, 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 operator's telephone and resistance-coil. She then pushes the commutator-piece of the switching device so that the springs rest on the piece *o* when spring *f* is still in contact with piece 3 and spring *f'* is in contact with piece 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 the circuit of the two 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 a metallic circuit which is not bridged by either the operator's telephone or generator and with which neither of them is connected. If at any time the operator desire 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 is passing over 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 piece *o*. If when the test was made as described the line had been switched at any board, the circuit of the line to the rheotome would have been open at the pair of contact-points of the switch used in switching, 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 switches located at her board. She has no need to test any of the other lines.

When the subscribers are through conversation, either one can press on his clearing-out switch and at the same time operate his calling-generator. By such operations the generator is disconnected from its ground connection and is looped into the metallic circuit of the two lines. A calling-current will thereby be directed through the circuit, which will operate the clearing-out annunciator which is included in the circuit and notify the operator who made the connection that the subscribers wish to be disconnected or cleared out. The connections to the lines having been made as hereinbefore required—viz., so that the plug-contacts *s'* are in connection with the switch-contacts *j*—the two branches of the line which are permanently connected to the office ground through their respective annunciators and retardation-coils, as described, are thereby bridged or shunted by a circuit which consists of one side of the cord-circuit merely and does not contain the clearing-out annunciator. This bridge or shunt-circuit is of so small resistance that when a clearing-out signal is made as described there will not enough current pass around through the four annunciators and the retardation-coils in the permanent ground connection of the two lines to operate any of these annunciators.

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.

It will be seen, as indicated, that when two subscribers are connected together for conversation the circuit is connected to the ground at the central office through the permanent ground connection of each line through the annunciators and retardation-coils. The use of the retardation-coils is to prevent or minimize the effect on the circuit which might arise from other metallic circuits, which may also be in like manner connected to the ground. The annunciators themselves offer a retardation to such an effect, and the use, size, and character of the special retardation-coils will depend on the construction and condition of the other apparatus and the circuits of the exchange. Incidentally the retardation-coils afford a resistance which will decrease the amount of calling-current which will pass through the annunciators connected with them when the clearing-out signal is sent in.

The divided switchboard system herein described and claimed may be practiced with other methods of clearing out than that herein claimed—as, for instance, the clearing-out annunciator in the plug-cords may be omitted and the central-office operator may listen in to ascertain when two connected subscribers have finished conversation.

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

1. In a telephone-exchange system, the combination of metallic-circuit 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, and switching apparatus whereby the operator at any board may 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 metallic-circuit telephone-lines divided into four classes, the switchboards divided into four classes, one class of boards for each class of lines, each line being connected to each board of its class and to one board of each of the other classes, 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.

3. In a telephone-exchange system, the combination of metallic-circuit 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, signaling apparatus whereby any subscriber may at will signal to a board in each class of boards where his line has a switch and switch-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.

4. In a telephone-exchange system, the combination of metallic-circuit lines divided into four classes, the switchboards divided into four classes, one class of boards for each class of lines, each line being connected to each board of its class and to one board of each of the other classes, signaling apparatus where-

by any subscriber may at will signal to a board in each class of boards and to a board where his line is connected and switch-connecting apparatus whereby the operator at any board may connect together any two lines which are connected to her board, substantially as set forth.

5. In a telephone-exchange system, the combination of metallic-circuit 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, and each branch of each line being normally grounded at the central office, four polarized annunciators for each line, one being located in each class of boards and at a board where the line has a switch, two annunciators being connected in opposite polarity in one branch of the line and the other two being connected in opposite polarity in the other branch of the line, electric calling apparatus and switches at each subscriber's station whereby the subscriber may at will send a current of either polarity into a circuit from the ground through either branch of the line to its office ground, and switch-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, the combination of metallic-circuit lines divided into four classes, the switchboards divided into four classes, one class of boards for each class of lines, each line being connected to each board of its class and to one board of each of the other classes and each branch of each line being normally grounded at the central office, four polarized annunciators for each line, one being located at each class of boards and at a board where the line has a switch, two annunciators being connected in opposite polarity in one branch of the line and the two other annunciators being connected in opposite polarity in the other branch of the line, electric calling apparatus and switches at each subscriber's station whereby the subscriber may at will send a current of either polarity into a circuit from the ground through either branch of the line to its office ground, and switching apparatus whereby the operator at any board may connect together any two lines which are connected to her board, substantially as set forth.

7. In a telephone-exchange system, the combination of metallic-circuit lines divided into two classes, the switchboards divided into two 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 the other class and each branch of the line being normally grounded at the central office, two annunciators for each line, one being located in each branch of the line and at a board in each of the two classes of boards and at a board where the line has a switch and one of the annunciators of each line being permanently in connection with its line, a calling-generator at each subscriber's station and grounding switches or keys at each subscriber's station whereby the subscriber may at will ground either side or branch of his line with his generator in the circuit between such ground and the normal office ground of such branch.

8. In a telephone-exchange system, the combination of metallic-circuit lines divided into classes, the switchboards divided into 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 and each branch of the line being normally grounded at the central office, two annunciators for each line, one being located in each branch of the line, and at a board in each of two classes of boards, and at a board where the line has a switch and one of the annunciators of each line being permanently in connection with its line, electric calling apparatus and switches at each subscriber's station whereby the subscriber may at will operate either annunciator and switch-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.

9. In a telephone-exchange system, two metallic-circuit lines, each extending from its subscriber's station to the central office, two ground connections at the central office for each line, one for each branch of the line, and two annunciators for each line, one in each of said ground connections, of which one is a permanent connection, in combination with switching apparatus at the central office to connect said lines into a closed metallic circuit which does not contain the line-annunciators, contacts at each subscriber's station to at will ground either branch of the line, and the subscriber's calling-generator in circuit with either branch thus grounded.

10. In a telephone-exchange system, a metallic-circuit line and two annunciators for said line at the central office, in ground connections to the two sides or branches of the line, respectively, and one of them permanently connected with the line, in combination with two keys at the subscriber's station for said line, each key having a lever and a contact-point with which the lever is normally in contact and another contact-point with which the lever may be brought into contact when pressed from its first-mentioned point, one side or branch of the line being connected to one lever and the other side or branch of the line being connected to the other lever and the two first-mentioned contact-points being connected together, and a calling-generator grounded on one side and connected on its other side to the two other contact-points of the keys.

11. In a telephone-exchange system, a metallic-circuit line having two sides or branches

each connected to spring-jack contacts at central office, one side or branch of which is grounded at the central office whether either switched or unswitched there and the other side or branch of which is connected to two or more multiple switchboards and is normally grounded at the central office, in combination with switching devices at each board by which the line may be connected in metallic circuit with another line and said second-mentioned or normal ground connection is then broken, substantially as set forth.

12. In a telephone-exchange system, a metallic-circuit line having two sides or branches each connected to spring-jack contacts at central office, one side or branch of which is grounded at the central office whether either switched or unswitched there and is connected to two or more switchboards and the other side or branch of which is normally grounded at the central office and is connected to the same switchboards, in combination with switching devices at each board by which the second or normal ground connection may be broken and the two sides or branches of the line connected with the two sides or branches respectively of another metallic-circuit line, substantially as set forth.

13. In a telephone-exchange system, a metallic-circuit line having two sides or branches each connected to spring-jack contacts at central office, one side or branch of which is grounded at the central office through an annunciator whether either switched or unswitched there and the other side or branch of which is normally grounded at the central office, in combination with switching devices by which the second or normal ground connection may be broken and the two sides or branches of the line connected with the two sides or branches respectively of another metallic-circuit line but with said annunciator not in the metallic circuit thereby established, substantially as set forth.

14. In a telephone-exchange system, a metallic-circuit line having two sides or branches each connected to spring-jack contacts at central office, one side or branch of which is grounded at the central office through a retardation-coil whether either switched or unswitched there and the other side or branch of which is normally grounded at the central office, in combination with switching devices by which said second or normal ground connection may be broken and the two sides or branches of the line connected with the two sides or branches respectively of another metallic-circuit line but with said retardation-coil not in the metallic circuit thereby established, substantially as set forth.

15. In a telephone-exchange system, a metallic-circuit line having two sides or branches each connected to spring-jacks at central office, one side or branch of which is grounded at the central office through an annunciator and a retardation-coil whether either switched or unswitched there and the other side or branch of which is normally grounded at the central office, in combination with switching devices by which said second or normal ground connection may be broken and the two sides or branches of the line connected with the two sides or branches respectively of another metallic-circuit line but with said annunciator and retardation-coil not in the metallic circuit thereby established, substantially as set forth.

16. In a telephone-exchange system, a metallic-circuit line having two sides or branches each connected to spring-jacks at central office, one side or branch of which is grounded at the central office whether either switched or unswitched there and is connected to two or more multiple switchboards and the other side or branch of which is normally grounded at the central office and is connected to the same boards, in combination with switching devices at each board by which said second or normal ground connection may be broken and the two sides or branches of the line connected with the two sides or branches respectively of another metallic-circuit line but with said annunciator not in the metallic circuit thereby established, substantially as set forth.

17. In a telephone-exchange system, a metallic-circuit line having two sides or branches each connected to spring-jacks at central office, one side or branch of which is grounded at the central office through a retardation-coil whether either switched or unswitched there and connected to two or more multiple switchboards and the other side or branch of which is normally grounded at the central office and is connected to the same boards, in combination with switching devices at each board by which said second or normal ground connection may be broken and the two sides or branches of the line connected with the two sides or branches respectively of another metallic-circuit line without the retardation-coil being included in the direct metallic circuit thereby established, substantially as set forth.

18. In a telephone-exchange system, the combination of metallic-circuit telephone-lines divided into three classes, switchboards divided into three classes, one class of boards for each class of lines, each line being connected to each board of its class and to one board of each of the other classes, 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.

19. In a telephone-exchange system, the combination of metallic-circuit lines divided into three classes, switchboards divided into three classes, one class of boards for each class of lines, each line being connected to each board of its class and to one board of each of the other classes, signaling apparatus whereby any subscriber may at will signal to a board in each class of boards and to a board

where his line is connected and switch-connecting apparatus whereby the operator at any board may connect together any two lines which are connected to her board, substantially as set forth.

20. In a telephone-exchange system, the combination of two classes of switchboards, two groups or classes of subscribers' lines, one class for each class of boards, switches for said lines, one switch for each line on each board of its class, and on one board of the other class, one of said lines being a metallic-circuit line, having one branch normally grounded at the central office, two polarized annunciators connected in opposite polarity in the normally-grounded branch of said line and located at boards of the two classes of boards where the line has switches, calling apparatus at the subscriber's station whereby the subscriber may send a current of either polarity into a circuit from the ground at the subscriber's station through the normally-grounded branch of the line, and switch-connecting apparatus whereby the operator at any board where said line has a switch may connect the line with any other line having a switch at her board, substantially as set forth.

21. In a telephone-exchange system, the combination of two classes of switchboards, two groups or classes of subscribers' lines, one class for each class of boards, switches for said lines, one switch for each line on each board of its class, and on one board of the other class, one of said lines being a metallic-circuit line, having one branch permanently grounded at the central office, two polarized annunciators connected in opposite polarity in the permanently-grounded branch of said line and located at boards of the two classes of boards where the line has switches, calling apparatus at the subscriber's station whereby the subscriber may send a current of either polarity into a circuit from the ground at the subscriber's station through the permanently-grounded branch of the line, and switch-connecting apparatus whereby the operator at any board where said line has a switch may connect the line with any other line having a switch at her board, substantially as set forth.

22. In a telephone-exchange system, the combination of metallic-circuit lines divided into three classes, switchboards divided into three classes, one class of boards for each class of lines, switches for said lines, one switch for each line on each board of its class and on one board of each of the other classes, one of said lines having both sides or branches normally grounded at the central office, two polarized annunciators connected in opposite polarity in one side or branch of the line and located in two classes of boards and where the line has switches, an annunciator connected in the other side of the line and located at a board in the other class of boards where the line has a switch, electric calling apparatus whereby the subscriber may at will send a calling-current of either polarity through said first-mentioned side or branch of the line, and a calling-current through the other side or branch of the line, and switch-connecting apparatus whereby the operator at any board where said line has a switch may connect the line with any other line having a switch at her board, substantially as set forth.

23. In a telephone-exchange system, two telephone-lines connected for conversation, a generator at each subscriber's station, the two annunciators of the lines at the central office in circuit with each generator, the clearing-out annunciator at the central office also in circuit with each generator, and a shunt-circuit connection (that does not contain the clearing-out annunciator) around the line-annunciators while said lines are thus connected, substantially as set forth.

24. In a telephone-exchange system, two metallic-circuit lines connected together in metallic circuit for conversation, a generator at each subscriber's station, the two annunciators of the lines at the central office in circuit with each generator, the clearing-out annunciator at the central office also in circuit with each generator, and a shunt-circuit connection (that does not contain the clearing-out annunciator) around the line-annunciators while said lines are thus connected, substantially as set forth.

25. In a telephone-exchange, the combination of telephone-lines divided into three classes, the switchboard for said lines divided into three classes, switches for said lines, 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 of each line of the third class on each board of the third class and one board of each of the other classes, connecting apparatus at each board whereby an operator at the board may connect together any two lines which have their switches at her board, substantially as set forth.

26. In a telephone-exchange system, the combination of telephone-lines divided into three classes, the switchboards for said lines divided into three classes, each line of one class being connected to each board of one class and to one board of each of the other classes, each line of a second class being connected to each board of the second class and to one board of each of the other classes, and each line of the third class being connected to each board of the third class and to one board of each of the other classes, signaling apparatus whereby any subscriber may call an operator at a board in each of the classes of boards and where his line is connected, and connecting apparatus at each board whereby

the operator may connect together for conversation any two lines which are connected to her board.

27. In a telephone-exchange system, the combination of telephone-lines divided into three or more classes, the switchboards divided into the same number of classes, one class of boards for each class of lines, switches, one switch for each line of each class on each board of its class, and on one board of each of the other classes, signaling apparatus whereby any subscriber may at will signal to a board in each class where his line has a switch and connecting apparatus at each board whereby an operator may connect together any two lines which have their switches at her board, substantially as set forth.

28. In a telephone-exchange, the combination of telephone-lines divided into three or more classes, the switchboards divided into the same number of classes, one class of boards for each class of lines, each line of each class being connected to each board of its class, and to one board of each of the other classes, and connecting apparatus at each board whereby an operator may connect together any two lines which are connected to her board, substantially as set forth.

29. In a telephone-exchange, the combination of telephone-lines divided into three or more classes, the switchboards divided into the same number of classes, one class of boards for each class of lines, each line of each class being connected to each board of its class and to one board of each of the other classes, signaling apparatus whereby any subscriber may at will signal to a board in each class of boards and where his line has a connection, and connecting apparatus at each board whereby the operator may connect together any two lines which have a connection at her board, substantially as set forth.

30. In a telephone-exchange, the combination of telephone-lines divided into three classes, the switchboards for said lines divided into three classes, 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 the 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, signaling apparatus whereby any subscriber may at will call an operator at a board in each of the classes of boards, and where his line has a switch and connecting apparatus at each board whereby an operator may connect together any two lines which have their switches at her board, substantially as set forth.

31. In a telephone-exchange, 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, and switching apparatus whereby the operator at any board may connect together any two lines which have their switches at her board, substantially as set forth.

32. 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 being connected to each board of its class and to one board of each of the other classes, and switching apparatus whereby an operator at any board may connect together any two lines which have their switches at her board, substantially as set forth.

33. 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 being connected to all the boards of its class, and to one of the boards of each of the other classes, signaling apparatus whereby any subscriber may at will signal to any class of the boards, and switch-connecting apparatus by which the operator at any board may connect together any two lines which are connected to her board, substantially as set forth.

34. In a telephone-exchange system, the combination of a subscriber's calling-generator, a commutator-piece on the armature-shaft to which one side of the armature-coil is connected, two commutator-springs bearing alternately on said commutator-piece as the armature revolves, two normally open circuit connections in derived or parallel circuit connected to said commutator-springs, respectively, and two other normally open circuit connections in derived or parallel circuit also connected to said commutator-springs respectively and keys by which either of said normally open circuit connections may be closed, substantially as set forth.

35. 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 continuous metallic and unbroken flexible-cord circuits, in combination with a switching device for the pair of plugs, two pairs of contact-points in said switching device, a commutator-piece adapted to be moved by the operator to open and close said pairs of points, and a calling-generator, two of said contact-points of the switching device, one of each pair, being connected to the two sides respectively, of the generator, and the two other points being connected to the two cord-circuits, respectively, which connect the plugs, substantially as set forth.

36. 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 continuously metallic and unbroken flexible-cord circuits, in combination with a bridge circuit or connection between the two cord-circuits

which connect the two plugs, a calling-generator in said bridge circuit or connection and switching apparatus whereby the operator may at will open and close said bridge-circuit, substantially as set forth.

37. 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 of the other, respectively, by continuously metallic and unbroken flexible-cord circuits, in combination with a bridge circuit or connection between the two cord-circuits which connect the two plugs, two derived circuits in said bridge-circuit, the operator's telephone in one of said derived circuits, a calling-generator in the other derived circuit, and switching apparatus by which the operator may at will close or open either of said derived circuits, substantially as set forth.

38. 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 of the other, respectively, by continuously metallic and unbroken flexible-cord circuits, in combination with two bridge circuits or connections between the two cord-circuits which connect the two plugs, an operator's telephone in one of said bridge-circuits, a calling-generator in the other bridge-circuit and switching apparatus by which the operator may at will open or close either of said bridge-circuits, substantially as set forth.

39. In a telephone-exchange system, two metallic-circuit lines temporarily connected together in metallic circuit continuously metallic and unbroken for conversation, in combination with a bridge circuit or connection at the central office between the two sides or branches of said metallic circuit, two derived circuits in said bridge-circuit, an operator's telephone in one of said derived circuits, a calling-generator in the other derived circuit, and switching apparatus by which the operator may at will open or close either of said derived circuits, substantially as set forth.

40. In a telephone-exchange system, three or more divisions of boards, three or more divisions of lines, one division of boards for each division of lines, the lines of each division of lines adapted to be connected to at the corresponding division of boards, means controlled by a subscriber to at will effect a signal on an annunciator at each division of boards, and means at that division of boards to connect his line with any other line of the division of lines belonging to said division of boards.

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

MILO G. KELLOGG.

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