T. G. MARTIN.

AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED AUG. 11, 1913.

1,190,185.

Patented July 4, 1916.

4 SHEETS—SHEET 1.

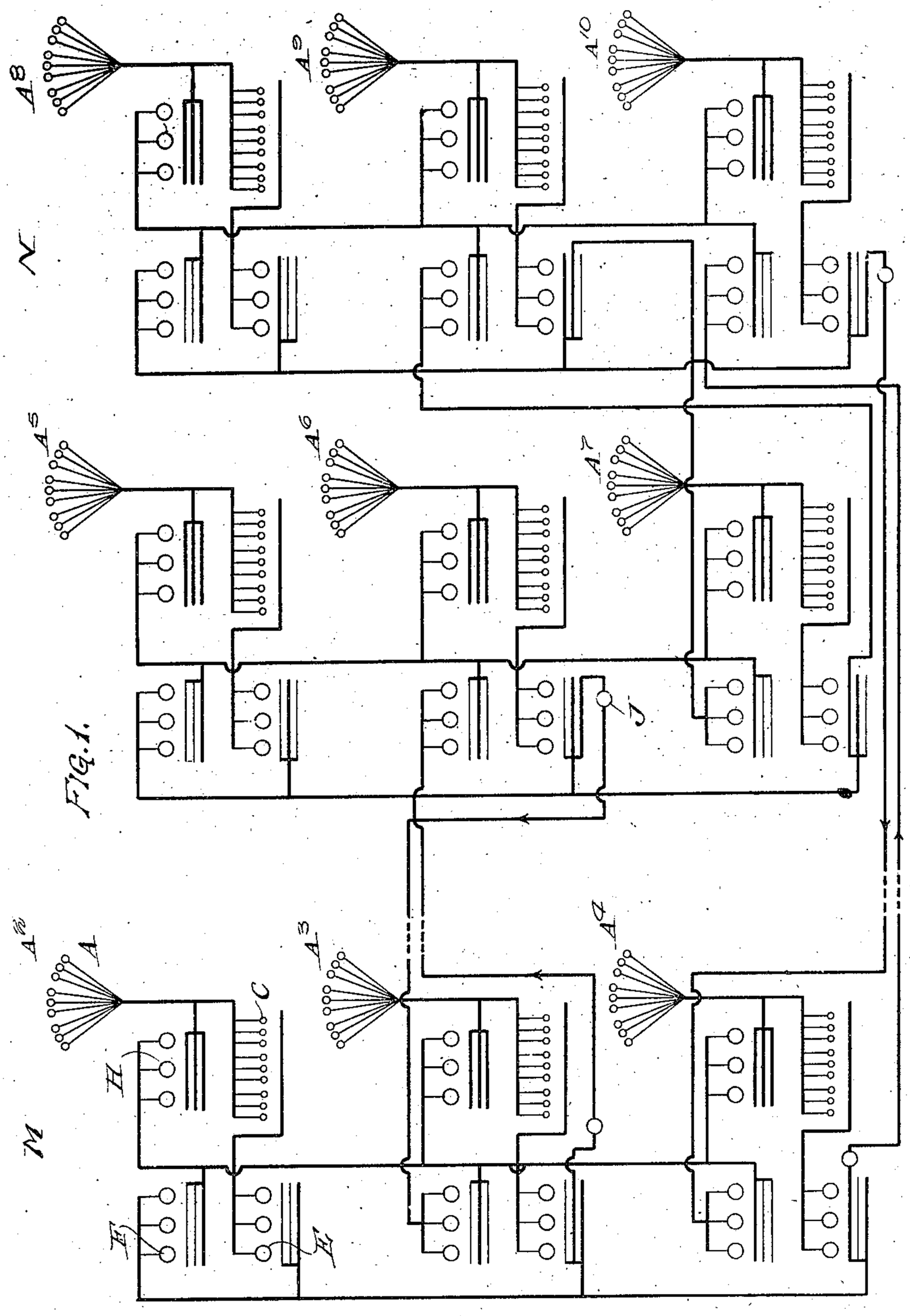

FIG. 1.

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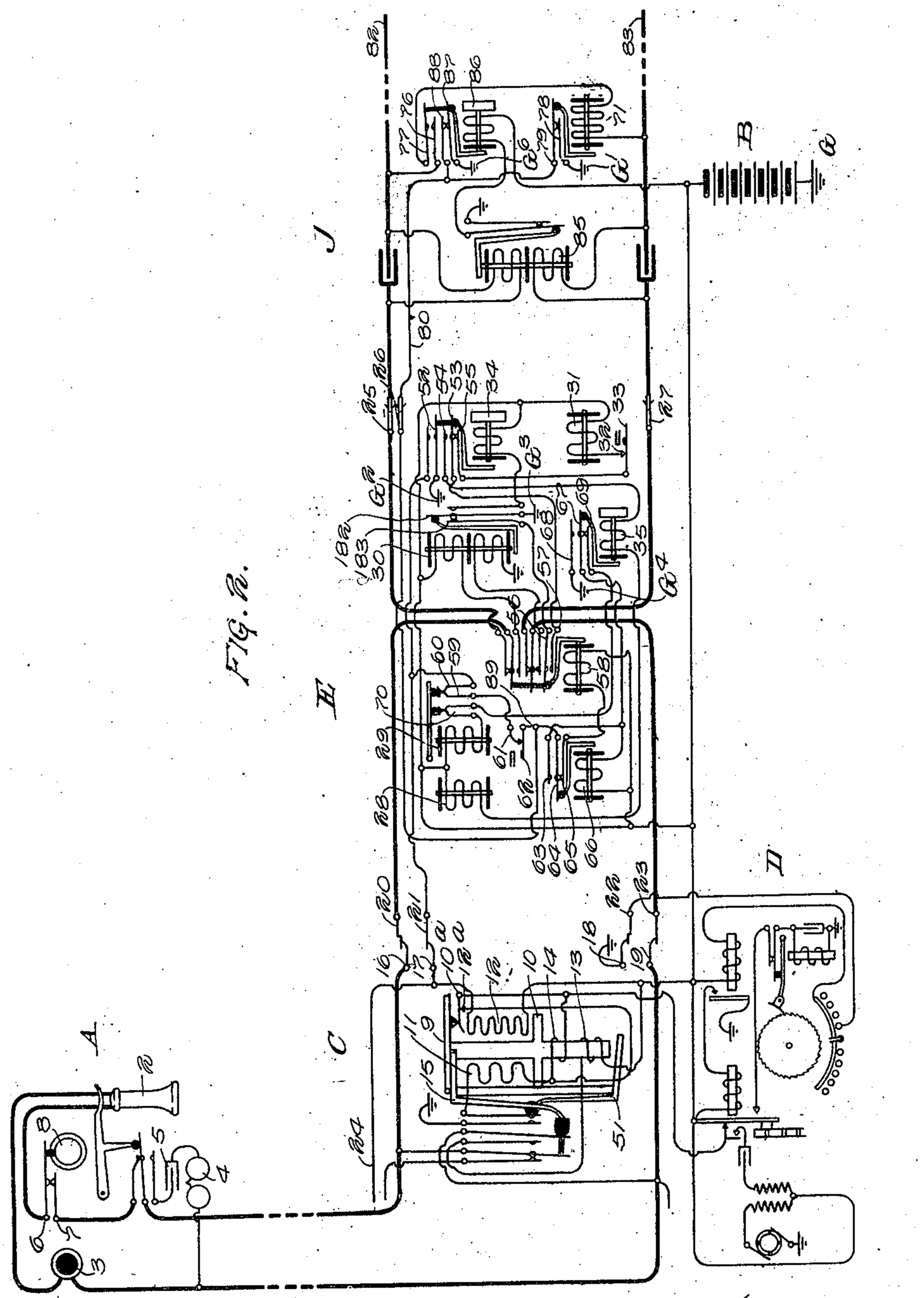
FIG. 2.



WITNESSES

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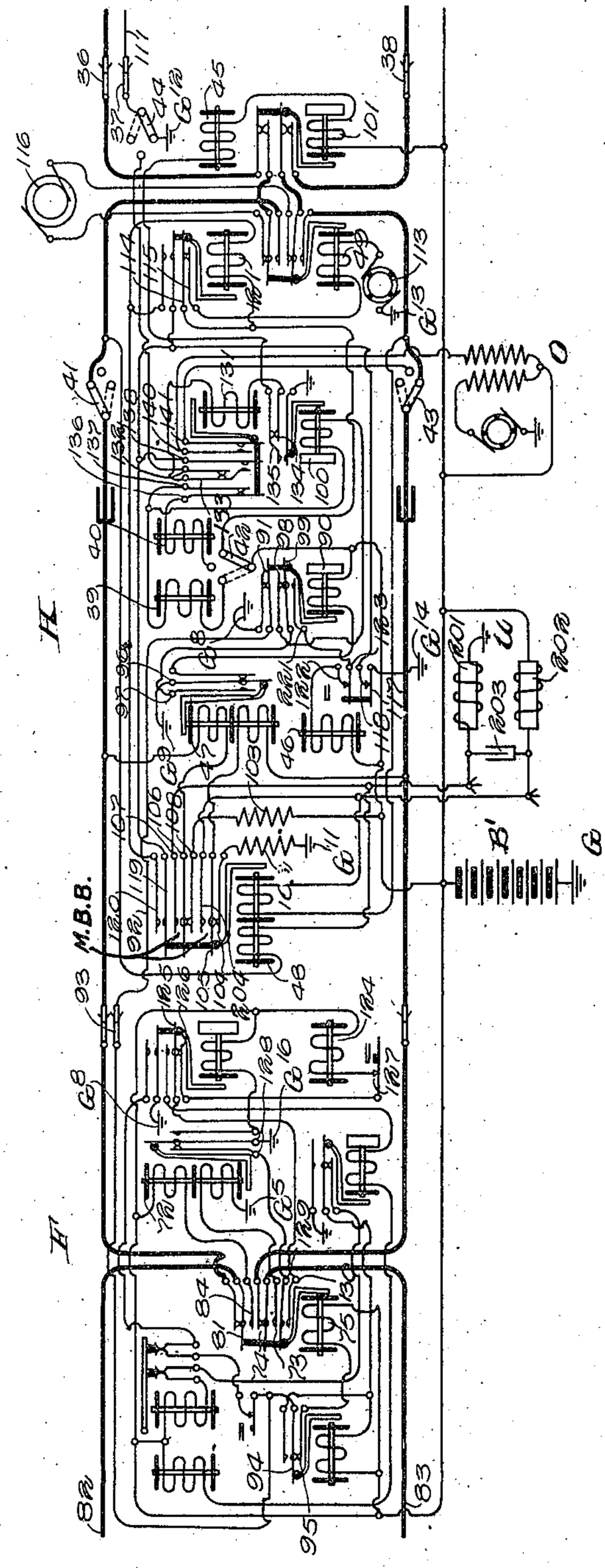

Fig. 3.

WITNESSES

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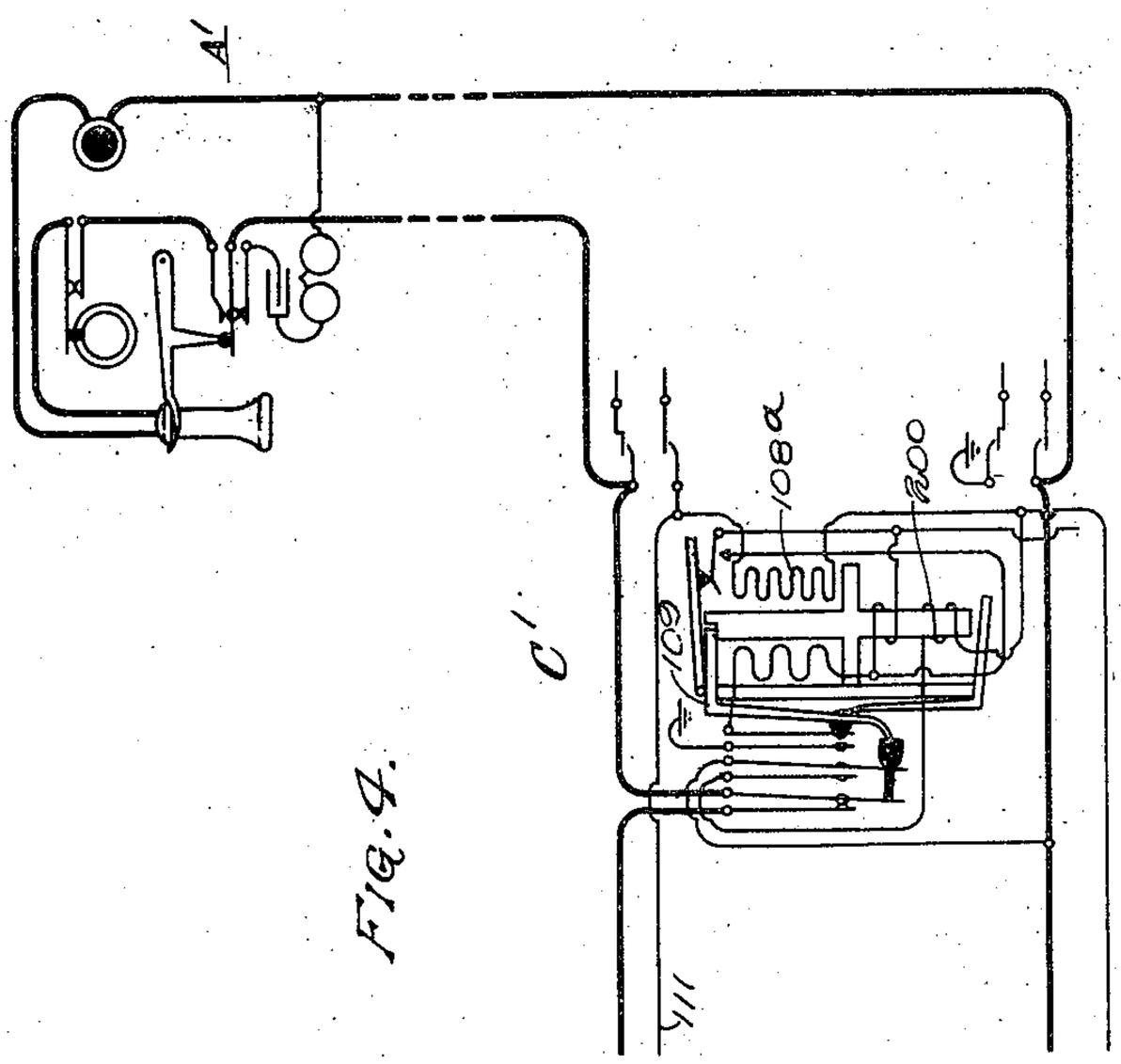

FIG. 4.

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UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

1,190,185. Specification of Letters Patent. Patented July 4, 1916.

Application filed August 11, 1913. Serial No. 784,096.

To all whom it may concern:

Be it known that I, TALBOT G. MARTIN, a citizen of the United States of America, and resident of Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Automatic Telephone Systems, of which the following is a specification.

My invention relates to improvements in automatic telephone systems, and more particularly to a system employing a common battery for talking and operating purposes. In these common battery systems in which battery is connected with the line various influences affect the potentials of the opposite poles of the battery, which changes in potential produce noises in the lines connected with this battery. Among the influences which cause this change in potential are the impulses for operating the switches in an automatic system. In order to reduce the effect of these changes in potential it is customary to connect the battery with the line through an impedance, this impedance usually being supplied by the line relay. The greater this impedance the less the effect the variations in the battery will have upon the connected line. If, however, the impedance in the line relays is increased to too great an extent, it will so reduce the impulses for operating the switches which pass through these relays as to seriously affect the operation of the switches.

It is an object of my present invention to provide means whereby the operating relays and magnets of the switches are connected with the battery without impedance, while the talking current is furnished through high impedance coils. While these coils have a high impedance, they have a low resistance so as not to materially reduce the direct energizing current for the microphone transmitters at the subscribers' stations.

A further object of my invention is to provide means for preventing a switch from stopping on a trunk one of whose conductors is open. Heretofore, if a conductor of a trunk became broken, there was nothing to prevent a switch from stopping upon this trunk, and if this trunk should happen to be the first one of the series with which a group of switches made contact, it would tend to tie up the whole group of trunks.

An object of my invention is, therefore, to provide means for placing a guarding potential on a trunk when either of its conductors are open and in this manner prevent any switch from stopping on such an open trunk.

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 a well-known form of automatic telephone system.

In the drawings Figure 1 is a diagrammatic layout of a telephone system in which I have chosen to illustrate my invention. Figs. 2, 3 and 4 show a complete connection between two automatic subscribers' stations in said system.

The telephone system illustrated in Fig. 1 comprises two automatic exchanges M and N of the well-known type comprising subscribers' individual preselector or line switches C, so-called 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 exchanges, the exchange M consisting of one thousand lines, while the exchange N consists of two thousand lines. The subscribers' substation A and the lines connected thereto are divided into groups A^2, A^3, 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 thousand, while the groups A^5, etc., to A^{10} represent two more thousand. With each group of subscribers' lines there is associated 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 selector and connector switches comprise banks of contacts arranged in horizontal rows or levels, usually ten in number. These levels are represented diagrammatically by horizontal lines which extend across a group of switches, thereby indicating that the corresponding contacts of all of the switches of the group are multipled together. All the line switches C belonging to a single group of subscribers' lines have common access to a group of first selectors E. The corresponding contacts of all the first selectors of each thousand are multipled together. Trunk lines leading from the first lever of the first selectors of any thousand extend to a group of second selectors associated with the first thousand.

Trunk lines leading from the second level of any thousand extend to second selectors associated with the second thousand, etc. The corresponding bank contacts of all the second selectors in each thousand are also multiplied together. Trunk lines leading from the first level of the second selectors of any thousand extend to connectors associated with the first hundred of that thousand. Trunk lines leading from the second level of the second selector of any thousand extend to connectors associated with the second hundred of that thousand, etc. This trunking arrangement of an automatic system is in general well known in the art and it is not thought necessary to describe it in greater detail herein.

In order to form a means of communication between the two automatic exchanges, there are provided a number of trunk lines leading from the banks of the first selectors in each exchange to second selector switches in the other exchange. Thus if a party in the N exchange wishes to converse with a party in the M exchange, only the line switch and first selector are operated in the N exchange, while the remainder of the connection is completed through a second selector and connector switch located in the M exchange.

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, being, however, of the particular type disclosed 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 which is controlled by the magnet 10. The magnet 10 comprises four windings, namely, a pull-down winding 11, cut-off or holding winding 12, line winding 13 and auxiliary winding 14. The core of the magnet 10 is so constructed that the magnetic circuit of the windings 11 and 12 is separate from that of the windings 13 and 14. The winding 11 operates both the plunger arm 9 and the armature 15, while the winding 12 is strong enough only to operate the cut-off armature 15 and to hold the plunger arm 9 in its operated position. When the plunger arm 9 is operated, the plunger is forced into a bank of contact springs, forcing the springs 16, 17, 18 and 19 into engagement with the springs 20, 21, 22 and 23, respectively. Although only one set of springs (16—23) 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 13, as will be hereinafter more fully explained.

The master switch D is of the same general type as that disclosed in British Patent No. 26,301 of 1906, referred to above, being, however, of the particular type disclosed in said British Patent No. 1419 of 1910. 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.

The first selector switch E is of the general type of selector switch 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, and the circuits are modified to adapt the switch to operate in a system in which it is controlled by impulses delivered over two sides of the line in series. 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 25, 26 and 27 carried upon a shaft (not shown) which has a vertical movement controlled by the vertical magnet 28 and a rotary movement controlled by the rotary magnet 29. The operations of various parts of the switch are controlled through the medium of the double-wound line relay 30. Means for permitting the switch to be restored to normal position are provided in the release magnet 31, which, upon energizing, withdraws the retaining pawls from the shaft. The springs 32 and 33 and 61 and 62 close only when the switch shaft has been raised one or more steps from its lowest position. The relays 34 and 35 are slow acting—that is, relays which deënergize slowly after their energizing circuits are broken. The second selector F is essentially the same as the first selector E.

The connector switch H (Fig. 3) is of the same general type of connector switch as disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, the circuits, however, being modified 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 36, 37 and 38 which is controlled by the vertical magnet 39 and the rotary magnet 40. The usual side switch comprising the wipers 41, 42, 43 and 44 is controlled by the private magnet 45 in the usual and well-known manner. The magnet 46 is the usual release magnet. The line relay 47 is connected with the battery B′ through the reversing springs of a so-called back-bridge relay 48, through the windings of which latter relay the called line is pro-

vided with talking current. The ringing relay 49 is the means through which ringing current is applied to the called line. At O there is shown a busy signaling machine which provides a busy signal, said busy signal being applied to the calling line through the medium of the busy relay 131 in case the called line is in use.

The substation shown at A′ and the line switch C′ (Fig. 4) are similar in all respects to the substation A and the line switch C (Fig. 2).

For the purpose of supplying battery current for operating the apparatus at different exchanges and for talking purposes, there are shown throughout the drawings a plurality of batteries B, B′, etc., having one terminal grounded at G. There need be in practice, however, only one such battery.

Associated with the trunk lines leading from the first selectors to the second selectors are a group of holding relays J which are for the purpose of supplying a holding ground to the first selector and also for the purpose of putting a guarding ground on the private bank contact of the trunk in the banks of all the first selectors that have access to said trunk should the trunk line between the exchanges become open for any reason. At U (Fig. 3) there are shown a couple of impedance coils through which battery is supplied to the calling line for talking purposes after the connection has been completed and the called subscriber has removed his receiver from the hook. The purpose of these coils will be more fully explained hereinafter.

A general description of the apparatus having been given, it will now be explained how a connection is extended from a calling substation A, whose lines we will assume terminate in the M exchange, to a called substation A′, whose lines terminate in the N exchange. It will also be explained how the reverse of the foregoing call may be made. We will assume the number in the N exchange 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, an energizing circuit is closed through the line winding 13 of the individual switch C, thereby attracting the line armature 51. The armature, upon being attracted, closes a circuit through the pull-down coil 11 in series with the auxiliary winding 14. The pull-down coil, upon energizing, attracts the plunger arm 9 to force the plunger into the bank of springs 16—23. It also operates the cut-off armature 15, thereby disconnecting the line winding 13 from the line. The armature 51 does not fall back immediately, however, owing to the fact that the winding 14 is still in series with the pull-down winding 11. Upon the plunger arm 9 being attracted the springs 10^a and 12^a are brought together to short-circuit the auxiliary winding 14, making same slightly slow acting. The armature 51 being slow to fall back allows sufficient time for a holding circuit to be closed in the switch ahead for the cut-off or holding winding 12. The engagement of the springs 16 and 19 with the springs 20 and 23, respectively, extends the subscribers' lines to the line relay 30 of the selector E. The line relay 30 of the selector switch E is thereupon energized, closing a circuit through the relay 34. The relay 34, upon energizing, closes the above-mentioned holding circuits through the cut-off winding 12 of the line switch C. This circuit extends from ground G^2 through the springs 52, bank springs 21 and 17, cut-off winding 12 to the battery B, thence through battery B to ground G. The winding 12, upon energizing, holds the armature 15 and the plunger arm 9 in their operated positions after the circuit of the pull-down winding is broken by the falling back of the line armature 51. A guarding ground potential is supplied to the connector private bank contacts of the calling line as soon as the relay 34 is energized. This circuit extends over the circuit just traced to the bank spring 17, thence over the conductor 24 to said private bank contact. The energization of the relay 34 also prepares a circuit for the vertical magnet by bringing into engagement the springs 53 and 54 and opens the circuit of the release magnet 31 by disengaging springs 53 and 55.

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 operated twice momentarily, each time breaking the circuit of the selector line relay 30. The relay 34 of the selector being slow acting does not deënergize during the momentary interruptions of its circuit by the line relay 30 and consequently, each time the latter relay deënergizes, an impulse is transmitted over the circuit extending from ground G^3 through the contact of springs 182 and 183, springs 56 and 57 of the relay 58, springs 53 and 54 of the relay 34, relay 35 and the vertical magnet 28 to battery B. 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. The off-normal springs 32 and 33 and 61 and 62 close as soon as the shaft is raised one step, but the circuit of the release magnet 31 still remains open at the springs 53

and 55. The slow acting relay 35 is maintained in its energized position while impulses are being sent through it to the vertical magnet, and in its energized position closes a circuit extending from ground G^4 through the springs 68 and 67 and the relay 66 to battery B. The relay 66, upon energizing, closes a locking circuit for itself extending from ground G^2 at the relay 34, through the springs 52, rotary magnet springs 60 and 59, normal springs 61 and 62, springs 64 and 63 of the relay 66, thence through the relay 66 to battery B. Thus, upon the deënergization of the relay 35 after the last impulse is delivered to the vertical magnet, the relay 66 remains energized and the circuit of the rotary magnet is closed. This circuit extends from ground G^2 through the springs 52, 60 and 59, 61 and 62, 64 and 63, 67 and 69, interrupter springs 70 and the rotary magnet 29 to battery B. The rotary magnet, upon energizing, rotates the wipers one step and, by opening the springs 59 and 60, disconnects ground G^2 from itself and the relay 66. If the first trunk line of the second level is idle, the relay 66 deënergizes as soon as the springs 59 and 60 are opened. If this trunk line is busy, however, the private wiper 26 finds the contact with which it engages provided with a guarding ground potential which is transmitted to the relay 66 through the springs 64 and 63, thereby preventing it from deënergizing. The rotary magnet, however, deënergizes when the springs 70 disengage, regardless of whether the relay 66 remains energized or not. If the relay 66 remains energized, the circuit of the rotary magnet will be again closed as soon as the armature drops back far enough to close the springs 59 and 60. The rotary magnet will, therefore, operate in the manner 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 26, whereupon the relay 66 deenergizes. The relay 66, upon deënergizing, whether after one or several operations of the rotary magnet, permanently breaks the circuit of the magnet 29 and closes the circuit of the switching relay 58. The circuit through said relay 58 extends from ground G^2 through the springs 52, 60 and 59, 61 and 62, 64 and 65 and the relay 58 to battery B. The relay 58, upon energizing, disconnects the line relay 30 from the line and extends the line connection over the heavy conductors through the wipers 25 and 27 to the second selector F.

The relay 71, which is normally bridged across the trunk lines 82 and 83, is energized as long as the trunk line is not in use. The circuit over which this relay is normally energized extends from ground G^5 at the selector F (Fig. 3) through the lower winding of the relay 72, springs 73 and 74 of the relay 75, conductor 83, relay 71, springs 77 and 76, conductor 82, springs 81 and 84 and the upper winding of the relay 72 to battery B'. The resistance of the relay 71 is sufficiently high to prevent the line relay 72 of the selector F from becoming operatively energized. The relay 71, however, does become operatively energized over this circuit and serves to hold the springs 79 and 78 out of engagement, whereby the guarding ground is kept from the release trunk 80. If one of the trunk lines 82 or 83 should become open for any reason, the relay 71 deënergizes and thereby places a guarding potential on the private bank contact of the called trunk in the banks of all the first selectors that have access to said trunk, which prevents any of said first selectors from selecting the trunk which is out of service. The relay 85, the windings of which are in series with the line relay 72 of the selector F when the lines are extended to the selector F by the operation of the selector E, described above, becomes energized, as well as the line relay 72. This circuit through the two relays extends from ground G^5 (Fig. 3) over the circuit above traced to the conductor 83, thence through the lower winding of the relay 85, wiper 27, thence over the heavy conductors to and through the substation A, back over the heavy conductors, wiper 25, upper winding of the relay 85, thence over the circuit traced above through the upper winding of the relay 72 to battery B'. The relay 85 (Fig. 2) and the relay 72 (Fig. 3) both operatively energize over the circuit just traced. The relay 85, upon energizing, closes a circuit through the slow relay 86. The relay 86, upon energizing, opens the circuit of the relay 71 at the springs 76 and 77 and closes a holding ground for the relay 58 of the selector E and the winding 12 of the line switch C. This holding ground for the selector E extends from ground G^6 through the springs 87 and 88, conductor 80, wiper 26, springs 64 and 65 of the relay 66, thence through the relay 58 to battery B. The holding ground for the winding 12 extends from ground G^6 over the circuit just traced to the point 89, thence through the normal springs 62 and 61, interrupter springs 59 and 60, springs 21 and 17 and the winding 12 to battery B. The apparatus is now in readiness for the operation of the dial at the calling substation for the second digit 2.

The operation of the calling device for the second digit 2 opens the circuit of the relays 85 and 72 twice. The slow relay 86 does not deënergize during the momentary interruptions of its circuit by the relay 85, thereby preventing the first selector E and the switch C from releasing. The operations of the selector F that are brought

about by the line relay 72 when the calling device is operated for the second digit 2 are similar in all respects to the operations of the first selector E when the dial was operated for the first digit 2. The selector, on being thus operated, extends the line to the connector H. The line relay 47 of the connector thereupon becomes energized and closes the circuit of the relay 90. The circuit of the relay 47 extends from ground G^{11} through the resistance 102, springs 104 and 105, lower winding of the relay 47, thence over the heavy conductors 83 to and through the substation A, back over the heavy conductor 82, through the upper winding of the relay 47, springs 106 and 108 and the resistance 103 to battery B′. The relay 90, upon energizing, provides a holding circuit for the relay 75 of the selector switch F. This circuit extends from ground G^{8} at the connector switch through the springs 91, conductor 92, wiper 93, springs 94 and 95 and the relay 75 to battery B′.

When the substation calling device is operated for the third digit 2, the circuit of the line relay 47 is broken twice. Since the relay 90 is slow acting it does not deënergize during the momentary interruptions of its circuit by the relay 47, so that each time the latter relay is deënergized, a circuit is closed extending from ground G^{9} through the springs 96 and 97, springs 99 and 98, relay 100, vertical magnet 39 and the side switch wiper 42 to battery B′. The vertical magnet 39 receives two impulses over this circuit and operates to raise the switch wipers 36, 37 and 38 to a position opposite the second level of bank contacts. The relay 100, which was included in series with the vertical magnet, remains in its energized position during the entire time that impulses are being sent through it and operates to close the circuit of the relay 101 and private magnet 45. After the last impulse is delivered, the relay 100 opens the circuit of the private magnet 45, which, upon deënergizing, permits the side switch to advance from first to second position. The movement of the side switch wiper 42 from first to second position transfers the battery connection from the vertical magnet 39 to the rotary magnet 40. The calling subscriber now operates his calling device for the last digit O, in response to which the connector line relay operates to transmit ten impulses through the rotary magnet 40 in series with the relay 100 whereby the shaft wipers are rotated onto the contacts of the desired line. The relay 100 operates in response to this digit in the same manner as for the previous digit to cause the private magnet 45 to advance the side switch one more position—that is, from second to third position—after the last impulse for the digit has been transmitted. By the engagement of the side switch wipers 41 and 43 with their third-position contact points, and by the deënergization of the relay 101 the line connection is completed with the called substation, as shown by the heavy conductors. The relay 101 controls 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 108^{a} of the switch C′ has had time to operate its armature 109 to disconnect the line relay 200 from the line. The circuit of the winding 108^{a} is closed by the engagement of the side switch wiper 44 of the connector H with its third-position contact point, said circuit extending from ground G^{12} through the side switch wiper 44, private wiper 37, conductor 111 and the winding 108^{a} to battery B′. The connection of ground G^{12} with the connector private bank contact of the called line prevents the called line from being seized by some other connector switch. By the engagement of the side switch wiper 42 with its third-position contact point, the circuit of the ringing relay 49 is closed. This circuit extends from ground G^{13} through the interrupter 113, relay 49, springs 115 and 114, side switch wiper 42 to battery B′. The ringing relay, upon energizing, disconnects the calling line from the called line and bridges the ringing current generator 116 across the called line to signal the called subscriber. The ringing relay is energized only intermittently through the medium of the interrupter 113. Upon the response of the called subscriber his line is provided with talking current through the windings of the back-bridge relay 48, which relay, upon energizing, closes the circuit of the ringing cut-off relay 121, said circuit extending from ground G^{14} through the springs 117 and 118, 119 and 120, relay 121 and the side switch wiper 42 to battery B′. The relay 121, upon energizing, interrupts the circuit of the ringing relay 49 at the springs 114 and 115 and closes a locking circuit for itself through its own springs independent of the springs 119 and 120 of the back-bridge relay 48. A further result of the energization of the back-bridge relay 48 upon the response of the called subscriber is the transposition of the battery connections of the windings of the line relay 47 with regard to the battery B′, whereby the direction of the current in the calling line is reversed.

It will be seen that the circuit previously traced for the line relay 47 included in series with said relay the two non-inductive resistances 102 and 103. The transposing of the battery connections of the relay 47 by the operation of the relay 48 serves to disconnect the resistances 102 and 103 and to supply battery to the relay 47 through the coils 201 and 202, these coils being of very high impedance but of low

resistance and are bridged by a high capacity condenser 203. The object of the resistances 102 and 103 is to prevent the complete short-circuiting of the battery connections, since the springs 105 and 106 engage the springs 204 and 107, respectively, before they break from the springs 104 and 108 when the relay 48 operates. In the drawings M. B. B. indicates this. The coils 201 and 202 are common to a group of connectors and are only included in the talking circuit after the called subscriber has answered. These coils 201 and 202 are for the purpose of eliminating from the talking circuit all battery noises due to operating impulses, etc., which are more or less common in automatic exchanges.

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 destroys the energizing circuit of the connector line relay 47 (Fig. 3) and the relay 85 (Fig. 2). The relay 47 is thereupon deënergized and opens the circuit of the relay 90. The relay 90, upon deënergizing, opens the holding circuit of the relay 75 of the selector F and also closes the circuit of the connector release magnet 46. This latter circuit extends from ground G^9 through the springs 96 and 97, springs 99 and 221, 123 and 122 and the release magnet 46 to battery B′. The magnet, upon energizing, restores the switch shaft and side switch wipers to normal position and its own circuit is broken at the springs 122 and 123 when the shaft reaches its lowest position. The deënergization of the relay 75 of the selector F closes a circuit through the release magnet 124. This circuit extends from ground G^{16} through the springs 128, springs 129 and 130, 125 and 126, normal springs 127 and the magnet 124 to battery B′. The selector F releases, breaking the circuit of its own release magnet when the shaft reaches its lowest position. The deënergization of the relay 85 (Fig. 2) breaks the circuit of the slow acting relay 86, which in turn deënergizes and closes the circuit of the relay 71 and also disconnects the holding ground from the first selector switch E and from the cutoff winding 12 of the line switch C. The first selector E releases in the same manner as described for the selector F. The winding 12 of the line switch C, upon becoming deënergized, allows the plunger arm 9 to return to normal position. It now having been explained how one subscriber establishes connection and releases the same, it will be explained how a connection is prevented from being made with a busy line and how the calling subscriber receives a busy signal when calling a busy number.

If the number called is busy there will be a guarding potential upon the connector private bank contact, just as explained in connection with the line switch C. The connector private wiper, upon engaging this guarding contact and before the side switch wipers have passed to third position, completes an energizing circuit through the busy relay 131. This circuit extends from the ground at the private wiper through the side switch wiper 44, springs 132 and 133, relay 131, springs 134 and 135, private magnet 45 and the relay 101 to battery B′. The private magnet energizes, and maintains the side switch wipers in second position. The relay 101 energizes and serves to keep the line open to the called subscriber. The relay 131 energizes and opens the circuit of the rotary magnet at the springs 136 and 137 and also forms a locking circuit for itself by disconnecting the spring 133 from the spring 132 and bringing it into engagement with the springs 138. The engagement of the springs 140 and 141 serves to close a circuit for the busy tone from the busy machine O through said springs and through the second-position contact point of the side switch wiper 43 over the conductor 83, through the calling telephone and back to the busy machine Q. The calling subscriber, upon receiving the busy signal, hangs the receiver upon the hook, thereby releasing the connection in the manner above described.

It will thus be seen that I have devised a very efficient form of telephone system in which practically all noises due to the variation in potential of the battery are eliminated. Furthermore, this is accomplished without in any way reducing the current passing through the line relays, so that the operating impulses for the switches are not affected. Furthermore, it will be seen that in this system the trunking efficiency is increased, as it is impossible for the switches to become tied up owing to any trunk being open.

Although I have explained the operation of the relay 71 in connection with an open trunk, yet it will be seen that this relay can be made to operate as a result of a reduction of energizing current over the trunk. For example, it can be so adjusted that it will indicate when the trunk goes short; that is, if the trunk conductors 82 and 83 are short circuited the current through the relay 71 will of course, be greatly reduced, or in some instances, although shunted out, which would, of course, cause the relay 71 to operate as previously described. It will also be seen that the relay 71 may also be made to operate by a ground on the trunk conductor

82. The grounding of this conductor will, of course, likewise operate to shunt the relay 71.

While I have illustrated my invention in connection with one particular type of automatic system, it will, of course, be understood that it is capable of use with many other forms of systems, and is equally as well adapted for use in connection with semi-automatic systems—that is, systems in which a manual link circuit is employed in combination with automatic means for establishing a connection between two subscribers' lines.

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 plurality of subscribers' lines, means including an automatic connector switch for establishing a talking circuit between two of said lines, a common battery for supplying talking current, a line relay normally included in series with said battery in a bridge across said talking circuit, and means for including an impedance in series with said line relay when said talking circuit is established.

2. In a telephone system, a plurality of subscribers' lines, means including an automatic connector switch for establishing connection between two of said lines, a common battery for supplying talking current, a line relay connected with said battery and included in a bridge across said talking circuit, and means for connecting an impedance in series with said line relay when said talking circuit is established.

3. In a telephone system, a plurality of subscribers' lines, means including an automatic connector for establishing a talking circuit between two of said lines, a common battery for supplying talking current, a line relay bridged across said talking circuit and connected with said battery, a non-inductive resistance normally included in said bridge, an inductive resistance, and means for cutting out said non-inductive resistance and including said inductive resistance in said bridge when said talking circuit is established.

4. In a telephone system, a plurality of subscribers' lines, means for establishing a talking circuit between two of said lines, a common battery for supplying talking current, said battery normally connected through a low impedance path with the conductors of said talking circuit, and means for increasing the impedance in said path when said talking circuit is established.

5. In a telephone system, a plurality of subscribers' lines, means for establishing a talking circuit between two of said lines, a common battery for supplying talking current, said battery normally connected through a low impedance path with the conductors of said talking circuit, and means for automatically increasing the impedance in said bridge.

6. In a telephone system, a plurality of subscribers' lines, means including an automatic connector switch for establishing a talking circuit between two of said lines, a common battery for supplying talking current, a line relay normally connected with the conductors of said talking circuit and to said battery, a second relay, means for energizing said second relay upon the response of the called subscriber, an impedance coil, and means controlled by the energization of said second relay for including said impedance coil in series with said battery and line relay.

7. In a telephone system, a plurality of subscribers' lines, means including an automatic connector switch for establishing a talking circuit between two of said lines, a common battery for supplying talking current, a line relay normally bridged across the conductors of said talking circuit in series with said battery, an impedance coil, and means controlled upon the response of the called subscriber for including said impedance coil in series with said line relay and battery.

8. In a telephone system, a plurality of subscribers' lines, means including an automatic connector switch for establishing a talking circuit between two of said lines, a common battery for supplying talking current, a line relay normally bridged across the conductors of said talking circuit in series with said battery, an impedance coil, a second relay bridged across the conductors of said talking circuit, means controlled upon the response of the called subscriber for energizing said second relay, and means controlled by said second relay for including said impedance coil in series with said line relay.

9. In a telephone system, a plurality of subscribers' lines, means including an automatic switch for establishing a talking circuit between two of said lines, a common battery for supplying talking current, said battery normally connected through a low impedance path with the conductors of said talking circuit, and means for increasing the impedance in said path when said talking circuit is established.

10. In a telephone system, a plurality of subscribers' lines, means including an automatic switch for establishing a talking circuit between two of said lines, a common battery for supplying talking current, said battery normally connected through a low impedance path with the conductors of said talking circuit, and means for automatically increasing the impedance in said bridge.

11. In a telephone system, a talking circuit, a common battery bridged across said circuit, and means for including an inductive resistance in said bridge on each side of said battery, and a condenser shunted across said resistances.

12. In a telephone system, a plurality of subscribers' lines, means including an automatic connector switch for establishing connection between two of said lines, a common battery for supplying talking current, a line relay normally connected with said battery included in a bridge across said talking circuit, means for including a pair of impedance coils in said bridge in series with said line relay, and a condenser in shunt of said impedance coils.

13. In a telephone system, a plurality of subscribers' lines, means including an automatic connector switch for establishing a talking circuit between two of said lines, a common battery bridged across said talking circuit, a line relay included in said bridge, a second relay, means for energizing said second relay upon the response of the called subscriber, a pair of impedance coils, means controlled by the energization of said second relay for including said impedance coils in said bridge, and a condenser in shunt of said impedance coils.

14. In a telephone system, a plurality of subscribers' lines, means including an automatic connector switch for establishing a talking circuit between two of said lines, a common battery bridged across said talking circuit, a line relay normally included in said bridge in series with a non-inductive resistance, an impedance coil, and means for automatically cutting out said non-inductive resistance and including said impedance coil in said bridge.

15. In a telephone system, a plurality of subscribers' lines, means including an automatic connector switch for establishing a talking circuit between two of said lines, a common battery bridged across said talking circuit, a line relay normally included in said bridge in series with a non-inductive resistance, a second relay, means for energizing said second relay upon the response of the called subscriber, an impedance coil, and means controlled by the energization of said second relay for cutting out said non-inductive resistance and including said impedance coil in said bridge.

16. In a telephone system, a plurality of subscribers' lines, means for establishing connection between two of said lines, said means including a trunk line having a pair of line contacts and a private contact, and means for placing a guarding potential on said private contact when one of the conductors of said trunk is open, to thereby prevent said trunk being seized.

17. In a telephone system, a plurality of trunk lines and an automatic switch for seizing any one of said trunk lines, means for propelling said switch to an idle trunk line, means for stopping the switch on said idle trunk line, and means for rendering said stopping means inoperative for stopping the switch if a conductor of said trunk line is open.

18. In a telephone system, a plurality of trunk lines and an automatic switch for seizing any one of said trunk lines, means for propelling said switch to an idle trunk line, means for stopping the switch on said idle trunk line, and a relay for rendering said stopping means inoperative for stopping the switch if a conductor of the idle trunk is open.

19. In a telephone system, a plurality of trunk lines and an automatic switch for seizing any one of said trunk lines, means for propelling said switch to an idle trunk line, means for stopping the switch on said idle trunk line, and a relay for placing a guarding potential on said trunk line if a conductor of the same is open for rendering said stopping means inoperative for stopping the switch.

Signed by me at Chicago, Cook county, Illinois, this 5th day of August, 1913.

TALBOT G. MARTIN.

Witnesses:

ALBERT ANDERSEN,

G. YANOCHOWSKI.