(No Model.) 2 Sheets—Sheet 1.

M. G. KELLOGG.

MULTIPLE SWITCHBOARD.

No. 592,373. Patented Oct. 26, 1897.

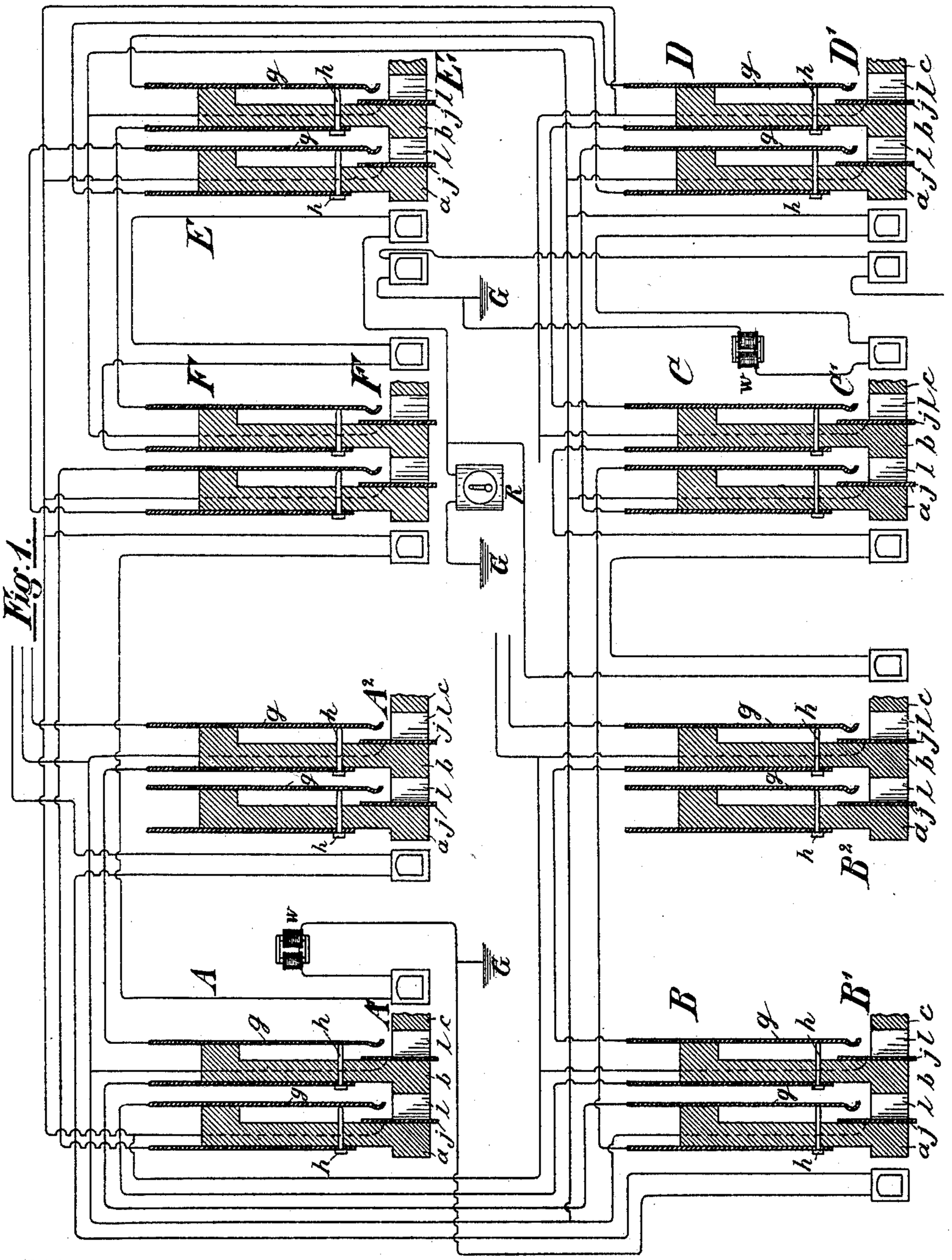

Fig: 1.

Witnesses:

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Inventor:

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(No Model.)

2 Sheets—Sheet 2.

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Fig. 2.

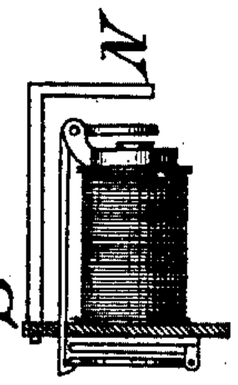


Fig. 5.

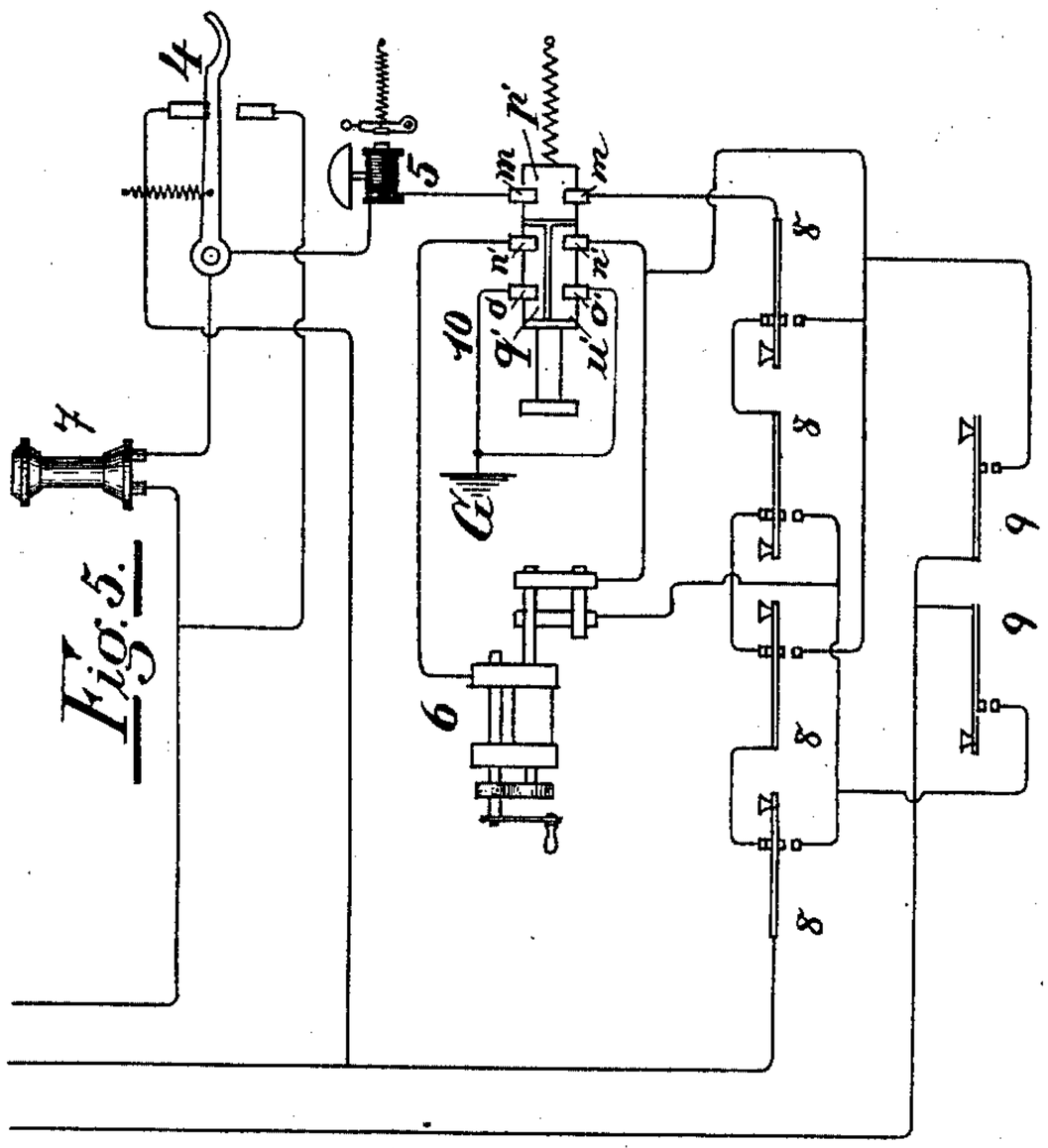


Fig. 4.

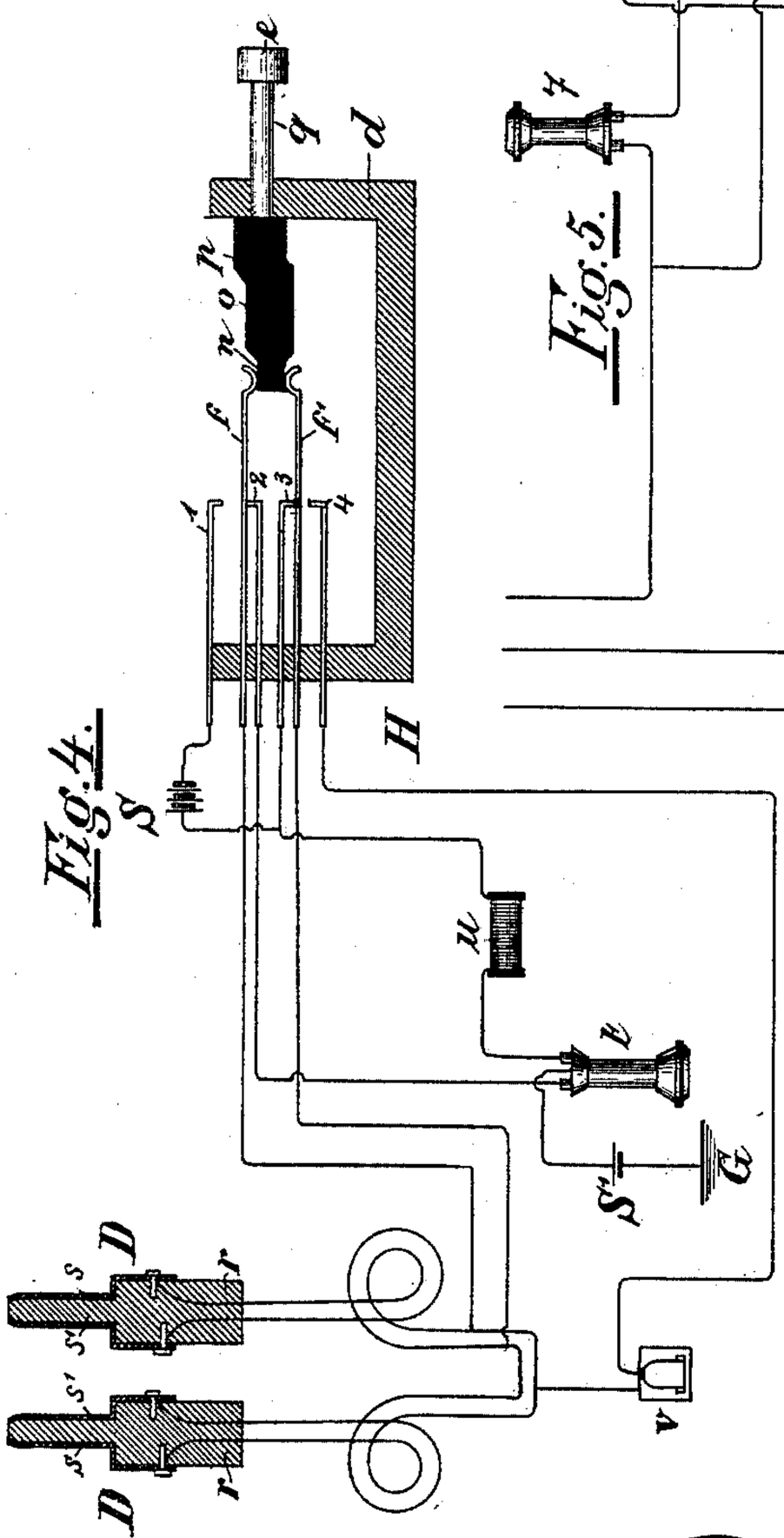


Fig. 3.

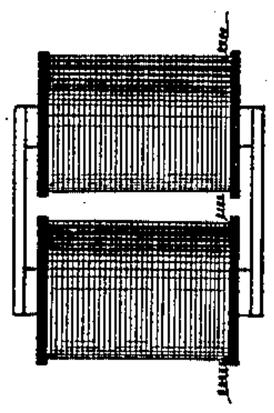
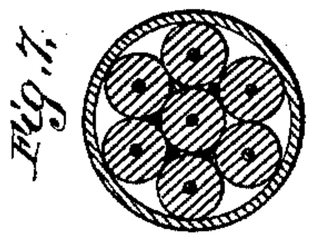


Fig. 6.

Fig. 7.



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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. 592,373, dated October 26, 1897.

Application filed July 26, 1890. Serial No. 360,083. (No model.)

To all whom it may concern:

Be it known that I, MILO G. KELLOGG, of Chicago, in the county of Cook and State of Illinois, temporarily residing at Stuttgart, in the Empire of Germany, have invented certain new and useful Improvements in Multiple Switchboards for Telephone-Exchanges, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to the telephone-exchange system described in my application, Serial No. 345,065, filed March 24, 1890, (Case No. 185.) In said application the metallic-circuit lines of the exchange are divided into four classes or divisions and the switchboards of the exchange are divided into four classes or divisions to correspond. Each line of one class is provided with a switch or switch connection 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 similarly connected to each board of its own class and to one board of each of the other classes. For each line there are four polarized annunciators. Two of the annunciators are connected in opposite polarity in one of the branches of the line at the central office and the other annunciators are connected in opposite polarity in the circuit of the other branch of the line at the central office. The two branches of the line are normally grounded at the central office. The subscriber's-station apparatus is provided with a calling-generator with commutator-pieces and with calling-keys, whereby the subscriber may include either branch of his line in a ground-circuit with his generator and send a current of either polarity to the circuit.

In the invention which I shall now describe each line has four polarized annunciators, which are connected into the circuit of the two branches, and also a calling-generator and four calling-keys, all connected and operating substantially as described above for the other application, whereby the subscriber may at will cause either of the four annunciators to indicate a call. For each subscriber there is also a private calling-wire grounded at the central office and with two polarized annunciators there connected into the circuit, so as to be operated by currents of opposite polarity. At the subscriber's station there are keys and connections by which the subscriber may at will also operate either of these annunciators, so that it indicates a call.

The lines of the exchange are divided into six classes, and the switchboards of the exchange are divided into six classes to correspond with the six classes of lines. Each line of each class has a switching connection on each board of its own class and on one board in each of the other classes. There are switch-plugs and connections whereby an operator at each board may connect together into metallic circuit any two lines which have switching connections at her board. The six annunciators of each line are located in the six sections of boards and at boards where the line has switching connections and its calls are intended to be answered. The annunciators and the switches should preferably be distributed among the boards, so that there are practically the same number of annunciators and lines to be answered at each board.

In the accompanying drawings, illustrating my invention, Figure 1 represents a complete diagram of the central-office main-line apparatus, circuits, and connections of the system. Fig. 2 shows in detail the calling-annunciators used at the central office. Fig. 3 shows a retardation-coil to be used for each line. Fig. 4 shows in diagram an operator's cord system or apparatus to be used at the boards. Fig. 5 shows in diagram a subscriber's-station apparatus to be used at each subscriber's station. Fig. 6 shows an end view of the generator-shaft of the subscriber's-station apparatus with two commutator-springs, one bearing on each side of the shaft. Fig. 7 is an end or sectional view of a cable which may be used in the exchange system herein described.

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

In Fig. 1, A' A^2 represent sectional views of sections of two switchboards of one class of boards; B' B^2, sectional views of sections of two boards of another class; C', of a board of a third class; D', of a board of a fourth class;

E′, of a board of a fifth class, and F′ of a board of a sixth class of boards. The six classes of boards are designated by the letters A, B, C, D, E, and F, respectively, to correspond. Each class of boards will have as many boards as are necessary in order to carry on successfully the switching operations required.

For convenience I call one class of lines "Class A," a second class, "Class B," a third "Class C," a fourth "Class D," a fifth "Class E," and the sixth "Class F" of lines. The lines may be each indicated in the exchange-catalogue and elsewhere by the letter or designation of its class—as, for instance, one line as "32^{A}," another "365^{B}," a third "365^{C}," a fourth "4^{D}," a fifth "15^{E}," and a sixth "15^{F}."

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 of boards. Each line of class B may have 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. In like manner each line of each of the other classes of lines has a switch on each board of a separate class of boards and upon one board in each of the other classes.

In Fig. 1 eight boards are shown, two boards belonging to each of classes A and B, and one board belonging to each of the other classes of boards C, D, E, and F. Two lines are shown, one line belonging to class A and the other to class B of lines. The calling-annunciators of these two lines and their retardation-coils are shown, six annunciators and one retardation-coil for each line. The annunciators of a line are distributed among the boards, so that one annunciator is at a board of each class and where the line has a switch and its calls are to be attended to. The other lines would in like manner have their annunciators distributed among the several classes of boards.

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 plug can be applied to it for testing and so that one of the contact-pieces of a loop-switch plug inserted into the switch will form connection with it. The switches are adapted to receive the loop-switch plugs shown in Fig. 4 and when a plug is inserted into a switch it raises the spring from the contact-point on which it normally bears and the two contact-pieces of the plug form connection with the spring and third or insulated piece of the switch, respectively.

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

a b c 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. 1 and in greater detail in Fig. 2 are polarized annunciators of known construction. Each annunciator responds or indicates a call when an electric current of one polarity passes through it, but does not respond when a current of the opposite polarity passes.

w w are retardation-coils, one for each line of the exchange. Each of these retardation-coils contains two spools or helices of insulated wire, each helix surrounding an iron core. The two cores are connected at their two ends by two cross-bars of iron. The helices are so connected together as to magnetize in the same direction the closed magnet-circuit made by the iron pieces of the coil.

R is an electric rheotome or circuit-breaker, which may be of substantially the shape 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 and as shown for the two lines shown: 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 the retardation-coil of the line and is then connected to the ground, but not through the rheotome contact-points. The other side or branch of the line passes normally successively through the several pairs of contacts *g h* of the switches of the line on the different boards, passing in each case to the spring *g* first and then successively through two other of the 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 the circuit that one is actuated by a current of one polarity and the other by a current of the other polarity passing through them.

Each subscriber has, in addition to his metallic-circuit line, a special calling-wire

which is grounded at the central office and has in its circuit the remaining two annunciators of the subscriber. These annunciators are also so connected that one of them will be operated when a current of one polarity passes through them and the other will be operated when a current of the other polarity passes.

In the operator's cord system shown in Fig. 4, D D are a pair of double or 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 indicated. 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.

The circuit connections connecting the contact-pieces of the plugs are continuous and are flexible throughout their length or to such extent as to permit the required operations.

H is a switching device for the pair of plugs and cords. This switching device has a rubber frame (marked *d*) which supports and insulates the various parts.

f f' are two contact-springs.

1, 2, 3, and 4 are contact-points located and insulated as shown and which form connections with the springs *f f'*, as will be described.

q is a sliding rod which passes through the standard of 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 this rubber piece are marked *n*, *o*, and *p*, respectively, as indicated. The rod *q* carries them in its reciprocating movement, and altogether they may be called the "commutator-piece" of the switching device. All the parts are constructed, insulated, mounted, and adjusted to perform the switching operations which I shall describe.

The button *e* and the piece *p* furnish stops for the commutator-piece, which limit its inward and outward motions.

When the commutator-piece is pushed in until its outer stop is close to or against the standard of the frame *d*, the springs *f f'* rest on piece *p*, and *f'* is in contact with 3, and *f* is in contact with 1. When the commutator-piece is pulled out into its central position and the springs rest on *o*, spring *f* is out of contact with 1 and 2 and spring *f'* is in contact with 4. When the commutator-piece is pulled still farther out and the springs rest on *n*, *f'* is in contact with 3 and *f* is in contact with 2.

t is the operator's telephone. S is her calling generator or battery. S' is her test-battery, and *u* is a resistance-coil.

Each operator has one telephone and resistance-coil and may have one generator and battery.

v is a clearing-out annunciator which may be unpolarized. 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. The two other contact-pieces of the plugs *s' s'* are connected together by the other conductor of the cords. The two cord-circuits which connect said pairs of plug contact-pieces are connected to the contact-springs *f f'* of the switching device, spring *f* being connected with *s s*, and *f'* with *s' s'*. The cord-circuits which connect *s s* and *s' s'*, respectively, are permanently continuous.

The contact-points 2 and 3 of the switching device are connected together through the operator's telephone and resistance-coil, and 1 and 3 are connected together through her calling-generator. The clearing-out annunciator is connected on one side to point 4 and on the other side to the circuit which connects contacts *s s*. The test-battery is grounded on one side and connected on the other side to the circuit-wire which connects the two telephone-coils.

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 suitably mounted for her work. The commutator-piece of each switching device should stand normally, or when it is not in use for switching a pair of lines, in its outer position, so that its springs rest on *n*.

In the subscriber's-station apparatus shown in Fig. 5, 4 is a telephone-switch. 5 is a signal-receiving bell. 6 is a calling-generator. 7 is the subscriber's telephone. 8 8 8 8 9 9 are six calling-keys, and 10 is a clearing-out switch.

The calling-generator is a usual construction of 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 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 the 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 into contact when it is pressed away from the other point by the subscriber in making a call, as hereinafter described.

The calling-keys 9 9 are two-point keys, having a point normally out of connection with the key-lever, but with which the lever comes in contact when it is pressed by the subscriber in making a call, as hereinafter indicated.

The clearing-out switch 10 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 rest a pair of contact-springs m m, while upon plates q' and u' rest pairs of contact-springs n' n' and o' o', respectively. The reciprocating block, with its parts, is held by a spring normally in the position shown. When the subscriber presses the 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 and connections 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 keys 8 8, 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 8 8, passing in each case with these keys to the contact-point first. This side thence connects with the other side or branch of the subscriber's line. The line is separated or divided 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 contact-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 8 8 whose connection with the line-circuit was first described have their lower contact-points (those upon which the lever may be pressed by the subscriber) connected to said two contact-springs, respectively, of the calling-generator, and the lower contact-points of the other two keys 8 8 are also connected to said springs, respectively. The two levers of the calling-keys 9 9 are connected to the subscriber's end of his special calling-wire, and the two contact-points of these keys 9 9 are connected to said two contact-springs, respectively, of the calling-generator.

It will be seen from the drawings and the description heretofore made of the connections and of the apparatus that when the subscriber presses on one of the two keys 8 8, whose connection with the line was first described and operates his calling-generator one side or branch of the line is disconnected from the other and has a calling-current of one polarity sent over it, and that when the other key of the pair is depressed and the generator operated a current of the other polarity will go over that branch of the line. The circuit then established is from the subscriber's ground through the contact established on his pressing the key to the branch of the line connected to the key-lever and through the circuit of that branch to its ground connection at the central office heretofore described. The subscriber can therefore operate (or cause to indicate) at will either of the two polarized annunciators connected into this branch. In like manner can the subscriber by operating his calling-generator and pressing on one or the other of his two other keys 8 8 operate at will either of the two annunciators connected into the circuit with the other branch of the line. By pressing on the lever of one of the keys 9 and operating his generator he can send a current of one polarity through the special calling-wire, and by pressing on the other key 9 and operating his generator he can send a current of the other polarity through the special calling-wire. He can therefore at will operate either of the annunciators connected in circuit with his special calling-wire. The circuit then established is from the ground through the generator and the contact established on pressing the key to the calling-wire and through its circuit to its ground connection at the central office. Any subscriber can therefore at will cause any of his six annunciators at the central office to indicate a call.

I prefer to mark or designate the six calling-keys at a subscriber's station A, B, C, D, E, and F, respectively, to correspond with the six classes of boards at which his six calling-annunciators are respectively located.

The operation of the system is as follows: When a subscriber wants to converse with any other, he finds in the exchange list or catalogue the number and designation of the line wanted. He then presses on the key corresponding with the designation or class of the line wanted and operates his calling-generator. For instance, if the line wanted belongs to class A he presses on key A, or if to class B he presses on key B, &c. He thereby calls an operator located at a board where he and the subscriber wanted each has a line-switch. The operator on observing the indication places one plug of a pair of her switch-plugs in the subscriber's switch, and her telephone is thereby included in a closed circuit with his line and she finds out by conversation what line is wanted. The circuit is complete by the pair of cords used, the

contact-springs *f f'* connected to its flexible conductors and contact-pieces 3 2, which are connected to the two sides of her telephone. When she finds out what line is wanted, she places a contact-piece 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. The operator will then 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, 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 connection which contains the operator's telephone and resistance-coil. She then pushes the commutator-piece of the switching device of the pair of cords so that the springs rest on piece *p*, and spring *f'* is still in contact with piece 3 and *f* is in contact with 1. A bridge to the metallic circuit is thereby established which contains the calling-generator and a calling-current will pass in split circuit to the two lines and operate the signal-bell of the subscriber wanted. The operator then pulls the commutator-piece out, so that the springs rest on *o*, and the two lines are in a metallic circuit which is bridged or cross-connected by the clearing-out annunciator, while neither the telephone nor the calling-generator is connected to their circuit. The connection with the annunciator is made by the closing of connection between *f'* and 4 and the circuit connections, as described.

If at any time the operator desires to listen to the circuit of the lines to determine whether conversation is finished, she pulls the commutator-piece of the switching device, so that the springs rest on 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 telephone-current from passing over her telephone-circuit when the commutator-piece is in the situation described.

If when the test was made, as described, the line had been switched at any board, the circuit of the line at the rheotome would have been open at the pair of contact-points of the switch used in switching and the operator would not distinguish the make and break of the 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 will have no occasion 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 subscriber's generator is disconnected from its ground connection and is looped into the circuit of the two lines, and a calling-circuit will go through the circuit and will operate the clearing-out annunciator which is in it. The operator who made the connection will thereby know that the subscribers wish to be disconnected or cleared out.

It will be observed that when the subscribers are connected together, as described, and the position of the commutator-piece of the switching device of the pair of cords is such that the openings *f f'* rest on *o*, the metallic circuit of the two lines is bridged or cross-connected at the central office by a circuit which contains the clearing-out annunciator of the pair of cords. The clearing-out annunciators should preferably be of high resistance and such as to afford considerable retardation to the passage of telephone-currents It will also be observed that when the commutator-piece is in one of its other two positions the metallic circuit is bridged or cross-connected by the operator's telephone, and when it is in its third position the circuit is bridged by the generator.

It will be observed that when the two lines are connected together for conversation their circuit is grounded at the central office through part of their annunciators and their retardation-coils. The retardation-coils prevent or minimize the effect on the circuit which might arise from other metallic circuits connected in like manner to the ground. The annunciators themselves offer a retardation to any such effect, and the use, size, and construction of the special retardation-coils will depend on the construction and conditions of the other apparatus and circuits of the exchange. The retardation-coils also provide a resistance which will decrease the amount of calling-current passing through the annunciators connected with them when the clearing-out signal is sent in.

In metallic-circuit exchanges of large size the lines will generally be in cables. The special calling-wires, which I have described as a part of the system, may be copper wires of small diameter. There is no other apparatus than the subscribers' generators and the calling-annunciators to operate in circuit with them, and it is not material to have the resistance small. In the system shown and described there is but one strand or wire for the calling-wire for each subscriber, and there are two insulated strands or wires for his metallic circuit. In the cables used in this system I plan to use copper wires of small diameter for the calling-wires, each placed in a space or angle formed in laying up the insulated metallic-circuit conductors in the usual way, so that each calling-wire will be in a separate angle or space between the

insulated conductors and said wires will be insulated and held apart by said insulated conductors. No other insulation in the cable need be provided for the calling-wires and they need not increase the size and will not greatly increase the cost of the cables. Fig. 7 shows an end or sectional view of a cable such as I have described.

More than one calling-wire may be used for each line of the exchange, each connected as described and provided with calling-keys and annunciators, as described for the calling-wires. In this way the subscribers may be provided with a greater number of annunciators than the six shown and described, and the lines and the switchboards may be divided into a greater number of classes to correspond and connected substantially as indicated, with one connection for each line on each board of its class and on one board of each of the other classes, and at boards where the line has annunciators.

It is also evident that one of the six calling-annunciators shown for each line may be left out of its circuit and the lines and boards may be divided into five sections or classes, with a switch for each line on each board of its class and on one board of each of the other classes and an annunciator for each line placed at a board of each class and where the line has a switch. Other annunciators for the several lines may in like manner be left out of the respective circuits, and a less number of divisions or classes of lines and boards made to correspond.

I use the terms "bridge" and "cross-connect" in connection with a complete metallic circuit to describe a connection between one side or branch of a circuit and its other side or branch, and an instrument in a bridge or cross-connecting circuit to the metallic circuit is not in the direct circuit, but is in a circuit connection across the two sides or branches of the metallic circuit.

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

1. In a telephone-exchange system, the combination of metallic-circuit lines divided into six classes, the switchboards divided into six 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, six polarized annunciators for each line, one being located in each class of boards and at a board where the line has a switch, two being connected in opposite polarity in one branch of the line, two others being connected in opposite polarity in the other branch of the line and the other two being connected in opposite polarity in a special calling-wire for the line, electric calling apparatus and keys or 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 his line or his special calling-wire to the office ground, and switch-connecting apparatus whereby the operator at any board may connect together any two lines which have their switches at the board substantially as set forth.

2. In a telephone-exchange system, the combination of metallic-circuit telephone-lines divided into five classes, switchboards divided into five 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, each branch of each line being normally grounded at the central office, a special calling-wire for each line, two polarized annunciators connected in opposite polarity in each of the two branches of each line in four of said classes at boards where the line has switches, an annunciator in the special calling-wire for the line located at a board of the other class where the line has a switch, electric calling apparatus, and keys or switches at the subscriber's station whereby the subscriber may at will send a calling-current of either polarity from his ground through either side or branch of his line to its central-office ground or may send a calling-current through his special calling-wire, and connecting apparatus whereby the operator at any board may connect together any two lines which have their switches at her board, substantially as set forth.

3. In a telephone-exchange system, the combination of metallic-circuit lines divided into five classes, switchboards divided into five 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, each branch of each line being normally grounded at the central office, two polarized annunciators connected in opposite polarity in one branch of each line, an annunciator connected in the other branch of the line, a special calling-wire for each line, two polarized annunciators connected in opposite polarity in said special calling-wire, said five annunciators of each line being located in the five classes of boards at boards where the line has switches, electric calling apparatus whereby any subscriber may send a calling-current of either polarity through either the said first-mentioned branch of his line or his special calling-wire, or send a calling-current through the other branch of his line, and connecting apparatus whereby the operator at any board may connect together any two lines which have their switches at her board, substantially as set forth.

4. In a telephone-exchange system, the combination of metallic-circuit lines divided into four classes, switchboards divided into four 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, each branch of each line being normally grounded

at the central office, a special calling-wire for each line, two polarized annunciators connected in opposite polarity in one branch of the line, an annunciator in the other branch of the line, an annunciator in the special calling-wire of the line, the four annunciators of the line being located at boards in the four classes of boards and where the line has switches, electric calling apparatus whereby the subscriber may send a calling-current of either polarity through said first-mentioned branch of his line and may send a calling-current through the other branch of the line and through his special calling-wire, and connecting apparatus whereby the operator at any board may connect together any two lines which have their switches at her board, substantially as set forth.

5. In a telephone-exchange system, the combination of metallic-circuit lines divided into four classes, switchboards divided into four 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, each branch of each line being normally grounded at the central office, a special calling-wire for each line, two polarized annunciators connected in opposite polarity in the special calling-wire, and an annunciator in each branch of the line, the four annunciators of a line being located at boards in the four classes of boards, and where the line has switches, and electric calling apparatus whereby the subscriber may send a calling-current of either polarity through his special calling-wire or a calling-current through each branch of his line, and connecting apparatus whereby the operator at either 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 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, a special calling-wire for each line, an annunciator in each branch of the line, an annunciator in the special calling-wire of the line, the three annunciators of the line being located in the three classes of boards and where the line has switches, electric calling apparatus whereby the subscriber may send a calling-current through either branch of his line and through his special calling-wire, and connecting apparatus whereby the operator at any board may connect together any two lines which have their switches at her board, substantially as set forth.

7. In a subscriber's-station apparatus, four calling-keys normally in the circuit of his metallic-circuit line, a calling-generator having commutator parts and connections for taking currents of either polarity and circuits and connections whereby the subscriber may on operating his generator and pressing on one and another of his calling-keys disconnect the two branches of his line from each other and send through each a current of either polarity, substantially as set forth.

8. In a telephone-exchange system, a metallic-circuit line, and four calling-keys at the subscriber's station, each having a lever normally in contact with a point and another point with which the lever comes in contact when it is pressed by the subscriber away from its other point, said line passing successively through the contacts of the keys normally in contact passing in two of the keys to the levers first and in the other two keys to the points first, in combination with a magneto-generator having a commutator-piece and two commutator-springs for taking currents of the two polarities, the two commutator-springs being connected to the two points respectively not in normal contact with the levers of the first-mentioned keys and also to the similar points respectively of the other two keys, said commutator-pieces being connected to one end of the armature-coil and the other end of the coil being connected to the ground, substantially as set forth.

9. In a telephone-exchange system, the combination of the lines divided into six classes, the switchboards for said lines divided into six 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 five other classes, signaling apparatus for each line giving at the will of the subscriber six indications, one 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 at the board may connect together any two lines which have their switches at her board, substantially as set forth.

10. In a telephone-exchange system, the combination of the lines divided into five classes, switchboards for said lines divided into five 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 four other classes, signaling apparatus for each line giving at the will of the subscriber five indications, one 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 at the board may connect together any two lines which have their switches at her board, substantially as set forth.

11. In a switching device, two circuit-changing springs *f*, *f'*, placed centrally, the outer points 1, 4, and the inner points 2, 3, all in the same plane and insulated from one another, in combination with the commutator-piece *n*, *o*, *p*, provided with commutator-surfaces in different planes, against which the springs *f*, *f'*, alternately press as the commutator-piece is moved to its different posi-

tions there being three surfaces against which spring *f* alternately presses, each of which is farther than the other from the center of the commutator-piece in its line of motion, there also being three surfaces against which spring *f'* alternately presses, the middle surface being farther from such center of the commutator-piece, and the two other surfaces being in the same plane with each other, whereby in the first position of the commutator-piece springs *f f'* are in contact with the points 2 and 3, respectively, in the second position of the commutator-piece, *f'* is in contact with 4 and *f* out of contact with 2, and in the third position of the commutator-piece, *f*, *f'*, are in contact with 1 and 3, respectively, substantially as set forth.

In witness whereof I hereunto subscribe my name this 23d day of June, 1890.

MILO G. KELLOGG.

Witnesses:
EMIL ABENHEIM,
C. STRICH-CHAPELL.