A. J. RAY.

AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED JUNE 16, 1913.

1,262,843.

Patented Apr. 16, 1918.

5 SHEETS—SHEET 1.

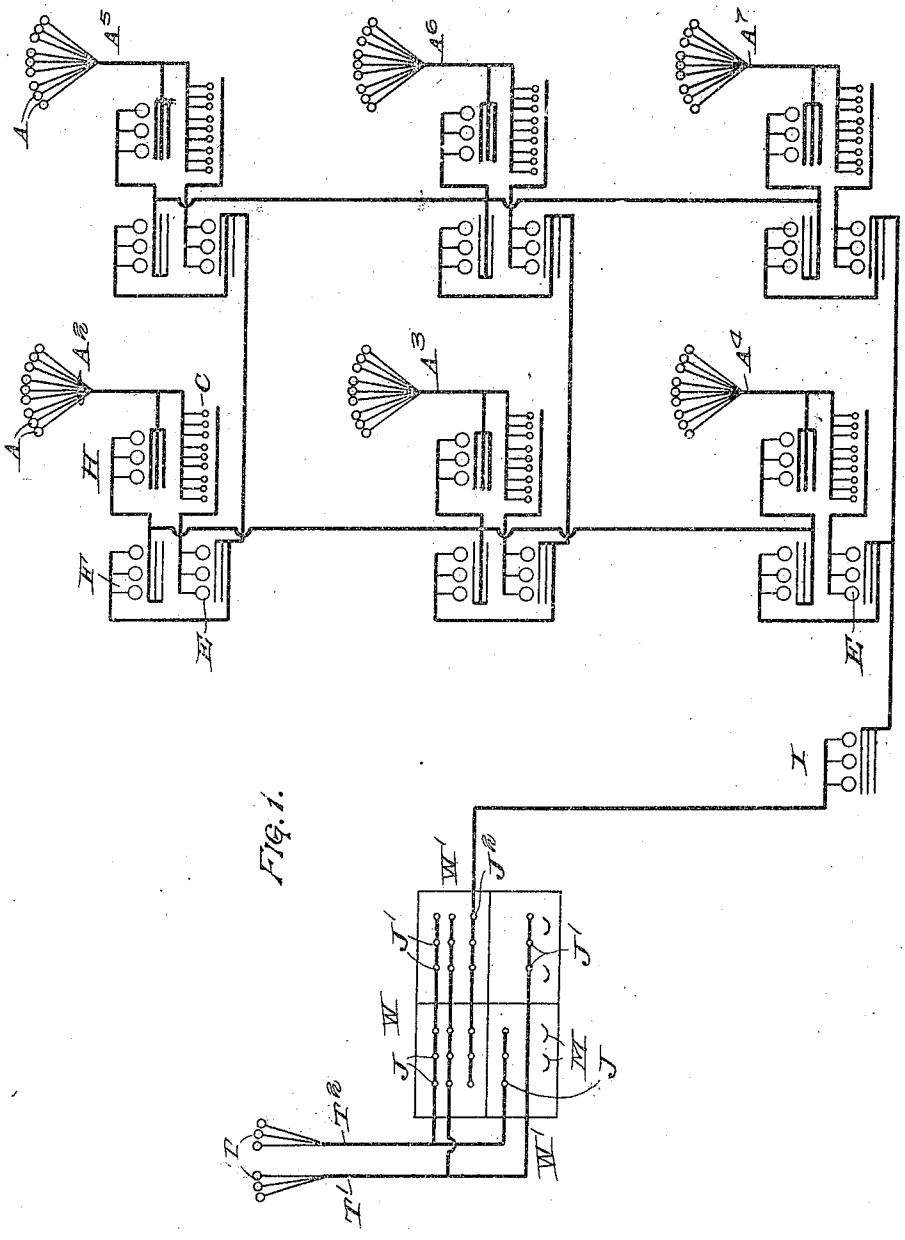


Fig. 1.

WITNESSES

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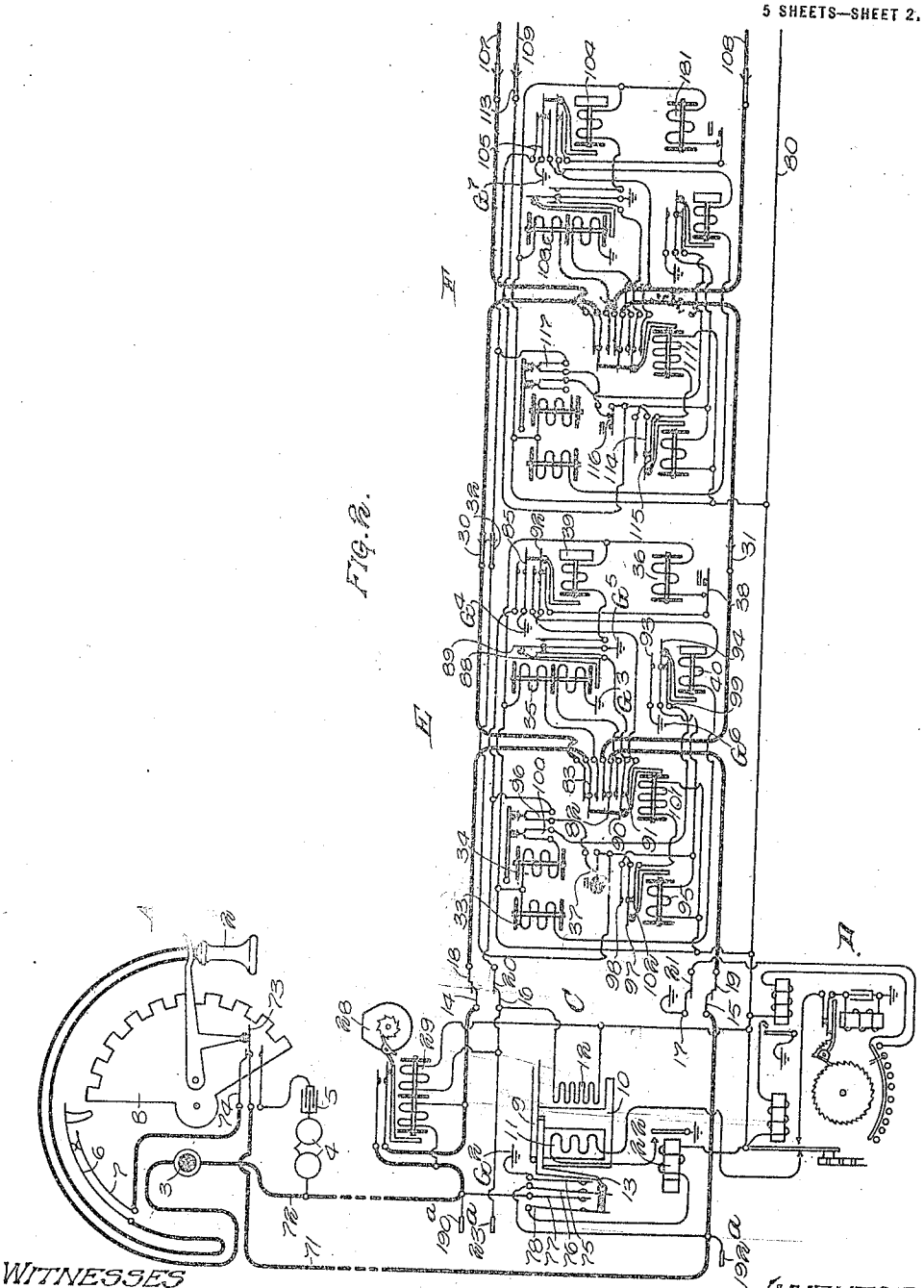


Fig. 2.

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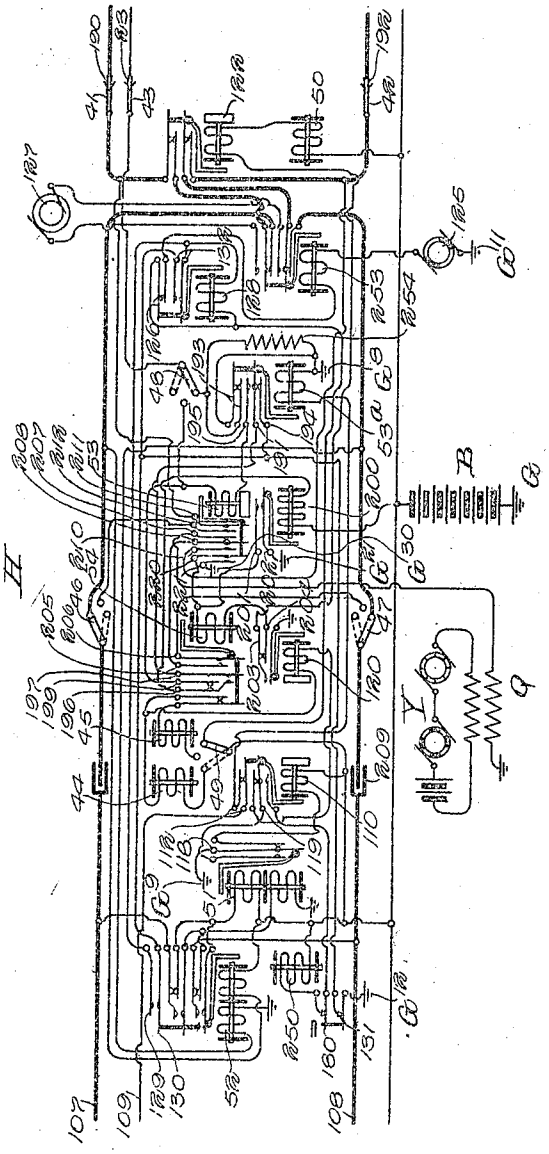


Fig. 3.

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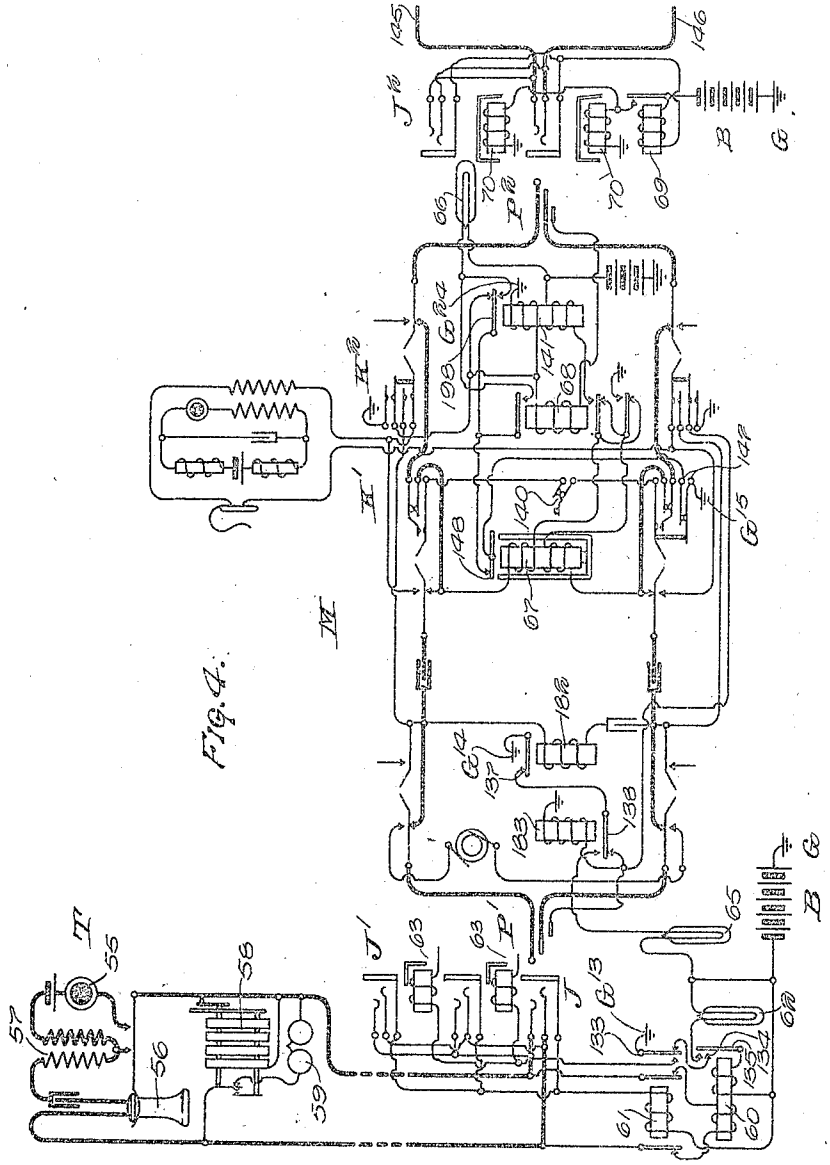


Fig. 4.

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5 SHEETS—SHEET 5.

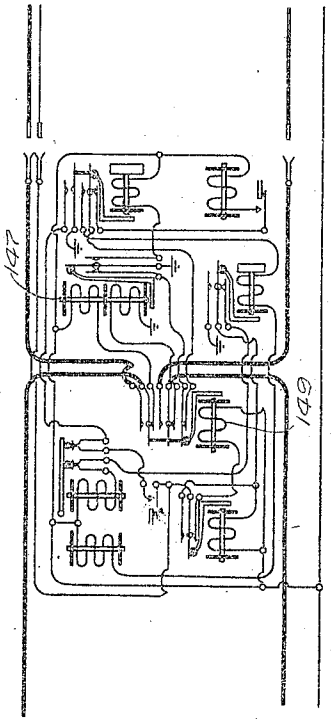


FIG. 5.

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UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

1,262,843. Specification of Letters Patent. Patented Apr. 16, 1918.

Application filed June 16, 1913. Serial No. 773,930.

To all whom it may concern:

Be it known that I, ARTHUR J. RAY, a citizen of the United States of America, and resident of Chicago, Cook county, Illinois, have invented certain new and useful Improvements in Automatic Telephone Systems, of which the following is a specification.

My invention relates to an improvement in automatic telephone systems, and more particularly to an improved means for handling long distance calls in connection with an automatic telephone system.

Toll or long distance calls are usually handled through an operator and it is, of course, desirable that these calls be given preference over local calls. Thus, where two subscribers are engaged in a local connection and one of these subscribers is desired in a long distance call, some means should be provided for notifying the desired subscriber of this fact. If the operator attempted to make connection with the line with the ordinary connector switch, she would merely receive the usual busy signal, without establishing a talking connection with the subscriber, and thus be unable to inform him of the fact that he was wanted in a long distance call. Heretofore, special connectors have been provided by using which the operator could obtain connection with the busy subscriber's line. It would, of course, be inadvisable to interrupt a long distance connection to advise the subscriber that he was wanted in a second such connection. Therefore, in these previous systems it was necessary to provide a differential busy test so that the operator, in first establishing connection through the ordinary connector, could determine whether the desired line was engaged in a local connection or in another long distance connection. Then, after ascertaining that the line was engaged in a local connection, she had to release that connection and employ a special connector in order to establish connection with the desired line.

The object of my invention is to provide a connector switch which, when employed in regular automatic or local service, operates in the usual and well-known manner. When a connection is extended to this connector, however, from an operator's board, means are provided in the connector whereby the operator can establish connection with a line which is involved in a previous local connection, but cannot obtain connection with a line which is involved in an established long distance connection. In other words, by the use of this improved connector, the operator at the long distance board can obtain connection with all busy lines, except those which are involved in an established connection from a long distance board, in order to advise these subscribers that they are wanted in a long distance connection.

These and other objects of my invention will be more readily understood by reference to the accompanying drawings, in which I have illustrated my invention in connection with automatic and manual apparatus of well-known types.

In the drawings Figure 1 represents a diagrammatic layout of a telephone system in which I have chosen to illustrate my invention.

Figs. 2 and 3 show a complete connection between a calling subscriber at substation A and a called subscriber's line.

Fig. 4 shows a manual telephone line and an operator's cord circuit.

Fig. 5 is an automatic selector switch, through the medium of which an operator extends a connection from the cord circuit.

The telephone system illustrated in Fig. 1 comprises an automatic exchange and a manual exchange. The manual exchange is represented by a switchboard W comprising a plurality of operator's positions W'. At T' and T^2 are shown groups of substations T the lines of each of which substations terminate in an answering jack J on one operator's position W' and in a multiple jack J' on each operator's position in the usual and well-known manner. Suitable cord circuits M are provided for establishing connections.

The automatic exchange is of a well-known type comprising subscribers' individual preselector switches C, first selector switches E, second selector switches F and connector switches H. In the drawings there is represented, on a scale of three to ten, two thousands of an exchange of ten thousand lines capacity. The subscribers' substations A are divided into groups A^2, A^3, A^4, etc., usually of one hundred lines each. On a scale of three to ten, therefore, the three groups A^2, A^3 and A^4 represent one complete thousand and the groups A^5, A^6, and A^7 repre-

sent another thousand. With each group of subscribers' lines there is associated in the central office a group of individual or line switches C, one for each line, a group of first selectors E, a group of second selectors F and a group of connectors H. The connector and selector switches represented herein comprise banks of contacts arranged in horizontal rows or levels, usually ten in number. These levels are represented by horizontal lines which extend across and beneath all the switches of a group to indicate that corresponding contacts of all the switches are multipled together. All the line switches C belonging to one group of subscribers' lines have common access to a group of first selectors E. The bank contacts of the first selectors E of corresponding groups or hundreds are multiplied throughout the different thousands. The first level of these first selectors is connected to trunk lines leading to second selector switches F associated with the first thousand, the second level of the first selectors is connected to trunk lines leading to second selectors associated with the second thousand, etc. The bank contacts of all the second selectors F associated with a given thousand are multipled together, and the first level is connected to trunk lines leading to connector switches H which have access to the subscribers' lines of the first hundred of that thousand, the second level is connected to trunk lines leading to connectors which have access to the lines of the second hundred, etc. This trunking arrangement of an automatic exchange is in general well known in the art, and it is not thought necessary to describe it in further detail herein.

In order to form a means of communication between the automatic and manual exchanges, there are provided a number of trunk lines leading from multiple jacks J^2 on the manual exchange to selector switches I in the automatic exchange, which selectors correspond in function to the subscribers' first selector switches E. The bank contacts of the operators' selectors I may be multipled with those of some of the subscribers' selectors E, as indicated.

Although in the above description of the system shown in Fig. 1 reference has been made to an automatic exchange and to a manual exchange, it is to be understood that this does not mean that the manual part of the system is necessarily a separate and distinct exchange. It may be simply a manual switchboard which is usually installed in automatic exchanges for the purpose of handling long distance or toll calls.

In Figs. 2, 3, 4 and 5 the different parts of the apparatus are designated by the same reference characters, in so far as is consistent, as in the diagrammatic Fig. 1.

The automatic substation A (Fig. 2) comprises the usual receiver 2, transmitter 3, ringer 4 and condenser 5. Being an automatic substation, it is also provided with a suitable call-sending mechanism for controlling the automatic switches, which mechanism is represented diagrammatically by a pair of impulse springs 6 and 7 and an impulse wheel 8, which latter may be controlled in a well-known manner through the medium of a dial provided with finger holes in such a way that the impulse springs may be momentarily separated a number of times corresponding to the respective digits of the number of the called subscriber.

The subscriber's individual switch C is of the general type of subscriber's switch shown in British patent to R. W. James No. 26,301 of 1906, resembling more closely, however, the particular type shown in British patent to T. G. Martin No. 1419 of 1910. This line switch comprises, among other details, a plunger (not shown) attached to the end of a so-called plunger arm 9 controlled by a magnet 10, which magnet comprises an operating winding 11 and a holding winding 12. This magnet also controls the cut-off armature 13. The winding 11 operates both the plunger arm 9 and the armature 13, while the winding 12 is strong enough only to operate the armature 13 and to hold the plunger arm 9 in its operated position. When the plunger arm 9 is operated its plunger is forced into a bank of contact springs, forcing the springs 14, 15, 16 and 17 into engagement with the springs 18, 19, 20 and 21, respectively. Although only one set of springs, namely 14 to 21, inclusive, is shown, each line switch is provided with a plurality of such sets, each set forming the terminal of a trunk line leading to a first selector switch E. Each trunk line is connected in multiple with the corresponding springs of all the line switches of the group which is controlled by the master switch D. The switch C is controlled by the subscriber through the medium of the line relay 22, which relay is preferably slow acting—that is, slow to release its armature upon deënergizing. The master switch D is of the general type of master switches shown in British Patent No. 26,301 of 1906, referred to above, being, however, of the particular type disclosed in British Patent No. 1419 of 1910, also referred to above. The function of the master switch, as is well known, is to maintain the plungers of all the idle line switches in position to engage the terminal of an idle trunk line.

Associated with the line A there is shown a call register 28 which is controlled by a double-wound magnet 29.

The first selector switch E is of the general type of selector switches disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson

and Erickson, except that the so-called side switch is omitted. Among other details, the selector E comprises a bank of contacts arranged in horizontal rows or levels, which contacts are adapted to be engaged by a set of wipers 30, 31 and 32 carried upon a shaft (not shown) which has a vertical movement controlled by the vertical magnet 33 and a rotary motion controlled by the rotary magnet 34. The operations of the switch are controlled through the medium of the double-wound line relay 35. Means for permitting the switch to be restored to normal position are provided in the release magnet 36, which, upon energizing, withdraws the retaining pawls from the shaft. The spring contacts 37 and 38 are permitted to close only when the switch shaft has been raised one or more steps from its lowest position. The relays 39 and 40 are slow acting relays—that is, relays which deënergize slowly after their energizing circuits are broken. This slow action is usually obtained by placing a ring of copper around one end of the core of the relay.

The second selector F, as well as the selector I (Fig. 5), is the same as the selector E.

The connector switch H (Fig. 3) is of the general type of connector switches disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, the circuits being modified, however, to adapt the switch to operate in a system in which the central office apparatus is controlled by impulses delivered over the two sides of the line in series. Like the selectors, the connector is provided with a shaft (not shown) carrying the wipers 41, 42 and 43, which shaft is controlled by the vertical magnet 44 and the rotary magnet 45. The usual side switch comprising the wipers 46, 47, 48 and 49 is controlled by the private magnet 50 in the usual and well-known manner. The magnet 250 is the usual release magnet. The line relay 51 is connected with the line through the reversing springs of a so-called back-bridge relay 52, through the windings of which latter relay the called line is provided with talking current. The application of ringing current to the called line is controlled by the ringer relay 253. At Q there is shown a busy signaling machine which is connected through the contact of springs 207 and 208 of the relay 53 with the spring 205 of the relay 54, the function of which is to send, under certain conditions, a busy tone back over the line. The complete operation of this relay will be described later. The busy signaling machine, as represented herein, comprises an induction coil or transformer, the primary winding of which is included in a local circuit with a battery and two interrupters, one of high frequency and one of low frequency. Through the medium of these interrupters an intermittent interrupted current is supplied to the primary winding, which induces an intermittent alternating current in the secondary winding, whereby, when said winding is connected with the subscriber's line, an intermittent buzzing sound is heard in his receiver.

The substation T (Fig. 4) is an ordinary local battery manual substation comprising a transmitter 55, receiver 56, induction coil 57, magneto 58 and ringer 59. At the central office the line is provided with the usual answering jack J, one or more multiple jacks J′, the line relay 60, cut-off relay 61, line lamp 62 and a visual busy signal 63 associated with each multiple jack. The operator's cord circuit M resembles the usual cord circuit employed in manual systems in that it comprises an answering plug P′, a calling plug P^2, calling and answering supervisory lamps 65 and 66 and suitable relays for controlling the circuits thereof. The relay 67 in the calling end of the cord is a polarized relay. As shown, this cord circuit is adapted to complete connection with either another manual substation, such as the substation T, or with a trunk line leading to the automatic exchange, or with an ordinary common battery line. When the relay 68 is in its normal position, the circuits of the relay 67 are adapted for use in connection with a local battery line, or with a trunk line leading to the automatic exchange; but when the relay 68 is energized, the circuits of the relay 67 are adapted for use in connection with a common battery manual line, or a similar line.

The trunk lines which lead from the manual switchboard to the automatic exchange, as has been explained in connection with Fig. 1, terminate in the multiple jack J^2 on the manual switchboard. The sleeve conductors of the jack J^2 are connected to battery through a relay 69 which controls the springs of a visual busy signal 70 associated with each multiple jack.

For the purpose of supplying current for operating the central office apparatus and for talking there is shown a plurality of batteries B having one terminal grounded at G. In practice, however, only one battery need be used, or, preferably, one in each exchange.

A general description of the apparatus having been given, it will now be explained how connection can be established between the line of substation A and another substation line, the telephone and line switch of which are not shown in the accompanying drawings, but which may be the same in detail as the telephone or substation A and line switch C. The number of the called line we will assume to be 2220. Since the

automatic switching apparatus disclosed herein is in general well known in the art, and is described in the publications herein referred to, its operation will be explained in a more or less general manner. Upon the removal of the receiver from the switch hook at the substation A preparatory to making a call, the talking circuit of the substation is bridged across the line conductors 71 and 72 by the switch hook springs 73 and 74, whereby the circuit of the line relay 22 of the switch C is closed. This circuit extends from ground G^2 through the springs 75 and 76, line 71, substation A, line 72, springs 77 and 78 and the relay 22 to the battery lead 80, thence through battery B and to ground G. The relay 22, upon energizing, closes the circuit of the operating winding 11, which operates through the medium of the armature 13 to disconnect the relay 22 from the line and to thrust the plunger of the switch into the terminal of the trunk before which it is being held by the master switch, whereby the line circuit is extended through the springs 14 and 18 and 15 and 19 to an idle first selector switch E. The line relay 35 of the selector switch E is thereupon energized over a circuit extending from ground G^3 through the lower winding of said relay, back contact of the switching relay spring 82, thence over the heavy conductors to and through the substation A and back over the other side of the line, through the left-hand winding of the meter magnet 29, back contact of the switching relay spring 83 of the selector and the upper winding of the line relay 35 to the battery lead 80. The relay 35, upon energizing, closes the circuit of the relay 39, which in turn, upon energizing, closes a circuit extending from ground G^4 through the springs 85, line switch bank springs 20 and 16 and the holding winding 12 to the battery lead 80. The energization of this winding serves to hold the switch C in its operated position after the circuit of the winding 11 is broken by the relay 22, which deenergizes shortly after it is disconnected from the line. The energization of the relay 39 at the selector E also completes a circuit extending from ground G^4 to the springs 85, 20 and 16 and through the right-hand winding of the meter magnet 29 to the battery lead 80. The current in this winding is in opposition to the line current flowing through the other winding, and the magnet is therefore not operated at this time. At the same time a guarding potential is extended from ground G^4 at the selector to the connector private bank contact 23^a of the calling line in the bank of each of the connector switches which have access thereto. Upon the closure of the springs 17 and 21 by the operation of the switch C, the master switch D operates in a well-known manner to advance the plungers of the idle line switches to a position opposite an idle trunk line.

The calling subscriber now operates his calling device for the first digit 2 of the called number, whereby the substation impulse springs 6 and 7 are separated twice momentarily, each time breaking the circuit of the selector line relay 35. The relay 39 of the selector being slow acting does not deenergize during the momentary interruptions of its circuit by the relay 35, and consequently each time the latter relay deënergizes, an impulse is transmitted over the circuit extending from ground G^5 through the springs 88 and 89, 90 and 91, spring 92 and its front contact, relay 40 and the vertical magnet 33 to the battery lead 80. The vertical magnet receives two impulses over this circuit and operates to raise the switch shaft and wipers two steps to a position opposite the second row or level of bank contacts, and at the same time the shaft-controlled contacts 37 and 38 are closed. The slow acting relay 40 is maintained in its energized position continuously while impulses are being transmitted to the vertical magnet through it, and in its energized position closes a circuit extending from ground G^6 through the springs 93 and 94 and the relay 95 to the battery lead 80. The relay 95, upon energizing, forms a locking circuit for itself extending from ground G^4 at the relay 39, through the springs 85, springs 96 (which are controlled by the rotary magnet 34), shaft contact 37 and the springs 97 and 98 and the winding of the relay 95 to the battery lead 80. Thus upon the deënergization of the relay 40 after the last impulse is delivered to the vertical magnet, the relay 95 remains energized and the circuit of the rotary magnet 34 is closed, which circuit extends from ground G^4 at the relay 39 through the springs 85, 96, 37, 97, 98, 94, 99 and 100 and the magnet 34 to the battery lead 80. The magnet 34, upon energizing, rotates the wipers one step, and by opening the spring contacts 100 and 96 disconnects the ground G^4 from itself and from the relay 95. If the first trunk line of the second level is idle, the relay 95 deënergizes as soon as the spring contact 96 is opened. If this trunk line is busy, however, the private wiper 32 finds the contact which it engages provided with a guarding ground potential which is transmitted to the relay 95 through its springs 97 and 98, and thereby prevents it from deënergizing. The magnet 34, however, deënergizes when the spring contact 100 is broken, regardless of whether the relay 95 remains energized or not. If the relay 95 remains energized, the circuit of the rotary magnet will be again closed as soon as its armature drops back far enough to close the contacts 100 and 96. The rotary

magnet will, therefore, operate in a manner similar to that of a buzzer to advance the wipers step by step over the contacts until the non-grounded contact of an idle trunk line is reached by the wiper 32, whereupon the relay 95 deënergizes. The relay 95, upon deënergizing, whether after one or several operations of the rotary magnet, permanently breaks the circuit of the magnet 34 and closes the circuit of the switching relay 101, which circuit extends from ground G^4 through the springs 85, 96, 37, 97, 102 and the relay 101 to the battery lead 80. The relay 101, upon energizing, disconnects the line relay 35 from the line and extends the line connection over the heavy conductors shown through the wipers 30 and 31 to the second selector F. The line relay 103 of the switch F thereupon becomes energized and closes the circuit of the relay 104, which in turn, upon energizing, completes a circuit extending from ground G^7 through the springs 105, wiper 32 of the switch E and the springs 97 and 102 and the relay 101 to the battery lead 80. This circuit maintains the relay 101 energized after its original energizing circuit is broken by the relay 39, which deënergizes shortly after the line relay 36 is disconnected from the line. The relay 104 of the selector F also maintains a guarding ground potential upon the private bank contacts of the trunk line in the banks of the first selector switches E which have access thereto.

When the substation calling device is operated for the second digit 2, the selector F operates in the same manner as explained for the selector E to extend the connection over the trunk conductors 107, 108 and 109 to the connector H (Fig. 3). The line relay 51 of the connector thereupon becomes energized and closes the circuit of the relay 110. The relay 110, upon energizing, provides a holding circuit for the relays 111, 101 and 12 of the switches F, E and C, respectively. This circuit extends from ground G^8 at the connector switch through the relay 53^a, springs 112, conductor 109, wiper 113, thence through the springs 114 and 115 and relay 111 to the battery lead 80 and also through the contacts 116 and 117, wiper 32 of selector E and through the relays 101 and 12 over the circuits already traced. The right-hand winding of the meter magnet 29 is also included in the circuit in multiple with the relays above mentioned. The switching relays 111 and 101 of the switches F and E, the cut-off winding 12 of the switch C and the right-hand winding of the meter magnet 29 all have a comparatively high resistance, as compared with that of the relay 53^a of the connector switch, so that the latter relay is not operatively energized over this circuit.

When the substation calling device is operated for the third digit 2, the circuit of the connector line relay 51 is broken twice. Since the relay 110 is slow acting it does not deënergize during the momentary interruptions of its circuit by the relay 51, so that each time the latter relay is deenergized, a circuit is closed extending from ground G^9 through the spring 118 and its back contact, spring 119 and its front contact, relay 120, vertical magnet 44 and side switch wiper 49 to the battery lead 80. The vertical magnet 44 receives two impulses over this circuit and operates to raise the switch wipers 41, 42 and 43 to a position oposite the second level of bank contacts. The relay 120, which is included in series with the vertical magnet, remains in its energized position during the entire time that impulses are being transmitted through it and operates to close the circuit of the relay 122 and the private magnet 50. After the last impulse is delivered the relay 120 opens the circuit of the private magnet 50, which, upon deënergizing, permits the side switch to advance from first to second position. The movement of the side switch wiper 49 from first to second position transfers the battery connection from the vertical magnet to the rotary magnet 45. The calling subscriber now operates his calling device for the last digit 0, in response to which the connector line relay 51 operates to transmit ten impulses through the rotary magnet 45, in series with the relay 120, whereby the shaft wipers are rotated onto the contacts of the desired line. The relay 120 operates in response to the impulses for this digit in the same manner as for the previous digit to cause the private magnet 50 to advance the side switch one more position— that is, from second to third position—after the last impulse for the digit is transmitted. By the engagement of the side switch wipers 46 and 47 with their third-position contact points, and by the deënergization of the relay 122, the line connection is finally completed with the called substation, as shown by the heavy conductors. The relay 122 controls the contacts in the line circuit and is made slow acting so as to prevent the completion of the line connection until after the cut-off winding of the called subscriber's individual switch has had time to operate its armature to disconnect the switch from the line. This switch and winding correspond to the switch C of the calling subscriber and the winding 12. The springs that are actuated in the called subscriber's line or individual switch correspond to the springs 75, 76, 77 and 78. The contacts 190, 192 and 23 (Fig. 3) correspond to the contacts 190^a, 192^a and 23^a in Fig. 2. The circuit of the cut-off winding of the called subscriber's line switch is closed by the side switch wiper 48 passing

to third position, said circuit extending from ground G^8 through springs 193, side switch wiper 48, private wiper 43, contact 23 and through the winding corresponding to winding 12 in switch C. The connection of ground G^8 with the connector private bank contact of the called line over the portion of the circuit just traced provides said contact with a guarding potential to prevent any other connector switches used by an automatic subscriber in making a purely automatic call from connecting with said busy line. It will be described later how an operator in making a semi-automatic call can cut in on a connection regardless of whether said connection is busy or not. By the engagement of the side switch wiper 49 with its third-position contact point, the circuit of the ringing relay 253 is closed, which circuit extends from ground G^{11} through the interrupter 125, relay 253, springs 126 and side switch wiper 49 to the battery lead 80. The ringing relay 253, upon energizing, disconnects the calling line from the called line and bridges the ringing current generator 127 across the called line to signal the called subscriber. The ringing relay is energized only intermittently through the medium of the interrupter 125. Upon the response of the called subscriber his line is provided with talking current through the windings of the back-bridge relay 52 of the connector switch, which relay, upon energizing, closes the circuit of the ringing cut-out relay 128, said circuit extending from the battery lead 80 through the side switch wiper 49, relay 128, springs 129 and 130 and the shaft-controlled contact 131 to ground G^{12}. The relay 128, upon energizing, interrupts the circuit of the ringing relay 53 at the springs 126 and closes a locking circuit for itself through its own springs 132 independent of the springs of the back-bridge relay 52. A further result of the energization of the relay 52, upon the response of the called subscriber, is the transposition of the connection between the windings of the line relay 51 and the trunk conductors 107 and 108, whereby the direction of current in the calling line is reversed. This reversal of the current in the left-hand winding of the subscriber's meter relay 29 (Fig. 2) causes the two windings to assist one another and the armature is attracted to operate the meter to register the call.

After the conversation is completed the connection is released by the hanging up of the receiver at the calling substation in the following manner: When the receiver at the substation A is restored to the switch hook, the separation of the hook switch springs 73 and 74 destroys the energizing circuit of the connector line relay 51 (Fig. 3). The relay 51 thereupon deënergizes and opens the circuit of the relay 110. The relay 110, upon deënergizing, opens the holding circuits of the relays 111, 101 and 12 of the switches F, E and C, respectively, at the springs 112 and also closes the circuit of the connector release magnet 250. The latter circuit extends from ground G^9 through the spring 118 and its back contact, spring 119 and its back contact, shaft-controlled contact 180 and magnet 250 to the battery lead 80. The magnet 250, upon energizing, restores the connector switch shaft and side switch to normal position, and its own circuit is interrupted at the contact 180 when the shaft reaches its lowest position. The deënergization of the relays 101 and 111 of the switches E and F serves to close the circuits of their respective release magnets 36 and 181. The circuit for the magnet 36 of the switch E extends from ground G^5 through the springs 88, 89, 90, 91, spring 92 and its back contact, shaft contact 38 and magnet 36 to the battery lead 80. The circuit of the magnet 181 is similar to that of the magnet 36. The circuits of the magnets 36 and 181 are broken when the switch shafts reach their normal positions. The deënergization of the winding 12 of the switch C permits the plunger arm 9 and armature 13 to restore to normal position.

From the above description it is evident how connections are established and released in the automatic exchange. It will now be explained how an operator may establish a connection between the manual telephone T (Fig. 4) and an automatic substation. The subscriber at the telephone T signals the operator in the usual manner by operating the magneto 58, whereby the line relay 60 becomes energized and is locked in its operated position to close the circuit of lamp 62. The locking circuit for relay 60 extends from ground G^{13} through the back contact of armature 133, contact point 134, armature 135 and right-hand winding of relay 60 to the battery B. The operator answers the call by inserting the plug P′ into the jack J, whereby the calling line is connected with the cord circuit and a circuit is closed from ground G^{14} through the contact 137, armature 138 and its back contact, sleeve of the plug P′ and jack J and cut-off relay 61 to the battery B. The relay 61, upon energizing, disconnects the line relay from the line, breaks the holding circuit of the line relay and closes the circuit of the busy signals 63. Upon learning the number of the desired station, the operator inserts the plug P^2 into a multiple jack J^2 of an idle trunk line leading to a selector switch I in the automatic exchange, and operates the key K′ to connect a calling device similar to that at the automatic subscriber's substation with the trunk. In Fig. 4 the calling device is represented diagram-

matically by a pair of impulse springs 140. By the engagement of the sleeve conductors of the plug P^2 and the jack J^2 a circuit is closed from ground G^{24} in the cord circuit through the upper winding of relay 141, relay 68, plug P^2, jack J^2 and relay 69 to the battery B. The relay 69 has a sufficiently high resistance to prevent enough current from flowing over this circuit to energize the relay 68, but it is itself energized as well as the relay 141. The relay 141 prepares the circuit for the lamp 66, which circuit, however, is still open at the springs 142 of the key K'. The relay 69, upon energizing, closes the circuit of the busy signals 70. The connection of the cord circuit with the selector I over the trunk conductors 145 and 146 causes the line relay 147 of said selector to energize in the same manner in which the line relay of the selector E (Fig. 2) was energized when the connection was first extended to it from the calling substation. The operator now operates her calling device in accordance with the respective digits of the number called for. The selector I operates in response to the first digit in the same manner as explained for the selector E (Fig. 2) to extend the connection to a second selector similar to the selector F (Fig. 2). This second selector operates in response to the second digit to extend the connection to a connector switch, which in turn operates in response to the last two digits to complete connection with the called line in exactly the same manner as when said switches are operated by an automatic subscriber, as hereinabove explained. After the operator at the cord M has completed the operation of the calling device, the key K' is restored to normal position, whereby the calling device is disconnected from the line and the polarized relay 67 is bridged across the talking circuit instead. The current which flows through the relay 67 at this time is of the proper direction to maintain the contact 148 closed, whereby the circuit of the lamp 66 is completed, said circuit extending from ground G^{15} through the springs 142 of key K', contact 148, armature 198 and its front contact and lamp 66 to the battery B. Upon the response of the called subscriber, the current in the polarized relay 67 of the cord circuit is reversed in the same manner in which the current in the automatic substation was reversed. This reversal of current causes the relay 67 to open the contact 148, whereby the lamp 66 is extinguished to signify that the called subscriber has answered.

It will be remembered that in the connection described between the automatic substation A and the called subscriber's line the holding circuits for relays 111 and 101 of the selectors F and E were completed through the relay 53^a of the connector switch. In the same manner the holding circuit of the relay 149 of the selector I (Fig. 5) is completed through the relay 53^a of the connector when the operator makes a call. The relay 149 of the selector I has a low resistance as compared with the corresponding relays of the switches F and E, so that when the relay 149 is included in the circuit of the relay 53^a of the connector, the latter relay is operatively energized, attracting its armature to separate the spring 191 from the spring 194 and to make connection with the spring 195 to, at this point, close a circuit for the relay 53, which circuit is open at the present time at the springs 196 and 197 and at the second-position contact of side switch wiper 48. This circuit is the busy circuit and will be described later, together with the complete operation of the switch when a busy line is called. Whenever an operator calls an automatic line, sufficient current is permitted to pass through the relay 53^a for it to be operatively energized, but when an automatic subscriber calls another automatic subscriber, the resistance of the coils 111 and 101 in series with relay 53^a is too great to allow said relay to pull up. The object of this will also be explained later.

It having been explained how connections may be completed with an automatic line, either by an automatic subscriber or by the operator, it will now be explained how connection is prevented from being made with a busy line when an automatic subscriber is calling; also how an operator is prevented from making connection when the party she is calling is engaged in a long distance call. Provisions are also made whereby the operator, upon calling an automatic subscriber who is engaged in a local call, can cut in on the conversation without receiving the usual busy tone.

Assuming now that an operator is calling an automatic subscriber who is engaged in a long distance call. In other words, the subscriber whom the operator is calling is already engaged in a call initiated by another operator. Therefore, the relay 53^a in the connector employed in said call will be operatively energized and the guarding potential on the private contact 23 will come from ground G^8 and pass through a resistance similar to the resistance 254 in the switch H. Upon the second operator completing the operation for the last digit and the wipers coming to rest, the side switch wipers will, of course, be in second position and a circuit will be closed from the contact 23 through the private wiper 43, side switch wiper 48, springs 199 and 196 and through the relay 200 to battery B. The relay 200 becomes energized and closes a circuit through the busy relay 54 from ground G^{21}

through the springs 202 and 201, through said relay 54, contact of springs 204 and 203, relay 122 and the private magnet 50 to battery B. Upon the relay 54 energizing, the spring 196 breaks contact with the spring 199 and makes contact with the spring 197, which action, as is well known, locks the side switch in second position. This action also closes the circuit of the relay 53, said circuit being traced from the guarding potential on the private contact 23 (which, it will be remembered, passes through a resistance in the first connector side switch wiper 48), relay 53, springs 195 and 194, 197 and 196 and the relay 200 to battery B. Although the circuit of the relay 53 is closed, the resistance through which the guarding potential passes is too high to permit sufficient current to pass through said relay to operatively energize it. The springs 205 and 206 are also pressed together when the relay 54 is engaged, thereby connecting the busy tone to the line. The circuit of the busy signaling current is completed from ground through the secondary winding of the busy signaling machine Q, through the springs 207 and 208, 205 and 206 to the second position of the side switch wiper 47, condenser 209, thence over the heavy conductors to the calling line and back over the other side of the line, through the upper winding of relay 51 to battery B and ground G back to the signaling machine Q. In order to determine whether or not the called line is busy with a long distance call, the operator operates the key K^2 (Fig. 4) to connect her talking set with the line after the connection is completed, whereby a path of the busy signaling current is furnished through the operator's receiver. Upon receiving the busy signal, the operator knows at once that the party she is trying to reach is engaged in a long distance call; she informs the calling subscriber that the called line is busy and immediately removes the plugs P^1 and P^2 from their respective jacks. The calling subscriber hangs up his receiver and the apparatus is returned to normal.

Now we will assume that the operator at the cord M is calling an automatic subscriber who is engaged in a local call, *i. e.*, conversing with another automatic subscriber. It will be remembered that when one automatic subscriber calls another automatic subscriber, the relay corresponding to the relay 53^a is not operatively energized owing to the high resistance of the line switching relays 101 and 111 in the switches E and F with which it is in series. Therefore the guarding potential on the private contact 23 does not pass through a resistance such as the resistance 254 in Fig. 3. Thus when the wipers 41, 42 and 43 come to rest upon the operator completing the call, and while the side switch wipers are yet in second position, the same circuits are closed as were traced when the operator called a subscriber who was engaged in a long distance call, except that there will be no resistance 254 in series with the relay 53. Therefore sufficient current is permitted to flow through said relay to operatively energize it, thereby shifting the spring 208 out of connection with the spring 207 and into contact with the spring 210. The springs 211 and 212 are also pressed together. Upon the transfer of the spring 208, the busy machine Q is cut from the conductor 108 and said conductor is connected to the line of the called subscriber, which connection is traced from the side switch wiper 47 (in second position), springs 206 and 205, 208 and 210 and the conductor 192. Upon the springs 211 and 212 being pressed together, connection is extended from the second position of side switch wiper 46 to the conductor 190. Therefore it is seen that upon an operator calling a busy automatic subscriber engaged in a local call, no busy signal is given and her talking circuit is cut through. She can then inform the subscriber that a long distance call awaits his attention. Should an automatic subscriber find the desired line busy, he would get the busy tone signal, whether the calling party be engaged in a local or long distance call, for the relay 53^a would not be operatively energized for reasons heretofore stated. Therefore the circuit of the relay 53 would be kept open, thereby preventing the talking circuit from being cut through to the called subscriber's line and keeping the busy machine Q connected to the second position of side switch wiper 47. In the instance of the former kind of call, *i. e.*, an operator calling a subscriber engaged in a local call, should the subscribers already engaged in conversation release their connection just as the operator's connection is cut through to interrupt said conversation, the guarding potental would be taken from the contact 23, thereby breaking the circuit including the relays 53 and 200 and said relays would deenergize and break the circuit of the relays 54 and 122 and the magnet 50. The side switch would then pass to third position and the new connection would be extended to the called line and ring the bell. Owing to the relay 53 being slow acting—that is, slow to deënergize after the circuit is broken—the circuit of the relays 54, 122 and the magnet 50 is maintained a short time after the guarding potential is removed from the contact 23. This circuit is traced from ground G^{30} through the springs 221 and 220, relay 54, springs 204 and 203, relay 122 and the magnet 50 to battery B. The object of this arrangement is to give the local connection additional time in which to completely release before the private mag-

net 50 deënergizes to permit the side switch of the connector H to pass to third position, thus connecting the operator with the recently busy line.

It will be observed, therefore, that in the system herein shown and described a local subscriber cannot call a line which is busy as a result of either a local call or a toll call. In either case the relay 53 must not be energized, otherwise it would prevent the subscriber from getting a busy signal. The relay 53 is prevented from energizing because the relay 53^a cannot energize through the high resistance in the trunk-release circuit. Furthermore, it is obvious that in this system a toll operator cannot call a line which is busy by reason of having been called by a toll operator, but can make connection with a line which is busy by reason of having been called by a local subscriber. In the former case the relay 53 must not operatively energize even though the relay 53^a is energized, and this is prevented by the resistance 254. In the latter case the relay 53 must pull up in order to cut a calling toll operator's line through to the called line, notwithstanding the fact that the cutting off relay 122 is energized, to enable the operator to notify one of the two local subscribers that a toll connection is waiting for him.

While I have illustrated and described my invention in connection with apparatus of a particular type, it will, of course, be understood that I do not wish to limit myself to the exact construction shown and described. In place of the ordinary line switch and selectors shown, any suitable apparatus could be employed for extending the connection to the connector. Likewise, instead of having the local connection a purely automatic connection, it would, of course, be established by semi-automatic means—that is, through means which are partly manual and partly automatic. In such arrangement it would be merely necessary that the selector employed by the operator at the toll-board be a different selector than that employed by the operator at the other manual positions. Various other modifications and changes will readily suggest themselves to those skilled in the art and come within the contemplated scope of my invention.

What I claim as my invention is:—

1. In a telephone system, a called line, a connector switch for seizing said line, a plurality of means for extending connection to said connector switch, a second connector switch, means for operating said second connector switch to find said called line, means for preventing said second connector switch from establishing a talking circuit with the called line when one of said means has been employed to extend connection to the first connector switch, and means for completing a talking circuit through said second connector switch to the called line when the second of said means has been employed for extending connection to said first connector switch.

2. In a telephone system, a calling manual line, a calling automatic line, a called automatic line, an automatic connector switch, means for extending connection from said manual line to said connector switch, means for extending a connection from said calling automatic line to said connector switch, means for operating said connector to seize said called line, a second connector switch, means for operating said second connector switch to find said called line, means for preventing a talking circuit being established through said second connector to the called line when connection has been established with said called line through said first connector switch from the calling manual line, and means for completing a talking circuit through said second connector switch to the called line when a connection has been established with the called line through said first connector switch from the calling automatic line.

3. In a telephone system, a plurality of calling lines, a called line, an automatic connector switch, means for extending a connection from one of said calling lines to said connector switch, means for extending a connection from another of said calling lines to said switch, means for operating said switch to seize said called line, a second connector switch, means for operating said second connector switch to find the called line, means for preventing said second connector switch from establishing a talking circuit with the called line when said called line is in connection with one of said calling lines, and means for completing a talking circuit through said connector to said called line when said called line is connected with a second of said calling lines.

4. In a telephone system, a pair of calling lines, a called line, an automatic connector switch, means including a selector switch for extending a connection from one of said calling lines to said connector switch, means including another selector switch for extending a connection from the second of said calling lines to said connector switch, means for then operating said connector to seize said called line, a second connector switch, means for operating said second connector switch to find said called line, means for preventing said second connector switch from establishing a talking circuit with said called line when the connection has been established with said called line from said first-mentioned selector, and means for completing a talking circuit through said second connector switch to said called line when a connection has been established with

said called line from said second-mentioned selector switch.

5. In a telephone system, two groups of lines, an automatic connector switch for connecting with the lines of one of said groups, means including a selector switch for extending a connection from a line of one of said groups to said connector, means including another selector for extending a connection from a line of the other of said groups to said connector, a marginal relay in said connector, a low resistance relay in one of said selectors and a high resistance relay in the other of said selectors, means for connecting the relay of one of said selectors in series with the connector relay when a connection is established from said selector to the connector, said connector relay being adapted to be operatively energized when connected in series with said low resistance relay, but not when connected in series with said high resistance relay, and means controlled by said connector relay for enabling said connector to establish a talking circuit with a busy line.

6. In a telephone system, two groups of lines, an automatic connector switch for connecting with the lines of one of said groups, means including a selector switch for extending a connection from a line of one of said groups to said connector, means including another selector for extending a connection from a line of the other of said groups to said connector, a marginal relay in said connector, a low resistance release relay in one of said selectors and a high resistance release relay in the other of said selectors, means for connecting the release relay of one of said selectors in series with the connector relay when a connection is established from said selector to the connector, said connector relay being adapted to be operatively energized when connected in series with said low resistance release relay, but not when connected in series with said high resistance release relay, and means controlled by said connector relay for enabling said connector to establish a talking circuit with a busy line.

7. In a telephone system, a plurality of groups of subscribers' lines, an automatic connector switch having motion in one plane to select groups and motion in a plane at right-angles thereto to find a line in a selected group, means including a selector switch for extending a connection from a line of one of said groups to said connector, means including another selector for extending a connection from a line of the other of said groups to said connector, a marginal relay in said connector, a low resistance relay in one of said selectors and a high resistance relay in the other of said selectors, means for connecting the relay of one of said selectors in series with the connector relay when a connection is established from said selector to the connector, said connector relay being adapted to be operatively energized when connected in series with said low resistance relay, but not when connected in series with said high resistance relay, and means controlled by said connector relay for enabling said connector to establish a talking circuit with a busy line.

8. In a telephone system, a plurality of groups of subscribers' lines, an automatic connector switch having motion in one plane to select groups and motion in a plane at right-angles thereto to find a line in a selected group, means including a selector switch for extending a connection from a line of one of said groups to said connector, means including another selector for extending a connection from a line of the other of said groups to said connector, a marginal relay in said connector, a low resistance release relay in one of said selectors and a high resistance release relay in the other of said selectors, means for connecting the release relay of one of said selectors in series with the connector relay when a connection is established from said selector to said connector, said connector relay being adapted to be operatively energized when connected in series with said low resistance release relay, but not when connected in series with said high resistance release relay, and means controlled by said connector relay for enabling said connector to establish a talking circuit with a busy line.

9. In a telephone system, two groups of lines, an automatic connector switch for connecting with the lines of one of said groups, means including a selector switch for extending a connection from a line of one of said groups to said connector, means including another selector for extending a connection from a line of the other of said groups to said connector, a marginal relay in said connector, a low resistance relay in one of said selectors and a high resistance relay in the other of said selectors, means for connecting the relay of one of said selectors in series with the connector relay when a connection is established from said selector to the connector, said connector relay being adapted to be operatively energized when connected in series with said low resistance relay, but not when connected in series with said high resistance relay, and means controlled by the energization of said connector relay for enabling said connector to establish a talking circuit with a busy line.

10. In a telephone system, two groups of lines, an automatic connector switch for connecting with the lines of one of said groups, means including a selector switch for extending a connection from a line of one of said groups to said connector, means includ-

ing another selector for extending a connection from a line of the other of said groups to said connector, a marginal relay in said connector, a low resistance release relay in one of said selectors and a high resistance release relay in the other of said selectors, means for connecting the release relay of one of said selectors in series with the connector relay when a connection is established from said selector to the connector, said connector relay being adapted to be operatively energized when connected in series with said low resistance release relay, but not when connected in series with said high resistance release relay, and means controlled by the energization of said connector relay to enabling said connector to establish a talking circuit with a busy line.

11. In a telephone system, a plurality of groups of subscribers' lines, an automatic connector switch having motion in one plane to select groups and motion in a plane at right-angles thereto to find a line in a selected group, means including a selector switch for extending a connection from a line of one of said groups to said connector, means including another selector for extending a connection from a line of the other of said groups to said connector, a marginal relay in said connector, a low resistance relay in one of said selectors and a high resistance relay in the other of said selectors, means for connecting the relay of one of said selectors in series with the conector relay when a connection is established from said selector to the connector, said connector relay being adapted to be operatively energized when connected in series with said low resistance relay, but not when connected in series with said high resistance relay, and means controlled by the energization of said connector relay for enabling said connector to establish a talking circuit with a busy line.

12. In a telephone system, a plurality of groups of subscribers' lines, an automatic connector switch having motion in one plane to select groups and motion in a plane at right-angles thereto to find a line in a selected group, means including a selector switch for extending a connection from a line of one of said groups to said connector, means including another selector for extending a connection from a line of the other of said groups to said connector, a marginal relay in said connector, a low resistance release relay in one of said selectors and a high resistance release relay in the other of said selectors, means for connecting the release relay of one of said selectors in series with the connector relay when a connection is established from said selector to said connector, said connector relay being adapted to be operatively energized when connected in series with said low resistance release relay, but not when connected in series with said high resistance release relay, and means controlled by the energization of said connector relay for enabling said connector to establish a talking circuit with a busy line.

13. In a telephone system, a subscriber's line, a connector switch having line wipers, a trunk line extending to said connector, a normally open switch between said trunk and said line wipers, means for moving said wipers into contact with said line, means for then closing said normally open switch to complete the connection with the line when said line is idle, means for locking said wipers on said line and maintaining said switch open when said line is busy, a marginal relay, means for closing a circuit through said marginal relay when connection is made with a busy line, means for varying the amount of current flowing through said relay independent of the busy line with which connection is made whereby the relay will energize sometimes when a connector calls a line and sometimes not when the same line is called, and means controlled by said relay for closing a circuit around said switch to thereby complete the connection from said trunk to a busy line.

14. In a telephone system, a plurality of subscribers' lines, means for establishing a connection between two of said lines, said means including a trunk line and a connector switch connected thereto, said connector including line wipers normally disconnected from said trunk, an operating magnet operatively connected with said trunk for moving said wipers to select a group, a second operating magnet normally disconnected from said trunk for moving said wipers to connect with a line in the selected group, a side switch having a plurality of operative positions for successively controlling the connection to said operating magnets and then closing the connection from said line wipers to said trunk, means for locking said wipers on a busy line and for mantaining said side switch in a position to maintain the connection through the same to said line wipers open, a marginal relay, means for closing a circuit through said marginal relay when connection is made with a busy line, means for varying the amount of current flowing through said relay independent of the busy line with which connection is made, whereby the relay will energize sometimes when a connector calls a line and sometimes not when the same line is called, and means controlled by said relay for closing a circuit around said switch to thereby complete the connection from said trunk to a busy line.

15. In a telephone system, subscribers' lines divided into groups, a connector switch having motion in one plane to select groups and motion in a plane at right-angles thereto to connect with a line in a selected group, a plurality of means for extending a con-

nection from a calling line to said connector switch, a second connector switch, means for operating said second connector switch to find said called line, means for preventing said second connector switch from establishing a talking circuit with the called line when one of said means has been employed to extend connection to the first connector switch, and means for completing a talking circuit through said second connector switch to the called line when the second of said means has been employed for extending connection to said first connector switch.

16. In a telephone system, manual lines, a plurality of groups of automatic lines, an automatic connector switch having motion in one plane to select groups and motion in a plane at right-angles thereto to connect with a line in a selected group, means for extending a connection from said manual lines to said connector switch, means for extending a connection from said automatic lines to said connector switch, a second connector switch, means for operating said second connector switch to find said called line, means for preventing a talking circuit being established through said second connector to the called line when connection has been established with said called line through said first connector switch from the calling manual line, and means for completing a talking circuit through said second connector switch to the called line when a connection has been established with the called line through said first connector switch from the calling automatic lines.

17. In a telephone system, a plurality of groups of lines, an automatic connector switch having motion in one plane to select groups and motion in a plane at right-angles thereto to find a line in a selected group, means including a selector switch for extending a connection from one of said groups of lines to said connector switch, means including another selector switch for extending a connection from a second of said groups of lines to said connector switch, a second connector switch, means for operating said second connector switch to find said called line, means for preventing said second connector switch from establishing a talking circuit with the called line when one of said means has been employed to extend connection to the first connector switch, and means for completing a talking circuit through said second connector switch to the called line when the second of said means has been employed for extending connection to said first connector switch.

18. In a telephone system, a group of manual lines, a plurality of groups of automatic lines, an automatic connector switch having motion in one plane to select groups of automatic lines and motion in a plane at right-angles thereto to find a line in a selected group, means including an operator's cord circuit for extending a connection from one of said manual lines to said connector switch, means including a plurality of automatic switches for extending a connection from one of said automatic lines to said connector switch, a second connector switch, means for preventing said second connector switch from establishing a connection with a called line when connection has been established thereto from one of said manual lines, and means for establishing a talking circuit with said called line when said second connector makes connection therewith when connection has been established with said called line from one of said automatic lines through said first-mentioned connector.

19. In a telephone system, a called line provided with multiple terminals, a connector switch for seizing said line, a plurality of means for extending a connection to said connector switch, means in said connector for placing one guarding potential on said multiple terminals when one of said means is employed to extend a connection to said connector, means in said connector for placing a second guarding potential on said multiple terminals when the second of said means is employed for extending connection to said connector switch, and means in said connector operative when an attempt is made to establish a connection with a busy line and responsive to but one of said guarding potentials for enabling said connector switch to establish a talking connection with said busy line.

20. In a telephone system, a called line provided with multiple terminals, a connector switch for seizing said line, a plurality of means for extending a connection to said connector switch, a connection in said connector for connecting said multiple terminals through to ground when said connector seizes the called line, a relay in said connector, means for energizing said relay when connection is established with said connector through one of said means, means controlled by the energization of said relay for placing a resistance in said guarding ground connection to said multiple terminals, a marginal relay in said connector adapted to be connected in circuit with said multiple terminals when connection is made with a busy line, said marginal relay being adapted to respond only when connection is made with a busy line whose multiple terminals are connected to ground direct, but not responding when connection is made with a busy line whose multiple terminals are connected to ground through a resistance, and means controlled by said marginal relay for completing a talking circuit to the busy line.

21. In a telephone system, two groups of

lines, an automatic connector switch for connecting with the lines of one of said groups, means including a selector switch for extending a connection from a line of one of said groups to said connector, means including another selector for extending a connection from a line of the other of said groups to said connector, a marginal relay in said connector, a low resistance relay in one of said selectors and a high resistance relay in the other of said selectors, means for connecting the relay of one of said selectors in series with the connector relay when a connection is established from said selector to the connector, said connector relay being adapted to be operatively energized when connected in series with said low resistance relay, but not when connected in series with said high resistance relay, means for establishing a guarding potential on the multiple contacts of a called line by establishing a connection to ground through said connector when said connector seizes the called line, means controlled by the energization of said marginal relay for inserting a resistance in said ground connection to thereby lower the guarding potential on the multiple contacts of the called line, a second marginal relay in said connector adapted to be connected in circuit with multiple contacts of the called line, said second relay adapted to be energized when said connector attempts to make connection with a busy line whose multiple contacts are provided with a guarding potential from a direct ground, but not energized when the multiple contacts are provided with a guarding potential through a resistance to ground, and means controlled by the energization of said second marginal relay for completing a talking connection to the busy called line.

22. In a telephone system, a called line, a connector switch for seizing said line, a plurality of means for extending connection to said connector switch, a second connector switch, a plurality of means for extending connection to said second connector switch, means for operating said second connector switch to find said called line, means operative when one of said means has been used to extend connection to said second connector switch to prevent said second connector from completing a talking circuit to said called line when either of said means has been used for extending connection to said first connector switch, and means operative when the other means has been used for extending connection to said second connector switch to prevent said second connector switch from completing a talking circuit to the called line when one of the means has been used for extending connection to the first connector switch, but permitting a talking circuit to be closed with the called line when the other means has been used to obtain connection with the first connector switch.

23. In a telephone system, a called line provided with multiple terminals, a connector switch for seizing said line, a plurality of means for extending a connection to said connector switch, means in said connector for placing one guarding potential upon said multiple terminals when one of said means is employed to extend a connection to said connector, means in said connector for placing a second guarding potential on said multiple terminals when the second of said means is employed for extending connection to said connector switch, and means in said connector responsive to either of said guarding potentials to prevent a connection with a busy line when one means has been employed to extend connection to said connector, and responsive to but one of said guarding potentials to prevent a connection with a busy line when the other means has been employed to extend connection to said connector.

24. In a telephone system, a group of lines, a second group of lines, a called line, means for connecting a subscriber of either group with said called line and for applying a potential of one kind to the called line when a call is from one group, and for applying a potential of another kind to the called line when the call is from another group, and means responsive to one potential to make the called line busy to further calls from one group only and responsive to the other potential to make the called line busy to further calls from either group.

25. In a telephone system, a group of lines, a second group of lines, a called line, means for connecting a subscriber of either group with said called line, a circuit for applying a potential of one kind to the called line when the call is from one group, a relay controlling said circuit, another circuit for applying a potential of another kind to the called line when the call is from another group, and means responsive to one potential to make the called line busy to further calls from one group only and responsive to the other potential to make the called line busy to further calls from either group.

26. In a telephone system, a group of lines, a second group of lines, a called line, means for connecting a subscriber of either group with said called line, a circuit for applying a potential of one kind to the called line when the call is from one group, another circuit for applying a potential of another kind to the called line when the call is from the other group, a magnet controlling said circuits, and means responsive to one potential to make the called line busy to further calls from one group only and responsive to the other potential to make the called line busy to further calls from either group.

27. In a telephone system, a group of lines, a second group of lines, a called line, means for connecting a subscriber of either group with said called line and for applying a potential of one kind to the called line when a call is from one group, and for applying a potential of another kind to the called line when the call is from another group, and means responsive to one potential to make the called line busy to further calls from one group but accessible for talking to the other group and responsive to the other potential to make the called line busy to further calls from either group.

28. In a telephone system, a group of lines, a second group of lines, a called line, means for connecting a subscriber of either group with said called line, a circuit for applying a potential of one kind to the called line when the call is from one group, another circuit for applying a potential of another kind to the called line when the call is from another group, a relay controlling said circuits, and means responsive to one potential to make the called line busy to further calls from one group but accessible for talking to the other group and responsive to the other potential to make the called line busy to further calls from either group.

29. In a telephone system, a group of lines, a second group of lines, a called line, means for connecting a subscriber of either group with said called line, a circuit for applying a potential of one kind to the called line when the call is from one group, another circuit for applying a potential of another kind to the called line when the call is from the other group, a magnet controlling said circuits, and means responsive to one potential to make the called line busy to further calls from one group but accessible for talking to the other group and responsive to the other potential to make the called line busy to further calls from either group.

30. In a telephone system, a group of lines, a second group of lines, a called line, means for connecting a subscriber of either group with said called line and for applying a potential of one kind to the called line when a call is from one group, and for applying a potential of another kind to the called line when the call is from another group, and means comprising a relay responsive to one potential to make the called line busy to further calls from one group but accessible for talking to the other group and responsive to the other potential to make the called line busy to further calls from either group.

31. In a telephone system, a group of lines, a second group of lines, a called line, means for connecting a subscriber of either group with said called line, and means comprising a circuit for applying a potential of one kind to the called line when the call is from one group, and for applying a potential of another kind to the called line when the call is from another group, and means comprising a relay responsive to one potential to make the called line busy to further calls from one group but accessible for talking to the other group and responsive to the other potential to make the called line busy to further calls from either group.

32. In a telephone system, a group of lines, a second group of lines, a called line, means for connecting a subscriber of either group with said called line, means comprising a circuit for applying a potential of one kind to the called line when the call is from one group and comprising also a marginal relay for controlling said circuit, means comprising a circuit for applying a potential of another kind to the called line when the call is from the other group, and a marginal magnet controlling said circuit, and means comprising a marginal relay responsive to one potential to make the called line busy to further calls from one group but accessible for talking to the other group and responsive to the other potential to make the called line busy to further calls from either group.

33. In a telephone system, a line, a connector for establishing connection with said line, another connector for establishing connection with said line, circuits for each connector, a magnet in the first connector for controlling the circuits thereof, a magnet in the second connector for controlling the circuits thereof, a second magnet in the second connector for controlling the circuits thereof, an energizing circuit for said second magnet controlled by the other two magnets jointly, and a trunk for extending connection to said second connector and an energizing circuit for said second magnet energized over said trunk.

34. In a telephone system, a line, a connector for establishing connection with said line, another connector for establishing connection with said line, circuits for each connector, a magnet in the first connector for controlling the circuits thereof, a magnet in the second connector for controlling the circuits thereof, a second magnet in the second connector for controlling the circuits thereof, an energizing circuit for said second magnet controlled by the other two magnets jointly, trunks for extending connections to said connectors, said first magnet energized over one of said trunks and said second magnet energized over one of said trunks.

35. In a telephone system, a line, a switch for establishing connection with said line, a guarding circuit for said line, a magnet in said switch for applying either of two potentials to said guarding circuit, a second switch for establishing connection with said guarding potential, means in said second

switch operable over said guarding circuit to prevent the establishment of a connection with said called line, a second magnet in said second switch operable by one of the potentials in said guarding circuit to cause the establishment of a connection with the called line, a circuit for said magnet, and a third magnet in said second switch for controlling the circuit of said second magnet.

36. In a telephone system, a line a switch for establishing connection with said line, a guarding potential circuit for said line, means in said switch for establishing one of two potentials in said guarding circuit, a second switch, means in said second switch for calling the said line and for establishing connection with said guarding circuit, means in said second switch for preventing the establishment of a talking circuit with the said line, a magnet in said second switch operable by one of the potentials in said guarding circuit for establishing a talking circuit with said line, and means in said second switch for controlling the circuit of said magnet.

37. In a telephone system, a line, a switch for establishing connection with said line, a guarding potential circuit for said line, means in said switch for establishing one of two potentials in said guarding circuit, a second switch, means in said second switch for calling the said line and for establishing connection with said guarding circuit, means in said second switch for preventing the establishment of a talking circuit with the said line, a magnet in said second switch operable by one of the potentials in said guarding circuit for establishing a talking circuit with said line, and means in said second switch for controlling the circuit of said magnet, and a trunk line for extending connection to said first switch.

38. In a telephone system, a line, a switch for establishing connection with said line, a guarding potential circuit for said line, means in said switch for establishing one of two potentials in said guarding circuit, a second switch, means in said second switch for calling the said line and for establishing connection with said guarding circuit, means in said second switch for preventing the establishment of a talking circuit with the said line, a magnet in said second switch operable by one of the potentials in said guarding circuit for establishing a talking circuit with said line, and means in said second switch for controlling the circuit of said magnet, a trunk line for extending connection to said first switch, said first means comprising a magnet, an energizing circuit for said magnet, and means for energizing said magnet over said trunk.

39. In a telephone system, a line, a switch for establishing connection with said line, a guarding potential circuit for said line, means in said switch for establishing one of two potentials in said guarding circuit, a second switch, means in said second switch for calling the said line and for establishing connection with said guarding circuit, means in said second switch for preventing the establishment of a talking circuit with the said line, a magnet in said second switch operable by one of the potentials in said guarding circuit for establishing a talking circuit with said line, and means in said second switch for controlling the circuit of said magnet, means for extending connection to said second switch, said means comprising a magnet, an energizing circuit for said magnet and means for energizing said magnet over said trunk.

40. In a telephone system, a line, a switch for establishing connection with said line, a guarding potential circuit for said line, means in said switch for establishing one of two potentials in said guarding circuit, a second switch, means in said second switch for calling the said line and for establishing connection with said guarding circuit, means in said second switch for preventing the establishment of a talking circuit with the said line, a magnet in said second switch operable by one of the potentials in said guarding circuit for establishing a talking circuit with said line, and means in said second switch for controlling the circuit of said magnet, a trunk line for extending connection to said first switch, said first means comprising a magnet an energizing circuit for said magnet, means for energizing said magnet over said trunk, a trunk for extending connection to said second switch, said last means comprising a magnet, an energizing circuit for said magnet and means for energizing said magnet over said last trunk.

Signed by me at Chicago, Cook county, Illinois, this 9th day of June, 1913.

ARTHUR J. RAY.

Witnesses:
BLAKE E. RAY,
ALBERT ANDERSEN.