(No Model.) 3 Sheets—Sheet 1.

M. G. KELLOGG.

MULTIPLE SWITCHBOARD.

No. 592,424. Patented Oct. 26, 1897.

Fig. 1

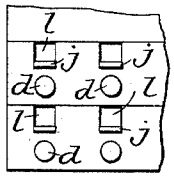


Fig. 3a

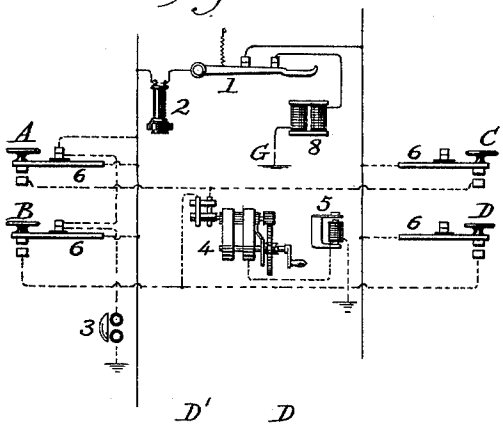


Fig. 4.

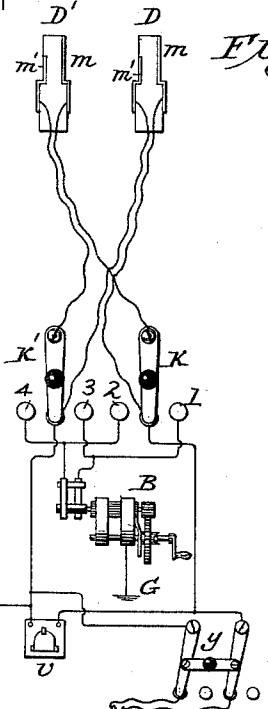
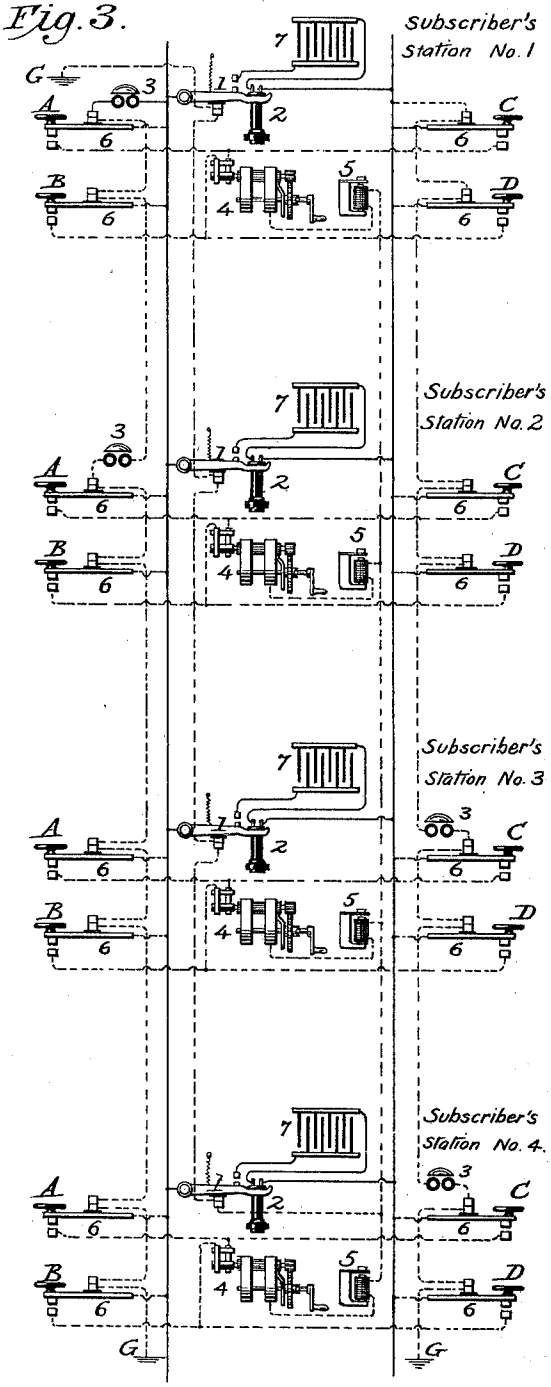


Fig. 3.



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Inventor,
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by his attorneys
Baldwin Davidson & Wright

(No Model.) 3 Sheets—Sheet 2.

M. G. KELLOGG.

MULTIPLE SWITCHBOARD.

No. 592,424. Patented Oct. 26, 1897.

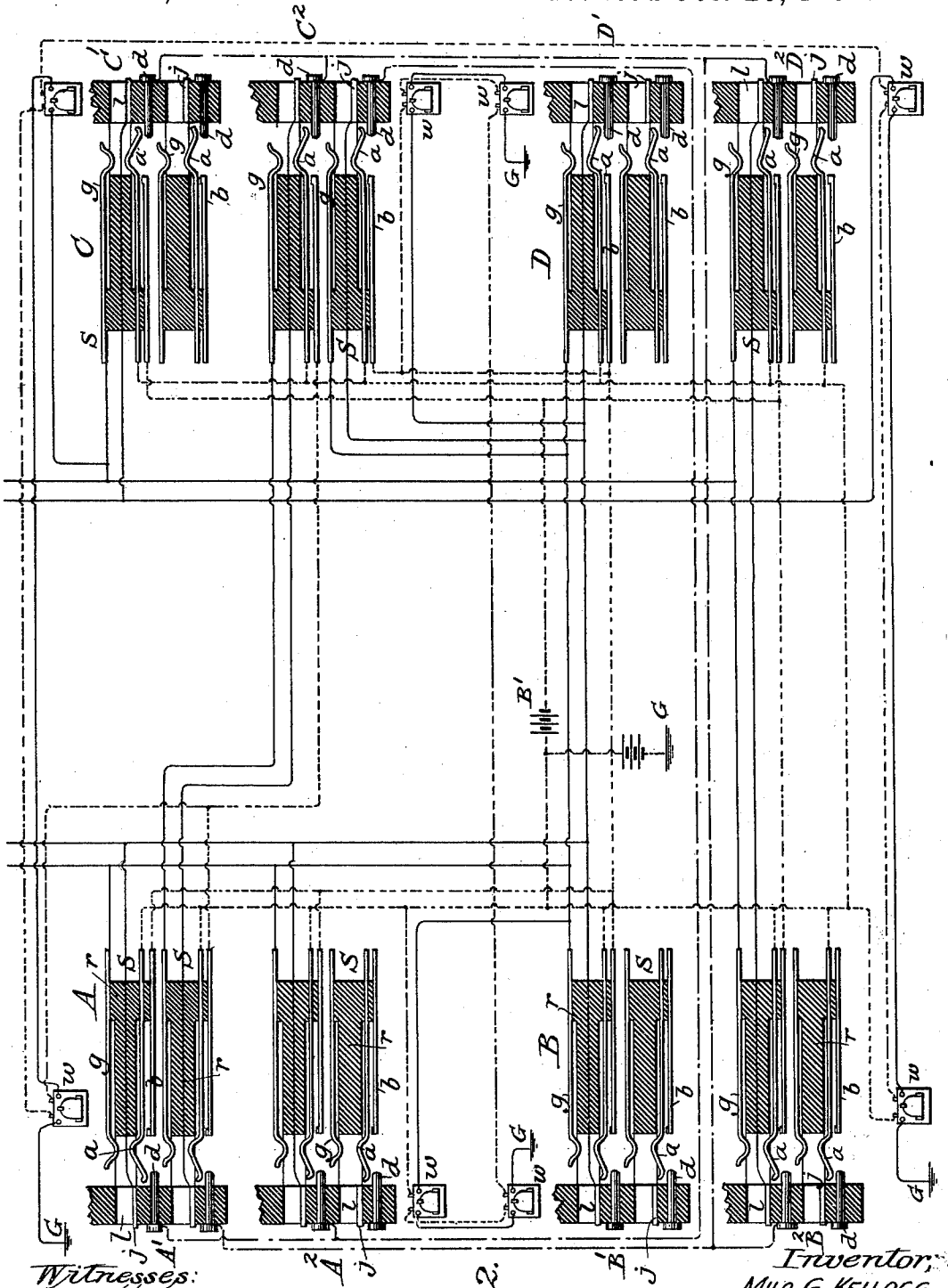

Fig. 2.

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(No Model.) 3 Sheets—Sheet 3.

M. G. KELLOGG.

MULTIPLE SWITCHBOARD.

No. 592,424. Patented Oct. 26, 1897.

Fig. 4a

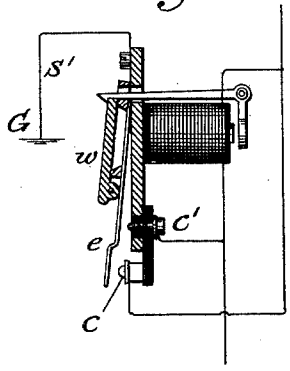


Fig. 5a

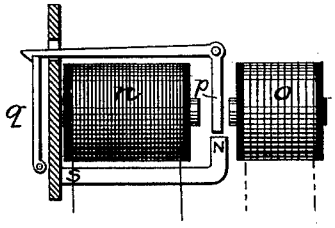


Fig. 5b

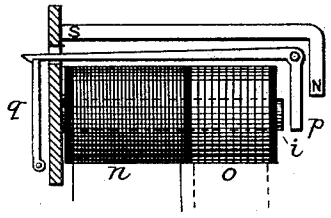


Fig. 5c

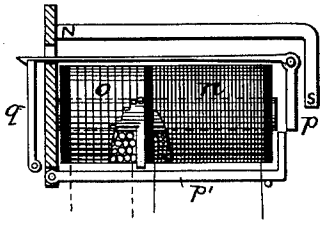


Fig. 5d

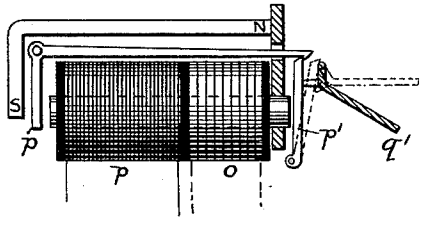


Fig. 6.

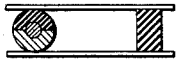


Fig. 7.

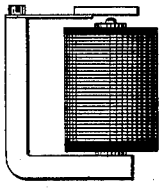
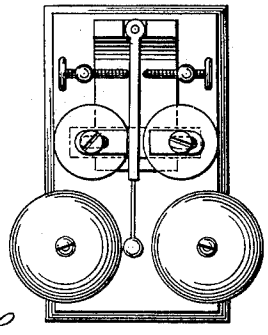


Fig. 8.



Witnesses:

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Guy E. Davis

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. 592,424, dated October 26, 1897.

Application filed March 2, 1895. Serial No. 540,336. (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. Each of these ground connections should be of comparatively high self induction or retardation, and this may be provided for by the construction of the annunciators themselves or by the use of supplementary retardation-coils. A local circuit containing an electromagnetic device is provided for each line with mechanism 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 locked or prevented from being operated when the calling-current is passing through them, and when the line is disconnected from the line or connection with which it is switched the normal condition of the annunciators is automatically reëstablished, so that the proper calling-current will operate them. 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 ground connection, which contains two of the polarized annunciators, and thus, when the line is not switched, be enabled at will to operate either one of his four annunciators and call an operator at either of the division 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 locks the annunciators of the line or prevents them from being operated while the line is switched, 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 telephone-line and each subscriber be enabled to call an operator at either of the divi-

sions 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 or more 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 or switchboards 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. Figs. 5^a, 5^b, 5^c, and 5^d show in detail various forms of polarized call-annunciators, with their local electromagnet and locking or retaining mechanism, 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 electromagnet 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 *de* 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 immaterial 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 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.

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. 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.

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 to a common circuit connection and thence through battery B^2 to ground. One side of the battery B' is connected to this circuit connection before it passes to the battery B^2. All of the contacts b b of all of the switches of any given line are connected together and are also connected through the local magnets of the annunciators of the line 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 described. 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 of 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 open 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.

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 keys 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.

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 keys 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 *l l* 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. 3[a] 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 of 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.

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-generators 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. x is a retardation-coil for the operator's telephone, connected on one side to one side of the telephone, as shown, and 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 x. 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 x 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 or 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 to 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.

In the polarized annunciator shown in Fig. 5^a, n is the main-line magnet, through which the subscriber's calling-current is to pass; o, the local-circuit magnet which is to prevent the operation of the annunciator when the local circuit of the line is closed, and the magnet o is magnetized by the local battery in closed circuit with it. p is the armature of the annunciator, pivoted as shown, with its lever and catch, of the form substantially as shown, operating on the drop or shutter q to hold the shutter in its normal position when the armature is in its normal position and to release the shutter and allow it to fall when the armature is moved by the main-line magnet of the annunciator. N S is a permanent steel magnet which magnetizes by induction the armature, so that the armature is repelled by one of the electromagnets when one polarity of current passes through them and is attracted when the other polarity of current passes through them. The local-circuit magnet and the main-line magnet of the annunciator are placed on opposite sides of the armature, as shown, so that when the main-line helix attracts the armature to itself it frees the shutter and allows it to fall and indicate a call, while the local helix is connected into its circuit, so that when the circuit is closed its core attracts the armature and tends to move the armature in the opposite direction and prevent the falling of the shutter. The local magnet should also be of such strength as compared with the main-line magnet that when it is energized, as described above, its power on the armature will overcome the power of the main-line magnet on it whenever calling-current passes through the latter and thus prevent the annunciator from indicating a call whenever its local magnet is energized. The arrangement and the construction of the parts to produce this result, including the windings of the electromagnets and the strength of the battery which is in the local circuit, can readily be determined by those who are skilled in the art. The construction may be facilitated by placing the core of the local magnet closer to the armature than the core of the main-line magnet.

In the annunciator shown in Figure 5^b, i is the soft-iron core of the electromagnet. n is the main-line helix, and o is the local-circuit helix, both wound around the core and placed on it as shown or in any other suitable manner. p is the armature of the annunciator, pivoted as shown, with its lever and catch, of the form substantially as shown, operating on the drop or shutter q to hold the shutter in its normal position when the armature is in its normal position and to release the shutter and allow it to fall when the armature is attracted and moved by the main-line magnet of the annunciator. N S is a permanent steel magnet which magnetizes by induction the armature, so that the armature is repelled by the electromagnet when the core is energized with one polarity of magnetism and attracted when the core is energized with the other polarity of magnetism. When the helix n is energized by the polarity of current which causes its core to attract the armature, the armature will be moved if the helix o is not also energized by the closing of the local circuit. The shutter will therefore fall and indicate a call. The helix o is connected into its circuit in such a direction that when the circuit is closed it will magnetize the core in such a direction that the core will repel the armature. The local helix should be so constructed and related to the circuit, the battery B′, and the other parts as to overcome the magnetism produced in the core i whenever any calling-current passes through the helix n to the extent that in such a case the magnetism of the core i will be insufficient to cause the armature to move and the shutter to be released. The arrangement and the construction of the parts to produce this result, including the windings of the helices and the strength of the battery which is in the local circuit, can readily be determined by those who are skilled in the art.

In the annunciator shown in Fig. 5^c, n is the main-line magnet; o, the local-circuit magnet which is to prevent the operation of the annunciator when the local circuit of the line is closed and the local battery is thus in closed circuit with it. p is the armature of the main-line magnet, pivoted as shown, with its lever and catch, of the form substantially as shown, operating on the drop or shutter q to hold the shutter in its normal position while the armature is in its normal position and to release the shutter and allow it to fall when the armature is moved by the main-line magnet. N S is a permanent steel magnet which magnetizes by induction the armature, so that the armature is repelled by the core of the electromagnet when one polarity of current passes and is attracted when the other polarity of current passes. p' is the armature of the local electromagnet, pivoted at one end, and with a catch or arm at the other end which engages with or locks the armature p when

the local electromagnet is energized to prevent the armature p from moving toward its magnet n to a sufficient distance to allow the shutter q to fall. When the local circuit is opened by the removal of a switch-plug from a line-switch, the armature p' drops by gravity and releases the armature p, so that it is free to respond to suitable current passing through the main-line magnet. The lever which carries the hook which engages the shutter should be of such elasticity and the hook and shutter should be so shaped and related to each other that the lever will bend and allow the shutter to be placed in its normal position even when the armature of the main-line magnet is locked by the local-magnet mechanism.

The annunciator shown in Fig. 5[d] has a restoring as well as a retaining mechanism, so that when the annunciator indicates a call and the circuit of the local magnet is closed it not only holds or prevents the annunciator from indicating a call, but first allows the shutter to take its normal position. n is the main-line electromagnet. o the local electromagnet which first allows the shutter to take its normal position and then retains or holds the mechanism, so that the annunciator shall not indicate a call as long as the electromagnet is energized by being in closed circuit with its battery. p is the armature of the main-line magnet, pivoted as shown, with its lever and catch, of the form substantially as shown, operating on the drop p' to hold the same in its normal position while the armature p is in its normal position and allow the drop to fall to its stop and press the shutter q, so as to cause the latter to show its number or indication. The drop p' is also the armature of the local electromagnet o and is normally placed close to the core of its magnet and is so related to it that when it has fallen the distance allowed by its stop, after being released from the hook or catch which normally holds it in place, it is still within the attractive force of the core of the electromagnet, so as to be brought to its normal position, where it is held by the catch. Pivoted in front of the drop p' and with its fulcrum near the top of p' is the shutter q, which may be of the shape substantially as shown and which should be of little weight and may be of aluminium. This shutter is so shaped as to incline normally downward, so that a number or indication placed on its under surface will not be seen by the operator in front and below it. When, however, the drop p' is released and falls against its stop, a knob near its upper end presses the aluminium shutter or disk out, so that its surface is substantially parallel with the horizon. The annunciator being mounted above and to the front of the operator, she will be able then to distinguish its number and know what line is indicated. The solid lines show the normal position of the drop p' and shutter q, and the broken lines show their position when the drop is allowed to fall against the stop. Of course the shutter q will take, by gravity, its normal position when the drop p' assumes its normal position. N S is the permanent magnet, which magnetizes by induction the armature p. When current passes through the helix of the electromagnet n of the polarity to cause the core to attract the armature p, the armature will move and its catch will be freed from the drop p'. This drop p' (unless retained by the local magnet being in closed circuit with its battery) will fall against its stop and cause the shutter q' to show its indication. When the magnet o is then energized by being placed in closed circuit with the battery by the placing of a switch-plug in a line-switch, p' will be attracted to its normal position, where its catch will engage with it and be held there by the action of the magnet o as long as the local circuit remains closed whether or not the armature p is caused to move by calling-current passing through its magnet.

The polarized bell shown in Fig. 8 and which is used at the subscribers' stations for their signal-receiving bells is an adaptation of the well-known Siemens form of polarized relay to the polarized electric bell shown. The heel of the electromagnet is mounted to one end of the permanent steel magnet. The other ends of the cores of the electromagnet have each a lug or projection which extend toward each other and whose position can be adjusted by means of a slot in each through which the screws pass which hold them to their cores. The armature is a tongue which is connected to the other end of the permanent magnet and which extends so as to be placed between the two lugs. At the end of the armature is a hammer-rod with a bell-hammer at its end adapted to strike alternately the two gongs as the armature vibrates between the two lugs. Adjustable screw-stops are shown by which the proper amount of vibratory motion of the armature to cause the hammer to strike alternately the two gongs may be obtained. The permanent magnet magnetizes the two cores and their lugs with one polarity of magnetism and magnetizes the armature with the other polarity. Therefore both lugs normally attract the armature. One of the lugs is adjusted or placed so as to be close to the armature, and the other lug is adjusted so as to be farther away from the armature and so much farther away that when the armature, through the action of the electromagnet, takes the position which brings it nearest to the last-mentioned lug it is even then closer to the other lug. Therefore the armature will normally, or when no current is passing through its electromagnet, take the position toward the first-mentioned lug. When current passes through the electromagnet in the direction which increases the normal magnetism of the lug which is thus nearest the armature, the armature will be still more strongly attracted and will re-

main in its normal position, and the bell will not be rung. When, however, electricity of the opposite polarity passes through the electromagnet, the normal magnetism of the electromagmet will be overcome, the lug toward which the armature normally bears will repel and the other lug will attract the armature, causing it to move and the hammer strike one of the gongs. When the current ceases, the armature will be attracted back to its normal position, causing the hammer to strike the other gong. Thus with intermittent current passing in one direction the armature will vibrate, causing the bells to continuously ring or sound, while with intermittent current in the other direction the armature will remain passive. It is evident that when the two bells which are in one circuit are practically identical as to construction and adjustment one of them may be made to sound when intermittent current of one polarity passes through the circuit and the other to sound with intermittent current of the other polarity by connecting one of them in one direction and the other in the other direction in the circuit. It is also evident that the two electromagnets may be connected in the same direction and the differentiation of calls be obtained by adjusting the lugs so that the armature of one bell normally takes a position in one direction and the armature of the other bell normally takes a position in the other direction. Other forms of polarized bells may also be used which respond to one polarity of current passing through them in one direction and fail to respond when the other polarity of current passes through them in that direction, and two of them may be so connected in each call-receiving wire which extends between the subscribers' stations that one will respond to one polarity of current only and the other will respond to the other polarity of current only.

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 *l* *l* 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 bridging his telephone and its condenser 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 closes the local circuit of the line, which local circuit contains the local magnets of its annunciators and makes the annunciators irresponsive to calling-currents in the manner substantially as heretofore indicated for the form of annunciator which may be used. The subscribers' and the operators' 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 closes the local circuit of this line and makes its annunciators irresponsive to calling-currents. 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 his 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 side 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 operated. This signal being thus given the operator imme-

diately removes the plugs from the switches. The local circuits of the lines are thereby automatically opened and the annunciators come into their normal condition ready to respond to calling-currents which may be sent through them.

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 locked or made irresponsive by their local magnet and mechanism, which has been described; 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 conversaton 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 subscribers' bells may be such as to respond to such currents.

The operation by which the line-annunciators are automatically locked or prevented from being operated by a calling-current whenever the 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 local magnets *o o* of the line-annunciators of the line into a closed local circuit, which operates, as heretofore described, to prevent the annunciators from responding or indicating when calling-currents pass through them. 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 demagnetizing the local magnets of the annunciators and removing the locking mechanism, so that the annunciators may respond to calling-currents.

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 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 and the battery B^2, which is in that ground connection. 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 operator 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 ground connections of high self-induction or retardation, each containing two of the high self-induction line-annunciators, 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.

Instead of the particular form of divided exchange and exchange operation and construction herein described various modifications of the same may be made which will come within the scope of my invention.

The exchange may be divided into two divisions only. In that case each board of each division will have a switch for each line of its division and one switch for each line will be located on the other division of boards. Two annunciators only will then be used for each line, one located in each division of boards. These annunciators may be polarized and permanently connected in opposite polarity to ground from one side or branch of the line. Under such a construction only two calling-keys would be required at each subscriber's station and these connected, as shown in Fig. 3, to the side of the line through which the line-annunciators are permanently grounded. They may be, for instance, keys A and B of that figure. The calling-keys connected to the other side of the line and the circuit connections to them will be omitted and the calling-wire branching off from that side of the line to ground through two of the subscribers' bells will be unbroken, or, in other words, will not pass through pairs of key-contacts. In this arrangement, also, contact *m* of one plug of each pair of operator's loop-plugs, as shown in Fig. 4, should preferably be connected to contact *m′* of the other plug. Thereby the two sides of a circuit containing two lines switched together for conversation will be grounded, one through the two annunciators of one line and the other through the two annunciators of the other line. The electric balance of the circuit will thereby be obtained and a path to ground secured through the clearing-out annunciator whenever either subscriber sends a clearing-out signal.

Any of the forms of annunciators shown in this application or annunciators having similar operations or producing similar re-

sults to those shown may be used. In telephone-exchanges of the class to which the divided exchange system is applicable, except in the exchanges of a very large number of lines, the two-division exchange is applicable and with exchanges of a certain size would be preferable. The two-division exchange which I have above described as a variation of the system set forth in this application could be used in exchanges of, say, twelve thousand lines and less and, with the party-line system which is herein set forth, would serve for about twenty-five thousand subscribers.

A two-division-exchange system could also be operated by the system herein shown by having the two annunciators required for each line, one connected permanently in the ground connection of one side of the line and the other connected permanently in the other ground connection of the line. These annunciators need not be polarized annunciators, but would have retaining devices in the local circuits of the line to prevent them from being operated when the line is switched for use. Two of the calling-keys at each subscriber's station, one connected to each side of the line—as for instance, keys B and D—as well as the circuit connections to them, would then be omitted. The subscribers' calling-generators might then be such as to send currents of alternate polarity. It is evident that with an exchange thus constructed each subscriber could signal to an operator at either division of the two divisions of boards and that the exchange operations in procuring and answering calls and connecting lines together would be substantially the same as in the four-division exchange herein described.

Exchanges may also be of such a class or size that a three-division exchange will be considered preferable to adopt rather than a two-division exchange or an exchange with a larger number of divisions than three. The substantial requirements for the operation of such an exchange are contained in the four-division-exchange system herein described. For instance, the division D of exchanges might be omitted and keys D D at the subscribers' stations to correspond and the annunciators located at division D of boards be omitted. This arrangement, carried out in the spirit of my invention and as would be understood by those skilled in the art, would give the means of operating a three-division-exchange system, giving service to, say, eighteen thousand lines and on my party-line system herein described to, say, thirty-five to forty thousand subscribers' stations.

A three-division-exchange system might also be constructed on substantially the lines of either of the two-division systems herein described, but employing a special calling-wire for each line, with an annunciator located therein and placed at the third division of boards, and keys at each subscriber's station by which he may direct current at will over the special calling-wire to operate the annunciator at the central office. For exchanges of such a class the electric cable of Patent No. 503,604, granted to me August 22, 1893, may be used. In a similar manner a five-division exchange might be construed, adding a fifth division to the boards and lines of the four-division system herein described and adding a special calling-wire for each line, with an annunciator therein located at the fifth division of boards, with a key at each subscriber's station to direct calling-current to this special wire to operate the annunciator located therein.

Again, a six-division exchange might be constructed, adding two divisions to the boards and lines of the four-division system herein described and adding a special calling-wire for each line with two polarized annunciators located therein at the fifth and sixth divisions of boards and connected to respond to currents of opposite polarity and adding two keys at each subscriber's station with connections to the calling-generator apparatus and circuits by which each subscriber may at will send a current of either polarity over the special calling-wire of his line to operate the annunciator at either of the fifth or sixth divisions of boards. The construction of such keys and their connections would be substantially the same as that shown in Fig. 3, except that the levers of the keys would of course connect to the special calling-wire.

With a special calling-wire for each line operated in connection with the systems above described for operating a three or a five or a six division exchange, or otherwise, the party-line system herein described may be extended so that six subscribers may be served by one line. All that is required to accomplish this is to have the special calling-wire extend to ground at its outer end, to have two of the polarized bells connected in the same so as to respond to currents of opposite polarity, and switching apparatus at each board where the line has a switch by which the operator may at will send currents of either polarity through this special calling-wire.

With the six-division exchange system above described, taken in connection with the party-line system which has been described, by which six subscribers' stations may be operated on one telephone-line, about thirty thousand lines may be operated in one exchange, about one hundred and eighty thousand subscribers' stations could possibly be operated in one exchange, and about eighty thousand subscribers might be served, giving to each subscriber the kind of service which he might select.

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 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, one side of the line is permanently grounded, and through the other two of which annunciators, connected in opposite polarity, the other side of the line is permanently 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 either of said four annunciators, and electromagnetic apparatus automatically controlled by the switching of each line to make said annunciators irresponsive to calling-currents.

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 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, one side of the line is permanently 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 make said annunciators irresponsive to calling-currents.

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 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 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 one side of the line is grounded, and through the other one of which annunciators 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 make said annunciators irresponsive to calling-currents.

4. 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 for 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 make said annunciators irresponsive to calling-currents, while the line is thus switched for conversation.

5. In a telephone-exchange system, a telephone-line grounded at the central office, a line-annunciator in its said ground connection, and switching apparatus to connect said line with another line, and then, or while said line is thus connected, make said annunciator irresponsive to calling-currents, in combination with two substations, to which the line extends, a signal-receiving ground connection for said line at its outer end, the signal-receiving bells of the two substations in said signal-receiving ground connection, calling-generator apparatus at each substation, and switching apparatus to at the will of the subscriber, disconnect said signal-receiving ground connection from the line and establish a calling-circuit which includes the line-annunciator, when the line is not switched for conversation, but not the signal-receiving bells of the two substations.

6. In a divided central exchange, annunciators, one at each division of the exchange for each line, permanently in unshunted connection with the line, a retaining-circuit for all of said annunciators of each line to render them irresponsive, retaining mechanism for each annunciator operated by said retaining-circuit and making the annunciator irresponsive to currents passing through its magnet, and an operator's switch for putting said circuit into action.

7. In a divided central exchange, annunciators, one at each division of the exchange for each line, permanently in unshunted connection with the line, a retaining-circuit for all of said annunciators of each line to render them irresponsive, retaining mechanism for each annunciator operated by said retaining-circuit and making the annunciator irresponsive to currents passing through its magnet, put into action by the act of switching said line for use.

8. In a divided central exchange, annunciators, one at each division of the exchange for each line, means for operating a selected annunciator, a resetting-circuit for all of said annunciators of a line operated by an operator at any one of the divisions of the exchange, and resetting mechanism for each annuncia-

tor operated by said resetting-circuit and automatically restoring the annunciator-indicator to its normal position.

9. In a divided central exchange, annunciators, one at each division of the exchange for each line, means for operating a selected annunciator, a retaining and a resetting circuit for all of said annunciators of a line operated at any division by the act of switching the line for use thereat, and retaining and resetting mechanism for each annunciator operated by said retaining and resetting circuit restoring the annunciator-indicator to its normal position and making the annunciator irresponsive to currents passing through its magnet.

10. In a divided central exchange, annunciators, one at each division of the exchange for each line, all permanently in unshunted or unshort-circuited circuit with their line, means for rendering said annunciators irresponsive, operated by an operator at a switchboard.

11. In a divided central exchange, annunciators, one at each division of the exchange for each line, all permanently in unshunted or unshort-circuited circuit with their line, means for rendering said annunciators irresponsive, operated by the act of switching said line for use.

12. A telephone-exchange line passing to several subscribers' stations, a signal-receiving wire branching off from said line and passing to said subscribers' stations and to ground, a signal-receiving bell in said signal-receiving wire at one or more of said stations, a calling-generator and a signaling-key at each of said stations, each key having two pairs of contacts insulated from each other, one pair normally closed and in the circuit of said signal-receiving wire but opened on depressing said key, to send a signal, the other pair normally open, but closed on depressing the key, one contact of said normally open pair being connected to the line, and the other through the calling-generator at the station to which the key belongs, to a grounding connection for said generators extending in series through pairs of contacts of telephone-switches of the several subscribers' stations and to ground, each of said pairs of contacts of the telephone-switches being normally (or when the telephone is on the switch) closed, but open while the telephone is off the switch.

13. In a divided central exchange, a metallic-circuit line passing to several subscribers' stations, two signal-receiving wires, one branching off from each of the sides of said line and to said subscribers' stations and to ground, a signal-receiving bell in each of said signal-receiving wires at one or more of said stations, a calling-generator and two signaling-keys at each of said stations, each key having two pairs of contacts insulated from each other, one pair of each of the two keys normally closed and in the circuit of a different one of said signal-receiving wires, but opened on depressing the key to send a signal, the other pair of each of the two keys normally open but closed on depressing the key, two contacts, one of each of said normally open pairs being connected to a different side of the line, and the other two contacts of the keys being connected to the ground through the calling-generator at the station to which the key belongs.

14. In a divided central exchange, a metallic-circuit line passing to several subscribers' stations, two signal-receiving wires, one branching off from each of the sides of said line and to said subscribers' stations and to ground, a signal-receiving bell in each of said signal-receiving wires at one or more of said stations, a calling-generator and two signaling-keys at each of said stations, each key having two pairs of contacts insulated from each other, one pair of each of the two keys normally closed and in the circuit of a different one of said signal-receiving wires, but opened on depressing the key to send a signal, the other pair of each of the two keys normally open but closed on depressing the key, two contacts, one of each of said normally open pairs being connected to a different side of the line, and the other two contacts of the keys being connected through the calling-generator at the station to which the key belongs, to a ground connection for said generators extending in series through pairs of contacts of the telephone-switches of the several subscribers' stations, and to ground, each of said pairs of contacts of the telephone-switches being normally (or when the telephone is on the switch) closed, but open while the telephone is off the switch.

15. A telephone-exchange line passing to several subscribers' stations, a signal-receiving wire branching off from said line and passing to said subscribers' stations and to a common return, a signal-receiving bell in said signal-receiving wire at one or more of said stations, a calling-generator and a signaling-key at each of said stations, each key having two pairs of contacts insulated from each other, one pair normally closed and in the circuit of said signal-receiving wire but opened on depressing said key, to send a signal, the other pair normally open, but closed on depressing the key, one contact of said normally open pair being connected to the line, and the other through the calling-generator at the station to which the key belongs, to a connection for said generators extending in series through pairs of contacts of telephone-switches of the several subscribers' stations and to said common return, each of said pairs of contacts of the telephone-switches being normally (or when the telephone is on the switch) closed, but open while the telephone is off the switch.

16. In a divided central exchange, a metallic-circuit line passing to several subscribers' stations, two signal-receiving wires, one branching off from each of the sides of said

line and to said subscribers' stations and to a common return, a signal-receiving bell in each of said signal-receiving wires at one or more of said stations, a calling-generator and two signaling-keys at each of said stations, each key having two pairs of contacts insulated from each other, one pair of each of the two keys normally closed and in the circuit of a different one of said signal-receiving wires, but opened on depressing the key to send a signal, the other pair of each of the two keys normally open but closed on depressing the key, two contacts, one of each of said normally open pairs being connected to a different side of the line, and the other two contacts of the keys being connected to the said common return through the calling-generator at the station to which the key belongs.

17. In a divided central exchange, a metallic-circuit line passing to several subscribers' stations, two signal-receiving wires, one branching off from each of the sides of said line and to said subscribers' stations and to a common return, a signal-receiving bell in each of said signal-receiving wires at one or more of said stations, a calling-generator and two signaling-keys at each of said stations, each key having two pairs of contacts insulated from each other, one pair of each of the two keys normally closed and in the circuit of a different one of said signal-receiving wires, but opened on depressing the key to send a signal, the other pair of each of the two keys normally open but closed on depressing the key, two contacts, one of each of said normally open pairs being connected to a different side of the line, and the other two contacts of the keys being connected through the calling-generator at the station to which the key belongs, to a connection for said generators extending in series through pairs of contacts of the telephone-switches of the several subscribers' stations, and to said common return, each of said pairs of contacts of the telephone-switches being normally (or when the telephone is on the switch) closed, but open while the telephone is off the switch.

In testimony whereof I have hereunto subscribed my name.

MILO G. KELLOGG.

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