(No Model.)

3 Sheets—Sheet 1.

M. G. KELLOGG.

MULTIPLE SWITCHBOARD.

No. 592,422. Patented Oct. 26, 1897.

Fig. 1.

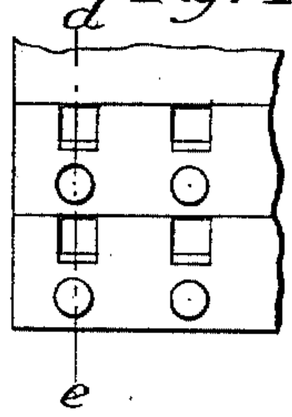


Fig. 4.

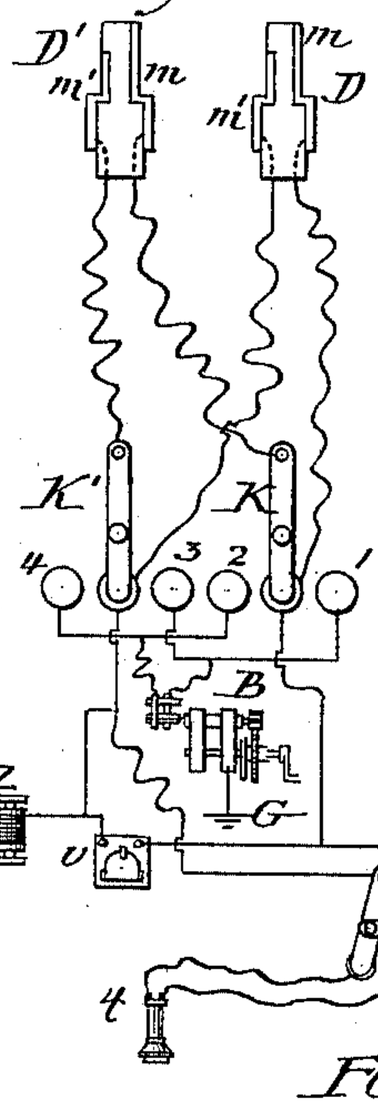


Fig. 4a.

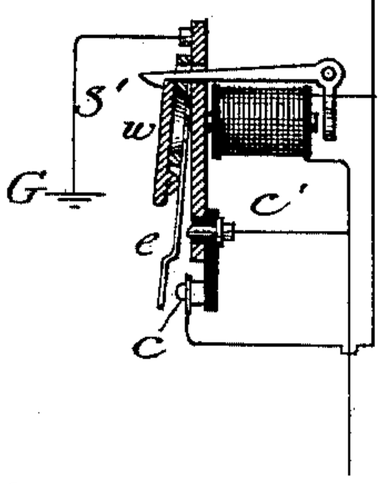


Fig. 5.

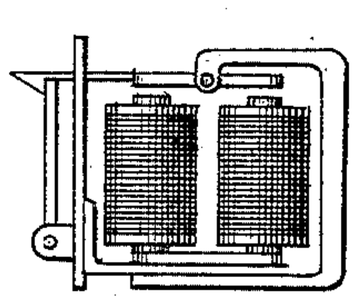


Fig. 7.

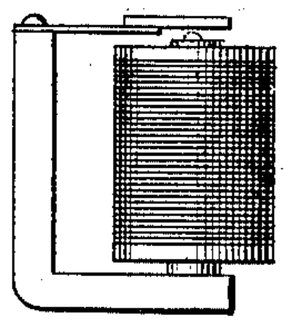
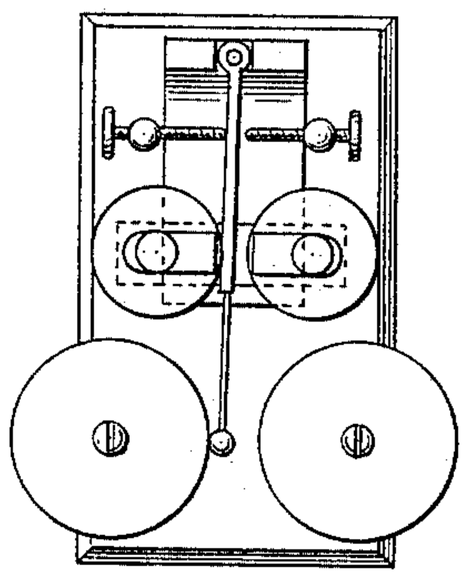


Fig. 6.

Fig. 8.



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B. F. Miller.

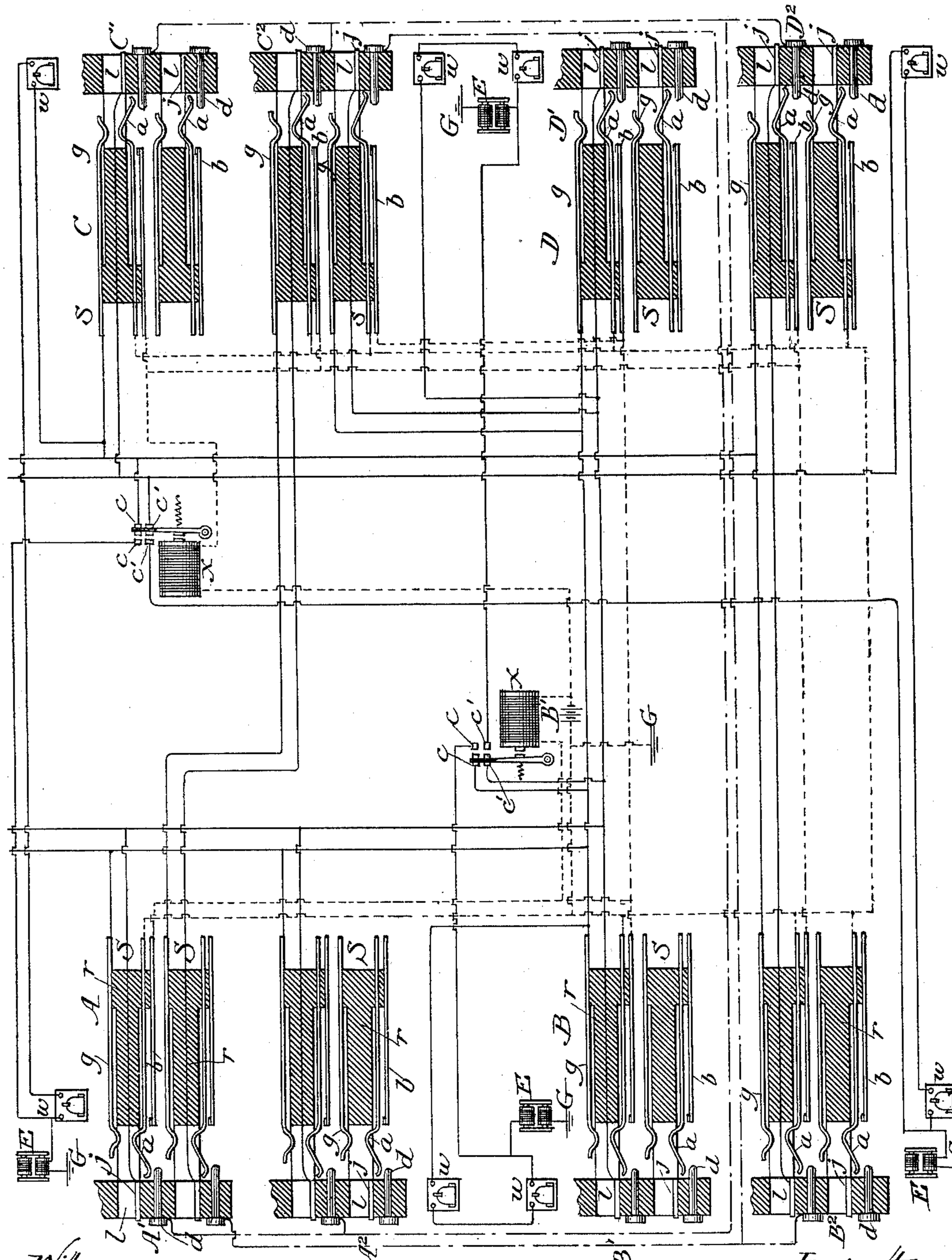
Inventor:
Milo G. Kellogg,
By Bby his Attorneys,
Baldwin Davidson & Wright

(No Model.) 3 Sheets—Sheet 2.

M. G. KELLOGG.

MULTIPLE SWITCHBOARD.

No. 592,422. Patented Oct. 26, 1897.



Witnesses:
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B. H. Miller.

Fig. 2.

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(No Model.)

3 Sheets—Sheet 3.

M. G. KELLOGG.

MULTIPLE SWITCHBOARD.

No. 592,422. Patented Oct. 26, 1897.

Fig. 3a.

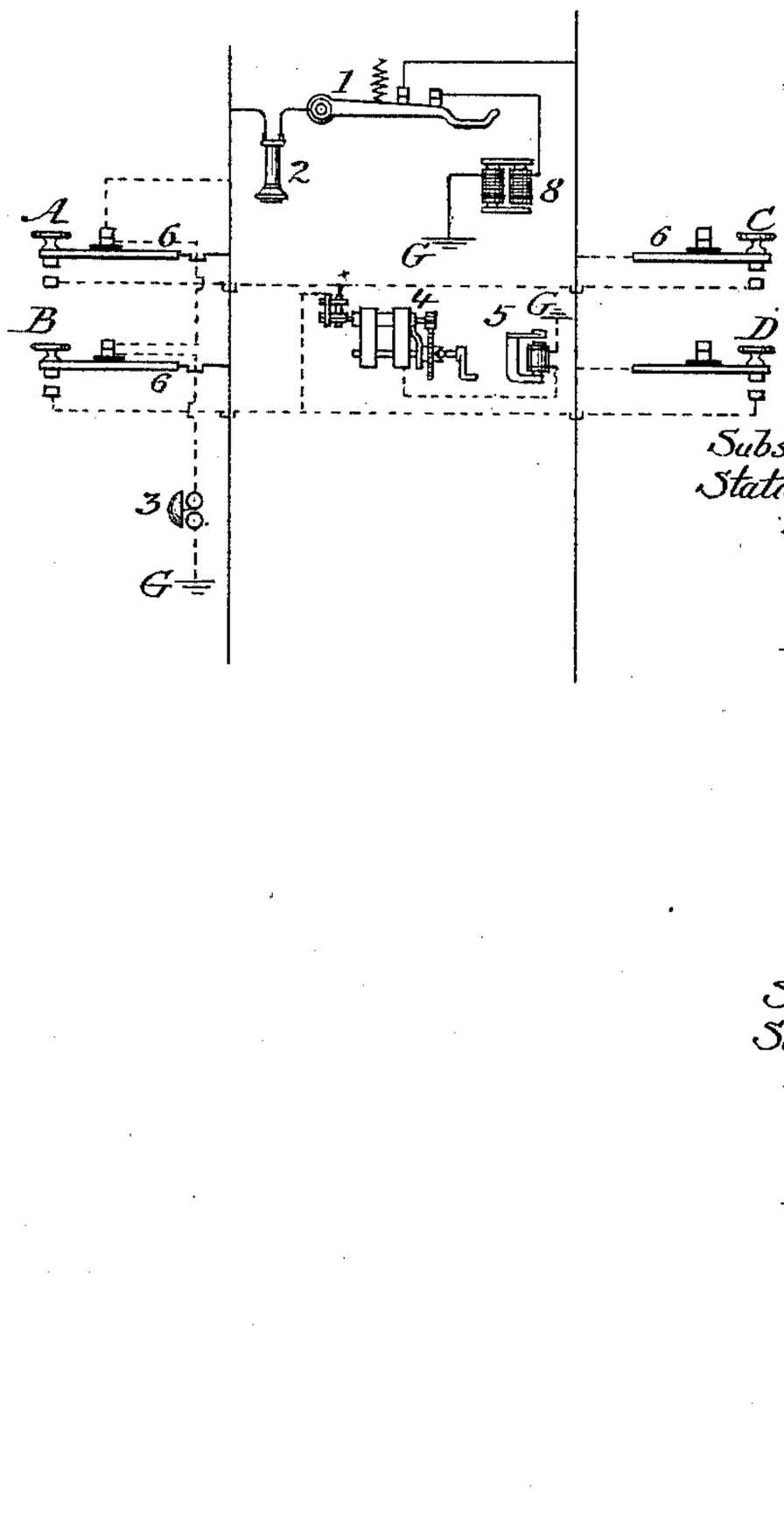
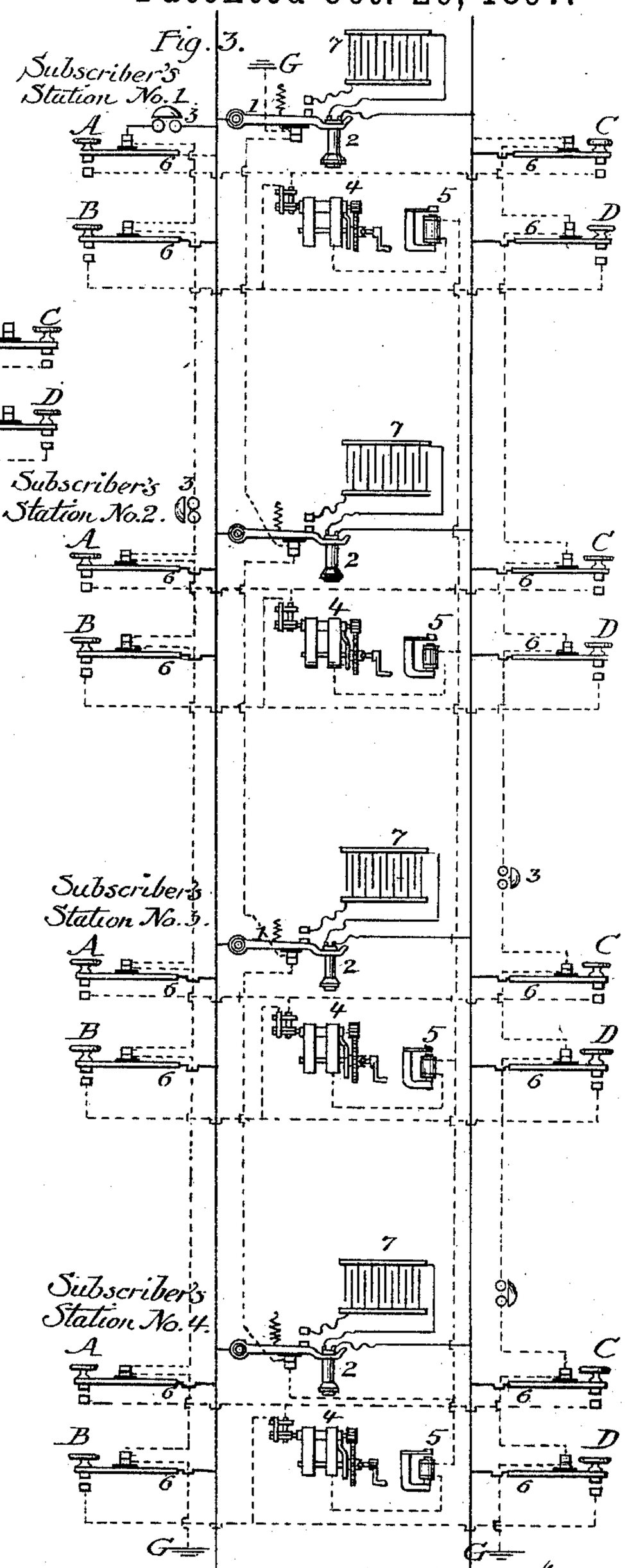


Fig. 3.



Witnesses:
Frank S. Blanchard
B. W. Miller.

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

UNITED STATES PATENT OFFICE.

MILO G. KELLOGG, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF SAME PLACE.

MULTIPLE SWITCHBOARD.

SPECIFICATION forming part of Letters Patent No. 592,422, dated October 26, 1897.

Application filed February 21, 1895. Serial No. 539,255. (No model.)

To all whom it may concern:

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

My invention relates to the telephone-exchange system described in my Patents No. 424,310, dated March 25, 1890, and No. 427,087, dated May 6, 1890, which system is generally known as the "divided exchange" system of multiple-switchboard operation. It relates to certain improvements of said system adapting the same to a metallic-circuit telephone-exchange system.

Certain features of my invention, which I shall describe and claim, are also applicable to metallic-circuit telephone-exchanges which are not operated on the divided exchange system.

In the system which I shall herein describe the lines of the exchange are divided into four classes or divisions and the sections of multiple switchboards are divided into four classes or divisions to correspond. Each line of one class is provided with a switch on each section of board of its class of boards and on one section of each of the other classes. Each line of the other classes is provided with a switch on each section of board of its class of boards and on one section of each of the other classes. For each line are four polarized annunciators placed in the four classes of boards and at a section where the line has a switch and its calls are to be answered. The annunciators should be preferably distributed approximately equally among the sections of the class of boards to which they belong. Two of the annunciators of each line are connected in opposite polarity in a ground connection to one side or branch of the line and the other two annunciators of the line are connected in opposite polarity in a ground connection to the other side or branch of the line. In each of these ground connections of a line is a retardation-coil. A local circuit containing an electromagnetic device is provided for each line with contacts by which when the line is switched for conversation at either board said annunciators in said ground connections which contain the annunciators of the line are automatically short-circuited, while said retardation-coils are not short-circuited, and when the line is disconnected from the line or connection with which it is switched the normal ground connections through the annunciators are automatically reëstablished by the opening of such short circuits. The calling-generator at each subscriber's station has commutator devices and keys or switches whereby the subscriber may at will when the line is not switched, as hereinafter described, send a current of either polarity from ground through either side or branch of the line to ground at the central office through the normal ground connection, which contains two of the polarized annunciators, and thus be enabled at will to operate either one of his four annunciators and call an operator at either of the divisions of boards and at a board where his line has a switch and it is intended his calls shall be attended to. Each operator has pairs of switching-plugs with cords and calling, answering, and clearing-out apparatus for the same, by which she may at will connect with any line connected at the board, answer their calls, connect the line with the line wanted, ring the bell of the subscriber wanted, connect a clearing-out annunciator in a bridge connection to the metallic circuit of the lines connected together for conversation, and test any line to determine whether or not it is switched for conversation. The local circuit of each line, which automatically short-circuits the annunciators of the line from the normal ground connections, is also utilized for the test system, as will be explained in detail.

The invention which I shall herein illustrate and describe shows apparatus whereby four subscribers' stations may be operated on one telelephone-line and each subscriber be enabled to call an operator at either of the divisions of board without signaling or disturbing either of the other subscribers on his line and the operator at the board where the call is indicated may connect directly with the subscriber who called and find out what

other subscriber is wanted and connect the calling-line directly with the line of the subscriber wanted. If the subscriber wanted by any other subscriber is one for which one line serves two subscribers, the operator in calling on this line rings the bell of the subscriber wanted and not the bell of the other subscriber. Thus when either a subscriber or an operator calls on a line on which there are four subscribers' stations the station wanted, whether it be the central office or a subscriber's station, is promptly called, while there is no call indicated at either of the other stations to attract unnecessary attention. While four subscribers can be served with one line, one, two, or three subscribers may also be served by one line. One feature of the system is that both the subscribers and the operators of the exchange perform substantially the same operations in obtaining and answering calls whether the line has one or two or more subscribers' stations on it, and these operations are substantially the minimum in number and take substantially the smallest amount of time required in any telephone system to obtain connection and service between two subscribers' stations. The four-division exchange which I have outlined and which I shall describe will readily, in the present state of the art as to the construction of switches, annunciators, &c., provide switching facilities for twenty-five thousand lines. Each line, as heretofore stated, can serve for four subscribers. Thus one hundred thousand subscribers' stations can be operated from one central station without trunk-line connections between boards and the service obtained be as prompt and require substantially no more labor or expense per connection than would be required in a little village exchange of one hundred subscribers where an operator makes the connections directly between one subscriber's line and another. While four subscribers' stations can be served by one line, yet in very many cases the telephone business of a subscriber is so great that true economy and good service require an individual line for him. On the other hand, especially in residence districts, the subscriber uses his telephone but a few times each day and then but for a few minutes. In such cases two or more subscribers' stations can be satisfactorily served by one line. Of course the telephone rates would be less per subscriber when two are served by one line. This fact, taken in connection with the relative advantages of having an individual line, would determine in each particular case which kind of service the subscriber would choose. It is safe, however, to estimate that the exchange system which I herein illustrate and describe would accommodate and give good and prompt exchange service to about fifty thousand subscribers' stations located on the twenty-five thousand lines.

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 to correspond with the four classes or divisions of lines and two lines connected thereto, one of each class A and C of lines and their central-office apparatus and connections. Fig. 3 shows in detail four subscribers'-station apparatus to be used at four subscribers' stations on one line with the circuit connections between them. Fig. 3^a shows the connections of a subscriber's-station apparatus where only one station is placed on a line. Fig. 4 shows in diagram an operator's cord system or apparatus to be used at the boards. Fig. 5 shows in detail a polarized call-annunciator which may be used in the system. 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. 4^a shows a clearing-out annunciator which may be employed. Fig. 7 shows in detail a buzzer or electromagnetic device which may be used at each subscriber's station. Fig. 8 shows in detail a polarized call-bell which will respond to only one polarity of current and which may be used at the subscriber's station.

G in each case represents a ground connection.

In Fig. 2, A' A^2 represent two boards of one class of boards; B' B^2, two boards of a second class of boards; C' C^2, two boards of a third class of boards, and D' D^2 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. As many sections or boards of each class or division of boards may be used as is found necessary or convenient for the number of operators required to answer the calls which are made to that class of boards. For convenience in designation I call one class of lines "Class A," a second class "Class B," a third class "Class C," and the fourth class "Class D" of lines to correspond with the designation of the different classes of board. 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 designation of the various classes of boards and lines and of the lines in each class is material so long as the division is made and the distinction kept up. Where several subscribers' stations are placed on one line, each line may have the designation as indicated above, while for the subscribers themselves numeral indications may be added. Thus if line 32^A has four subscribers' stations these stations may be indicated as "$32^{A'}$," "32^{A2}," 32^{A3}," and "32^{A4}."

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

Each line of class C has a switch on each board of class C of boards and on one board of each of the other classes.

Each line of class D has a switch on each board of class D of boards and on one board of each of the other classes.

The line-switches are marked S S. Each switch has two contact-pieces, (marked *g j*,) with which, respectively, the two contact-pieces of the loop-switch plugs shown in Fig. 4 and marked D D′ are connected when a plug is placed into the switch for switching. These contact-pieces *g j* are connected with the main-line circuit, as will hereinafter be described, and may therefore be called the "main-line" contacts of the switch. Each switch has also three other contact-pieces, (marked *a*, *b*, and *d*,) which are insulated from said other contact-pieces and are normally out of contact with each other; but when a switch-plug is inserted into a switch it presses the contact-piece *a* into contact with *b* and *d*. When the plug is withdrawn, the contact of *a* with *b* and *d* is automatically broken. The contacts *a*, *b*, and *d* are connected to the local system for disconnecting the annunciators and for testing, as will be described, and may be called the "local" contacts of the switches. The last-mentioned contact-piece *d* is at or extends to or near the front of the switch, so that an operator's test contact-piece may be readily connected to it for testing.

l l are the switch-holes, adapted to receive the plugs, and *r r* are the rubber pieces, on which the metal parts are mounted.

The loop-switch plugs shown in Fig. 4 and adapted to be inserted into the line-switches are of the shape substantially as shown and each plug has two contact-pieces, (marked *m m′*.) When a plug is placed into a switch, its contact *m* forms connection with the contact *g* of the switch and its contact *m′* forms connection with the contact *j* of the switch, while the rubber insulation of the plug presses the piece *a* of the switch into contact with the pieces *b* and *d*. The switches and plugs may be of the shape and construction substantially as shown. They may, however, be greatly changed in shape and construction and yet have substantially the same switch parts operating in substantially the same manner or forming substantially the same connections as heretofore described.

w w are the line polarized annunciators, of which there are four for each line, one for each line being located in each division of boards and at a board where the line has a switch and its calls are to be answered.

E E are retardation-coils, of which there are two for each line.

x x are the electromagnetic devices, of which there is one for each line, constructed and arranged for the purpose of short-circuiting the annunciators from their ground connection while the line is switched for conversation. This device consists substantially of an electromagnet and an armature for the same, with a retractile spring and two pairs of contacts, (marked *c c* and *c′ c′*, respectively,) which are insulated from each other and are open when no current passes through the helix, but are automatically closed by the movement of the armature, so as to be closed while current is passing through the helix. The electromagnetic device is in fact a front-contact relay with two pairs of insulated contacts.

The main-line connections are as follows and as shown: One side or branch of the line is connected to one of the main-line contacts of each of its switches on the several boards, say to contact *g*. It is also connected to the ground through two of the polarized annunciators of the line connected in opposite polarity and thence through one of the retardation-coils of the line. One of the insulated contacts of a pair, say of *c c*, of the electromagnetic device of the line is connected to one of the ground connections on one side of the annunciators. The other contact of *c c* is connected to the other side of the annunciators, but the retardation-coil is not between the two connections. The other side or branch of the line is connected to the other main-line contacts of its switches, say *j j*, and is connected to the ground through the other two polarized annunciators of the line connected in opposite polarity, and thence through the other retardation-coil of the line. One of the contacts of the other pair of contacts, say *c′ c′*, of the electromagnetic device is connected to the ground connection on one side of these annunciators, while the other contact of *c′ c′* is connected to the ground connection on the other side of these annunciators, but the retardation-coil is not between the two connections.

The local connections of the system are substantially as follows: All of the contacts *a a* of all the switches of the exchange are connected together by a grounded circuit connection. One side of the battery B′ is connected to this circuit connection. All of the contacts *b b* of all of the switches of any given line are connected together and are also connected to one side of the electromagnetic device *x* of the line, while the other side of the electromagnetic device of the line is connected to the other side of the battery B′ than that side which is connected to the contacts *a a* of the switches. The contacts *d d* of each line are connected together.

The circuit connections, both main-line and local, are shown substantially as above de-

scribed. For clearness of illustration the main-line circuits and connections are represented by solid lines and the local circuits and connections are represented by broken lines.

Fig. 3 shows in diagram the apparatus for four subscribers' stations on one line, with the apparatus, circuits, and connections connected therewith to show my invention. The apparatus for the different stations are marked "Subscriber's station 1," "Subscriber's station 2," "Subscriber's station 3," and "Subscriber's station 4." The apparatus at each station contains substantially the telephone-switch, (marked 1,) the subscriber's telephone, (marked 2,) his signal-receiving bell, (marked 3,) his calling-generator 4, a buzzer or non-polarized signal-receiving device, (marked 5,) four calling-keys, (marked 6 6 6 6,) and a condenser, (marked 7.)

The telephone-switch 1 is a usual form of automatic switch which may close certain contacts when the telephone is on the switch and opens them and close other contacts when the telephone is taken off the switch. The telephones are shown on the switches. This is their normal position, and a telephone is removed from the switch when it is desired to use it for conversation. The switch has a pair of contacts normally closed, but open while the telephone is off the switch, and another pair of contacts insulated from the first-mentioned pair, which are normally open, but are closed when the telephone is off the switch.

The subscriber's telephone 2 is shown as the ordinary hand-telephone. However, the usual telephone-outfit with battery-transmitter and magnet-receiver may be used and its application to the system shown will be apparent to those skilled in the art.

The subscriber's signal-receiving bell 3 (shown in greater detail in Fig. 8) is a polarized bell and is so constructed that it sounds or responds when an intermittent current of one polarity passes through it, but does not sound or respond when the current of the other polarity passes through it.

The subscriber's calling-generator 4 is a usual construction of telephone magneto 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 in Fig. 6. There are two stationary insulated 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. The contact-springs are so placed in relation to the armature that one of them is in contact with said insulated piece on the shaft when a current of one polarity is generated in the coil and the other is in contact with it when a current of the other polarity is generated.

The buzzer device 5 (shown in greater detail in Fig. 7) is so constructed that it will sound whenever intermittent currents of either polarity pass through it. The use of this device will be described later when the operation of the system is described.

The calling-keys 6 6 6 6 each have two pairs of contacts insulated from each other, one pair of which is normally closed and the other normally open. When the key-lever is depressed, it opens the normally closed pair of contacts and closes the normally open pair of contacts.

The condensers 7 7 are such as are suitable for use in circuits through which telephone connection passes.

The circuits of the subscriber's-station apparatus, as shown in Fig. 3, are as follows: Each side or branch of the metallic-circuit line passes to subscribers' stations 1, 2, 3, and 4. A wire branches off from one of said sides or branches of the line and passes successively through the normally closed pair of contacts of two of its keys 6 6—A and B, for example. It then passes in the same manner through two of the keys 6 6 of the other stations 2, 3, and 4 and thence to the ground. In like manner another wire branches off from the other side or branch of the line and passes successively through the normally closed pair of contacts of the keys C D at each of the subscribers' stations 1, 2, 3, and 4, and thence to ground. In one of the wires thus branching off are placed two of the subscribers' polarized signal-receiving bells, one at each station, so connected in the circuit that one of them will sound when an intermittent current of one polarity passes through it, and only then, and the other will sound when an intermittent current of the other polarity passes through it, and only then. On the other wire and similarly connected and located at the other stations are placed the two other polarized bells. One of the spring-contacts of the subscriber's generator is connected to one of the normally open contacts of two of the keys 6 6, as A C, one connected in each side or branch of the line. The other spring of the generator is connected to the two similar contacts of the keys, as B D. The other side of the normally open contacts of key A B are connected to one side or branch of the line, and the similar contacts of keys C D are connected to the other branch of the line.

One side of the armature-coil of the generator is connected to the insulated contact-piece on the armature-shaft. The other side of the coil is connected to the frame of the generator. The frame is connected to the buzzer of the subscriber's station and thence to a local wire between the stations. This local wire then passes successively by a conductor through the normally closed contacts of the switches 1 1 of the several stations and thence to the ground. The main wires are represented by solid lines and the branch wires, which pass through the normally closed

pairs of contacts of the keys and switches, are represented by broken lines.

The pair of contacts of each telephone-switch 1, which are normally open, but are closed when the telephone is removed from the switch, are in a bridge connection between the two sides of the line, which bridge connection contains the subscriber's telephone 2 and his condenser 7.

In Fig. 3ª the connections of the subscriber's-station apparatus are shown when only one subscriber's station is used on the line. The apparatus and connections are substantially as follows: The parts are substantially of the character shown in Fig. 3. One side of the line has a circuit-wire which passes through the normally closed pairs of contacts of the keys A B and through the calling-bell 3 to ground. The four calling-keys A B and C D are connected to the two sides of the line and to the spring of the calling-generator 4, the same as in one of the stations shown and described for Fig. 3. The calling-generator is of the same construction as that shown and described for Fig. 3. The switch 1 bridges the subscriber's telephone between the two sides of the line when the telephone is removed from the switch. 8 is a retardation-coil through which is grounded when the telephone is switched for use that side of the line which is not normally grounded through the signal-receiving bells. The switch 1 shows a pair of contacts and connections for thus grounding the line through the retardation-coil. It is immaterial to what point of the line this ground connection through the retardation-coil is made providing the subscriber's telephone is between it and the ground connection through the bell.

Two or three stations may be used on one line and their apparatus and connections be substantially the same as shown in Fig. 3. When two stations only are connected on one line, the branch calling-wire connected to one side of the line and containing two of the signal-receiving bells may of course be omitted, or if both branch calling-wires are used a signal-bell may be placed in each. The application to the system and the circuit connections to a less number of stations than four on one line will be apparent to those skilled in the art. The order in which the wires branch off from the sides or branches of the lines and pass successively through the normally closed pairs of contacts of the switches 6 6 is immaterial. For instance, the wires may branch off from the sides of the line at the subscriber's station 4 and pass back through the pairs of contacts of the keys 6 6 and the signal-receiving bells to subscriber's station 1, and thence to ground.

In the system which has been described for Figs. 3 and 3ª the signal-receiving-bell apparatus should be so constructed that it offers great retardation to telephone-currents, but does not offer too great a resistance to the calling-currents to prevent the bells from being operated from the central office. This can be easily accomplished by those skilled in the art.

In the operator's cord system shown in Fig. 4, D D′ are a pair of loop-switch plugs, the construction and operation of which, when the same are inserted into the line-switches, are as have heretofore been described.

K K′ are two calling switches or keys for the pair of plugs. Each consists, substantially, of a key-lever resting normally on a contact-bolt and with two other bolts, on either of which at will the lever may be placed by the operator. These switches may be greatly changed in form and yet produce substantially the switching operations described.

B is the operator's calling-generator, with contact-spring, commutator-piece, and general construction such as the calling-generator's shown in Fig. 3, as heretofore described, whereby intermittent current of either polarity may be generated.

v is the clearing-out annunciator for the pair of cords, which may be non-polarized, and which should preferably have contacts, as shown in Fig. 4ª, whereby the annunciator-magnet is grounded on both sides while the annunciator indicates a call.

Y is a looping-in switch with two movable levers and two pairs of contacts, on which the levers may be alternately placed at the will of the operator.

t is the operator's telephone.

z is a retardation-coil for the operator's telephone, connected on one side to one side of the telephone, as shown, and on the other side to one side of the test-battery B^2, which is grounded on the other side. Each operator has as many pairs of plugs with their flexible cords as she may require to answer the calls and attend to the lines required, and for each pair of plugs has two calling switches or keys K K′, a looping-in switch Y, and a clearing-out annunciator *v*. Each operator's telephone has its retardation-coil *z*. One calling-generator, which should preferably be a power-generator, may answer for several operators.

The connections of the operator's cord apparatus are as follows and as shown: The contact-piece *m* of plug D′ is connected to the lever of switch K and the contact-piece *m′* of that plug to the lever of switch K′. The contact *m* of plug D is connected to the contact-piece with which the lever of switch K is normally in contact. *m′* of that plug is connected to the similar contact-piece of switch K′. The contact-pieces with which the lever of switch K may be alternately placed in contact are marked 1 and 2, respectively. The similar contact-pieces of switch K′ are marked 3 and 4, respectively. The contacts 1 and 3 are connected together and to one of the commutator-springs of the generator B. Contacts 2 and 4 are also connected together and are connected to the other commutator-spring of the generator. The frame of the generator is connected to

ground. Contact-piece *m* of plug D is connected to the contact-piece of the switch K, with which the lever is normally in contact, and contact-piece *m'* of the plug is connected to the similar contact-piece of switch K'. These two last-mentioned contact-pieces of the switches K K' are connected to the two sides, respectively, of the annunciator *v* and to the two levers, respectively, of the switch Y. The two sides of the operator's telephone *t* are connected to the two contact-bolts, respectively, on which the levers of the switch Y normally rest. The retardation-coil *z* is connected to the circuit so that the telephone *t* is between it and contacts *m m* of the plugs. The parts of the operator's cord system should be suitably mounted and arranged for her work, and the flexible conducting-cords should be long enough so that she may reach any line-switch at her board.

It is evident from the apparatus shown and described above that the operator may by moving the lever of the switch K in one and the other direction send intermittent current of one or the other polarity from ground to the side of the line-circuit which is connected to contact *m* of the plug D' and to ground at the outer end of that side of the line through its two signal-receiving bells 3 3, as shown in Fig. 3. In like manner she may by removing the levers of the switch K' send intermittent current of either polarity over the side of the line which is connected with contact-piece *m'* of plug D and to ground at its outer end through its two bells. The contact-pieces of the switches K K' may be marked 1, 2, 3, and 4, respectively, and the stations on each line designated and connected accordingly, so that when the operator places a lever on piece 1 it will ring the bell at station 1, when on piece 2 it will ring the bell at station 2, when on piece 3 it will ring the bell at station 3, and when on piece 4 it will ring the bell at station 4. Thus the operator can readily know what movements to make to ring the bell of any station connected to her switchboard.

The operation of the system is as follows: When a subscriber wishes to converse with any other subscriber, he finds out in the exchange-list or otherwise the designation or division to which the line belongs. He then by pressing the proper key and operating his generator causes his annunciator, which is located at a board of the division to which the line wanted belongs, to indicate a call. For instance, if the line wanted belongs to division A he would on calling press on his key A; if it belongs to division B, he would press on key B; if to division C, on key C, and if to division D on key D. If when he thus presses on one of his keys and operates his generator his line is not switched at the central office and neither his own telephone nor the telephone of any other subscriber on his line is switched for conversation, his generator is in closed circuit with the annunciator located at the board wanted and current will pass through the circuit of that polarity, which will operate the annunciator and attract the attention of the operator at the board wanted. This closed circuit is from ground at the central office through the line-annunciators to one side or branch of the line, thence to the subscriber's station, thence through the pair of contacts closed by pressing the key, thence through the subscriber's generator, thence to the local-circuit connection of the generator, and thence successively through the closed pairs of contacts of the telephone-switches 1 1 of the line to ground. The subscriber will then take his telephone from his switch, thus automatically disconnecting his calling-generator from the ground at its outer end and bringing his telephone and its condenser in a bridge between the two sides of the line. The operator on noticing the call on the annunciator will place one of her loop-plugs D into the switch of the line, its switch being then so that her telephone bridges between the two sides of the line. The act of placing the plug in the switch automatically short-circuits the annunciators of the line from its ground connections, as will hereinafter be described. The subscriber's and the operator's telephones are thus brought into closed circuit with each other, and the operator finds out what line is wanted. She then tests the line wanted, as will hereinafter be described, and if she finds that it is free or unswitched she places the other plug D' of the pair into the switch of this line. This act also short-circuits the annunciators of this line from its ground connection through them and its retardation-coils. She then moves the lever of the switch K or K' which is connected to the last-mentioned plug so that it is in position to send current of the polarity to operate the bell of the subscriber wanted, and the bell will be rung. When the bell of the subscriber wanted is rung, he also takes his telephone from its switch, thus connecting his telephone in a bridge between the two sides of his line and disconnecting the calling-generator circuit from its ground connection at its outer end. The operator then moves her switch Y so as to disconnect her telephone from the circuit. The two subscribers' telephones being thus in closed circuit with each other, they carry on their conversation. When they are through conversation, they place their telephones on their switches, and thus automatically establish the ground connections of their generators at the outer ends. Either subscriber may then send a clearing-out signal by operating his generator and pressing on either of his four calling-keys. Current will pass from ground through the branch of the line to which the key is connected to the central office and across the bridge which contains the clearing-out annunciator to the ground connections of the other branch of the circuit, and the annunciator will thereby be oper-

ated. This signal being thus given, the operator immediately removes the plugs from the switches. The short circuits of the annunciators of the lines are thereby automatically taken off, and the lines are in their normal position ready to give or receive calls.

When a line which has two or more subscribers on it is switched for conversation and one of them is using it, another subscriber on the line cannot give a signal at the central office on one of the line-annunciators and thus cause confusion for two reasons. First, the line-annunciators are short-circuited from the ground connection, and, second, the generator is ungrounded at the outer end of the line from the opening of the normally closed pair of contacts of the switch of the subscriber who is already using the line. For the last reason the subscriber on operating his generator will not even cause the clearing-out annunciator to indicate a call. The use of the normally closed pairs of contacts of the telephone-switches is especially to prevent a false clearing-out signal when a subscriber attempts to send a call while his line is already in use by another subscriber.

When a subscriber operates his generator as heretofore described and the same is in a closed circuit by reason of the line not being in use, his buzzer 5 will be in this closed circuit and will respond to the pulsations of the intermittent current. If, however, by reason of the line being already in use by the telephone at one of its stations being off its switch no closed circuit is established and there will be no sound from the buzzer. The subscriber will therefore know when he operates his generator whether or not his line is already in use, and if it should happen to be in use, which would but seldom be the case, he will wait until it is out of use and then repeat the operation of calling. It is evident that three subscribers' stations may be placed on one line with their three call-bells connected, two to one branch and one to the other branch of the line, and that the operator may ring at will either of the three bells by pressing on her suitable calling-key. When several subscribers' stations are placed on one line, they will be selected so that they are located near each other and as far as possible so that they will require little or no telephone conversation with each other. For this reason the circuit connections between them, used for calling and indicated by broken lines in Fig. 3, will be short connections. For the same reason the subscribers of one line will very seldom desire to carry on telephone conversation with each other.

If a subscriber wishes to carry on conversation with another subscriber located on the same line, he calls the central office in the manner heretofore indicated and tells the operator what subscriber he wants. The operator will then replace the plug D with the plug D′ and move the lever of one of the switches K K′, so that it is adapted to ring the bell of the subscriber wanted. This subscriber is thus called and the conversation can take place between them on their own line. When the operator calls to obtain such a connection, the condenser in the bridge-circuit with the calling-subscriber's telephone prevents part of the current from passing across the bridge and ringing the bell of another subscriber who is not wanted, even if the first subscriber has not replaced his telephone on its switch while his call is being attended to. This is the function of the condenser. Of course the condenser would not be necessary or operated for this purpose should the subscriber at this time replace his telephone on its switch, as the operation of the switch itself would open this bridge-circuit. The rules of the exchange might be such that under such circumstances the subscribers were always to place their telephones on their switches. With such a rule always acted upon the use of the condensers would not be necessary. When the system which I have described is applied to telephone-exchanges where only one subscriber's station is placed on each line, the operator's generator may give alternate current and the subscriber's bells may be such as to respond to such currents.

The operation by which the line-annunciators are automatically short-circuited whenever a line is switched at the central office is briefly this: Whenever a plug is placed in the switch of a line, it automatically closes the local contacts *a b* of the switch, as heretofore described. This brings the battery B′ and the electromagnetic device *x* of the line into a closed local circuit, which causes the armature of the device to be attracted and closes the normally open contacts connected with it, thus short-circuiting all the annunciators. The closed local circuit may be traced thus: from the contact *b* of the switch to and through the battery B′ and thence through the helix of the electromagnetic device to the contact *a* of the switch. When the plug is removed, the contact between *a* and *b* is broken and the local circuit is therefore open, thus opening the relay-contacts and removing the short circuits of the annunciators.

The test system is as follows: When an operator desires to test any line to determine whether or not it is switched at the central office, she places the contact *m* of one of her switch-plugs on the contact-piece *d* of the switch of the line, the switch Y being then in position, so that her telephone bridges across the two cord-circuits of the plug. If the line is then switched for use, a closed circuit is established which contains the battery B^2 and the operator's telephone, and the operator will hear a click in her telephone and know that the line is already in use. This closed circuit may be traced as follows: from the ground through the test-battery B^2 and the retardation-coil and telephone of the operator to the contact *m* of the plug used in

testing, thence to the contact *d*, to which the plug is applied, and thence to the contact *d* of the switch at which the line is switched, thence to contact *a* of that switch, which is then in contact with *d*, and thence to ground through the common ground connection of the contacts *a a* of the switches of the exchange. If the line is not switched at any board, no closed circuit will be established on testing, because no contact *d* of the line is in contact with its spring *a*. The operator will therefore hear no click in her telephone, and will thereby know that the line is not in use and will place a plug in its switch.

As has been stated, the normal position of the switches Y or their position when the pairs of plugs are left for future use after being taken from use is such that the operator's telephone is bridged across between the two conductors of the plugs. In that case the operator may immediately bring her telephone into connection with the calling subscriber by merely inserting a plug into the switch of his line.

The purpose of the contacts and connections shown on the clearing-out annunciator shown in Fig. 4ª is that a ground connection at the central office of practically no resistance will be placed on the circuit of both sides of the annunciator as soon as the clearing-out annunciator indicates, and thereby prevent the subscriber who is sending the signal from causing a continuous ring of one of the bells of a subscriber on the other line connected with his. The short circuit of the annunciator-magnet which is then established may be traced from points *c c'* to spring *e* and through wire S to ground.

It will be seen from the description of the system as heretofore made that each subscriber of the exchange may call an operator at a board where his own and any other subscriber's line have their switches and may there have his call promptly answered and connection made with the line wanted. It will also be seen that when several subscribers' stations are placed on one line each subscriber may make any of the desired calls to the central office without ringing the bell of any other subscriber on the line and that the operators may connect to any line wanted, and where several stations are on one line she may ring the bell at any station without ringing the bell at any other station or in any way disturbing any other subscriber. It will also be seen that when any subscriber on a party-line is connected for conversation and has his telephone switched for use no other subscriber on that line can, by operating his calling-generator or his calling-keys, or both, disturb the connection at the central office or elsewhere, while at the same time he has himself an indication that some other subscriber is using the line.

It will be seen also that when two lines are connected together for conversation and a subscriber on each line has his telephone switched for use their two telephones are in closed telephone-circuit with each other; that this circuit is bridged at the central office by a clearing-out annunciator; that the two sides of the circuit are each grounded at the central office through two retardation-coils, and that each line is grounded at or near its outer end by two ground connections of high self-induction or retardation, one on each side of the subscriber's telephone, and that as the two sides of the metallic conductors of each line will be constructed so as to be practically the same electrically, the electric balance of each talking-circuit is practically provided for.

I claim as my invention—

1. In a telephone-exchange system, 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 switching apparatus whereby the operator at any board may connect together any two lines which have their switches at her board, in combination with two retardation-coils and four polarized annunciators for each line, said annunciators being located at the four divisions of boards and where the line has switches, through two of which annunciators connected in opposite polarity and one of said retardation-coils, one side of the line is grounded, and through the other two of which annunciators connected in opposite polarity and the other retardation-coil the other side of the line is grounded, electric calling apparatus at each subscriber's station to at will send current of either polarity through a ground-circuit containing each side of the line to operate any of said four annunciators, and electromagnetic apparatus automatically controlled by the switching of each line to short-circuit said annunciators, but not said retardation-coils from the ground connections of the lines in which they are placed.

2. In a telephone-exchange system, 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 switching apparatus whereby the operator at any board may connect together any two lines which have their switches at her board, in combination with a retardation-coil and two polarized annunciators for each line, said annunciators being located at the two divisions of boards and where the line has switches, through which annunciators connected in opposite polarity and retardation-coil one side of the line is grounded, electric calling apparatus at each subscriber's station to at will send current of either polarity through a ground-circuit containing said side of the line to operate either of said two annunciators, and electromagnetic apparatus

automatically controlled by the switching of each line to short-circuit said annunciators, (but not said retardation-coil) from the ground connection in which they are placed.

3. In a telephone-exchange system 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 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, in combination with two retardation-coils and two annunciators for each line, said annunciators being located at the two divisions of boards, and where the line has switches, through one of which annunciators and retardation-coils one side of the line is grounded, and through the other one of which annunciators and retardation-coils the other side of the line is grounded, electric calling apparatus at each subscriber's station to at will send current through a ground-circuit containing each side of the line to operate either of said two annunciators and electromagnetic apparatus automatically controlled by the switching of each line to short-circuit the annunciators but not the retardation-coils from the ground connections in which they are placed.

4. In a telephone-exchange system, metallic-circuit lines, a switchboard, switches, one switch on said board for each line, each switch having two contact-pieces to which respectively the two sides of its lines are connected, and means at said board to connect any two lines into a metallic circuit for conversation by joining the two contact-pieces respectively of their switches, in combination with a ground connection for each line between one of its two sides or branches and the ground, and an annunciator and a retardation-coil for each line located in its said ground connection, electromagnetic apparatus for each line automatically operated by the switching of the line for conversation to short-circuit said annunciator, but not said retardation-coil from said ground connection of its line, a calling-generator at each subscriber's station, and switching apparatus there to at the will of the subscriber include the generator in a ground circuit with that branch of the line to which its said ground-circuit connection is normally made.

5. In a telephone-exchange system, telephone-lines, a switchboard, switches, one switch on the board for each line, in combination with a ground connection for each line, an annunciator, and a retardation-coil for each line located in its said ground connection, and means at said board to connect any two lines into a closed circuit for conversation by joining the contact-pieces of their respective switches with the two sides of said circuit grounded through their said ground connections respectively, electromagnetic apparatus for each line automatically operated by the switching of the line for conversation to short-circuit said annunciator, but not said retardation-coil from said ground connection of the line, a clearing-out annunciator in a bridge connection to said closed circuit of two lines and a calling-generator at each subscriber's station operated in a ground-circuit which includes the line-annunciator when the line is not switched, and the clearing-out annunciator when the line is switched for conversation.

6. In a telephone-exchange system, metallic-circuit lines and switching apparatus at the central office to connect any two of said lines into a closed metallic circuit for conversation, in combination with two ground connections for each line at the central office, one from each side or branch of the line, a different line-annunciator in each of said two ground connections, and electromagnetic apparatus with a local circuit for each line, including battery, automatically operated by the switching of the line for conversation to short-circuit said annunciators from said ground connections, while the line is thus switched for conversation.

7. In a telephone-exchange system a metallic-circuit line and a signal-receiving bell at the subscriber's station in a ground connection to one side of said line, in combination with the subscriber's telephone, his telephone-switch, a retardation-coil, and switch-contacts and connections to bridge said telephone between the two sides of the line when the telephone is switched for conversation and ground to the other side of the line through the retardation-coil.

8. In a telephone-exchange system, a telephone-wire permanently grounded at the central office, and the line-annunciator and a retardation-coil in its said ground connection, there, in combination with a calling-generator at the subscriber's station operated by the subscriber to send calling-current from a ground connection at the outer end of said wire and over said wire, switching apparatus to at the will of the operator switch said subscriber's line with another line for conversation, electromagnetic apparatus automatically controlled by the switching of said line to short-circuit said annunciator but not said retardation-coil from said ground connection, and a clearing-out annunciator also in a ground connection to said wire while the line is switched for conversation.

9. In a divided central exchange, annunciators, one at each division of the exchange for each line, each normally or as long as the line is not switched at the central office in a branch circuit connection connected with the line; a short-circuiting device for the annunciators of each line, in a local circuit rendering the annunciators irresponsive, and an operator's switch for putting said circuit into action.

10. In a divided central exchange, annuncia-

tors, one at each division of the exchange for each line, each normally or as long as the line is not switched at the central office in a branch circuit connection connected with the line; a short-circuiting device for the annunciators of each line in a local circuit rendering the annunciators irresponsive, put into action by the act of switching said line for use.

11. In a telephone-exchange, annunciators, one for each line, each normally or as long as the line is not switched at the central office in a branch circuit connection connected with the line; a short-circuiting device for the annunciator of each line in a local circuit rendering the annunciator irresponsive, and an operator's switch for putting said circuit into action.

12. In a telephone-exchange, annunciators, one for each line, each normally or as long as the line is not switched at the central office in a branch circuit connection connected with the line; a short-circuiting device for the annunciator of each line in a local circuit rendering the annunciator irresponsive, put into action by the act of switching said line for use.

13. In a party-line telephone-exchange system, a metallic-circuit line, extending to four subscribers' stations, at each of which stations is a subscriber's telephone set in a normally open bridge between the two sides of said metallic-circuit line, at two of which stations connected from one side of the line to ground are two polarized signal-receiving bells connected to respond to opposite polarities of currents sent over the side of the line to which they are connected, and at the two other stations connected from the other side of the line to ground are two other polarized signal-receiving bells connected to respond to opposite polarities of current sent over the side of the line to which they are connected, and at the central office a calling-generator having one side of its armature grounded, commutator devices connected with the other side of the armature to take currents of either polarity, and switching devices to at will direct such current of either polarity to either of said two sides of the line.

In testimony whereof I have hereunto subscribed my name.

MILO G. KELLOGG.

Witnesses:
A. M. McLACHLEN,
LLOYD B. WIGHT.