H. E. HERSHEY.

AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED NOV. 28, 1913. RENEWED JUNE 7, 1918.

1,292,465.

Patented Jan. 28, 1919.

5 SHEETS—SHEET 1.

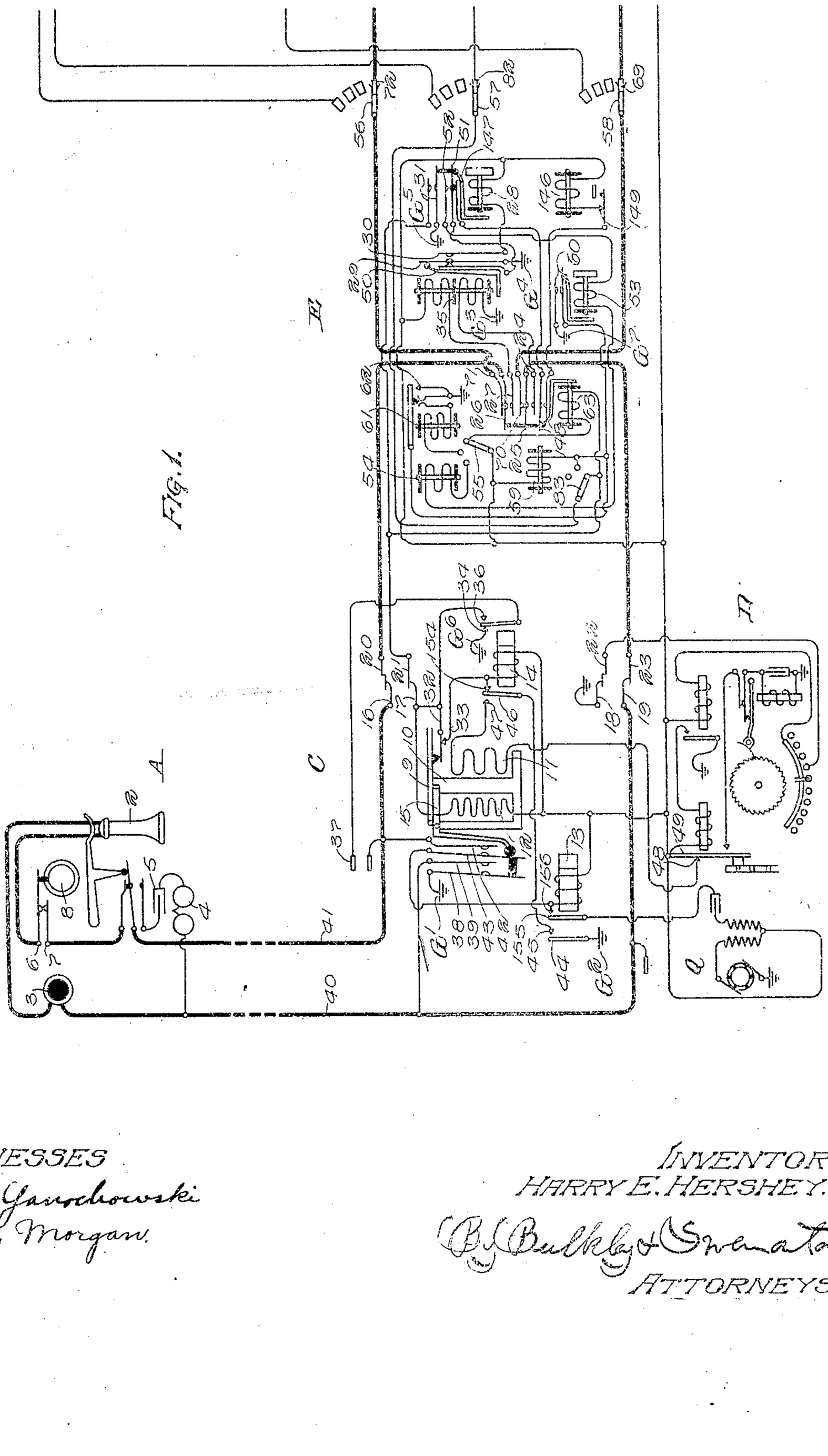

FIG. 1.

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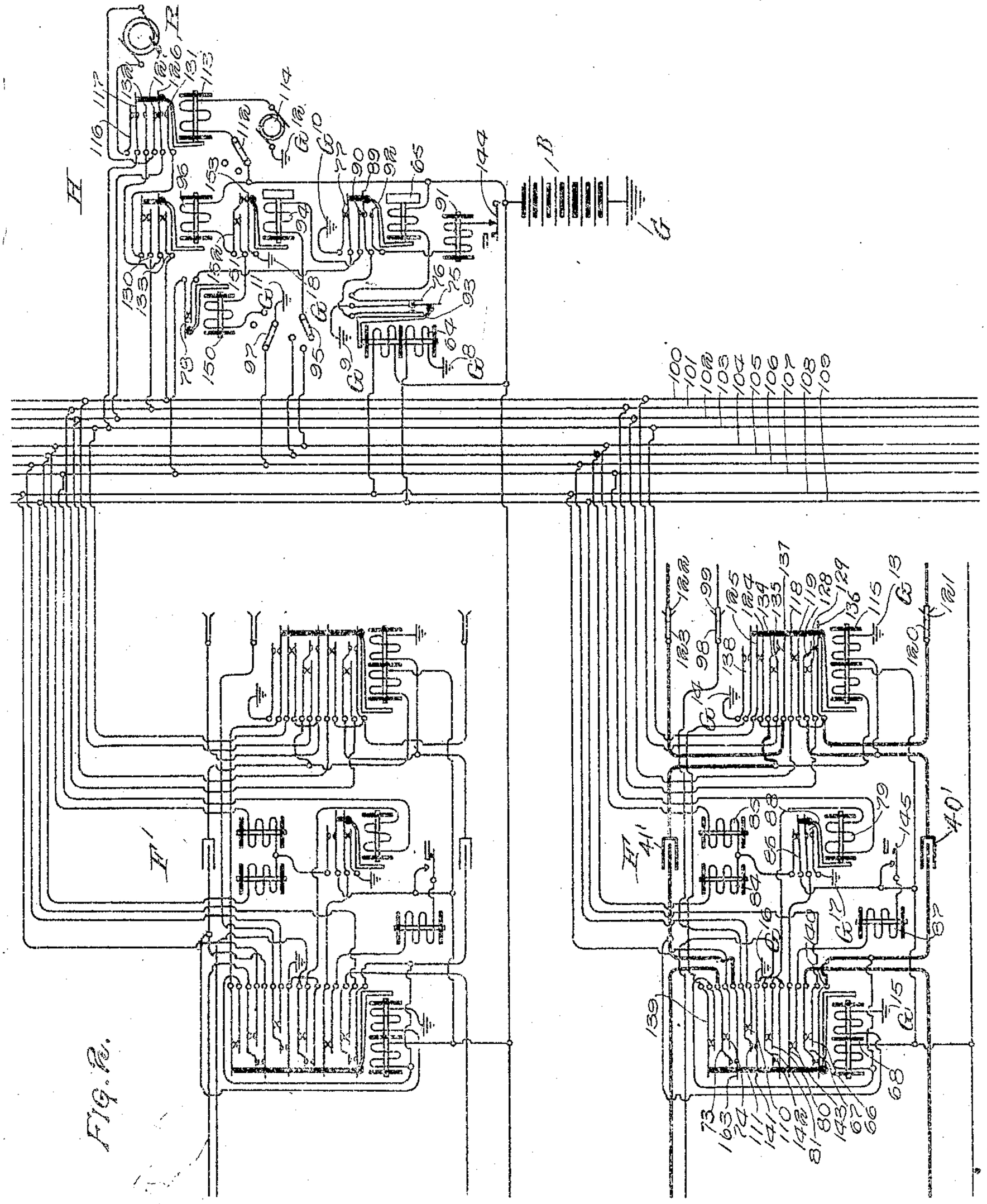

Fig. 2.

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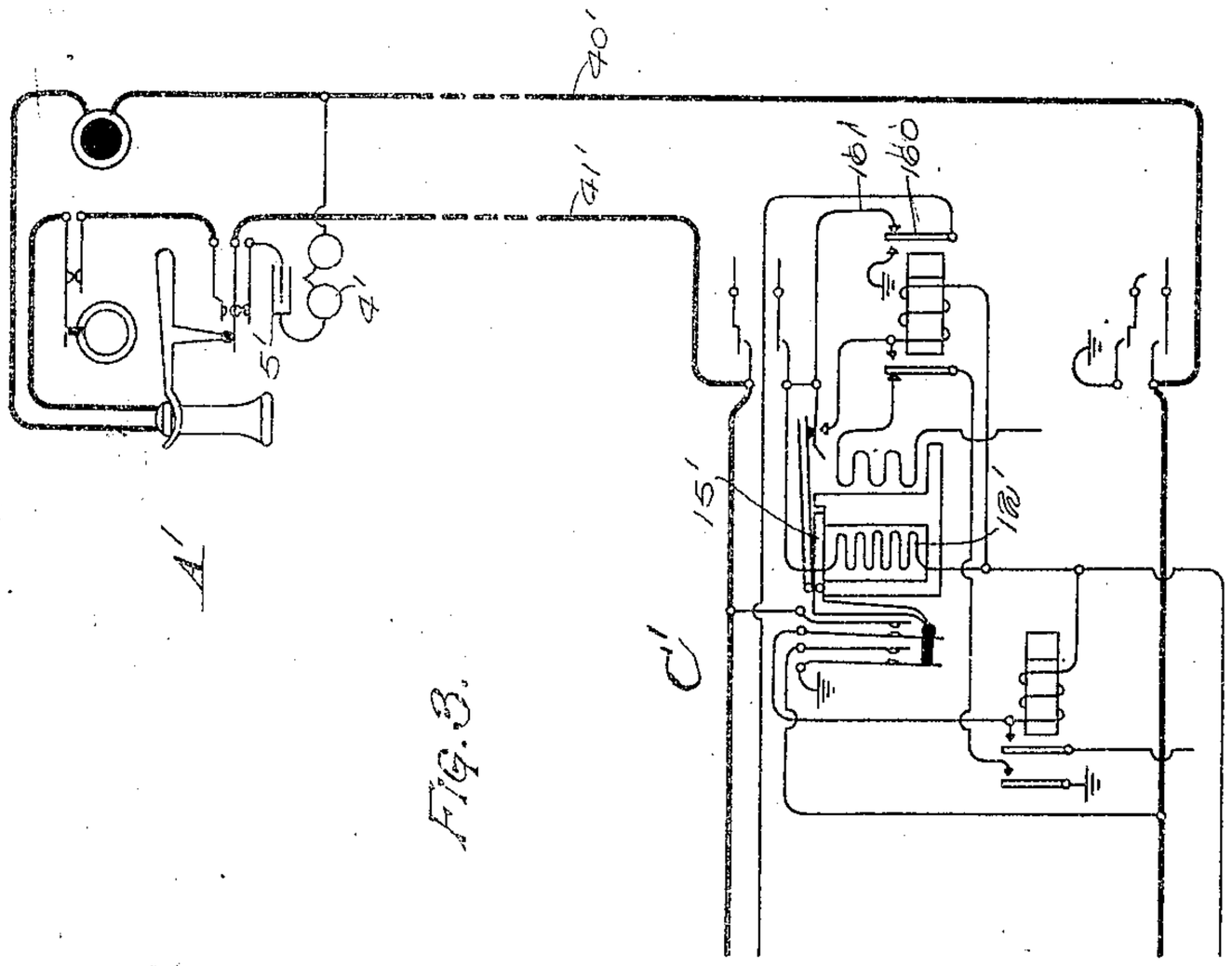

FIG. 3.

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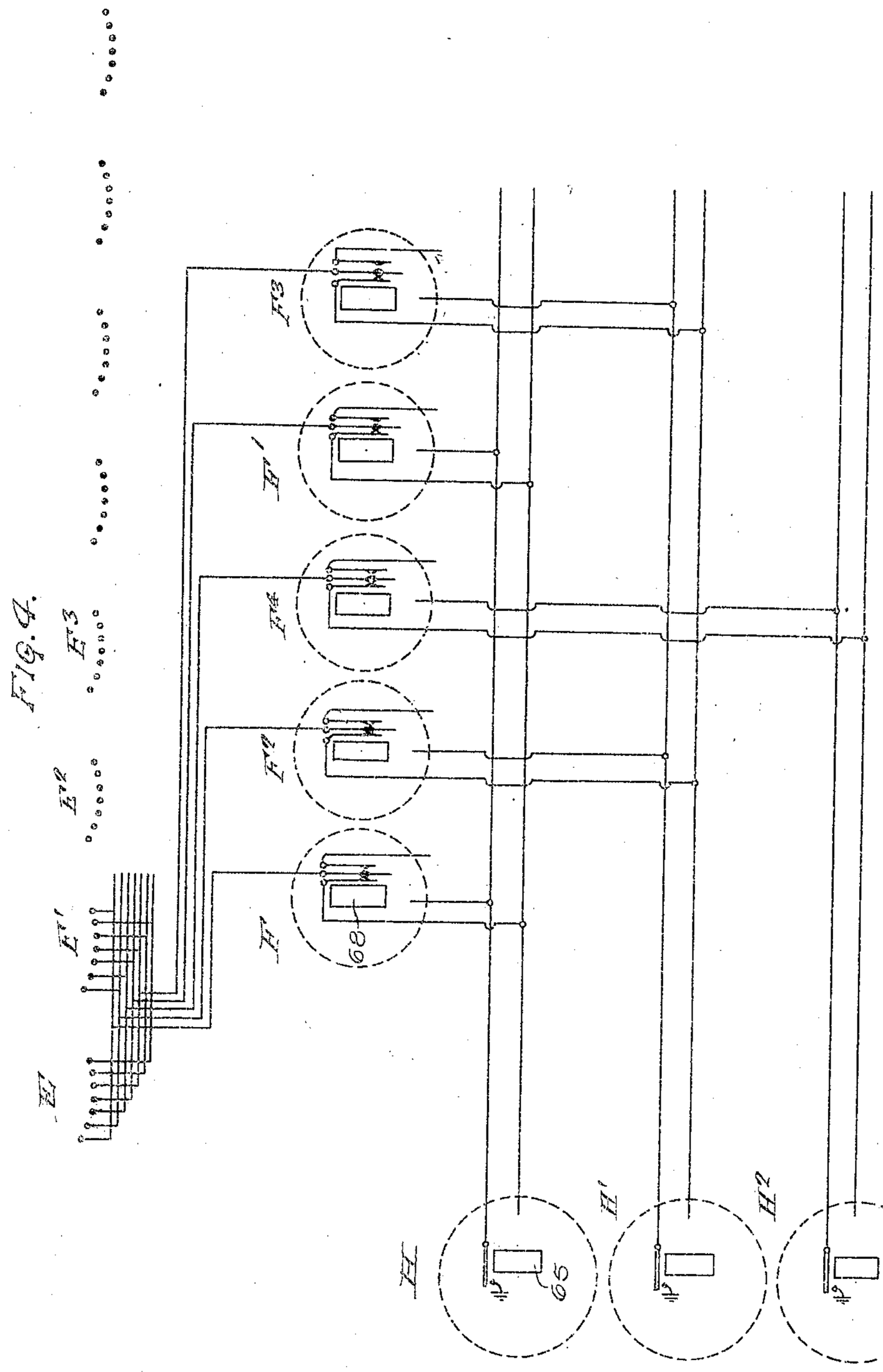
APPLICATION FILED NOV. 28, 1913. RENEWED JUNE 7, 1918.

1,292,465. Patented Jan. 28, 1919.

5 SHEETS—SHEET 4.

FIG. 4.



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AUTOMATIC TELEPHONE SYSTEM.

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5 SHEETS—SHEET 5.

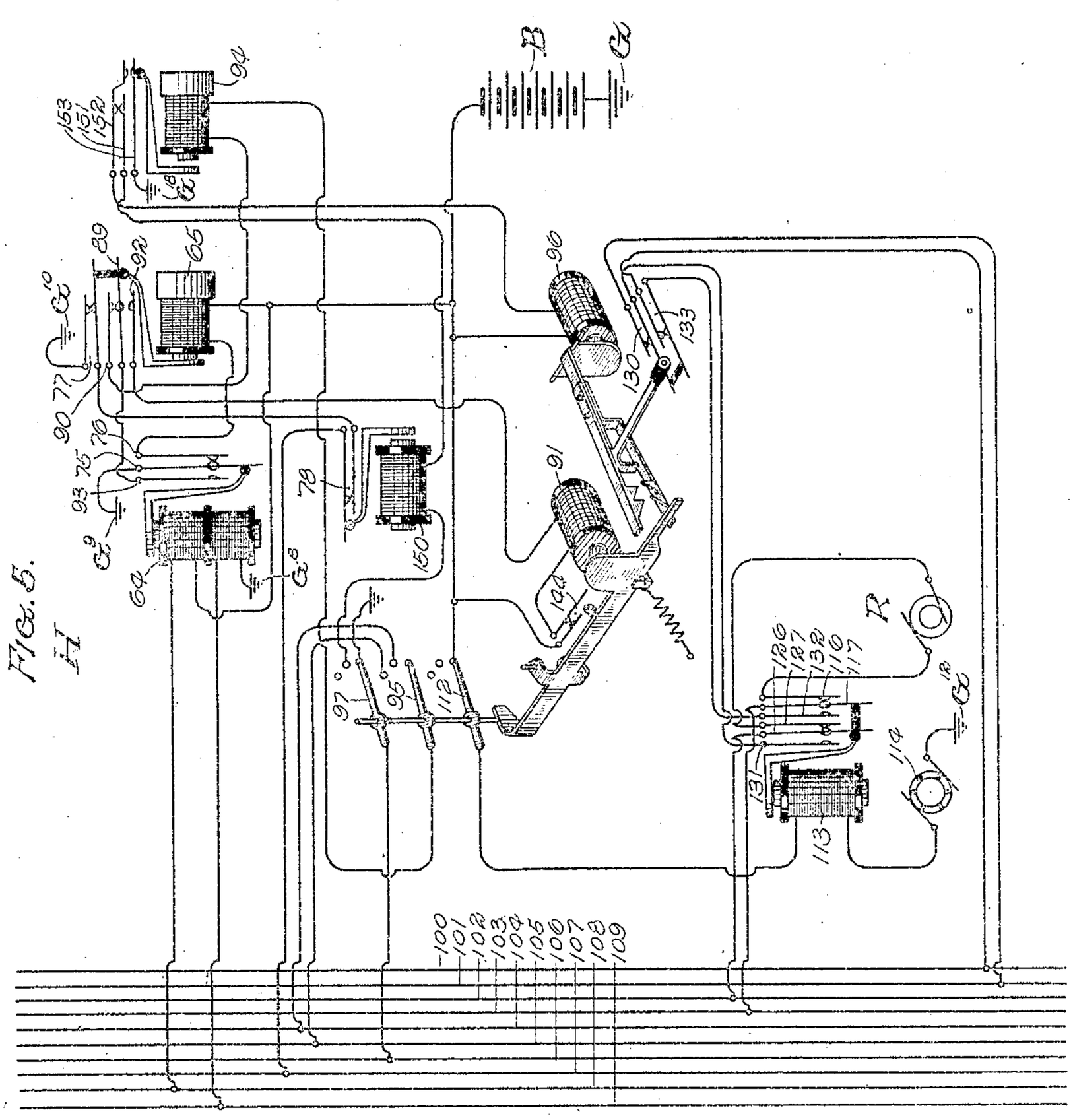

FIG. 5.

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UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

1,292,465. Specification of Letters Patent. Patented Jan. 28, 1919.

Application filed November 28, 1913, Serial No. 803,522. Renewed June 7, 1918. Serial No. 238,774.

To all whom it may concern:

Be it known that I, HARRY E. HERSHEY, a citizen of the United States of America, and resident of White Water, Butler county, Kansas, have invented certain new and useful Improvements in Automatic Telephone Systems, of which the following is a specification.

My invention relates to automatic telephone systems, and more particularly to the mechanism employed for completing a connection to a called line. Heretofore, in the well-known type of automatic system, this connection has been completed by means of a connector switch. These connectors are usually divided into groups and each connector is complete in itself.

The object of my invention is to simplify the construction of these connectors by having each group of connectors provided with one or more common mechanisms, which common mechanism includes certain of the elements heretofore individual to each connector. For instance, this common mechanism can include the usual side switch, line relay, private magnet, ringer relay and the busy relay, and whenever a connection is extended to a connector, this connector monopolizes one of these common devices and operates to extend the connection to the called line in the usual manner. As soon as the called subscriber answers, however, the connector releases this common mechanism and it is then in condition to be used by another connector of the group. In this manner it is possible to greatly simplify the construction of the connector switches themselves, and the amount of apparatus constituting any group of connector switches is greatly reduced.

These and other objects of my invention will be more clearly understood by reference to the accompanying drawings, in which I have illustrated the same in connection with an automatic system and switches of a well-known type.

In the drawings Figures 1, 2 and 3 show a complete connection between a calling substation A (Fig. 1) and a called substation A′ (Fig. 3) in a system embodying the principles of my invention. Fig. 4 shows a group of connectors F, F′, etc., with the auxiliary connectors H, H′, H², which are to be used by connectors F, etc. Above this group of connectors are shown the banks of the selectors E, E′, etc., only one level in each selector being shown. The first contact in the level of selector E leads to the connector F, which uses the auxiliary connector H. The first contact in level of selector E′ leads to the connector F², which uses the auxiliary connector H′. In a similar manner the first contact in level of selector E² leads to connector F⁴, which will use the auxiliary connector H². It has been found in practice that three auxiliary connectors allotted to ten connectors are sufficient. Auxiliary connector H is accessible to connectors F, F′, etc., while the auxiliary connector H′ is accessible to connectors F², F³, etc. This arrangement of auxiliary connectors taken in combination with the slip between selector banks above described provides for a minimum amount of rotation by a selector in hunting for an idle connector and the auxiliary connector associated therewith. Fig. 5 shows the mechanical structure of the auxiliary connector H shown in Fig. 2.

At A there is represented an automatic substation to the line conductors of which there is allotted at the central office an individual or line switch C. At D there is shown a master switch for controlling a group of the switches C. The line switches of this group have common access to a number of trunk lines which lead to first selector switches E. A number of first selectors have common access to a number of connector switches F and F′, by means of which connection may be completed with subscribers' lines. At H is shown an auxiliary connector which may control the operations of any number of connectors, such as the connectors F and F′, although only two are shown. Associated with the auxiliary connector H there is shown a ringing current generator R. At B a battery is shown having one terminal grounded and at Q a busy machine is represented.

The substation A shown herein may be of any suitable or approved type and comprises the usual receiver 2, transmitter 3, ringer 4 and condenser 5. Being an automatic substation it is also provided with an impulse transmitter or calling device, which is represented herein by a pair of impulse springs 6 and 7 and an impulse wheel 8, which latter is assumed to be controlled through the medium of a finger hole dial (not shown) in such a manner that the impulse springs 6

and 7 may be momentarily separated a number of times, corresponding to each digit of the number to be called.

The line switch C, which is associated with the line of substation A, is of the general type of line switch shown in British patent to James No. 26,301 of 1906, and more particularly of the type shown in British patent to T. G. Martin No. 1419 of 1910, the circuits being slightly modified to operate in a system embodying the principles of my invention. 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 two windings, namely, the pull-in winding 11 and the holding or cut-off winding 12. The winding 11 operates both the plunger arm 9 and the cut-off armature 15, while the winding 12 is only strong enough to operate the armature 15 and to hold the plunger arm 9 in an operated position after it has once been operated by the pull-in winding 11. The circuit of the pull-in winding 11 is controlled by the line relay 13 and the slow acting relay 14, both of which I prefer to make slow acting, *i. e.*, they are slow to deënergize after their energizing circuit has been broken. When the plunger arm 9 is operated, the plunger is forced into a bank of 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 selector switch E. Each trunk line is connected in multiple to the corresponding springs of all the switches of the group which is controlled by the master switch D. The line switch C is controlled 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, above referred to, 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.

The selector E is of the general type of selector disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, the circuits being modified in order to operate in a system in which the impulses are delivered over both sides of the line in series. Also, the private magnet 59 is controlled by the rotary magnet 61 electrically through the medium of the contact point 62, instead of mechanically as shown in the selector patent above referred to. Among other details, the selector E comprises a set of wipers 56, 57 and 58 carried upon a vertically and rotatably movable shaft (not shown). The vertical movement is controlled by the vertical magnet 54 and the rotary movement is controlled by the rotary magnet 61. The selector is directly controlled by means of the line relay 35. Means for permitting the switch to be restored to normal position are provided in the release magnet 146, which, upon energizing, withdraws the retaining pawls from the shaft. The springs 149 are permitted to close only when the switch shaft has been raised one or more steps from its lowest position. The relays 28 and 53 are slow acting relays, *i. e.*, they are slow to deënergize after their energizing circuits are broken.

The connector F is of the general type of connector switch disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, but has no side switch, and the circuits are modified in order to operate in a system in which the impulses are delivered over both sides of the line in series. The connector is provided with a shaft (not shown) which carries the wipers 98, 120 and 123 and is controlled by the vertical magnet 84 and the rotary magnet 85. The connector is provided with the so-called back-bridge relay 115, through which the called substation is provided with talking current. Means for permitting the switch to be restored to normal position are provided in the release magnet 87, which, upon energizing, withdraws the retaining pawls from the shaft. The springs 145 are permitted to close only when the switch shaft has been raised one or more steps from its lowest position.

The connector F' is similar to the connector F.

The auxiliary connector H, which is common to a plurality of connectors F, consists of a group of relays and the well-known side switch controlled by the private magnet 96 carrying the wipers 95, 97 and 112. The operations of the auxiliary connector are controlled by the line relay 64. At 113 is shown a ringer relay through the medium of which ringing current may be applied to the called line after connection is completed therewith. Means for restoring the side switch to normal position is provided in the release magnet 91. The springs 144 are permitted to close only when the side switch has moved from first position.

Having given a general description of the apparatus, I will now explain in detail the operations by which one subscriber establishes connection with another in a system embodying the principles of my invention. It will be explained how the substation A may obtain connection with the substation

A′, it being assumed that the number of the substation A′ is 222. It will also be explained how, if the called substation is busy, all of the apparatus is automatically released and returned to normal position, whereby the trunks and switches are kept from being made busy, while the calling subscriber is given a busy signal through the medium of his individual line switch C.

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 relay 13 of the line switch C. This circuit extends from ground G′ through the springs 38 and 39, conductor 40, through the substation A, conductor 41, through the springs 42 and 43 and through the line relay 13 to battery B. The line relay 13, upon energizing, operates to close the circuit of the pull-in winding 11. This circuit extends from ground G^2 through the springs 44 and 45, through the springs 46 and 47, through the pull-in winding 11 and the springs 48 and 49 to battery B. The pull-in winding 11 operates to cause the armature 15 to force the springs 38 and 43 out of engagement with the springs 39 and 42, respectively, and also operates to force the plunger on the plunger arm 9 into the bank of contacts 16 to 23, inclusive. The disengagement of the springs 38 and 43 from the springs 39 and 42 opens the circuit of the line relay 13. The line relay 13 being slow acting does not fall back immediately, however, but causes the plunger arm 9 to be held in an operated position until a holding ground is supplied to the holding winding 12 from the selector E. The engagement of the springs 16 and 19 with the springs 20 and 23, respectively, extends the subscriber's line to the line relay 35 of the selector E. This circuit is from ground G^3 through the lower winding of the relay 35, through the springs 24 and 25, through the springs 23 and 19, conductor 40 to and through the substation A, conductor 41, through the springs 16 and 20, through the springs 26 and 27 and the upper winding of the relay 35 to battery B. The relay 35, upon energizing, closes the circuit of the relay 28 from ground G^4 through the springs 29 and 30 and through the relay 28 to battery B. The relay 28, upon energizing, closes a circuit for the holding winding 12 and the relay 14 of the line switch C, said circuit being from ground G^5 through the springs 31 and through the springs 21 and 17, at which point the circuit divides, one part continuing through the holding winding 12 to battery B. The other part of said circuit continues from the spring 17 through the springs 32 and 33 (which are closed at this time by the plunger arm 9) and through the relay 14 to battery B. The relay 14, upon energizing, extends a guarding potential to the private bank contacts associated with the line switches C over the following path: From ground G^6 through the springs 34 and 36 to the private bank contact 37. The relay 28, upon energizing, also prepares the circuit of the vertical magnet 54 and opens the circuit of the release magnet 146 at the springs 147 and 51.

The calling subscriber now operates his calling device for the first digit 2, which momentarily separates the impulse springs 6 and 7 twice. Each time these springs are separated, the first selector line relay 35 deënergizes. Since the relay 28 is a relay which is slow to deënergize, its armature does not have time to fall back during the momentary interruptions of its circuit by the line relay 35. Therefore, each time the relay 35 deënergizes, a circuit is closed through the vertical magnet from ground G^4 through the springs 29 and 50, through the springs 51 and 52, relay 53, vertical magnet 54 and the side switch wiper 55 (in first position) to battery B. The two impulses received by the vertical magnet 54 cause it to raise the shaft wipers 56, 57 and 58 two steps to a position opposite the second row or level of bank contacts. The slow acting relay 53, which is included in the operating circuit of the vertical magnet, closes a circuit through the private magnet 59 at the first vertical impulse and keeps it closed until after the last impulse for the digit is transmitted. Said circuit extends from ground G^7 through the springs 60 and the private magnet 59 to battery B. The relay 53, upon deënergizing, breaks the circuit of the private magnet, which in turn deënergizes and permits the side switch to pass to second position. In second position the side switch wiper 55 completes a circuit through the rotary magnet 61. The side switch remains in second position and causes the rotary magnet to operate in a manner similar to that of a buzzer to rotate the wipers step by step over the bank contacts of the second level until the wipers reach the contacts of an idle trunk line, whereupon the side switch passes to third position. The movement of the side switch wiper 55 from second to third position, besides breaking the circuit of the rotary magnet, closes the circuit of the line-switching relay 63. This circuit extends from ground G^5 through the springs 31, relay 63 and through the side switch wiper 55 (in third position) to battery B. The relay 63, upon energizing, disconnects the line relay 35 from the line and extends the line connection through the line wipers 56 and 58 to the connector F, whereupon the line relay 64 of the auxiliary connector H becomes energized over the following circuit: from ground G^8 through the lower winding of the relay 64, conductor 109, springs 66 and 67 of the relay 68 of the

connector F, bank contact 69, line wiper 58, springs 70 and 25, springs 23 and 18, conductor 40 to and through the substation A, conductor 41, springs 16 and 20, springs 26 and 71, line wiper 56, bank contact 72, springs 73 and 74, conductor 108 and the upper winding of the relay 64 to battery B. The energization of the relay 64 causes a circuit to be closed through the relay 65, said circuit extending from ground G^9 through the springs 75 and 76 and the relay 65 to battery B. The energization of the relay 65 affords a holding circuit for the relay 63 of the selector E and for the relay 14 and holding winding 12 of the line switch C to take the place of ground G^5, which an instant later is removed by the deënergization of the relay 28. Said circuit extends from ground G^{10} through the springs 77, springs 78, conductor 107, relay 79, springs 80 and 81, contact 82, private wiper 57 and the side switch wiper 83 (in third position), at which point the circuit divides, a part continuing through the relay 63 and the side switch wiper 55 (in third position) to battery B. Returning to the side switch wiper 83 (in third position), the other branch of the circuit extends through the springs 21 and 17, at which point the circuit again divides, a part passing through the holding winding 12 to battery B, the other part passing through the springs 32 and 33 and the relay 14 to battery B. The energization of the relay 79 in the connector F places battery upon the vertical and rotary magnets 84 and 85, respectively, at the springs 86, at the same time opening the circuit of the release magnet 87 at the springs 88. The ground upon the bank contact 82 makes all the multiples of the trunk leading to the connector F busy, and it will be readily seen that the ground placed upon the conductor 107 makes the private bank contacts of all the connectors associated with the auxiliary connector H busy, in this way insuring that none of them will be seized while the auxiliary connector H is engaged in putting a call through one of them. The energization of the relay 65 also prepares a circuit for the vertical magnet 84 by means of the springs 89 and 90 and opens the circuit of the release magnet 91 at the springs 92 and 89.

The calling subscriber now operates his calling device for the second digit 2, momentarily separating the impulse springs 6 and 7 twice, each time breaking the circuit of the auxiliary connector line relay 64. Since the relay 65 of the auxiliary connector is slow acting it does not have time to deenergize during the momentary opening of its circuit by the relay 64. Consequently each time the relay 64 deënergizes, a circuit is completed from ground G^9 through the springs 75 and 93, springs 89 and 90, relay 94, side switch wiper 95 (in first position), conductor 105, vertical magnet 84 and the springs 86 to battery B. It will be readily seen that the ground on the conductor 105 does not form a circuit through the vertical magnet of other connectors associated with the auxiliary connector H, for the reason that the relay in said connectors, corresponding to the relay 79 of the connector F, is not energized. The relay 79 and its duplicate are marginal relays. Should a selector pass over the busy private contact of the connector F', the relay 79 in the connector F' will not be operatively energized, for it will be in series with the private magnet of said selectors. However, the relays 79 will be operatively energized when in a circuit in which they receive battery current through the relay 63, relay 14 and the holding winding 12 in multiple, as shown at the connector F. The vertical magnet 84 receives two impulses over this circuit and operates to raise the shaft wipers of the connector F two steps. The slow acting relay 94, which is included in the operating circuit of the vertical magnet, closes a circuit through the private magnet 96 and keeps it closed until after the last impulse for the digit is transmitted, said circuit extending from ground G^{13} through the springs 153 and 152 and the private magnet 96 to battery B. The relay 94, upon deënergizing, breaks the circuit of the private magnet 96, which in turn deënergizes and permits the side switch to pass to second position. The movement of the side switch wiper 95 from first to second position transfers the operating circuit from the vertical magnet 84 to the rotary magnet 85.

The operation of the substation calling device for the last digit breaks the energizing circuit of the relay 64 twice. Each time the relay 64 deënergizes it completes a circuit from ground G^9 through the springs 75 and 93, springs 89 and 90, relay 94, side switch wiper 95 (in second position), conductor 104, rotary magnet 85 and the springs 86 to battery B. The rotary magnet 85 receive two impulses over this circuit and operates to rotate the wipers two steps onto the contacts of the line number 322. The private magnet relay 94 operates in the same manner as for the previous digit to operate the private magnet 96 and thus cause the side switch to pass to third position after the last impulse for the digit is transmitted. It will readily be seen that, while the shaft wipers are being rotated over the bank contacts, the back-bridge relay 115 is removed from the line wipers by means of springs controlled by the private magnet 96. The side switch wiper 97 (in third position) extends a guarding potential from ground G^{14} through the private wiper 98 to the connector private bank contacts of the called

line, and also provides an energizing circuit for the holding winding 12′ of the line switch C′. The circuit extends from ground G^{11} through the side switch wiper 97 (in third position), conductor 106, springs 110 and 111, private wiper 98, private bank contact 99, springs 160 and 161 and the holding winding 12′ to battery B. The winding 12′, upon energizing, attracts the armature 15′, which operates to disconnect the switch C′ from the called line. When the side switch wiper 112 reaches third position, an energizing circuit is established for the ringer relay 113. This circuit extends from ground G^{12} through the ringing interrupter 114, relay 113 and the side switch wiper 112 (in third position) to battery B. Since this circuit includes the interrupter 114, the relay 113 is energized only intermittently. Each time the relay 113 is energized it operates to disconnect the calling line from the called line and to bridge the generator R across the called line. A circuit may be traced from one side of the generator R through the springs 116 and 117, conductor 103, springs 125 and 124, line wiper 123, bank contact 122, conductor 41′, condenser 5′, ringer 4′, conductor 40′, bank contact 121, line wiper 120, springs 119 and 118, conductor 102 and the springs 126 and 127 to the other side of the generator R. When the called subscriber removes his receiver, or as soon thereafter as the relay 113 deënergizes, if it happens to be energized at the time, the called substation is provided with talking current over a circuit extending from ground G^{13} through the right-hand winding of the relay 115, springs 128 and 129, conductor 101, springs 130, springs 131 and 126, conductor 102, springs 118 and 119, line wiper 120, bank contact 121, conductor 40′ to and through the substation A′, conductor 41′, bank contact 122, line wiper 123, springs 124 and 125, conductor 103, springs 117 and 132, springs 133, conductor 100, springs 135 and 134 and the left-hand winding of the relay 115 to battery B. All the springs upon the relay 115 are adjusted to close their make contacts before any break contacts are opened for this reason: When the relay 115 is energized over the above circuit its armature, upon assuming an operated position, completes a circuit from ground G^{13} through the right-hand winding of the relay 115, springs 128 and 136, line wiper 120, bank contact 121, conductor 40′ to and through the substation A′, conductor 41′, bank contact 122, wiper 123, springs 137 and 134 and the left-hand winding of the relay 115 to battery B. As a result, the relay 115 continues to be energized. The closing together of the springs 138 upon the energization of the relay 115 completes a circuit from ground G^{14} through the springs 138, springs 139 and the left-hand winding of the relay 68 to battery B. The springs 139 are adjusted to remain in contact until the armature of the relay 68 is entirely pulled down. A circuit is then formed from ground G^{15} through the right-hand winding of the relay 68, springs 163 and 73, bank contact 72, line wiper 56, springs 71 and 26, springs 20 and 16, conductor 41 to and through the substation A, conductor 40, springs 19 and 23, springs 25 and 70, line wiper 58, bank contact 69, springs 67 and 140 and the left-hand winding of the relay 68 to battery B. For this reason the relay 68 entirely energizes, and it will be seen that the flow of current through the substation A has been reversed. Also, the energization of the relay 68 places ground upon the private wiper 98 from ground G^{16} through the springs 111 and 141 before the ground from ground G^{11} is cut off at the spring 110. Also, the spring 81 is adjusted to make contact with the spring 142 before it breaks contact with the spring 80. The engagement of the spring 142 with the spring 81 places the ground G^{16} upon the release trunk to afford a holding circuit for the relay 63 of the selector E and the relay 14 and winding 12 of the line switch C in place of ground G^{10}. The engagement of the spring 142 with the spring 81 also shunts out the relay 79, whose circuit is opened when the spring 81 disengages from the spring 80. The relay 79, upon deënergizing, opens the circuit of the vertical and rotary magnets at the springs 86, and also closes the release circuit at the springs 88, but the release does not take place at this time, for the circuit is now open at the springs 143. The energization of the relay 68 also opens the circuit of the line relay 64 of the auxiliary connector H. The line relay, upon deënergizing, opens the circuit of the relay 65. The relay 65 in turn, upon deenergizing, energizes the release magnet 91 over a circuit extending from ground G^{9} through the springs 75 and 93, springs 89 and 92, release magnet 91 and the off-normal springs 144 to battery B. The release magnet, upon energizing, restores the side switch to normal position, its own circuit being opened at the off-normal springs 144 when the side switch reaches first position. The deënergization of the relay 65 also removes the ground G^{10} from the private bank contacts of all the idle connectors associated with the auxiliary connector H, whereupon it is in position to receive another call from any of said connectors.

Upon the completion of the conversation, the restoring of the receiver at the substation A opens the circuit of the relay 68 of the connector F. The deënergization of the relay 68 closes a circuit through the release magnet 87 as follows: from ground G^{17} through the springs 88, springs 143, release magnet 87 and the off-normal springs 145 to battery

B. The release magnet 87, upon energizing, withdraws the retaining pawls from the shaft and its own circuit is opened by the springs 145 when the shaft has reached its lowest position. The deënergization of the relay 68 also causes the ground G^{16} to be removed from the circuit of the relay 63, relay 14 and the winding 12. The relay 63, upon deënergizing, completes a circuit through the release magnet 146 extending from ground G^4 through the springs 29 and 50, springs 51 and 147, springs 148, off-normal springs 149 and the release magnet 146 to battery B. The release magnet 146, upon energizing, withdraws the retaining pawls from the shaft and its own circuit is broken by the springs 149 when the shaft reaches its lowest position. The deënergization of the winding 12 allows the plunger arm 9 to withdraw the plunger from the bank of contacts. The deënergization of the relay 14 removes ground G^6 from the private bank contacts associated with the line switch C.

It having been explained how one subscriber establishes connection and releases the same, it will now be explained how a connection is prevented from being made with a busy line, how the calling subscriber's line switch is released and how the calling subscriber receives a busy signal through his own individual switch. If the called number is busy there will be a guarding potential upon the connector private bank contact, just as explained in connection with the line switch. The connector private wiper 98, upon engaging this guarding contact, and before the side switch wipers have passed to third position, completes a circuit through the relay 150. This circuit extends from ground at the private bank contact through the private wiper 98, springs 111 and 110, conductor 106, side switch wiper 97 (in second position), relay 150, springs 151 and 152 and the private magnet 96 to battery B. The energization of the relay 150 removes the holding circuit for the relay 63, relay 14 and the winding 12 by opening the springs 78. The relay 63, upon deënergizing, will release the selector E, as previously explained. The relay 79 will no longer be in circuit with the relays 63 and 14 and the winding 12, whereupon it deënergizes and causes the release of the connector F, as previously explained. The release of the selector E opens the circuit of the line relay 64 and the release of the auxiliary connector follows, as previously explained. The winding 12, upon deënergizing, allows the armature 15 to fall back and the springs 38 and 43 to make contact with the springs 39 and 42, respectively. The plunger arm 9 withdraws the plunger from the bank of contacts 16 to 23, inclusive. The springs 38 and 43 making contact with the springs 39 and 42 close a circuit through the relay 13 of the line switch C. The line relay 13, upon energizing, completes a holding circuit for the relay 14. The said circuit extends from ground G^2 through the springs 44 and 45, springs 46 and 154 and the relay 14 to battery B. The relay 14 remains energized over the above traced circuit and retains the circuit of the pull-in winding 11 open at the springs 46 and 47. The line switch C is thus prevented from tripping and the cut-off armature 15 is prevented from operating. A busy signal is transmitted to the calling subscriber over a circuit extending from the busy machine Q through the springs 155 and 156, springs 43 and 42, conductor 41 to and through the substation A, conductor 40 and the springs 39 and 38 to ground G' and back to the busy machine Q. The subscriber, upon receiving the busy signal, replaces his receiver upon the receiver hook. The replacing of the receiver upon the receiver hook allows the switch-hook springs to separate, which action opens the circuit of the line relay 13, which allows the line switch C to return to normal.

It will be seen, therefore, that each connector has been stripped of the usual side switch, the line relay, private magnet, ringer relay, and busy relay. Instead there are provided devices common to each group of connectors which are supplied with similar details to take the place of the parts that have been removed from the individual connectors. Each time that a call goes through to a connector, the connector operates to monopolize one of these common devices during the period of operation of the last two digits, through the medium of which the wipers of the connectors are advanced into engagement with the called line. As soon as the called subscriber answers the connector releases the common mechanism leaving it accessible to some other connector for the same purpose. As has been explained, when a call comes through, for example, from the selector E, and assuming that the wipers of this selector stop on the first contact, it will establish connection with the first connector F. This connector will then appropriate for its temporary use the first auxiliary device H. The first auxiliary device, as illustrated in the particular arrangement of the drawings, is accessible only to the first, fourth, etc. connectors. The second auxiliary device is accessible to the second, fifth and so on connectors, and the third auxiliary device to the third, sixth and so on connectors. Now when the first connector appropriates the first auxiliary device to its use it operates to make that auxiliary device busy to all other selectors. It will be seen that this can be done by putting a guarding potential on the banks of the selectors, so that when the first connector is seized the first auxiliary

device operates to make not only the first connector busy in the selector banks, but also and at the same time it operates to make the fourth and other similar connectors which have access to the first auxiliary device busy at the selector banks. It will be seen that normally all of the connectors that have access to an auxiliary device are connected to it, which auxiliary device when brought into operation, sends impulses back which would operate all of the connectors which are associated with a device, were there a selector switch connected with each one of these connectors.

It will thus be seen that I have devised a very efficient arrangement by which the present complicated connectors can be greatly simplified and in which it is merely necessary to supplement a group of these simplified connectors with a less number of auxiliary devices. As these auxiliary devices are only in use during the operation of the connector and until the called subscriber answers, but are not tied up during the conversation, it will be readily seen that the number can be much less than the number of connectors in any group. In practice it is found that about three of these auxiliary devices are sufficient to take care of a group of ten connectors.

While I have illustrated and described one particular embodiment of my invention, and have shown the same in connection with well-known forms of automatic switches, it will, of course, be understood that various changes and modifications can be made without in any way departing from the spirit of my invention.

What I claim as my invention is:—

1. In a telephone system, a plurality of subscribers' lines, a group of connectors adapted to establish connection with said lines, and a mechanism common to a plurality of said connectors, said common mechanism being adapted to operate the shaft and wipers for establishing connection with a line, and being then adapted to be disconnected from said connector as soon as the called subscriber answers.

2. In a telephone system, a plurality of subscribers' lines, a group of connectors adapted to establish connection with said lines, a mechanism common to a plurality of said connectors, said common mechanism being adapted to operate the shaft and wipers for establishing connection with a line, and being then adapted to be disconnected from said connector as soon as the called subscriber answers, and means by which said common mechanism can make busy all other connectors which have access to the same.

3. In a telephone system, a group of connector switches without line relays and ringer relays, and a mechanism common to said connectors including line relays and ringer relays, said common mechanism adapted to be monopolized by one of said connectors during operation thereof.

4. In a telephone system, a group of connector switches, each connector being without line relays and ringer relays, and common mechanisms less in number than the connectors, without the provision of shaft and wipers for operating the connector shaft and wipers, said common mechanisms including a line relay and ringer relay, and each common mechanism being adapted to be made individual to a connector during operation thereof.

5. In a telephone system, a plurality of lines, a step by step trunking switch for each line, a relay connected to receive impulses from any one of said lines for operating the switch associated therewith.

6. In a telephone system, a plurality of lines, a trunking switch for each line, a relay connected to receive impulses from any one of said lines for operating the switch associated therewith for extending a circuit to another line, a signal for said other line, and a source of signaling current individual to said relay and controlled therethrough to signal said other line.

7. In a telephone system, a plurality of lines, a trunking switch for each line, another line, a relay associated with said first lines to receive impulses from any one of said first lines for operating the switch associated therewith to extend a connection to said other line, a signal for said other line, and a source of signaling current associated with said relay and controlled by said relay for operating said signal.

8. In a telephone system, a plurality of lines, a trunking switch for each line, another line, a relay associated with said first lines to receive impulses from any one of said first lines for operating the switch associated therewith to extend a connection to said other line, a signal for said other line, a source of signaling current associated with said relay and controlled by said relay for operating said signal, a release circuit controlled over the said other line, release equipment in said release circuit associated with said relay, said release equipment controlled over said other line to disassociate said relay from one of said first lines.

9. In a telephone system, a plurality of lines, a trunking switch for each line, a relay associated with said lines to receive impulses from any one of said lines for operating the switch associated therewith, a plurality of other trunking switches having access in common to said lines, a busy test circuit for said lines, a source of guarding potential, said relay controlling said source for applying a guarding potential to said busy test circuit whenever one of said other trunk-

ing switches establishes connection with one of said lines, whereby said lines are made inaccessible to the remaining of said other switches.

10. In a telephone system, a plurality of trunking switches, a plurality of lines accessible to said switches, an auxiliary trunking switch for each one of said lines, a relay associated with said auxiliary switches to receive impulses from any one of said lines for operating the auxiliary switch associated therewith, a busy test circuit for said lines, a source of guarding potential, said relay controlling said source for applying a guarding potential to said busy test circuit whenever one of said trunking switches establishes connection with one of said lines, whereby said lines are made inaccessible to the remaining of said trunking switches.

11. In a telephone system, a plurality of trunking switches, a plurality of lines accessible in common to said switches, an auxiliary switch for each one of said lines, another line accessible to said auxiliary switches, a relay associated with said first lines for receiving impulses from any one of said lines for operating the auxiliary switch associated therewith for extending a circuit to said other line, a busy test circuit for said lines, a source of guarding potential, said source under the control of said relay to apply the same to the test circuit for establishing a guarding potential therein whenever one of said trunking switches establishes a connection with one of said first lines, whereby said lines are made inaccessible to the remaining of said trunking switches, a signal for said other line, a source of signaling current associated with said relay and controlled by said relay for operating said signal, a release circuit under the control of said other line, said release circuit having associated therewith release equipment for controlling said relay to disassociate said relay from one of said first lines.

12. In a telephone system, a plurality of trunking switches, a plurality of lines accessible in common to said switches, an auxiliary switch for each one of said lines, another line accessible to said auxiliary switches, a relay associated with said first lines for receiving impulses from any one of said lines for operating the auxiliary switch associated therewith for extending a circuit to said other line, a busy test circuit for said lines, a source of guarding potential, said source under the control of said relay to apply the same to the test circuit for establishing a guarding potential therein, whenever one of said trunking switches establishes a connection with one of said first lines, whereby said lines are made inaccessible to the remaining of said trunking switches, a signal for said other line, a source of signaling current associated with said relay and controlled by said relay for operating said signal, a release circuit under the control of said other line, said release circuit having associated therewith release equipment for controlling said relay to disassociate said relay from one of said first lines, and for removing said test potential from the remaining said first lines.

13. In a telephone system, a plurality of trunking switches, a plurality of lines accessible in common to said switches, an auxiliary switch for each one of said lines, another line accessible to said auxiliary switches, a relay associated with said first lines for receiving impulses from any one of said lines for operating the auxiliary switch associated therewith for extending a circuit to said other line, a busy test circuit for said lines, a source of guarding potential, said source under the control of said relay to apply the same to the test circuit for establishing a guarding potential therein, whenever one of said trunking switches establishes a connection with one of said first lines, whereby said lines are made inaccessible to the remaining of said trunking switches, a signal for said other line, a source of signaling current associated with said relay and controlled by said relay for operating said signal, a release circuit under the control of said other line, said release circuit having associated therewith release equipment for controlling said relay to disassociate said relay from one of said first lines and for removing said test potential from the remaining said first lines, and for maintaining a test potential over the line from which the relay is disassociated.

14. In a telephone system, subscribers' lines, a plurality of trunk lines, a trunking switch for each trunk line, means for connecting one of said subscribers' lines with one of said trunk lines, a relay connected to receive impulses from said subscribers' lines over any one of said trunk lines for operating the switch associated therewith to connect with another one of said subscribers' lines.

15. In a telephone system, a plurality of trunk lines each terminating in an automatic switch, common conductors normally connected to said trunk lines in multiple, and a controlling relay for said switches in bridge of said conductors.

16. In a telephone system, a plurality of trunk lines each terminating in an automatic switch, a relay normally connected to said trunk lines in multiple, and means for bringing said switches successively under the control of said relay.

17. In a telephone system, a plurality of trunk lines normally connected in multiple

and terminating in a common relay, an automatic switch associated with each trunk line, means for extending a calling line to an idle trunk line, and means for then bringing the switch associated therewith under the control of said relay.

18. In a telephone system, a plurality of automatic switches, operating magnets for said switches, multiple connections from one terminal of each magnet to a common conductor, a battery, and a common relay for controlling the connection of said battery to said conductor.

19. In a telephone system, a plurality of automatic switches, operating magnets for said switches, multiple connections from one terminal of each magnet to a common conductor, a battery, a common relay for controlling the connection of said battery to said conductor, and means for connecting the other terminals of said magnets to said battery separately.

20. In a telephone system, a plurality of automatic switches, an operating magnet in each switch, a battery, common means adapted to connect one pole of said battery to all of said magnets in multiple, and a plurality of individual means, one in each switch, adapted to connect the other pole of said battery to said magnets separately.

21. In a telephone system, a plurality of lines, a plurality of automatic switches having common access to said lines, an operating magnet for each switch, a battery, common means for controlling the application of one pole of said battery to all of said magnets in multiple, and a plurality of individual means, one for each switch, for connecting the other pole of said battery to said magnets separately.

22. In a telephone system, a plurality of lines, a plurality of automatic switches having common access to said lines, an operating magnet for each switch, multiple connections from one terminal of each magnet to a common conductor, a source of operating current, and a relay for controlling the application of said source to said conductor.

23. In a telephone system, a subscriber's line, a plurality of connector switches, a set of wipers for each switch, means for operating any switch to bring its wipers into engagement with said line, a pair of common conductors normally connected to said wiper sets in multiple, a source of ringing current, and means for connecting said conductors with said source.

24. In a telephone system, a plurality of connector switches for completing connection between calling and called lines, means for extending a calling line to an idle one of said switches, and a relay common to said switches and operable over the extended calling line to control the switch to which said line has been extended to connect with a called line.

25. In a telephone system, a plurality of connector switches for completing connection between calling and called lines, means for extending a calling line to an idle one of said switches, a relay common to said switches and operable over the extended calling line to control the switch to which said line has been extended to connect with a called line, and means under the control of said relay for rendering the remainder of said switches inaccessible to other calling lines.

26. In a telephone system, a plurality of connector switches for completing connection between calling and called lines, means for extending a calling line to an idle one of said switches, a relay common to said switches and operable over the extended calling line to control the switch to which said line has been extended to connect with a called line, means under the control of said relay for rendering the remainder of said switches inaccessible to other calling lines, and means controlled over the connected called line for again rendering the remainder of said switches accessible to other calls.

27. In a telephone system, a plurality of connector switches for completing connections between calling and called lines, means for extending a calling line to an idle one of said switches, a relay common to said switches and operable over the extended calling line, and means for bringing the switch to which said line has been extended under the control of said relay whereby said switch may be operated to connect with a called line.

28. In a telephone system, a plurality of connector switches for completing connections between calling and called lines, means for extending a calling line to an idle one of said switches, a relay common to said switches and operable over the extended calling line, means for bringing the switch to which said line has been extended under the control of said relay whereby said switch may be operated to connect with a called line, and means for rendering the remaining switches busy during the operation of any one of them.

29. In a telephone system, a plurality of connector switches for completing connections between calling and called lines, means for extending a calling line to an idle one of said switches, a relay common to said switches and operable over the extended calling line, means for bringing the switch to which said line has been extended under the control of said relay whereby said switch may be operated to connect with a called line, means for rendering the remaining

any one of them, and means whereby after the connection to the called line is completed said relay is reverted to common use and the remaining switches are rendered accessible to other calls.

30. In a telephone system, a plurality of connector switches, an individual controlling relay for each switch, means for extending a calling line to an idle one of said switches, a common controlling relay for said switches normally connected to the calling line when so extended, said common relay adapted to control the operation of any switch to which connection has been extended, and means whereby after a switch is operated the calling line is shifted to the individual controlling relay to maintain the said switch in operated position.

31. In a telephone system, a plurality of trunk lines each terminating in an automatic switch, a busy test circuit for each trunk line, a common conductor normally connected to said circuits in multiple, a relay, means whereby said relay is enabled to operate said switches in succession, means controlled by said relay for connecting a source of busy potential to said conductor during the operation of any switch, and means whereby after any switch is operated the busy potential is removed from said conductor and the test circuit associated with the operated switch is disconnected from said conductor and connected to said source at another point.

32. In a telephone system, subscribers' lines, a plurality of trunk lines each terminating in an automatic switch, means for connecting any one of said subscribers' lines when calling with an idle one of said trunk lines and a relay connected to receive impulses from any connected line via the connected trunk line to operate the switch associated therewith.

33. In a telephone system, a plurality of automatic trunking switches, a lesser plurality of auxiliary controlling switches for said trunking switches, and means controllable by a calling subscriber for simultaneously selecting for use an idle trunking switch and an idle auxiliary switch.

34. In a telephone system, a plurality of automatic trunking switches, a lesser plurality of auxiliary controlling devices, operating magnets in each trunking switch, relays in said auxiliary devices for controlling said magnets, and means controlled by a calling subscriber for simultaneously selecting for use an idle trunking switch and an idle auxiliary device.

35. In a telephone system, a plurality of automatic trunking switches divided into groups, an auxiliary controlling mechanism for the switches of each group, and means controllable by a calling subscriber for selecting an idle mechanism and an idle trunking switch of the associated group simultaneously.

36. In a telephone system, a plurality of automatic trunking switches divided into groups, an auxiliary controlling mechanism for the switches of each group, means controllable by a calling subscriber for selecting an idle mechanism and an idle trunking switch of the associated group simultaneously, and automatic means for rendering the remaining trunking switches of the selected group unselectable.

37. In a telephone system, a plurality of groups of trunk lines each terminating in an automatic switch, an auxiliary controller for the automatic switches in each group, another automatic switch, and fixed terminals of said trunk lines in said last switch arranged in such order that adjacent terminals belong to trunk lines of different groups.

38. In an automatic telephone system, a plurality of groups of trunk lines each of which terminates in an automatic switch, sub-divisions of said groups, an auxiliary controller for the automatic switches of each sub-division, another automatic switch, and groups of fixed terminals for the said groups of trunk lines in said last switch, the terminals of each group being so arranged that adjacent terminals belong to trunk lines of different subdivisions.

39. In a telephone system, a temporarily established connection including a calling line, an automatic progressively movable switch, and a called line, a test circuit for rendering the said switch busy, a second test circuit for rendering the called line busy, and a relay maintained energized over the connected calling line to connect a source of potential to said test circuits.

40. In a telephone system, means for connecting a calling and a called line including an automatic connector switch, movable line terminals in said connector for completing the connection, a ringing relay, a double wound relay having one terminal of each winding connected to opposite poles of a battery, connections from the other terminals of said windings extending by way of contacts on the said ringing relay to said line terminals whereby said double wound relay may be energized upon the response of the called subscriber, and contacts controlled by said double wound relay when the same is energized effective to directly connect the said line terminals to the said other terminals of said windings.

41. In a telephone system, the combination with a called telephone line and a plurality of connector switches, each switch being provided with a movable test terminal for testing the said line, of a test relay connected in multiple to all of said test ter-

minals, means for operating one of said switches to connect with said lines, and means for energizing said relay if the said line is busy.

42. In a telephone system, the combination with a called telephone line and a plurality of connector switches, each switch being provided with a movable test terminal for testing the said line, of a test relay connected in multiple to all of said test terminals, means for operating one of said switches to connect with said line, means for energizing said relay if the said line is busy, and means controlled by said relay for releasing the operated switch.

43. In a telephone system, the combination with a called telephone line and a plurality of connector switches, of means for operating any one of said switches to connect with said line, and a common test relay responsive to the busy condition of said line when any one of said switches is so operated.

44. In a telephone system, the combination with a called telephone line and a plurality of connector switches, of means for operating any one of said switches to connect with said line, a common test relay responsive to the busy condition of said line when any one of said switches is so operated, and means controlled by the said test relay for releasing the operated switch.

45. In a telephone system, the combination with a calling and a called line, of connecting means comprising a plurality of connector switches, means for operating any one of said switches over the calling line to connect with the called line, and a common test relay responsive to the busy condition of said called line when any one of said switches is so operated.

46. In a telephone system, the combination with a calling and a called line, of connecting means comprising a plurality of connector switches, means for operating any one of said switches over the calling line to connect with the called line, a common test relay responsive to the busy condition of said called line when any one of said switches is so operated, and means controlled by said relay for releasing the operated switch.

47. In a telephone system, the combination with a calling and a called line, of connecting means comprising a plurality of connector switches, means for operating any one of said switches over the calling line to connect with the called line, a common test relay responsive to the busy condition of said called line when any one of said switches is so operated, means controlled by said relay for releasing the operated switch, and means for then giving the called subscriber a busy signal.

48. In a telephone system, a plurality of subscribers' lines, means including a plurality of progressively movable switches for establishing connection between two of said lines, said switches being divided into groups, and a common mechanism for controlling the operation of a group of said switches one at a time without moving the others, said common mechanism being normally at rest.

49. In a telephone system, a plurality of subscribers' lines, means including a plurality of progressively movable switches for establishing connection between two of said lines, said switches being divided into groups, a common mechanism for controlling the operation of a group of said switches one at a time without moving the others, said common mechanism being normally at rest, and a magnet individual to each switch for controlling a circuit therethrough.

50. In a telephone system, a plurality of subscribers' lines, means including a plurality of progressively movable switches for establishing connection between two of said lines, said switches being divided into groups, a common mechanism for controlling the operation of a group of said switches, said common mechanism controlled over any of said lines, and a magnet individual to each switch for controlling the operation thereof.

51. In a telephone system, a plurality of incoming lines each terminating in an automatic switch, a plurality of outgoing lines accessible to said switches, and a device common to all of said lines and operable in response to impulses transmitted over any incoming line to direct the movement of the switch associated therewith to connect with an outgoing line.

52. In a telephone system, a plurality of incoming lines, each terminating in an automatic switch, a plurality of outgoing lines accessible to said switches, a device common to all of said lines and operable in response to impulses transmitted over any incoming line to direct the movement of the switch associated therewith to connect with an outgoing line, and means for restoring said device to normal position after each operation while leaving the operated switch and the outgoing line connected.

53. In a telephone system, a plurality of numerical switches, a common controlling mechanism for operating any one of said switches, and means for preventing a second switch from being brought into use when one of said switches is being operated.

54. In a telephone system, an automatic switch having mechanically distinct controlling and connecting means, lines accessible to said switch, means for bringing said connecting means under the control of said con-

trolling means whereby connection may be established with one of said lines, and means for restoring said controlling means to normal position thereafter without destroying said connection.

55. In a telephone system, an automatic switch having movable connective terminals, lines accessible to said terminals, a directive impulse controlled mechanism for moving said terminals into connection with one of said lines, and means for releasing said mechanism thereafter without destroying said connection.

56. In a telephone system a plurality of trunk lines each terminating in an automatic switch, a relay normally connected to said trunk lines in multiple and mechanism responsive to calling lines for bringing said switches successively under the control of said relay.

57. In a telephone system, a plurality of automatic switches, operating magnets for said switches, multiple connections from one terminal of each magnet to a common conductor, a battery, a common relay for controlling the connection of said battery to said conductor, and relays for connecting the other terminals of said magnets to said battery separately.

58. In a telephone system, a plurality of automatic switches, an operating magnet in each switch, a battery, a common relay adapted to connect one pole of said battery to all of said magnets in multiple, and a plurality of individual relays, one in each switch, adapted to connect the other pole of said battery to said magnet separately.

59. In a telephone system, a subscriber's line, a plurality of connector switches, a set of wipers for each switch, means for operating any switch to bring its wipers into engagement with said line, a pair of common conductors normally connected to said wiper sets in multiple, a source of ringing current, and a relay for connecting said conductors with said source.

60. In a telephone system, a plurality of connector switches for completing connection between calling and called lines, means for extending a calling line to an idle one of said switches, a relay common to said switches and operable over the extended calling line to control the switch to which said line has been extended to connect with a called line, and busy test circuits under the control of said relay for rendering the remainder of said switches inaccessible to other calling lines.

61. In a telephone system, a plurality of connector switches for completing connection between calling and called lines, means for extending a calling line to an idle one of said switches, a relay common to said switches and operable over the extended calling line to control the switch to which said line has been extended to connect with a called line, busy test circuits under the control of said relay for rendering the remainder of said switches inaccessible to other calling lines, and a relay controlled over the connected called line for again rendering the remainder of said switches accessible to other calls.

62. In a telephone system, a plurality of connector switches for completing connections between calling and called lines, means for extending a calling line to an idle one of said switches, a relay common to said switches and operable over the extended calling line, a relay for bringing the switch to which said line has been extended under the control of said first relay whereby said switch may be operated to connect with a called line, and test circuits for rendering the remaining switches busy during the operation of any one of them.

63. In a telephone system, a plurality of connector switches for completing connections between calling and called lines, means for extending a calling line to an idle one of said switches, a relay common to said switches and operable over the extended calling line, a relay for bringing the switch to which said line has been extended under the control of said first relay whereby said switch may be operated to connect with a called line, test circuits for rendering the remaining switches busy during the operation of any one of them, and relay mechanism whereby after the connection to the called line is completed said first relay is reverted to common use and the remaining switches are rendered accessible to other calls.

64. In a telephone system, a plurality of connector switches, an individual controlling relay for each switch, means for extending a calling line to an idle one of said switches, a common controlling relay for said switches normally connected to the calling line when so extended, said common relay adapted to control the operation of any switch to which connection has been extended, and switching devices whereby after a switch is operated the calling line is shifted to the individual controlling relay to maintain the said switch in operated position.

65. In a telephone system, a plurality of trunk lines each terminating in an automatic switch, a busy test circuit for each trunk line, a common conductor normally connected to said circuits in multiple, a relay, means whereby said relay is enabled to operate said switches in succession, means controlled by said relay for connecting a source of busy potential to said conductor during the operation of any switch, and

relay controlled switching devices whereby after any switch is operated the busy potential is removed from said conductor and the test circuit associated with the operated switch is disconnected from said conductor and connected to said source at another point.

Signed by me at Chicago, Cook county, Illinois, this 13th day of November, 1913.

HARRY E. HERSHEY.

Witnesses:
GEORGE A. YANODROWSKI,
MARJORIE R. MORGAN.