

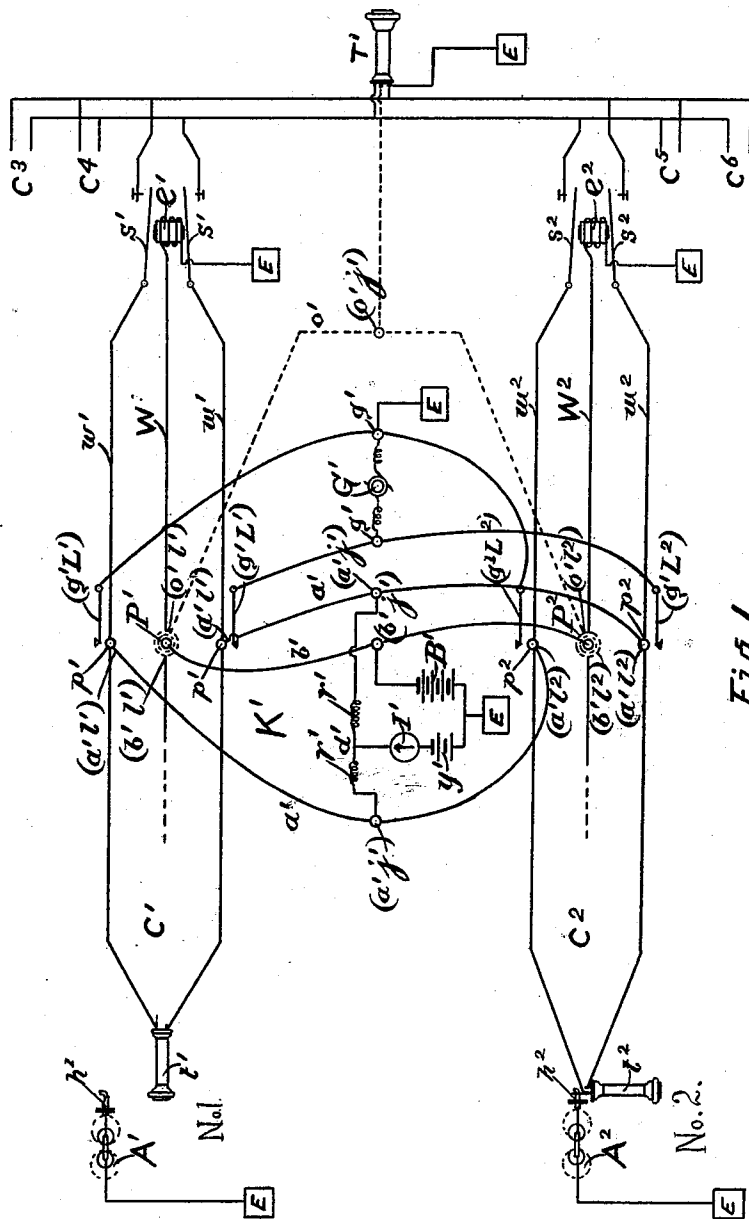
(No Model.)

7 Sheets—Sheet 1.

W. W. JACQUES.
TELEPHONE EXCHANGE SYSTEM.

No. 510,863.

Patented Dec. 12, 1893.



Witnesses:

W. W. Swan
B. L. Ruggles.

Inventor:

William W. Jacques

(No Model.)

7 Sheets—Sheet 2.

W. W. JACQUES.
TELEPHONE EXCHANGE SYSTEM.

No. 510,863.

Patented Dec. 12, 1893.

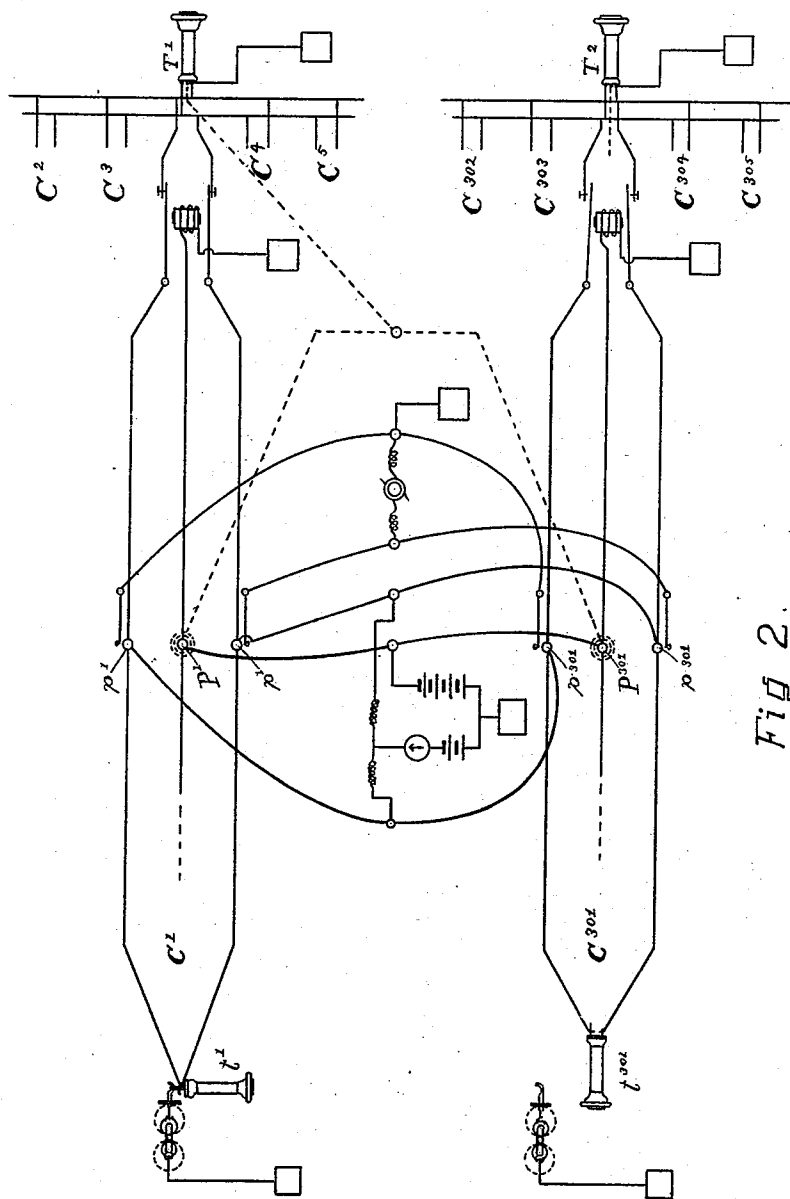


Fig 2.

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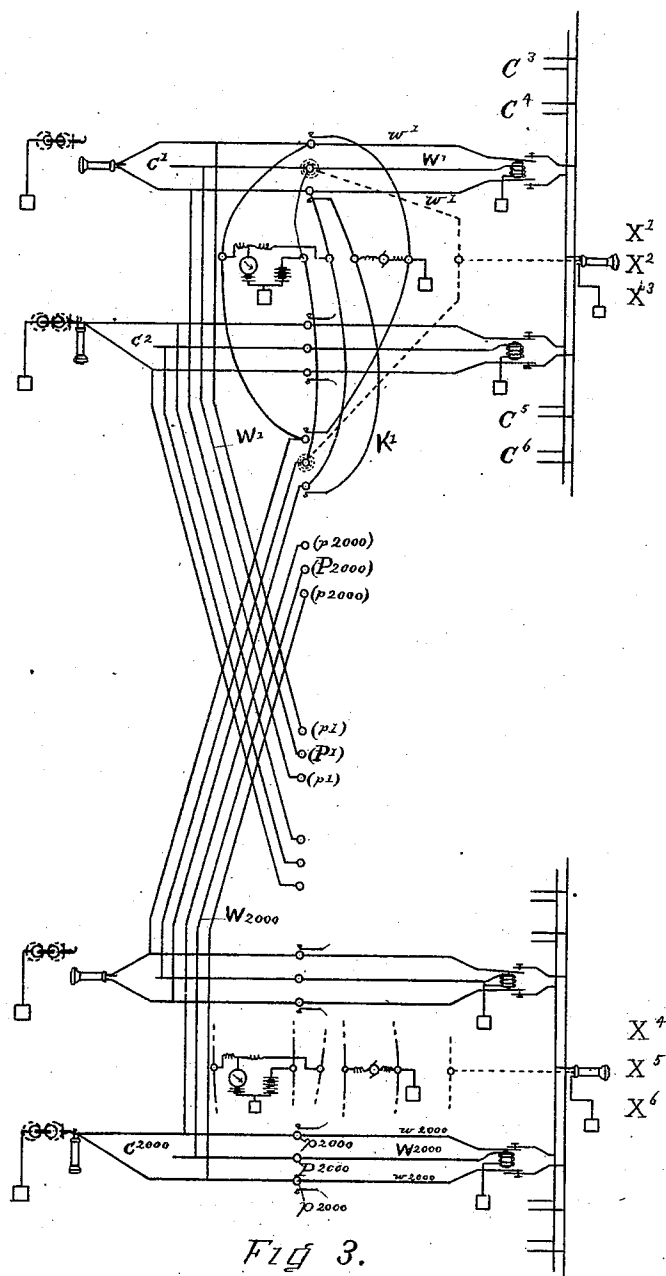
(No Model.)

7 Sheets—Sheet 3

W. W. JACQUES.
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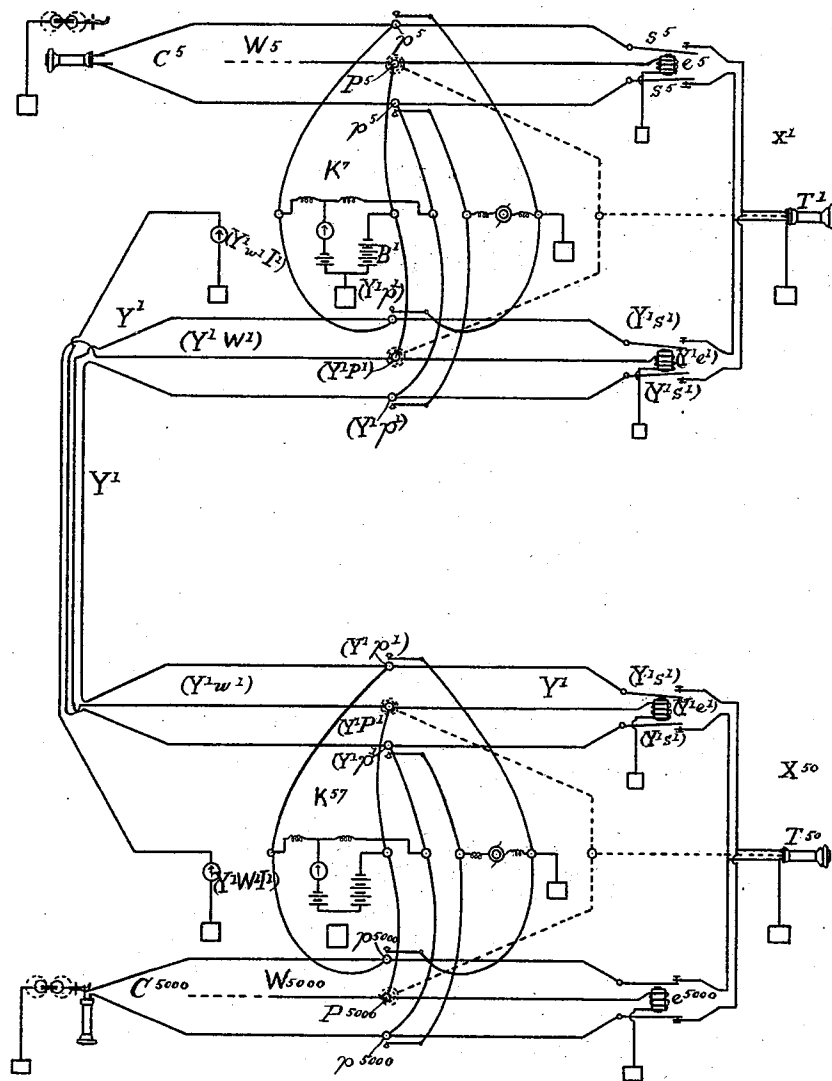


FIG 4

Witnesses:

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7 Sheets—Sheet 5.

W. W. JACQUES.
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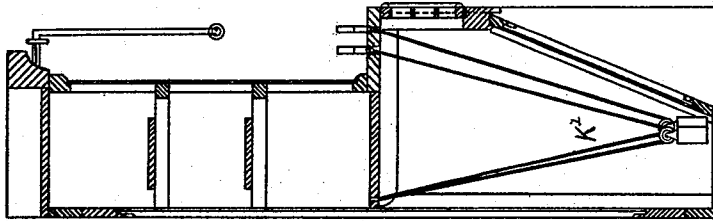


Fig. 6.

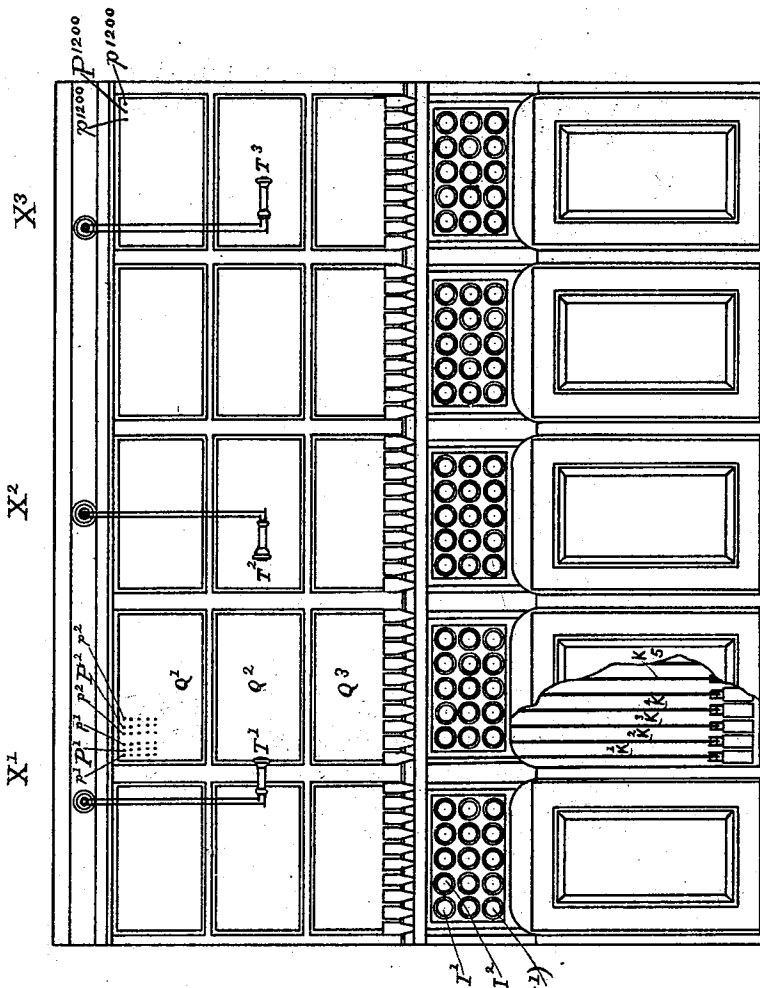


Fig. 5.

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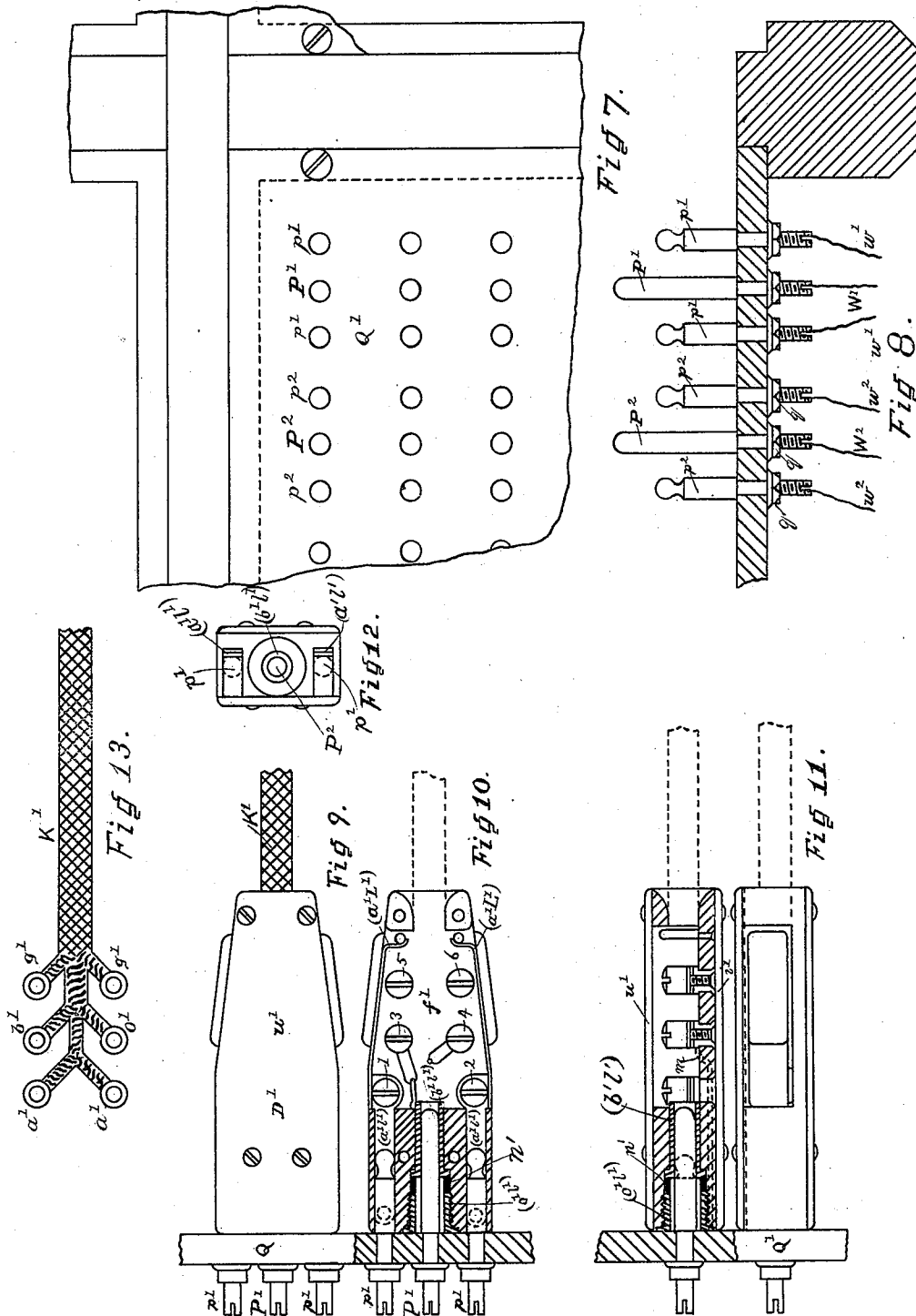
(No Model.)

7 Sheets—Sheet 6.

W. W. JACQUES.
TELEPHONE EXCHANGE SYSTEM.

No. 510,863.

Patented Dec. 12, 1893.



Witnesses:

N. W. Swan

B. L. Puggles

Inventor:

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(No Model.)

7 Sheets—Sheet 7.

W. W. JACQUES.
TELEPHONE EXCHANGE SYSTEM.

No. 510,863.

Patented Dec. 12, 1893.

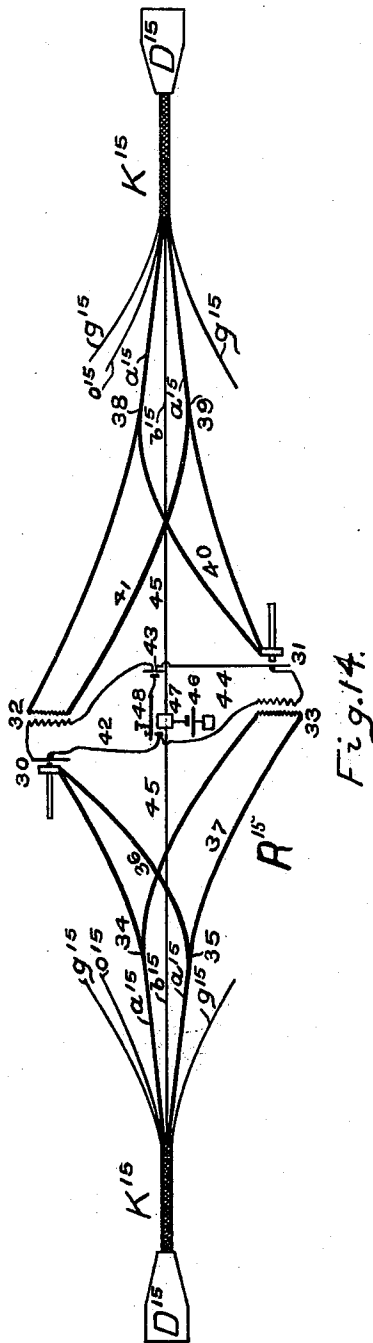


Fig. 14.

Witnesses.

H. W. Swan

B. L. Puggles.

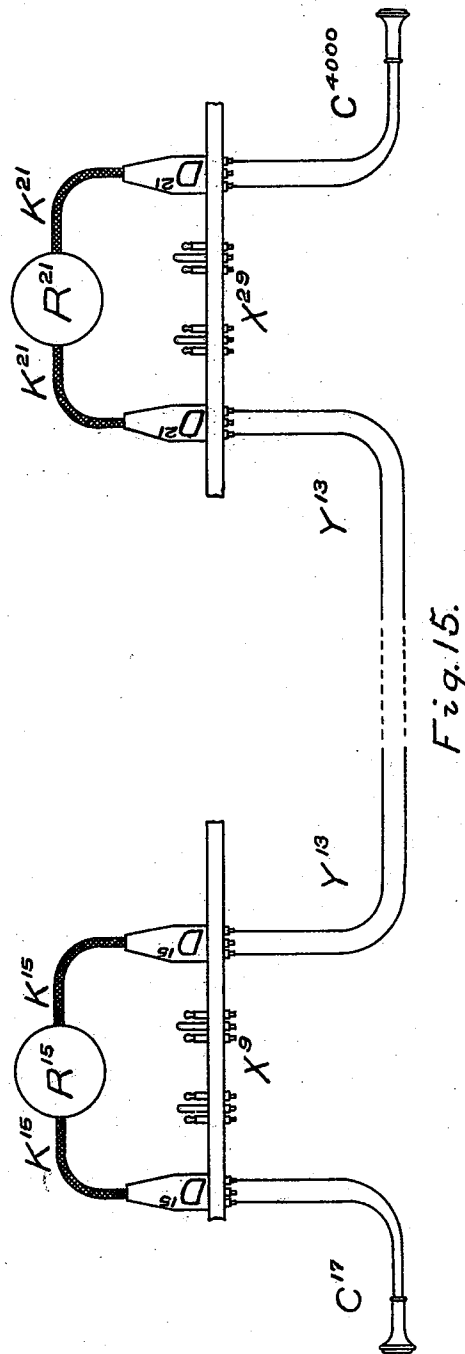


Fig. 15.

Inventor.

William W. Jacques

UNITED STATES PATENT OFFICE.

WILLIAM W. JACQUES, OF NEWTON, ASSIGNOR TO THE AMERICAN BELL
TELEPHONE COMPANY, OF BOSTON, MASSACHUSETTS.

TELEPHONE-EXCHANGE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 510,863, dated December 12, 1893.

Application filed December 1, 1892. Serial No. 453,786. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM W. JACQUES, of Newton, in the State of Massachusetts, have invented a new and useful Improvement in Telephone-Exchange Systems, of which the following is a specification.

In an exchange system constructed, arranged and operated according to this invention, apparatus by which the subscribers signal to the central office is eliminated and the subscriber's telephone is put normally in circuit with an operator's telephone, a large number of them with a single operator's telephone each by a separate metallic circuit. Every telephone line is brought to every section of the switchboard by branch terminals, although some of the details of the invention are applicable to systems in which the lines are looped into the different sections of the board. With a single instrument in each hand the operator determines whether a line is in use, disconnects any two lines from his own telephone, connects the said two lines together, signals both parties, and provides a busy test, all by a simple movement of the two hands. No operator is required or is able to talk by telephone with a subscriber or with another operator. Each section of the switchboard has fewer pieces of apparatus than have been required hitherto, and for a given number of subscribers fewer sections of switchboard and fewer operators are required. Special trunk line operators are dispensed with. A long distance system of telephoning is within the invention.

As will be explained in detail, the invention consists partly in the construction of new apparatus especially adapted to the new system, partly in combinations of new apparatus or portions thereof with old apparatus, and partly in combinations of old apparatus.

In practicing this invention use is made upon the switchboard of third terminals so grouped or associated, one with each pair of branch terminals belonging to the several metallic circuits centering at the switchboard, that the same instrument and same movement thereof that make or break a connection with the pair of terminals belonging to the metallic circuit will make or break a connection with the third terminal associated

therewith. These third terminals branch to the switchboard from short grounded wires at the central office closely associated one with each metallic circuit, and each of these third or associate wires contains or may contain more or less electrical mechanism. As shown each contains an electro-magnet and some of them contain an indicator. Corresponding to the third or associate terminals on the switchboard and the third or associate wires at the central office connected therewith, the operator's cord contains in addition to the usual pair of wires and their terminals for making and breaking connections with the metallic circuit terminals on the switchboard, a third wire with terminals at each end so grouped with the terminals of the said pair of wires that when the last named terminals make or break a connection with the metallic circuit terminals on the switchboard, the third or associate terminal of the cord will make or break a connection with the third or associate terminal on the switchboard. This third wire in the cord has electrical connection with a grounded battery, and consequently when a circuit is made by bringing the terminals of the operator's cord in contact with the corresponding terminals on the switchboard the third wire associated with the circuit at the central office is connected with a battery, and when the operator's cord is removed the connection between the said associate wire and the battery is broken. It follows that the magnet heretofore mentioned as in the said associate wire will be excited when a group of terminals of the operator's cord thus far described is in contact with a group of terminals on the switchboard. So likewise the indicator mentioned as in some instances being in the said associate wire, would be operated by such contact.

The two wires in the operator's cord used in making and breaking connection on the switchboard with branch terminals of the metallic circuit are in this specification often called the talking wires, and the third wire of the cord, which, as above stated, is connected with a battery, is often called the battery wire.

If the groups of terminals thus far described, at both ends of the operator's cord

make connections with two corresponding groups of terminals on the switchboard two metallic circuits will be connected; but since to avoid signaling the central office, as mentioned above, the metallic circuits are normally in connection with the operator's telephone, the connections with the switchboard being by branch terminals, and since, as will hereinafter be more clearly shown, many circuits are thus normally connected with each operator's telephone, it becomes necessary to disconnect from that telephone any two metallic circuits between which a connection is made at the switchboard for the purpose of carrying on conversation. By this invention the operator's telephone is cut out by the same operation or movement on the part of the operator that unites the two circuits. For this purpose double switches are placed in each metallic circuit between the operator's telephone and the branch terminals of the switchboard in position to be operated by the above mentioned magnets to break the circuits, each when its magnet is charged by a battery, as aforesaid, and to restore the circuit when the battery is taken out of the circuit. Any switch thus operated will be within this branch of the invention generally considered.

When the metallic circuits branch to several switchboards, or to several sections of the switchboard, and it may be when they branch to several subsections of the switchboard, it becomes important or of advantage for the operator, before making a connection between two subscribers' circuits, to ascertain whether the one to be connected at the request of the other is in use. This is accomplished by the use of a fourth wire in the operator's cord branching to the operator's telephone, the said fourth wire being furnished with a terminal at each end of the cord adapted to make connection with the third or associate terminals on the switchboard. It follows that if when an operator brings a terminal of a fourth wire, which may be called the "testing wire," in contact with an associate or third wire terminal on the switchboard, he hears in his telephone a click, he knows, that the third or battery wire of some other cord is in connection with that terminal. An associate terminal cannot be used unless the companion metallic circuit terminals are in use also, and thus it is evident that the circuit is in use. In the absence of a click the circuit is not in use.

It will be observed in the description of the apparatus as actually constructed that the third or associate terminals on the switchboard are longer than the metallic circuit terminals. The terminals on the switchboard are in the form of pins. Those on the operator's cord are corresponding thimbles or sockets; but in order that the terminals of two separate wires in the cord may at different times be brought into connection with the switchboard terminal, I make the thim-

ble or terminal of the fourth or testing wire of larger diameter than that of the terminal of the third or battery wire and place the one of larger diameter in front of the other. In the operation the long pin on the switchboard will first touch the terminal or thimble of larger diameter in the cord and give a click or not as the case may be, and afterward when contact is established with the thimble or terminal of small diameter there will be no contact with the thimble or terminal of larger diameter.

In the operation of connecting two subscribers' lines at a central station it is necessary to signal the second subscriber, or the one with whom the first subscriber desires a connection to be made. For this purpose the operator's cord is provided with two additional wires, termed the "signaling wires," which connect, one with one pole of an alternating current calling generator and the other with the other pole of the same generator, and are provided at both ends with spring terminals adapted to make connection with the pairs of branch terminals on the switchboard belonging to the metallic circuits between which connection has already been made by the talking wires of the cord. This last named connection having been made the operator presses the two springs of the signaling wires at each end of his cord and thus establishes a connection between the generator and both metallic circuits. This makes a noise that may be heard in both subscribers' telephones; or the generator may be made to operate bells at the subscriber's station as hereinafter described. For clearness the terminals of the signaling wires of the operator's cord are termed spring terminals, and are so shown in diagrams illustrative of the operation of the invention. In actual construction the circuit is still open between the branch terminals on the switchboard and the generator after the talking wires are in connection with said branch terminals, and the spring contacts for closing the circuit are back within hand instruments in which all the wires of the operator's cord terminate as will be hereinafter explained. In the diagrams hereinafter explained the terminals of the signaling wires are shown as spring terminals.

The application of the invention to trunk lines and long distance telephoning, and also the use of disconnecting signals according to the invention, will be described farther on.

In the drawings Figure 1 is a diagram illustrative of the mode of operation of the invention when but one operator is employed at a section of the switchboard. Fig. 2 is a similar diagram, provision being made for more than one operator at a section. Fig. 3 is a diagram representing the mode of operation with two sections of switchboard, whereby the operator at either section can make a connection not only with a line terminating in his own section, but with a line terminating

in a neighboring section. Fig. 4 is a diagram illustrative of the trunking system. Figs. 5 and 6 are respectively a front and a side elevation of the switchboard. Figs. 7 and 8 are details of the switchboard. Fig. 9 is a top view of the hand instrument containing the group of terminals of the operator's cord in position on the switchboard. Fig. 10 is the same as Fig. 9 with the cover of the instrument removed. Fig. 11 is a side view of two hand instruments, one having a side removed. Fig. 12 is an end view of the said hand instrument. Fig. 13 is a detail of the operator's cord. Figs. 14 and 15 are diagrams illustrative of the use of telephone relays.

So far as may be the same letters refer in all the figures to like instruments, apparatus, wires, &c., numerals being added to the letters and the letters sometimes being coupled for the purpose of designating the subscriber's circuit, the operator's section, a particular portion of the operator's apparatus, &c. Thus, *t* in all cases designates a subscriber's telephone; *C* in all cases a subscriber's metallic circuit; *T* in all cases the receiving telephone of an operator at a central office; *G* in all cases an alternating current calling generator, and *E* an earth or a ground; *B* and *y* always batteries; *w* one of the wires of a subscriber's metallic circuit; *W* an associate wire elsewhere more particularly mentioned and described; *e* is always an electro-magnet; *r* a retardation coil or current graduator; *I* a current indicator; both *P* and *p* are branch terminal posts, while *s s* are a pair of switches in the two wires *w* of metallic circuits. *K* is always a connecting cord consisting of a bundle of six insulated wires, two of which *a a* are talking wires, while *b* is a battery wire, *g g* generator or signaling wires, and *o* the operator's testing wire; *j* is always a junction, while *L* and *l* in all cases designate terminals, being added to the insulated wires of which they are terminals, and *L* designating more particularly a spring terminal, as *t l* and *t L*; *A* in all cases is a call bell at a subscriber's station, and *h* a hook, connecting through the call bell with the ground, upon which the telephone may be hung. Metallic circuits for trunk lines are everywhere designated by *Y* with a numeral to designate the particular trunk line. Associate wires for trunk lines are marked *Y W* and *Y w* with proper numerals. Trunk line indicators are designated by *Y W I* and *Y w I* with numerals.

Numerals are in some instances used independent of letters to indicate parts of instruments.

To avoid confusion, so much of the apparatus, only, is shown in the drawings as will enable the invention and its mode of operation to be understood.

In the apparatus actually used at a central office there are, as in other systems, several sections of switchboard each containing three subsections. It is planned that there shall be an operator at each subsection who will

be able to reach not only the branch terminals of his own subsection but also the branch terminals of the subsection on either side of his own. The three operators at each section have in common sixty operators' cords and there are sixty indicators at the same section whose office it is to show whether or not any particular cord is in use or is to be disconnected.

In the diagram at Fig. 1, the two metallic circuits *C'* and *C''* are both normally connected with an operator's telephone *T'* at a single division of the switchboard at the central office, thus normally connecting both subscriber's telephone *t'* and subscriber's telephone *t''* with said telephone *T'*. In practice a large number of subscribers' telephones *t* are thus normally connected with the single telephone *T* of an operator.

By following the diagram at Fig. 1 a large part of the invention will be easily understood; it will readily be seen how in practical operation the telephones *t'* and *t''* are put into a metallic circuit distinct from any other, both being disconnected from the telephone *T'*, and how the normal condition is thereafter resumed, viz: The subscriber at station 1 takes the telephone *t'* from hook *h'*, and speaking into it asks, for example, that subscriber's station 1 be connected with subscriber's station 2. The operator, by a single operation hereinafter fully explained, puts the terminals (*a' l'*) (*a' l'*) of his cord *K'* in connection with the branch terminal posts *p' p'*, the cord spring terminals (*g' L'*) (*g' L'*) in position to be thereafter connected to the same branch terminal posts *p' p'* by operating the springs of said terminals, and the cord terminal (*b' l'*) in contact with branch terminal post *P'*, the said branch terminal posts belonging as shown to circuit No. 1. In like manner the operator puts the terminals at the other end of the connecting cord *K'* in connection with or in position to be connected with the branch terminals belonging to circuit No. 2, viz: cord terminals (*a' l''*) (*a' l''*) in connection with branch terminals *p'' p''*, the cord spring terminals (*g' L''*) (*g' L''*) in position to be connected with the same branch terminals *p'' p''* and the cord terminal (*b' l''*) in contact with branch terminal post *P''*. The branch terminal *p' p'* are in the wires *w' w'* of the metallic circuit *C'*, the branch terminals *p'' p''* are in the wires *w'' w''* of the circuit *C''*, the branch terminal *P'* is in the associate wire *W'* and the branch terminal *P''* is in the associate wire *W''*.

When the terminal (*b' l'*) makes connection with post *P'*, it brings grounded battery *B'* in connection with associate wire *W'* and allows a current to ground through electro-magnet *e'*. This operates switches *s' s'* to disconnect metallic circuit *C'* from central telephone *T'*. In like manner the connection of cord terminal (*b' l''*) with branch terminal post *P''* operates to disconnect metallic circuit *C''* from central telephone *T'*. The connections are made at the same time between (*a' l'*) (*a' l'*)

and posts $p' p'$ at one end of cord K' , and between ($a' l'$) ($a' l'$) and posts $p^2 p^2$ at the other end of said cord. Thus the two metallic circuits C' and C^2 including telephones T' T^2 are connected through the talking wires $a' a'$. The operator now operates the spring terminals ($g' L^2$) ($g' L^2$) to make connection with posts $p^2 p^2$, thus sending a current from the calling generator G' through telephone T' , hook h^2 and call bell A^2 to ground, and notifying the subscriber at station 2 that his telephone is connected with another subscriber. When the conversation is finished, either party, by hanging up his telephone, notifies the operator at the central station that the connected lines are to be restored to their normal condition, a circuit being thereby made from the ground at station No. 1 (supposing that subscriber to have hung up his telephone) through wires $w' w'$ of circuit 1 and cord wires $a' a'$, junctions ($a' j'$) ($a' j'$), bridge wire d' , indicator I' which is grounded through its own battery y' to earth. The operator then by a single operation in each instance also hereinafter to be explained, removes all the cord terminals at each end of the connecting cord from the branch terminals with which they have been connected.

It remains to describe the office of the sixth wire o' of the connecting cord K' . This wire has two terminals ($o' l'$) ($o' l'$) and from a central junction $o' j'$ connects with the operator's telephone T' . The operator, by touching either of said last named terminals to the P-terminal of the associate W-wire of any circuit, may determine by a click or the absence of a click in his telephone whether there is a battery on that wire, and consequently whether or not the circuit to which the associate wire is appropriated is in use. If, for instance, circuit C^2 is in use, the test will be from grounded battery B' to junction ($b' j'$), cord wire b' , and the connection of the latter at P^2 through wire o' to the telephone T' .

$X' X^2 X^3$ (see more particularly Fig. 5) are several subsections of the switchboard at the central office collectively under the control of the several operators provided with the several telephones $T' T^2 T^3$ which are normally in circuit each with a group of subscribers' metallic circuits, twelve hundred in all.

$p' P' p'$ form the group of posts constituting the branch terminals of subscriber's metallic circuit C' and the associate wire W' .

$p^2 P^2 p^2$ form the group of posts constituting the branch terminals of circuit C^2 and associate wire W^2 , and so on up to $p^{1200} P^{1200} p^{1200}$.

The branch terminal posts P', P^2 , &c., (see Fig. 8,) project farther from the switchboard than the posts $p' p' p^2 p^2$, &c., for a purpose explained hereinafter.

In practical operation telephone T' will be employed with the first four hundred subscribers' circuits and associate wires. Telephone T^2 will be connected with the second four hundred, and telephone T^3 with the third four hundred, &c.

K', K^2 , &c., (but few of them are shown) are sixty operators cords to be operated in common by the three several operators having in charge the three separate telephones $T' T^2$ and T^3 . They are hung in the switchboard and retained in place by weights in the ordinary way. Each of said sixty cords, as already stated in the description of Fig. 1, contains six insulated wires, $a' a', g' g', b',$ and o' , and, as also already stated, these insulated wires at each end of their respective connecting cords have terminals corresponding to the branch terminals $p' P' p'$, &c., of the switchboard. These connecting cord terminals are grouped in a single instrument as shown in detail at Figs. 9 to 13. The several six insulated wires of each connecting cord are provided with batteries, calling-generators, electro-magnets, switches, and current indicators, as stated above.

I', I^2 , &c., (Fig. 5) are the current indicators, preferably small galvanometers, belonging to the connecting cords K' to K^2 , &c.

The construction and arrangement of terminals of the switchboard are shown in detail at Figs. 7 and 8. Q' is a rubber plate forming a part of the face of the switchboard. In all there are fifteen such rubber plates, Q', Q^2 , &c., in the three subsections forming a section of the board (see Fig. 5); $p' p', p^2 p^2$, &c., are metal posts forming the terminals belonging to the metallic circuits centering at the board as aforesaid; being secured in the face of the board by nuts g , behind the board as shown (see Fig. 8); P', P^2 , &c., are the terminals belonging to the associate wires W', W^2 , &c., being also of metal and secured in the same way as $p' p', p^2 p^2$, &c. Each associate wire terminal is grouped with a pair of metallic circuit terminals and is longer than the metallic circuit terminals as herein elsewhere explained.

An instrument containing a group of terminals belonging to a connecting cord is shown in detail at Figs. 9 to 13. It is lettered as if belonging to cord K' and is shown in place upon the switchboard as attached to the group of switchboard terminals $p' P' p'$, although in operation it might be attached to any group of switchboard terminals.

D' is the instrument as a whole. The frame of the instrument D' consists of a chambered block of rubber f' , and is provided with a top u' and a bottom i' . Within the chamber in said block are six binding posts 1, 2, 3, 4, 5, 6, of which binding posts 1 and 2 make connection between insulated wires $a' a'$ of the connecting cord K' and terminals ($a' l'$) ($a' l'$), which are two metal plates shown in contact with posts $p' p'$ of the switchboard. Binding post 3 connects insulated wire b' with the tubular terminal ($b' l'$) held within the frame and shown in contact with the long post P' . The fourth binding post, 4, connects insulated wire o' by means of wire m with tubular terminal ($o' l'$) which, as shown, is of larger diameter than tubular terminal ($b' l'$)

and is insulated therefrom by a ring n' . As already explained, the tubular terminal ($o'l'$) makes passing connection with post P' , while the instrument D' is being put upon the corresponding terminals of the switchboard. Binding posts 5 and 6 make permanent connection with insulated wires $g' g'$, and temporary connection with the springs ($a'l'$), ($a'l'$), which, as shown, are extensions of the metal plates ($a'l'$) ($a'l'$) and are secured to the rubber frame f' by the before mentioned binding posts 1 and 2.

As elsewhere stated the posts $p' P' p'$, &c., are secured in the switchboard by means of nuts q , and are adapted to make connection with the wires w', w' &c., by soldering or otherwise.

The plate terminals ($a'l'$) ($a'l'$) of the operator's instrument from their shape, together with the nature of the material of which block f is made (Fig. 12), have considerable elasticity, and press, both of them, inward toward the corresponding terminal posts $p' p'$ of the switchboard. This insures with easy construction good contacts between the talking terminals of the cord and the metallic circuit terminals of the switchboard when the battery tubular terminal ($b'l'$) is upon the long post terminal P' belonging to the associate wire W' .

When the number of subscribers becomes too large to have the requisite connections made by the operators at a single section of the switchboard, which, as aforesaid, comprises three subsections, a new section consisting of an equal number of subsections $X^4 X^5 X^6$, may be added for the additional subscriber, when each subscriber, both old and new, will be furnished with a set of branch terminals at each section as illustrated by diagram at Fig. 3, where each metallic circuit branches to both sections. Thus the C' metallic circuit, the call of which will be executed as above described at section $X' X^2 X^3$ of the board, branches to enter section $X^4 X^5 X^6$, and there has a second set of terminals (p') (p'), as has also its associate wire W' , viz: (P'); and in like manner the metallic circuit C^{2000} , the call of which will be executed at section $X^4 X^5 X^6$, branches to and has terminals (p^{2000}) (p^{2000}), while associate wire W^{2000} has an additional branch terminal (P^{2000}) in the section $X' X^2 X^3$ as well as its terminal P^{2000} in section $X^4 X^5 X^6$.

It follows that any connecting cord $K' K^2$, &c., at any subsection of the switchboard, will serve to connect any two metallic circuits of the entire system thus far described.

The invention is particularly applicable to trunking, and the different switchboards may be at one office or at different offices. Wherever located, each switchboard has its own subscribers' lines entering every section, and is provided with branch line terminals, associate wires with magnets, cut off switches and terminals therefor, and a number of six-wire conducting cords, each provided with its bat-

teries, indicators, generators, and terminals corresponding to the branch wire and associate wire terminals projecting from the face of the switchboard, all as previously described. In addition, each switchboard has a portion of each section appropriated to trunk lines, which are metallic circuits stretching from board to board, or from several boards to one board, each accompanied with two associate wires for substantially the whole length of the trunk circuit. Each trunk metallic circuit with one of its associate wires at one board, and the other associate wire at the other board, has at both ends in each of the two boards that it connects a set of terminal posts such as have been already described ($p' P' p'$ Fig. 8). At each board in operation the trunk circuits entering the board are treated as subscribers' circuits belonging to the same board. In practice, a subscriber requests the operator at his switchboard to connect his line with another switchboard. This the operator does with any one of his connecting cords, connecting the $p P p$ terminals of the subscriber's particular metallic circuit and associate wire with the $p P p$ terminals on the same board of a trunk line and one of the associate wires extending to the other switchboard. The subscriber then asks the operator at the other switchboard to connect his line (giving the number of the first switchboard) with the desired subscriber's line belonging to the second board. This puts the two subscribers in communication.

If there be more than one trunk line between two switchboards, it becomes necessary when one of them is used that the operator at the second switchboard shall know which of them it is that he is to connect with a subscriber's line entering the second board. For this purpose indicators, operated as hereinafter described, are placed in the associate wires of the trunk lines in position to be seen at the second switchboard.

The diagram at Fig. 4 where is illustrated so much of the apparatus of two distinct switchboards as would serve to put a subscriber connected with one of the boards in communication with a subscriber belonging to the other board, will require little further explanation. T' is the operator's telephone at section X' of one of the boards. C^5 is a subscriber's metallic circuit, W^5 the associate wire of that circuit, e^5 its magnet, and $s^5 s^5$ the switches operated thereby to cut out telephone T' as before described in the explanation of Fig. 1. $p^5 P^5 p^5$ are branch terminals belonging to C^5 and W^5 . Y' is a trunk line, ($Y' W'$) one of the associate wires belonging to said trunk line, and ($Y' w'$) the other associate wire, ($Y' e'$) the electro-magnet in said associate wire, ($Y' s'$) ($Y' s'$) a pair of switches in trunk circuit Y' . ($Y' p'$), ($Y' P'$), ($Y' p'$) are branch terminals belonging to said trunk circuit and associate wire.

T^{50} is the operator's telephone at section X^{50} in a second switchboard, C^{5000} a subscriber's

metallic circuit, W^{5000} an associate wire, e^{5000} an electro-magnet; and p^{5000} P^{5000} p^{5000} are terminals.

($Y' W' I'$) is an indicator in wire ($Y' W'$) and ($Y' w' I'$) an indicator in wire ($Y' w'$). To avoid unnecessary confusion, the terminals, electro-magnets, &c., of a trunk line are marked with the same letters in both boards.

As illustrated in the diagram at Fig. 4, subscriber's circuit C^5 has been connected, by any one of the operators' connecting cords (the operator has taken K^7) at section X' of a switchboard, with trunk line Y' running from said section to section X^{50} of a distant second switchboard, thus connecting subscriber's line C^5 with operator's telephone T^{50} of subsection X^{50} , as already sufficiently well described; but in addition to the operation previously described, battery B' , which has operated the e -magnet for the purpose before described, has also operated the grounded indicator ($Y' W' I'$) in wire ($Y' W'$) at the distant subsection X^{50} . Further, the said trunk line Y' has been connected, by any one of the connecting cords (the operator has taken his K^{57}) at subsection X^{50} , with subscriber's line C^{5000} .

Two central offices connected by a trunk line may be so far apart that the trunk line becomes in practice a long distance line, when it may be desirable to employ relay telephones. Accordingly a certain number of the operators' cords constructed and provided with terminals, as already described, at each section of switchboard are also provided with relay telephones, so that when an operator connects a subscriber's line with a trunk line he may make the connection through a relay. A more powerful telephone may be used for the relay than is required for the subscriber's station, and thus every subscriber may have the advantages of long distance lines without the expense of a long distance outfit. A relay may be brought into the line with advantage at either end of the trunk line, for I have found it advantageous to relay a current from a near telephone over a long line or a current from a distant telephone over a short line; and accordingly telephone repeaters, consisting each of two relay telephones arranged to work in opposite directions are placed in some of the cords.

The mode of operation when relays are employed including the manner in which a repeater is inserted in, or interposed between the two ends of an operator's cord, is represented at Figs. 14 and 15. K^{15} is an operator's cord containing the talking wires a^{15} a^{15} and battery wire b^{15} and also testing and signaling wires, as hereinbefore described, all of them having terminals, as already described, in hand instruments D^{15} D^{15} . R^{15} is a repeating apparatus or a telephone repeater in said cord K^{15} , and as shown at Fig. 14 is thus constructed: 30 is a relay telephone and 31 is a second relay telephone. 32 is an induction coil; 33 is a second induction coil. The wires a^{15} a^{15} are cut or opened within the cord K^{15}

and on one side the two ends, 34, 35, thus exposed are connected by a wire 36 passing through the spool of the magnet which operates the diaphragm of the relay 30, while a second connection between the same two ends 34, 35, is made by wire 37 which passes through the secondary of induction coil 33. On the other side of the cut opening in the wires a^{15} the two ends 38, 39 are connected by wire 40 passing through the spool of the magnet which operates the diaphragm of relay 31, and by wire 41 which passes through the secondary of the induction coil 32. 42 is the local microphone circuit of relay 30 and passes through the primary of induction coil 32 and also through battery 43. 44 is a local microphone circuit of relay 31, and passes through the primary of induction coil 33 and battery 43 which is common to both of said local circuits. Then the magneto circuit of one relay and the microphone circuit of the second are connected in multiple to the talking terminals at one end of the cord K^{15} , while the magneto circuit of the second relay and the microphone circuit of the first are connected in multiple with the terminals that are at the other end of said cord K^{15} . Battery wire b^{15} is connected by wire 45 with a grounded battery 46 (it may be the same battery that is connected with said wire for other purposes as hereinbefore described), the said wire 45 passing through the spool of a magnet 47 that operates switch 48 to close or open the said local circuits of said relay telephones 30 and 31.

In the diaphragm at Fig. 15, an operator at section X^9 of a switchboard at one central office, by the use of his cord K^{15} containing telephone repeater R^{15} , has made a connection between subscriber's line C^{17} and a trunk line Y^{13} leading to section X^{29} of a distant switchboard, and an operator at this distant switchboard, by his cord K^{21} containing telephone repeater R^{21} has connected the same trunk line Y^{13} with a subscriber's line C^{4000} . In some cases it may not be necessary to use both repeaters, when (taking the diaphragm at Fig. 15) an operator's cord in which the repeater has been omitted may be substituted for cord K^{21} .

I claim—

1. A telephone system consisting of several metallic circuits each terminating in a telephone at the subscriber's station, and all terminating in a single telephone at the central station, all said telephones being normally in circuit and each of said metallic circuits being provided at the central office with a pair of branch terminals, in combination with third or associate wires, one for each of said metallic circuits, open at one end and grounded at the other and provided with branch terminals associated one with each pair of branch terminals in its associate metallic circuit, an electro-magnet in each said associate wire, a double switch in each of said metallic circuits, arranged to be operated by said magnet

to break both wires of its said metallic circuit, a calling generator, a battery grounded at one pole, and a connecting cord consisting of six insulated wires, two of which associated as a pair are provided at both ends with terminals adapted to make connection with any of said pairs of branch terminals in said metallic circuits, while two others also associated as a pair make connection, one with one pole and the other with the other pole of said generator, and are provided at both ends with spring terminals also adapted to make connection with any of said pairs of branch terminals, a fifth of said insulated wires being connected to the open pole of said battery and provided at each end with a terminal adapted to make connection with any branch terminal in said associate wires, while the sixth of said insulated wires is connected with said central telephone and is provided with terminals at each end also adapted to make connection with any of said branch terminals in said associate wires, substantially as described.

2. In a telephone system comprising several metallic circuits each provided in a switchboard at a central office with one or more pairs of branch terminals and each provided with an associate wire also having one or more branch terminals in said switchboard one for and grouped with each pair of terminals of the associate metallic circuit, the combination with said metallic circuits, associate wires and terminals, of a grounded battery and an operator's cord provided with connecting wires, two of which are associated as a pair and are provided at both ends with terminals adapted to make connection with any of said pairs of terminals in said switchboard belonging to said metallic circuits, while a third is connected to the open pole of said battery and is provided at each end with a terminal adapted to make connection in said switchboard with the branch terminals of said associate wires, the said terminals at either end of said cord being grouped to correspond with the groups of terminals in said switchboard, substantially as described.

3. In a telephone system comprising several metallic circuits each provided in a switchboard at a central office with one or more pairs of branch terminals and with an associate wire and a branch terminal or terminals therefor grouped with its own said terminals in said switchboard, the combination with said metallic circuits, associate wires, and branch terminals, of a grounded battery, a grounded telephone, and two operators' connecting cords, one of which is connected to the open pole of said battery and provided at each end with a terminal adapted to make connection with the said branch terminals in said switchboard belonging to said associate wires, while the other is connected with said grounded telephone and adapted to make connection with any branch terminal on said

switchboard belonging to the same associate wire, substantially as described.

4. Two or more metallic circuits, a telephone in which all of said metallic circuits terminate, a double switch in each of said metallic circuits, associate wires one for each of said metallic circuits open at one end and grounded at the other and having in it an electro-magnet arranged to operate the double switch of the metallic circuit to which the associate wire containing said electro-magnet is appropriated, in combination with a switchboard containing branch terminals in groups of three, two of which in each group branch from a separate one of said metallic circuits while the third branches from the associate wire of said metallic circuit, a grounded battery and a connecting cord containing a pair of wires with terminals at the ends adapted to make connection with the metallic circuit branch terminals belonging to either of said groups of terminals on said switchboard and a third wire connected with said grounded battery and having at each end a terminal adapted to make connection with the third branch terminal of the same group, on the switchboard, substantially as described.

5. A number of metallic circuits each provided in a switchboard with one or more pairs of branch terminals, in combination with a generator and a connecting cord containing several wires, two of which are associated as a pair and provided with terminals adapted to make connection with any of said pairs of branch terminals belonging to said metallic circuits, while two others are also associated as a pair and make connection, one with one pole and the other with the other pole of said generator, and are provided at both ends with spring terminals adapted to make connection with the said branch terminals already in connection with the said other pair of wires in said connecting cord, substantially as described.

6. In a telephone system comprising several metallic circuits each provided in a switchboard at the central office with one or more pairs of branch terminals and each provided with an associate wire also having one or more branch terminals in said switchboard, one for and grouped with each pair of terminals of the associate metallic circuit, the combination with said metallic circuits, associate wires and terminals, of a grounded battery, a grounded telephone, and an operator's cord provided with connecting wires, two of which, the talking wires, are associated as a pair and are provided at both ends with terminals adapted to make connections with any of said pairs of terminals in said switchboard belonging to said metallic circuits, while another, the battery wire, is connected to the open pole of said battery and is provided at each end with a terminal adapted to make connection to the branch terminal of an associate wire grouped in said switchboard with

the pair of terminals to which the terminals of said talking wires are connected, and still another, the testing wire, is connected to said grounded telephone and is provided at each end with a terminal adapted to make passing contact with the same branch terminal of an associate wire with which said battery wire makes connection, substantially as described.

7. In a telephone system comprising several metallic circuits each provided in a switchboard at a central office with one or more pairs of branch terminals, and at the subscriber's station with a ground connection arranged to be established by hanging up the subscriber's telephone, the combination with said metallic circuits and branch terminals, of a current indicator, a grounded battery, and an operator's cord containing a pair of talking wires which are provided at both ends with terminals adapted to make connection with any of said pairs of terminals in said switchboard belonging to said metallic circuits, while the said indicator is connected on one side with said grounded battery and on the other side, through branching wires each containing a proper resistance, with the said pair of talking wires in said operator's cord, substantially as described.

8. In a telephone system comprising several metallic circuits each provided in a switchboard at a central office with one or more pairs of branch terminals and each provided with an associate grounded wire also having

one or more branch terminals in said switchboard, the combination with said metallic circuits, associate wires and terminals, of a grounded battery, two relay telephones, a local battery circuit and induction coil for each, a circuit closer, and an operator's cord provided with two talking wires, a battery wire and terminals at each end for all said wires, substantially as described.

9. In a telephone system comprising two switchboards located in different central offices, subscribers' circuits provided with terminals each in one of said switchboards and a trunk or long distance line with terminals in both of said switchboards, the combination with said switchboards, subscribers' circuits trunk line and terminals, of an operator's cord, at either one or both of said switchboards, provided with terminals at each end and having inserted in it a telephone repeater consisting of two relay telephones, the magneto circuit of the first relay and the microphone circuit of the second being connected in multiple to the terminals at one end of said cord, while the magneto circuit of the second relay and the microphone circuit of the first are connected in multiple with the terminals at the other end of said cord, substantially as described.

WILLIAM W. JACQUES.

Witnesses:

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B. L. RUGGLES.