(No Model.) 3 Sheets—Sheet 1

M. G. KELLOGG.

MULTIPLE SWITCHBOARD.

No. 592,420. Patented Oct. 26, 1897.

Fig. 1

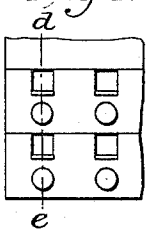
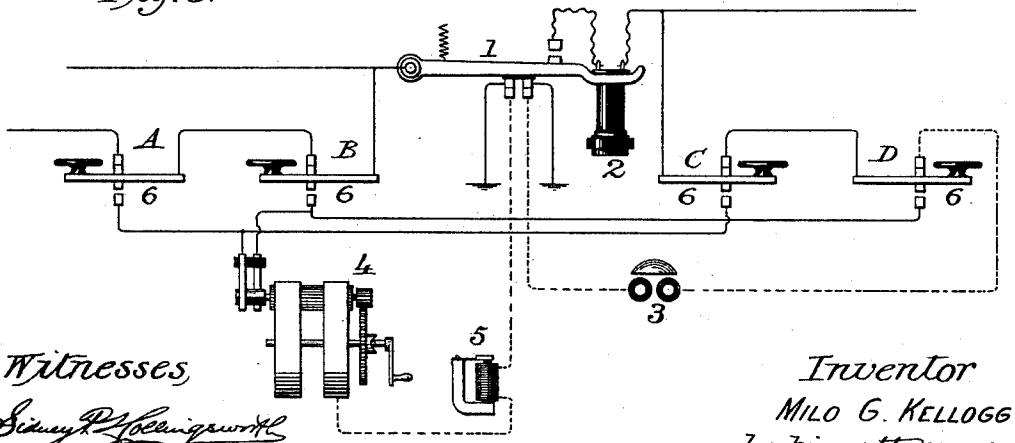


Fig. 3.

Fig. 3b

Fig. 3a



Witnesses,
Sidney R. Hollingsworth
C. W. Brooke.

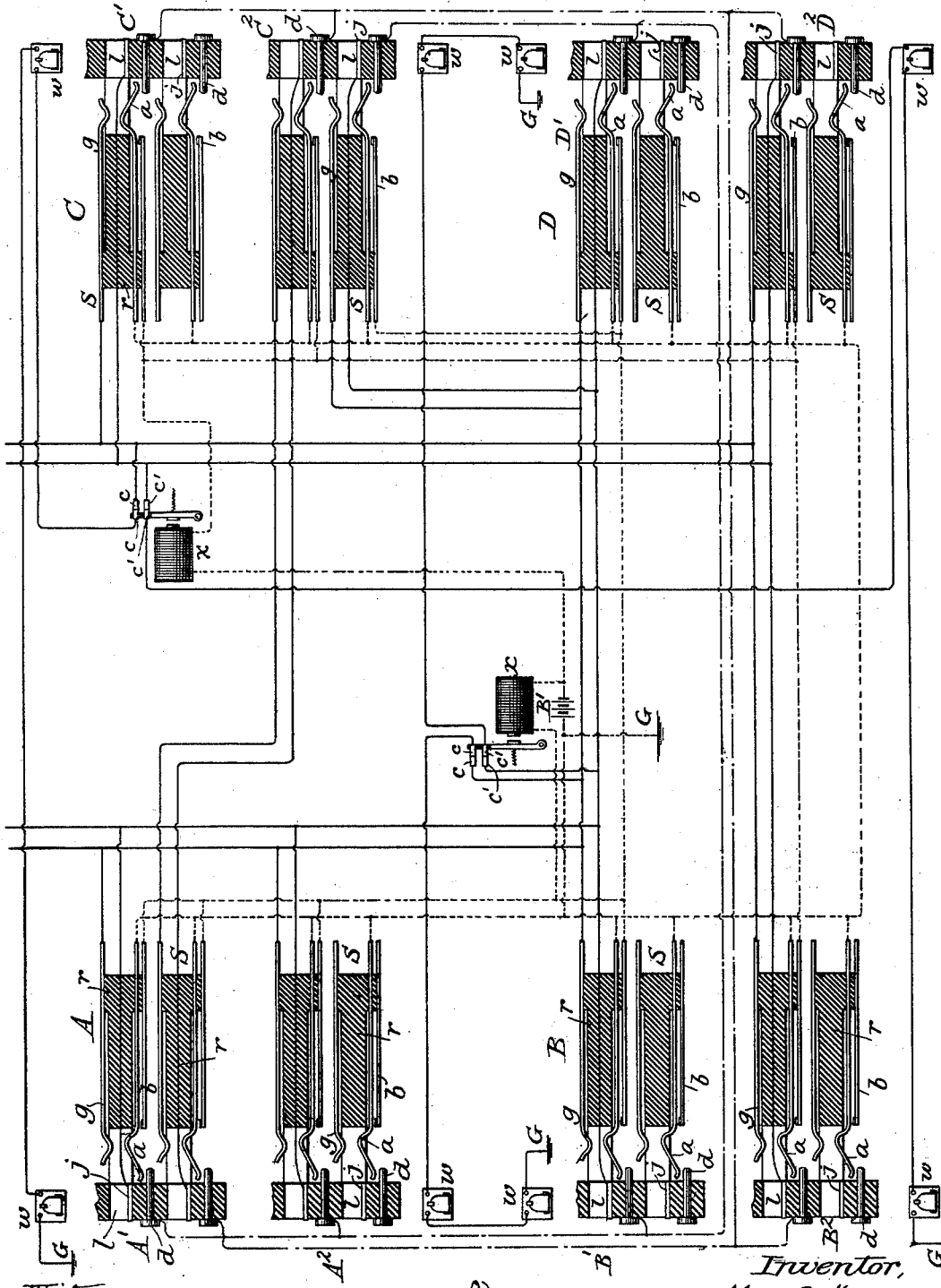
Inventor
Milo G. Kellogg
by his attorneys,
Baldwin, Davidson & Wright

(No Model.) 3 Sheets—Sheet 2

M. G. KELLOGG.

MULTIPLE SWITCHBOARD.

No. 592,420. Patented Oct. 26, 1897.



Witnesses
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Fig. 2

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(No Model.) 3 Sheets—Sheet 3.

M. G. KELLOGG.

MULTIPLE SWITCHBOARD.

No. 592,420. Patented Oct. 26, 1897.

Fig. 4.

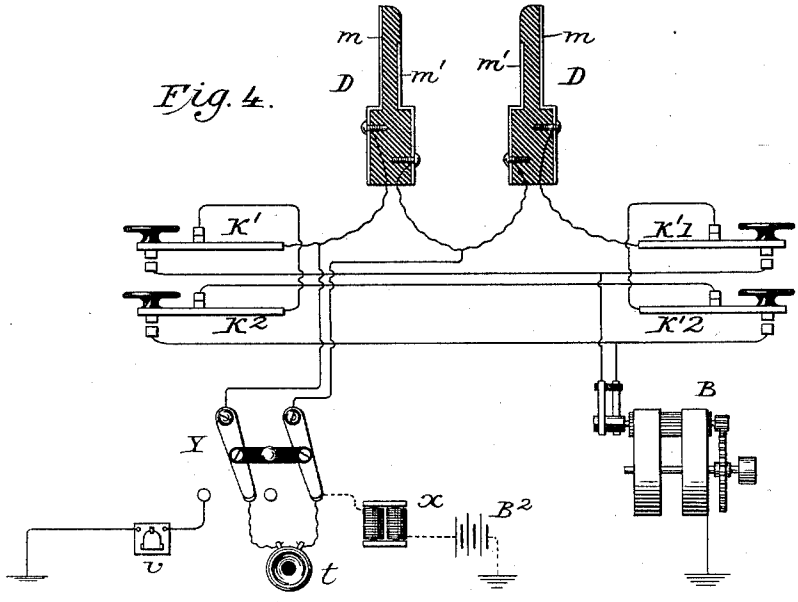


Fig. 5.

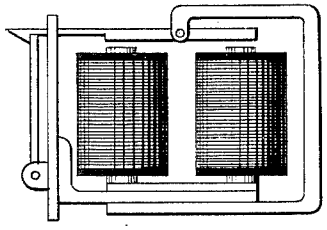


Fig. 6

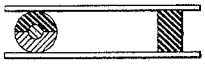


Fig. 7

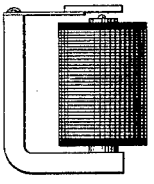


Fig. 4a

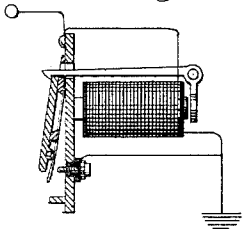
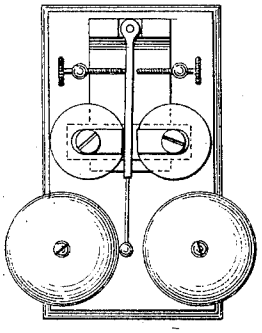


Fig. 8.



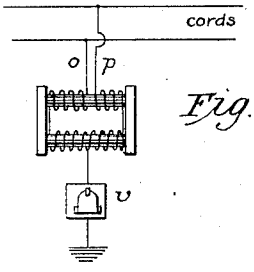


Fig. 4b

Witnesses,
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Inventor,
Milo G. Kellogg
by his attorneys,
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UNITED STATES PATENT OFFICE.

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

MULTIPLE SWITCHBOARD.

SPECIFICATION forming part of Letters Patent No. 592,420, dated October 26, 1897.

Application filed February 12, 1895. Serial No. 538,137. (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 generically 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 normal 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 normal ground connection to the other side or branch of the line. 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 ground connections which contain the annunciators of the line are automatically opened, and when the line is disconnected from the line with which it is switched the normal ground connections through the annunciators are automatically reëstablished. 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 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 ground connection to one of the metallic circuits of his 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 opens the normal ground connections of the line 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 two subscribers' stations may be operated on one telephone-line and each subscriber be enabled to call an operator at either of the divisions of the 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 call-

ing 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 two 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 two subscribers can be served with one line, one 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 subscribers 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 two subscribers. Thus fifty 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 two 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 from thirty-five to forty thousand subscribers' stations located on the twenty-five thousand lines. The system, moreover, as I shall also indicate, is adapted to give service with three or four subscribers' stations on one line, as well as with one or two on a line. Therefore one hundred thousand subscribers might be served from one exchange center, and giving such service as each might select, and about fifty thousand subscribers' stations would probably be satisfactorily operated from one exchange center. Moreover, a divided exchange system is entirely feasible in which a greater number of divisions than four may be used and a correspondingly greater number of lines and subscribers could be accommodated thereby.

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 two subscribers'-station apparatus to be used at two 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. 3^b shows a subscriber's switch which may be used with four subscribers' stations on one 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. 4^b shows a modification of the clearing-out annunciator which may be used. 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 in-

stance, 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 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 the subscribers themselves numeral indications may be added. Thus if line "32^{A}" has four subscribers' stations these stations may be indicated as "32^{A1}," "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-swiches 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.

x x are the electromagnetic devices, of which there is one for each line, constructed and arranged for the purpose of disconnecting the two sides of the line from its normal ground connection through the line-annunciators 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 closed when no current passes through the helix, but are automatically broken by the movement of the armature so as to be open while current is passing through the helix. The electromagnetic device is, in fact, a back 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 one of the insulated contacts of a pair—say of *c c*—of the electromagnetic device of the line. The other contact of *c c* is grounded through two of the polarized annunciators which are connected in the circuit 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 one of the contacts of the other pair of contacts—say *c' c'*—of the electromagnetic device, while the other contact of *c' c'* is grounded through the two other polarized annunciators of the line, which are also connected in their circuit in opposite polarities.

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 the switches 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 two 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" and "subscriber's station 2." 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,) and four calling-keys, (marked 6 6 6 6.)

The telephone-switch 1 is a usual form of automatic switch, which closes certain contacts when the telephone is on the switch and opens them and closes other contacts when the telephone is taken off the switch. The telephones are shown on the switches. That 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 two other pair of contacts insulated from each other and from the first-mentioned pair, which are normally closed, but are open 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 magneto-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 are three-point keys, each having one point on which the lever normally bears and another point normally insulated from the lever and with which it comes into contact when it is pressed or operated by the subscriber in calling.

The circuits of the subscriber's-station apparatus, as shown in Fig. 3, are as follows: One side or branch of the metallic-circuit line passes to subscriber's station 1 and thence passes successively through the normally closed pair of contacts of two of its keys 6 6—A and B, for example—passing in each case to the key-lever first. It then passes in the same manner through two of the keys 6 6 of the other station 2. In like manner the other side or branch of the line passes successively through the normally closed pairs of contacts of the keys C D at each of the subscribers' stations, passing in each case to the lever first. Thence one side or branch of the line passes successively through a different pair of the two normally closed pairs of contacts of the switches 1 1 at the two stations and thence to ground. Their circuit connection back through the switch-contacts at the several stations and thence to ground are indicated by broken lines. In this circuit connection are placed the two 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. One of the spring-contacts of the subscriber's generator is connected to the lower or normally open contact 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 other contacts of the keys, as B D.

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 through the buzzer of the subscriber's station and thence to a local wire between the two stations. This local wire then passes, by a return-conductor, through the two other closed contacts of the two telephone-switches 1 1 and thence to ground. This local wire is also represented by broken lines and its use in connection with the system will hereinafter be described.

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.

In Fig. 3ª the connections of the subscrib-

er's-station apparatus is shown when only one subscriber's station is used on the line. The apparatus and connections are substantially the same as those shown for station 2 in Fig. 3, except that the broken lines are connected directly to ground instead of going to ground after passing through the pairs of contacts of another subscriber's-station apparatus.

Four stations may be used on one line and their apparatus and connections be substantially the same as shown in Fig. 3, except that two more polarized bells for the two extra stations would be employed, connected in the other branch of the line and passing successively through a third pair of normally closed contacts of each of the four switches and to ground. The drawings Figs. 3 and 3^a being for apparatus adapted for use with one or two stations only on each line do not show the third pair of contacts. Fig. 3^b, however, shows such a switch. Its application to the system and the circuit connections through them, as described above, to provide for four subscribers on one line will be apparent to those skilled in the art.

In the operator's cord apparatus 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, have heretofore been described. K' K' K'^2 K'^2 are four calling-keys, each with a key-lever normally in contact with one contact-point and out of contact with another contact-point, and when a lever is depressed by the operator for signaling purposes it leaves its contact with one of the points and passes into contact with the other point. *v* is the clearing-out annunciator, which may be non-polarized, and should be of such construction as to offer considerable resistance and retardation to telephone and similar currents. A retardation-coil may be used in the ground-circuit with the clearing-out annunciator if found necessary or desirable. Y is a looping-in switch with two movable levers and two pairs of contacts on which the lever 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 on the other side to one side of a common test-battery B^2, which is grounded on the other side. B is an operator's calling-generator substantially of the kind shown and described in Fig. 3, so as to give at will current of either polarity. It should, however, preferably be a power-generator. For each pair of plugs there are four calling-keys, a looping-in switch, and a clearing-out annunciator. One generator may be used for many operators. Each operator's telephone has its retardation-coil.

The connections of the operator's cord apparatus are thus: The contact-piece *m* of each of the plugs is connected to its strand of flexible conductor, which is connected successively through the normally closed contacts of two different keys, as K' K^2 and K'^1 K'^2, respectively, of the four keys, passing in each case to the lever first, and they are afterward united, as shown. The two lower contacts of keys K^1 K'^1 are united by a circuit-conductor and are connected to one of the insulated springs of the operator's generator. In like manner are the lower contacts of keys K^2 K'^2 connected to the other spring of the generator. The frame of the generator is connected to ground. The contacts *m' m'* of the pair of plugs are united by a flexible conducting-circuit. The two levers of the switch Y are connected, respectively, to the two flexible conducting-circuits which unite the contact-pieces of the plugs. The two sides of the operator's telephone are connected, respectively, to the two contact-pieces of a pair on which the switch-levers may at will be placed. That contact-piece of the other pair which is made to form contact with the lever of the switch which is connected to the circuit connection between *m m* of the plugs is connected from between the keys K' K^2 and K'^1 $K^{2\,2}$, respectively, through the clearing-out annunciator *v*, and thence to ground.

It is evident from the apparatus as shown and described that the operator may, by depressing the levers of K^1 or K^2, direct at will intermittent current of one or the other polarity to the circuits in which is one of the contacts *m* of the plugs and by depressing the lever of K'^1 or K'^2 direct at will intermittent current of one or the other polarity to the circuit in which is the other contact *m*. She may also, by operating the switch Y, connect her telephone in a bridge which contains her telephone and bridges across between the two conductor-circuits which connect the contact-pieces of the plugs. She may also, by placing the levers of the switch in the other position, ground the conducting-circuit which connects the contacts *m m* through the clearing-out annunciator *v*. The normal position of the switch Y should be that in which the telephone bridges across between the two conductors of the pair of plugs.

A retardation-coil may be used in the ground connection with the clearing-out annunciator, if found necessary or desirable; also, another retardation-coil device may be used to ground the other cord-circuit or that which connects the contacts *m' m'* of the pair of plugs, and in this case the retardation effect of the circuit in which is the clearing-out annunciator *v* need not be so great. The clearing-out annunciator *v* (shown in Fig. 4^a) has a pair of contacts which are automatically closed while the annunciator indicates a call, and thereby short-circuits the annunciator and any resistance which may be in circuit with it.

The side of the operator's telephone which connects with the contacts *m' m'* of the plugs is connected through its retardation-coil and the battery B^2 to ground.

Each operator has as many pairs of plugs

with their flexible cords and apparatus, as described, as she may need to make the necessary connections between subscribers. Their connections to the system will be the same as that of the pair of plugs shown and such as will be apparent to those skilled in the art. The cords should be long enough so that the operator may connect with any switch at her board. The various parts should be conveniently mounted for her work.

The side or branch of the line which contains the signal-receiving bells of Fig. 3 should be connected to the contact-springs *g g* of its switches, (shown in Fig. 2,) and of course the other side of the line will then be connected to the contacts *j j* of its switches.

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-annunciator and the pair of closed contacts of the line-relay 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 through the then-closed contacts of the automatic device of the generator, and thence successively through the closed pairs of contacts of the telephone-switches of the line to ground. The subscriber will then take his telephone from his switch, thus automatically disconnecting his line from the ground at its outer end and bridging his telephone between the two sides of the line, and the operator on noticing the call on the annunciator will place one of her loop-plugs into the switch of the line, its switch Y being then so that her telephone bridges between the two sides of the line. The act of placing the plug in the switch automatically disconnects the line from its ground connections through its annunciators, 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 of the pair into the switch of this line. This act also disconnects this line from its ground connection through its annunciators. She then presses on the key which is connected to the last-mentioned plug, which is adapted to send current of the polarity to operate the bell of the subscriber wanted, and the bell will be rung. If there are two stations on the line, the bell at station 1 might be adapted to ring when current is directed through it by the pressing of K^1 and the bell at station 2 respond to the current of K^2. 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 his line from its ground connection at its outer end. The operator then moves his switch Y, so as to disconnect her telephone from the circuit and ground the circuit through the clearing-out annunciator *v*. 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 one of them operates his calling-generator, pressing at the same time on one of his calling-keys A or B. This brings the annunciator *v* into a closed circuit with the generator, and the annunciator will indicate the clearing-out signal. This signal being thus given the operator immediately removes the plugs from the switches. The lines are thereby automatically grounded again through their respective annunciators and 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 is then disconnected from its ground connections through its annunciators, and, second, the generator is ungrounded at the outer end of the line from the opening of one 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 no closed circuit is established, 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.

If four subscribers' stations are placed on one line, as heretofore described, instead of two, as shown in Fig. 3, the operator would have four more keys for calling with each pair of plugs, and these keys would be connected into the cord-circuit which connects the plug-contacts m' m' and to the other apparatus in the same way the keys shown in Fig. 4 are connected to their cord-circuit and to the other apparatus. By means of these keys the operator could at will ring either of the four bells connected with each of the two lines to which the plugs are connected. Thus she would be able to call and connect for conversation any two subscribers on any two lines of the exchange.

It is evident that three subscribers' stations may be placed on one line, with their three call-bells connected, two in one branch and one in 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, however, a subscriber should wish to carry on telephone conversation with another subscriber located on the same line, he will place his telephone on its switch after giving his order at the central office, and the operator will then call the subscriber wanted by pressing on the suitable calling-key. The rules of the exchange will provide that the subscriber shall thus temporarily place his telephone on his switch when he desires conversation with another subscriber located on the same line, and the operators may be instructed to remind him to do this when he makes a call for such a connection. The two subscribers will then take their telephones from their switches, and the telephones will thereby be placed in closed circuit on their line. When their conversation is completed, both will replace their telephones on the switches and the clearing-out signal will automatically be indicated to the operator. By means of the operator's keys with their levers connected to both plugs the operator can send signaling-currents to the line from which the call originated as well as to the other line. This arrangement is especially useful where the subscriber wanted is located on the same line as the calling subscriber.

It is evident that the system of calling to the central office and clearing-out indication which I have herein described is also applicable to a three-division or two-division system of the divided-exchange system. In that case one or two of the line-annunciators, as the case might be, would be left out of the normally closed ground connections of the line and the corresponding calling-keys omitted at the subscribers' stations. With a two-division system the two annunciators required for the line might be polarized annunciators connected in a normally closed ground connection to one side of the line, and in that case there would be no normally closed ground connection to the other side of the line; or both ground connections might be used and one annunciator placed in each. In this case the annunciators need not be polarized. Again, the calling and clearing-out system might be used in a straight or non-divided exchange multiple system by omitting one of the normally closed ground connections at the central office and placing the line-annunciator in the other ground connection and employing the subscribers' calling-keys adapted to operate it. In that case the line-annunciator need not be a polarized annunciator, and the calling-generator may be such as to give alternate currents. 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 normal ground connections of a line through the line-annunciators are automatically broken 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 opens the normally closed contacts connected with it. The closed local circuit may be traced thus: from the contact a of the switch to and through the battery B' and thence through the helix of the electromagnetic device to the contact b of the switch. When the plug is removed, the contact between a and b is broken and the local circuit is therefore open.

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 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 heretofore indicated, the subscriber's stations on any given line may be indicated by the designations 1, 2, 3, and 4. The keys of the operators may be marked 1, 2, 3, and 4, as heretofore indicated, and the apparatus of the exchange be so connected that the key marked 1 will ring the bell at station 1, key 2 ring the bell at station 2, key 3 at station 3, and key 4 at station 4. Thus the operators would always know what key to depress to ring the bell of any particular subscriber.

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. Various expedients may be used to insure that the switches shall be brought to their normal position, indicated above. For instance, the mechanism of the switches may be made such that when the plugs are brought down by their usual cord-weights to their normal position they will automatically move the switch to its normal position, or the mechanism of the switches may be such that the plugs cannot take their normal positions until their switch Y is placed in its normal position.

The clearing-out annunciator shown in Fig. 4^a may be advantageously employed in varieties of this system where subscribers' signal-receiving bells are placed on the same side of the line-circuit as that to which the clearing-out annunciator is connected when the line is switched for conversation. The purpose of the contacts and connections shown is that a ground connection at the central office of practically no resistance will be placed on the circuit of this side of the line as soon as the clearing-out annunciator indicates, and thereby prevent the operator 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 *g* to spring *d*, thence to point *c*, and through wire S′ to ground.

The system which has been heretofore described contemplates that the subscribers when sending the clearing-out signal shall always press on a special one of their calling-keys, as, for instance, key A. The system may, however, be modified—as, for instance, as shown in Fig. 4^b—so that the clearing-out annunciator will indicate a call when a connected subscriber operates his generator and presses on either of his four calling-keys. The two wires *o p* of Fig. 4^b should be connected to the two sides of the cord-circuit, Fig. 4, to which they belong.

The calling system may also be modified in a manner similar to that shown in my Patent No. 427,087, so that only three calling-keys need be used at each subscriber's station to call the four divisions of boards. One division of board will then be called by operating the generator without pressing on any calling-key. The connection of the clearing-out annunciator to the side of the circuit necessary to operate the clearing-out signal when one key is dispensed with, as indicated above, will be apparent to those skilled in the art.

The clearing-out annunciators may be connected permanently to their cord-circuits, as is preferred by some, instead of being switched from their cord-circuit when the operator's telephone is connected therewith, as shown in Fig. 4. Fig. 4^b shows the clearing-out-annunciator connection to the cord-circuit to be permanent.

The system by which the central office calls the desired subscriber is not claimed herein, the same being covered by claims which I have made in another application filed by me.

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, 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 normally grounded, and through the other two of which connected in opposite polarity the other side of the line is normally 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 disconnect the line from its normal ground connections through its annunciators.

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, 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 normally 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 disconnect the line from its normal ground connection through its annunciators.

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 annunciators for each line, located at the two divisions of boards, and where the line has switches, through one of which annunciators one side of the line is normally grounded, and through the other one of which the other side of the line is normally 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 disconnect the line from its normal ground connections through its annunciators.

4. In a telephone-exchange system, metallic-circuit lines, unconnected with the ground at the subscribers' stations while in use for conversation, 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 line 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 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 open 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, 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 a battery, automatically operated by the switching of the line for conversation to open its two said ground connections, while the line is thus switched for conversation.

6. In a telephone-exchange system, a metallic-circuit telephone-line, one side or branch of which is normally grounded at the central office, a line-annunciator in its said ground connection, and switching apparatus to connect said line for conversation, and then or while the line is thus connected, open its said ground connection, in combination with two substations to which the line extends, a signal-receiving ground connection for said side or branch of 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 of the line and establish a grounded calling-circuit which includes said side or branch of the line and the line-annunciator, when the line is not thus switched, but does not include its said signal-receiving ground connection.

7. Two telephone-lines temporarily connected together at the central office into a combined circuit for conversation and one of them having two subscribers' stations, at each of which is a signal-receiving bell, said receiving-bells being normally in a ground-circuit connection with the line, in combination with a clearing-out annunciator at the central office in a ground connection to said combined circuit and contacts to short-circuit said annunciator, or ground the combined circuit through a circuit of comparatively no resistance, while the annunciator indicates a call, whereby either of said signal-receiving bells of said line will be short-circuited so as to prevent them from sounding continuously when a clearing-out signal is sent from the other line.

8. Two telephone-lines temporarily connected together at the central office into a combined circuit for conversation, and one of them having two subscribers' stations, at

each of which is a signal-receiving bell, said bells being each normally in a circuit with the line, in combination with a clearing-out annunciator at the central office in connection with said combined circuits, and with contacts to short-circuit said signal-receiving bells whenever the annunciator indicates a call, whereby a clearing-out signal sent from the other line will not cause either of said signal-receiving bells to give a prolonged signal.

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 circuit connection connected with the line, a relay in a relay-circuit for all of said annunciators of each line, opening the circuit of the annunciators connected with the line, and an operator's switch for putting said relay into action.

10. 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 circuit connection connected with the line, a relay in a relay-circuit for all of said annunciators of each line, opening the circuit of the annunciators connected with the line, put into action by the act of switching said line for use.

11. In a divided central party-line exchange, annunciators, one at each division of the exchange for each line, means for rendering said annunciators irresponsive to calling-currents from the subscribers' stations, while the lines are switched for conversation, in combination with signal-receiving bells at the several subscribers' stations of each line and means for making them irresponsive to the same calling-currents.

12. In a telephone-exchange system, a metallic-circuit telephone-line, one side or branch of which is normally grounded at the central office, a line-annunciator in its said ground connection and switching apparatus to connect said line for conversation, and then or while the line is thus connected, making said annunciator inoperative to calls over the line, in combination with two substations to which the line extends, a signal-receiving ground connection for said side or branch of 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 of the line and establish a grounded calling-circuit which includes said side or branch of the line and the line-annunciator, when the line is not thus switched, but does not include its said signal-receiving ground connection.

13. In a telephone-exchange system, a telephone-line normally grounded at the central office, and a line-annunciator in its said ground connection, in combination with two substations to which the line extends, a subscriber's calling-generator at each of the substations, a subscriber's calling-key at each of the substations operated at the will of the subscriber, each key having a line-contact connected with the line and another or ground-contact normally insulated from said line-contact but connected with the line-contact when the key is operated by the subscriber, said ground-contact of each key being connected to one side of the subscriber's generator at its substation, the other sides of the two subscribers' generators being brought to a common connection which extends to the two substations and thence to ground, and two telephone-switches, one at each substation, each having a pair of contacts normally closed but open while the telephone is switched for use, said common connection which extends to the two substations and thence to ground passing successively in series through said pair of normally closed contact-points, of each of said telephone-switches, substantially as and for the purpose set forth.

14. In a telephone-exchange system, a telephone-line normally grounded at the central office and a line-annunciator in its said ground connection in combination with two substations to which the line extends, a subscriber's calling-generator at each of the substations, a subscriber's calling-key at each of the substations operated at the will of the subscriber, a signal-receiving bell at one of the substations each key having a pair of normally closed contacts through which pairs of contacts of the two keys the line normally passes and thence to ground through said signal-receiving bell, said pair of contacts being opened when the key is operated each key having a third or ground contact normally insulated its two other contacts and into which that one of them which is then connected with the line is brought into contact when the key is operated, said third or ground contact of each key being connected to one side of the subscriber's generator at its substation, the other sides of the two substations being brought to a common connection which extends to the two substations and thence to ground, and two telephone-switches, one at each station, each having a pair of contacts normally closed but open while the telephone is switched for use, said common connection which extends to the two substations and thence to ground passing successively in series through said pair of normally closed contact-points of each of said telephone-switches, substantially as and for the purpose set forth.

15. In a telephone-exchange system, a telephone-line normally connected to a return at the central office, and a line-annunciator in its connection, in combination with two substations to which the line extends, a subscriber's calling-generator at each of the substations, a subscriber's calling-key at each of

the substations operated at the will of the subscriber, each key having a line-contact connected with the line and another or return contact normally insulated from said line-contact but connected with the line-contact when the key is operated by the subscriber, said return-contact of each key being connected to one side of the subscriber's generator at its substation, the other sides of the two subscribers' generators being brought to a common connection which extends to the two substations and thence to said return, and two telephone-switches, one at each substation each having a pair of contacts normally closed but open while the telephone is switched for use, said common connection which extends to the two substations and thence to said return passing successively in series through said pair of normally closed contact-points of each of said telephone-switches, substantially as and for the purpose set forth.

16. In a telephone-exchange system, a telephone-line normally connected to a return at the central office and a line-annunciator in its connection in combination with two substations to which the line extends, a subscriber's calling-generator at each of the substations, a subscriber's calling-key at each of the substations, operated at the will of the subscriber, a signal-receiving bell at one of the substations each key having a pair of normally closed contacts through which pairs of contacts of the two keys the line normally passes and thence to ground through said signal-receiving bell, said pair of contacts being opened when the key is operated each key having a third or return contact normally insulated its two other contacts and into which that one of them which is then connected with the line is brought into contact when the key is operated, said third or return contact of each key being connected to one side of the subscriber's generator at its substation, the other sides of the two substations being brought to a common connection which extends to the two substations and thence to said return, and two telephone-switches, one at each substation, each having a pair of contacts normally closed but open while the telephone is switched for use said common connection, which extends to the two substations and thence to said ground passing successively in series through said pair of normally closed contact-points of each of said telephone-switches, substantially as and for the purpose set forth.

In testimony whereof I have hereunto subscribed my name.

MILO G. KELLOGG.

Witnesses:
H. M. WALKER,
E. S. WALKER.