E. D. FALES.

SEMI-AUTOMATIC TELEPHONE SYSTEM.

APPLICATION FILED SEPT. 3, 1912.

1,242,164.

Patented Oct. 9, 1917.

4 SHEETS—SHEET 1.

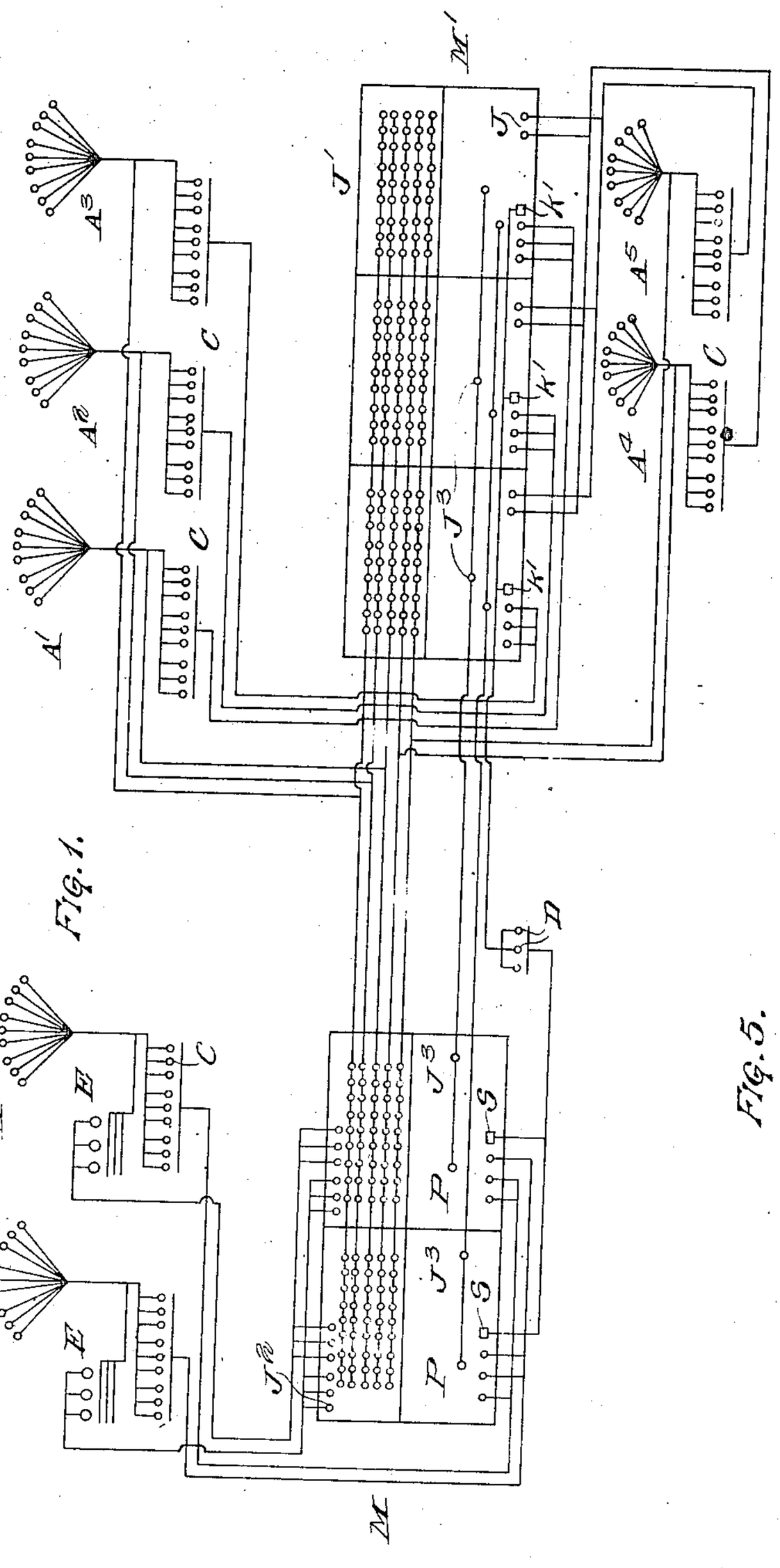

FIG. 1.

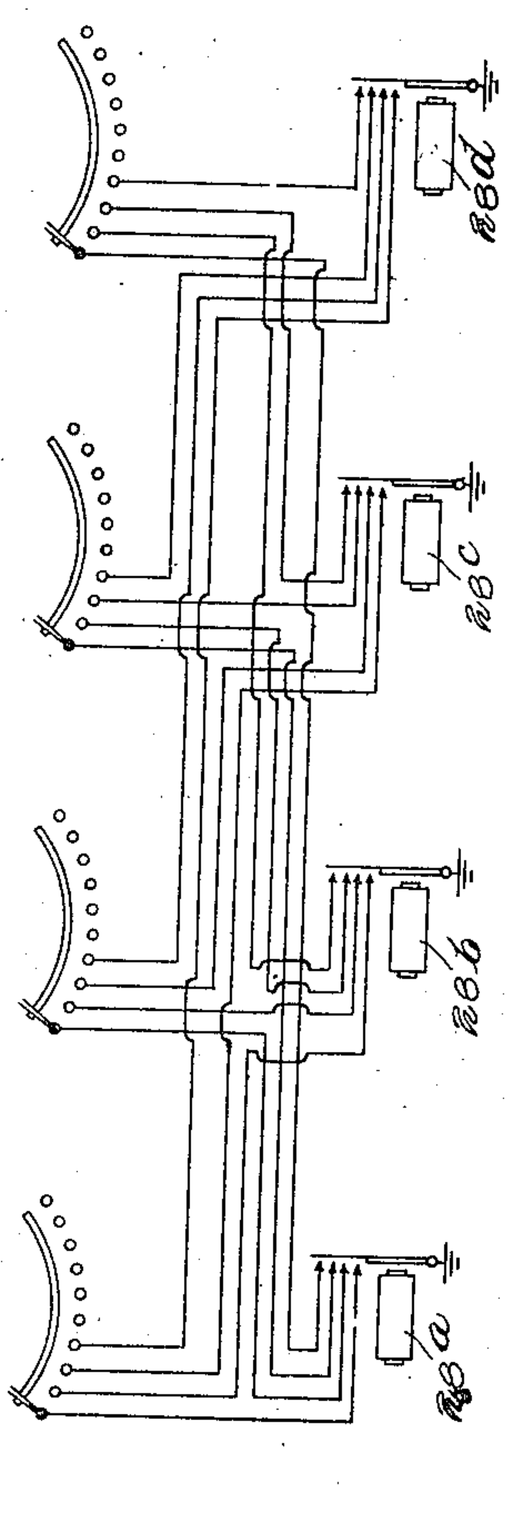

FIG. 5.

WITNESSES

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4 SHEETS—SHEET 2.

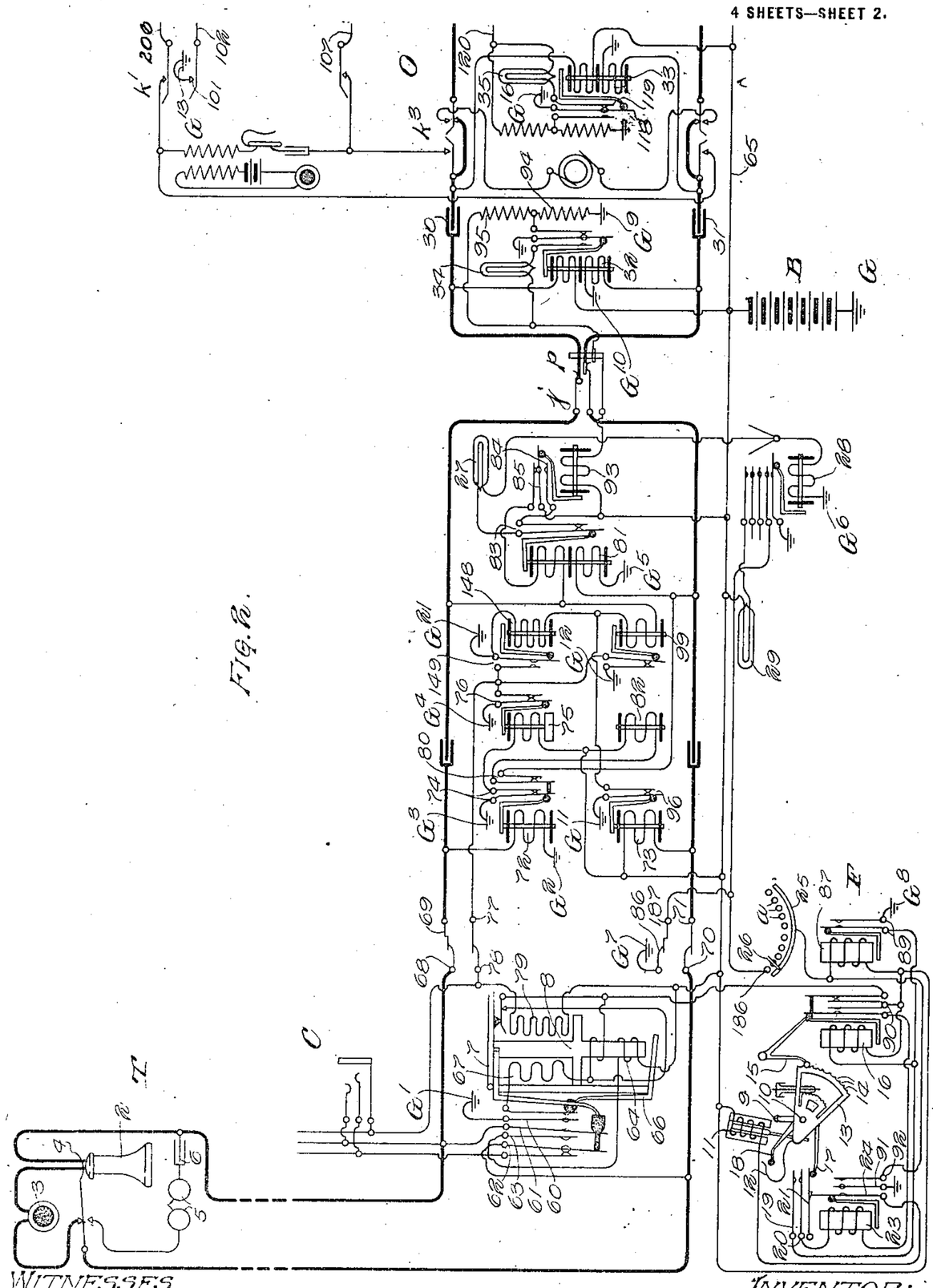

FIG. 2.

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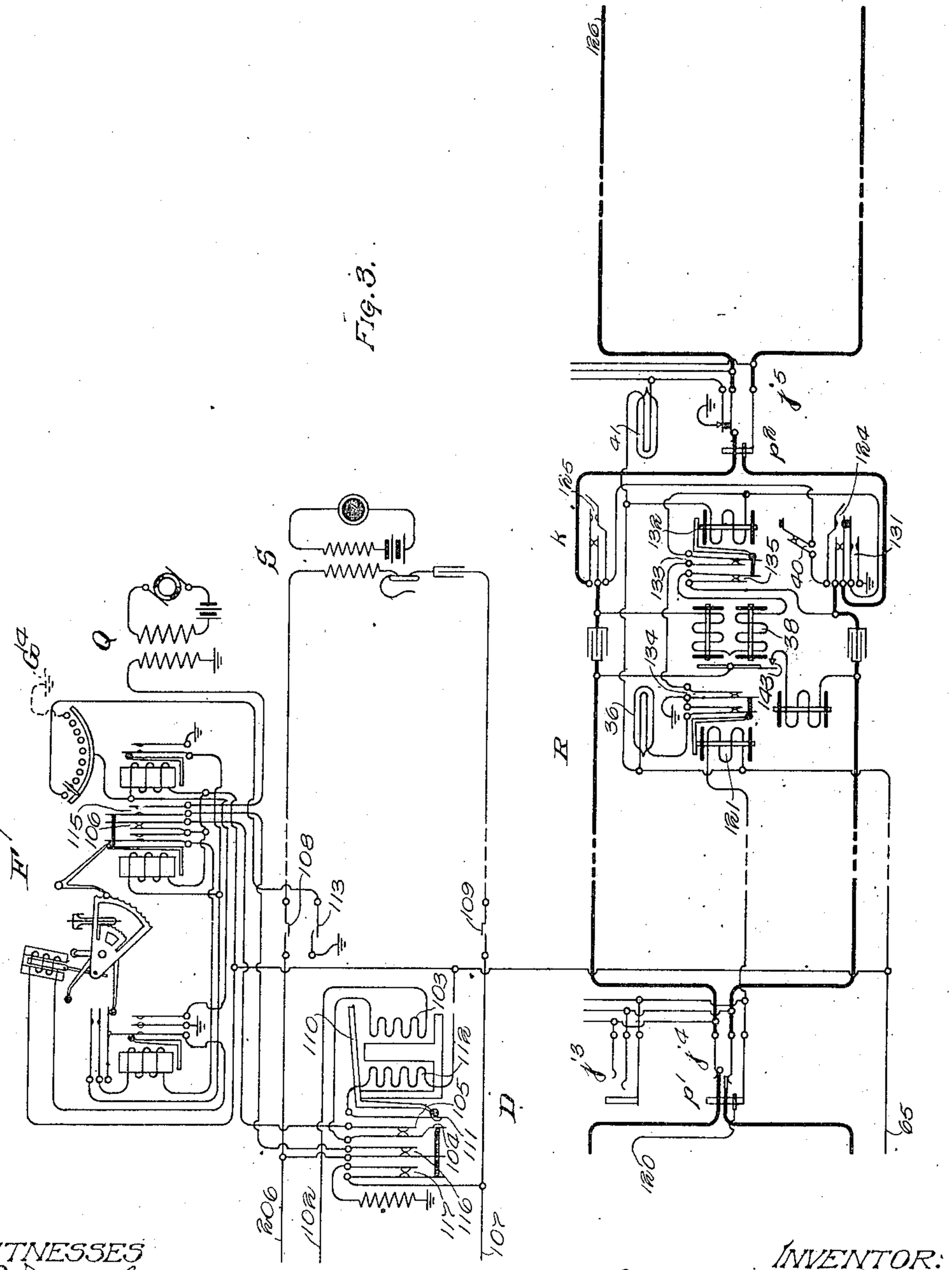
4 SHEETS—SHEET 3.

FIG. 3.



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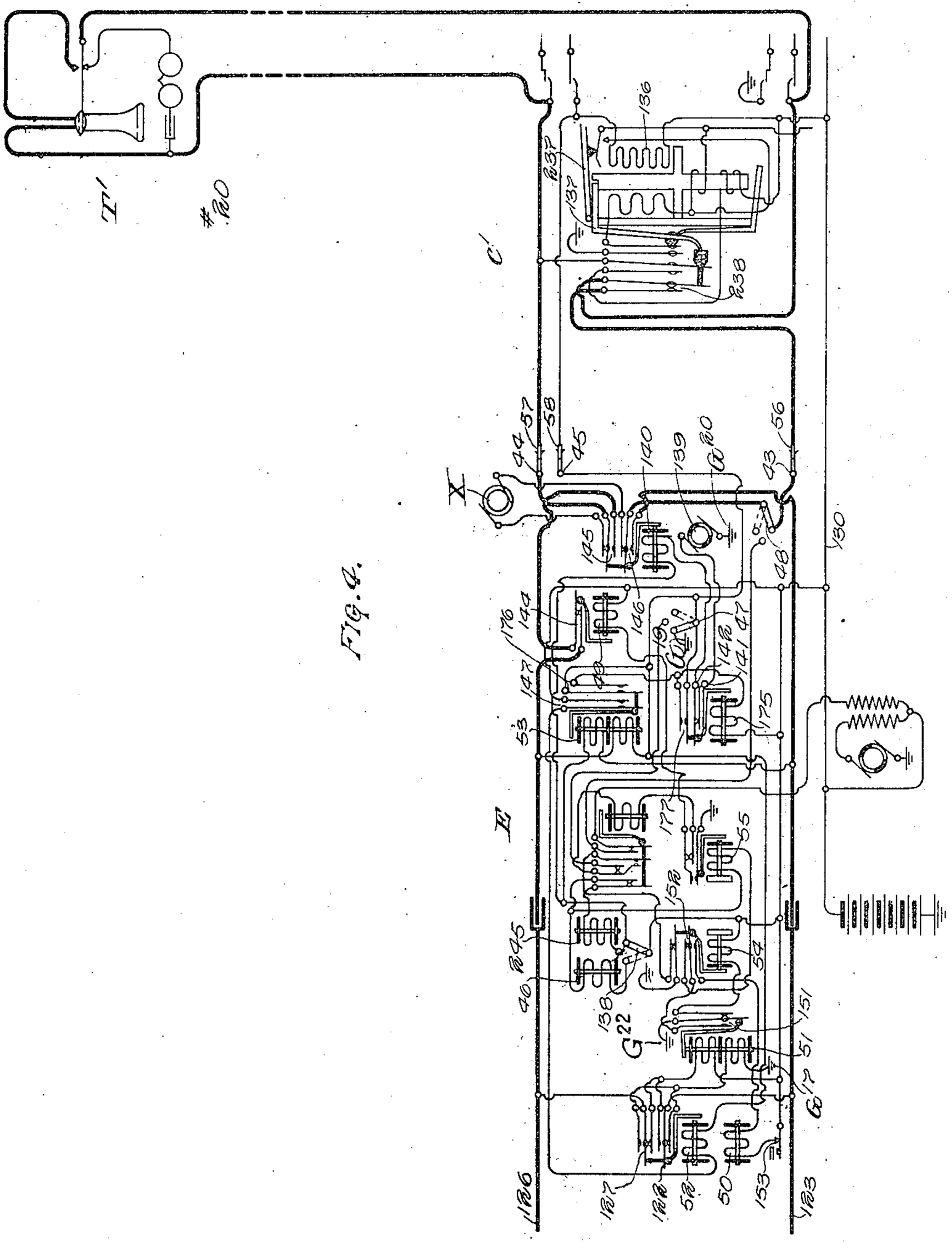

Fig. 4.

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UNITED STATES PATENT OFFICE.

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SEMI-AUTOMATIC TELEPHONE SYSTEM.

1,242,164. Specification of Letters Patent. Patented Oct. 9, 1917.

Application filed September 3, 1912. Serial No. 718,335.

To all whom it may concern:

Be it known that I, EDWARD D. FALES, a citizen of the United States of America, and resident of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Semi-Automatic Telephone Systems, of which the following is a specification.

My invention relates to improved telephone systems, and more particularly to semi-automatic systems, and the object is to improve the general efficiency of such a system, and especially to increase the trunking efficiency.

In my improved system the subscribers' lines are divided into groups, and one of these groups may be allotted to one operator and a second group to a second operator, and then there are various groups which have distributed trunks—that is, trunks which extend to various operators so that any one of these operators can take care of the calls from these groups.

I make special provision whereby the subscribers in these distributed groups cannot obtain a connection with an operator at whose board there is an unanswered call. In this manner the traffic is more evenly distributed and more efficient trunking obtained.

A further object is the provision of improved means whereby an operator at one board can give orders to an operator at a second board. Ordinarily operators at one board all have direct access to an order wire which leads to each of the operators at the second board. With this arrangement several operators may get in on the same order wire at the same time and thereby create a great deal of confusion. An object of my invention is to provide an automatic switch which has access to a plurality of order wires one of which leads to the operator's talking circuit at each position on the second board and this switch is adapted to automatically select an idle operator. In this way all confusion is avoided.

These and other objects of my invention will be more readily understood by reference to the accompanying drawings, in which I have illustrated one embodiment of my invention.

In said drawings Figure 1 is a diagrammatic layout of a telephone system embodying the principles of my invention.

Figs. 2, 3 and 4 taken together represent a complete connection between a calling telephone T and a called telephone T′ in the above system.

Fig. 5 represents the wiring of a portion of the master switch bank contacts.

In Fig. 1 there are represented two manual switchboards M and M′. Associated with the board M′ there are shown five groups of subscribers' stations A', A^2, A^3, A^4 and A^5. The subscribers' lines, instead of terminating directly in the manual switchboard in answering jacks in the usual manner, are each provided with an automatic trunk-selecting switch C. The switches C are divided into groups corresponding to the subscriber groups A', A^2, etc., each group having access to a plurality of trunk lines less in number than the subscribers in the group, which trunk lines terminate in answering jacks J at the switchboard. Although there is shown only one line leading from each group of switches C to the switchboard, this line is assumed to be a cable containing as many separate trunk lines as there are shown jacks J connected therewith at the switchboard. There are shown herein, therefore, three trunks for each subscriber's group. All of the trunk lines which are accessible to each of the groups of subscribers' stations A', A^2 and A^3 terminate upon the same operator's position of the switchboard. The trunk lines which are accessible to the subscriber groups A^4 and A^5, however, are uniformly distributed among the different operators. For the purpose of being called, the subscribers in the groups A', A^2, A^3, A^4 and A^5 are provided with the usual multiple jacks J′, not only in the switchboard M′ but also in the switchboard M. The subscribers in the groups A^6 and A^7, which are associated with the board M, are provided with trunking switches C in the same manner as the previous groups referred to. The trunk lines to which the subscribers A^6 and A^7 have access are distributed among the operators at the board M. Instead of the usual multiple jacks, the subscribers in the groups A^6 and A^7 are connected to the bank contacts of a plurality of automatic connector switches E, which connectors are accessible over trunk lines leading from jacks J^2 in the switchboard M. Each of these trunk lines is provided with a multiple jack J^2 in each

operator's position in the switchboard. As a means of interconnection between the two boards M and M′, a plurality of trunk lines is provided extending from multiple jacks J^3 in the board M′ to the plug P in the board M. Each of these trunk lines is also preferably provided with a jack J^3 in the board M. As a means of communication between the operators of the two boards, order wires are provided. From each operator's position on the board M′ an individual order wire leads to an automatic trunk-selecting switch D. The switches D have access to a plurality of circuits, one leading to each operator's position at the board M.

The connection shown in Figs. 2, 3 and 4 is assumed to be a connection between one of the subscribers of one of the groups A^4 or A^5 in the board M′ to one of the subscribers in one of the groups A^6 or A^7 at the board M, and involves all of the different kinds of apparatus employed in the system. The telephone T may be of any suitable type of manual common battery telephone, and, as represented herein, comprises the usual receiver 2, transmitter 3, switch hook 4, ringer 5 and condenser 6.

The trunking switch C, which is individual to the line of the telephone T, is of the general type of line switch disclosed in British patent to R. W. James, No. 26,301 of 1906, being however, of the specific form shown in British patent to T. G. Martin, No. 1,419 of 1910. This type of line switch, as is well known, comprises a plunger (not shown) attached to a so-called plunger arm 7, which, when attracted by the magnet 8, causes its plunger to be thrust into some one of a plurality of groups of contact springs, each of which forms the terminal of a separate trunk line. The line switches C of the subscribers in the groups A^4 and A^5 (Fig. 1) should have self-alined plungers—that is, their plungers, when released from an operated position, should automatically restore into locking engagement with their common plunger guide shaft and, therefore, in alinement with all the idle plungers in the group, as shown in said British Patent No. 26,301 of 1906, rather than remain in front of the trunk terminal from which they were disengaged until they are subsequently picked up by the master switch, as shown in said British Patent No. 1,419 of 1910. All the switches C of a group are controlled by a common mechanism or master switch F. The master switch F is of the general type of master switch disclosed in the British patents hereinabove referred to, being of a somewhat different construction from either, however. In the form of master switch shown herein the usual plunger guide shaft 9 is connected with a rotary shaft 10 in such a manner that as said shaft 10 rotates in either direction the plunger guide shaft 9 is given an oscillating motion about the same as an axis. The movement of the shaft 10 in one direction is produced by a solenoid 11, while the movement of the shaft in the other direction is produced by a spring 12. Attached to the shaft 10 there is a locking plate 13, said plate being provided in its periphery with as many notches 14 as there are trunk lines to which the line switches C of the group controlled by the master switch have access. The notches 14 are adapted to coöperate with a locking dog 15, whereby the plunger shaft 9 may be locked with its plungers in front of any one of the trunk lines. The locking dog 15 may be withdrawn from the plate 13 by the energization of the relay magnet 16. Secured to the shaft 10 there are also two arms 17 and 18. When the plunger shaft reaches the limit of its travel in one direction, the arm 18 presses the spring 19 into engagement with the spring 20; and when the plunger shaft reaches its limit in the other direction, the arm 17 raises the spring 21 to unlock the springs of the relay 23, which, at that time, will be held in their operated positions by the engagement of the spring 24 with the detent on the under side of the spring 21, as will hereinafter be explained. The master switch is also provided with the usual bank of contacts comprising the common segment 25 and a plurality of individual contacts *a*, one for each trunk line. The wiper 26 is adapted to maintain the segment 25 in engagement with the individual contact of a trunk line before which the plungers of the idle switches are resting.

The trunk line leading from the group of switches C to the manual board terminates at the board in the jack *j* and is provided with the usual line lamp 27. The trunk circuit is provided with a plurality of circuit-controlling relays, the operation of which will be fully described hereinafter. The line lamp 27 is connected to ground through the winding of a pilot relay 28 which is common to all of the trunks leading into a single operator's position. The relay 28, besides controlling the circuit of the usual pilot lamp 29, is provided with a plurality of contact springs, one of which is connected to the master switch bank contact of each one of the trunk lines which leads to that operator's position from the group of subscribers' substations, such as the groups A^4 and A^5 (Fig. 1), which are the groups which have distributed trunk lines. The apparatus associated with the subscribers in the groups A′, A^2 and A^3 (Fig. 1) may be the same in all respects as the apparatus associated with the subscribers in the groups A^4 and A^5, except that there are no connections leading from their master switch bank contacts to the pilot relays 28 of the switch-

board. Referring to Fig. 5, the manner in which the master switch bank contacts of the groups, such as the groups A^4 and A^5, are connected to the pilot relays 28 is as follows: In this figure there are represented the master switch banks of four groups of subscribers and the pilot relays 28 of four operators' positions. It is assumed that the first trunk line of each of the groups of subscribers leads to one operator's position, that the second trunk line in each group leads to the second operator's position, and so on. The first contact in each of the four banks is, therefore, shown connected to a contact in the relay 28^a of the first operator's position. The second contact in each bank is shown connected to a contact in the relay 28^b of the second position, and so on.

The operator's cord O (Figs. 2 and 3) is adapted for use at either of the boards M or M′ and is similar to the usual form of operator's cord circuit. It comprises the plugs p and p' connected together through the condensers 30 and 31 and is provided with the usual calling and answering supervisory relays 32 and 33 and the lamps 34 and 35. At R (Fig. 3) there is shown one of the trunk lines which connects the two boards M and M′ (Fig. 1). This trunk is shown provided at one end with two multiple jacks j^3 and j^4 and terminating at the other end in a plug p^2. This trunk is provided with a supervisory lamp 36 and suitable relays for controlling the same. The relay 38 is a polarized relay. Each operator at the board M is also provided with an automatic calling device of a suitable character for controlling the connector switches E, which calling device may be connected with the cord circuit by means of a key k. The calling device is represented in Fig. 3 diagrammatically by a pair of impulse springs 40. The calling device may be of the character shown in British patent to S. G. S. Dicker, No. 29,654 of 1910, or any other suitable construction can be employed.

At k' (Fig. 2) there is shown an order wire key such as is located at the manual board M′ (Fig. 1). At S there is shown one of the operator's sets of the manual board M (Fig. 1). At D is shown one of the automatic trunk-selecting switches by means of which idle order wires are selected. The switch D is the same in principle as the subscriber's individual switch C (Fig. 2). It, however, has no line relay, such as that which comprises the lower portion of the plural wound magnet 8 in the switch C. The switches D belonging to all the operators at the board M′ are controlled by a common master switch F′ which is similar to the master switch F (Fig. 2). At Q there is shown a busy tone signaling machine.

Leading from the jack j^5 (Fig. 3) to the connector E (Fig. 4) there is shown one of the trunk lines which lead from the manual board M (Fig. 1) to the connectors which have access to the subscriber groups A^6 and A^7. Although only one jack j^5 is shown in Fig. 3, it will be understood that this trunk might be provided with a plurality of multiple jacks. With each jack there is associated a visual busy signal which, in this case, is represented by a lamp 41. The connector E (Fig. 4) is assumed to be of the type of connector switches represented in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, the circuits being somewhat modified, however, so that the switch may be operated by impulses delivered over the two sides of the line in series, in a manner similar to that described in said British Patent No. 1,419 of 1910 above referred to. In general, the switch comprises a bank of contacts arranged in rows or levels which are adapted to be engaged by a set of wipers 43, 44 and 45 which are carried upon a vertically and rotatably movable shaft, the movement of which shaft is controlled by the vertical magnet 46 and the rotary magnet 245. The usual side switch comprising the wipers 138, 47 and 48 is controlled by the private magnet 49 in the usual and well-known manner. The usual release magnet is represented at 50. The operations of the switch are controlled through the medium of a double-wound line relay 51 which is connected with the line through the springs of a reversing relay 52, which relay 52 is in turn controllable by the called subscriber through the medium of the so-called back-bridge relay 53. The relays 54 and 55 are slow acting relays—that is, relays which de-energize slowly after their energizing circuits have been broken. The proper operation of these relays may be conveniently obtained by securing a heavy ring of copper or other conducting material around one end of the core.

The substation T′ and the line switch C′ may be in all respects the same as the substation T and the line switch C (Fig. 2), with the exception that instead of multiple jacks, the line of the substation T′ is provided with multiple contacts 56, 57 and 58 in a plurality of connector switches E.

Having given a general description of the apparatus, the operation by which the connection is extended from the telephone T to the telephone T′ will now be explained in detail. Upon the removal of the receiver from the switch hook at the telephone T, a bridge is closed across the calling line through the receiver 2 and transmitter 3, whereby an energizing circuit is closed extending from ground G′ through the springs 60 and 61, telephone T, springs 62 and 63

and the line winding 64 to the battery lead 65, and thence through battery B to ground G. The winding 64, upon energizing, attracts the armature 66, whereby the circuit of the operating winding 67 is closed. The winding 67, upon energizing, attracts the plunger arm 7, whereby the plunger of the switch extends the line connection through the springs 68 and 69 and the springs 70 and 71 to an idle trunk line leading to the manual board. When this occurs the relays 72 and 73 in the trunk become energized over a circuit extending from ground G^2 through the relay 72, springs 68 and 69, telephone T and back over the other side of the line through the springs 70 and 71 and the relay 73 to the battery lead 65. The relay 72, upon energizing, completes a circuit extending from ground G^3 through the contact 74 and the relay 75 to the battery lead 65. The relay 75, upon energizing, completes a circuit extending from ground G^4 through the contacts 76 and the line switch bank springs 77 and 78 and the holding winding 79 of the switch C to the battery lead 65. The energization of the winding 79 serves to maintain the switch C in its operated position after the line winding 64 is disconnected from the line upon the operation of the switch. There is a branch connection from the springs 78 in the circuit last traced which extends to the sleeve contact of the multiple jacks of the calling line, whereby said jacks are provided with a busy test potential from the ground G^4. The closure of the contact 80 upon the energization of the relay 72 completes a circuit extending from ground G^5 in the right-hand end of the trunk through the lower winding of the relay 81, contact 80 and impedance coil 82 to the battery lead 65. The relay 81, upon energizing, closes the circuit of the lamp 27, said circuit extending from ground G^6 through the pilot relay 28, lamp 27, contact 83 and springs 84 and 85 to the battery lead 65.

The closure of contact between the band springs 86 and 187 upon the operation of the line switch C completes a circuit extending from ground G^7 through said springs, master switch bank contact 186, wiper 26 (which is assumed to be resting upon the contact 186 at the time), segment 25 and the relay 87 to the battery lead 65. The relay 87, upon energizing, completes a circuit extending from ground G^8 through the contact 89 and the relay 16 to the battery lead 65. The relay 16, upon energizing, withdraws the locking dog 15 from the cam 13 and allows the master switch to rotate the plungers of the idle line switches to an idle trunk line. It will be seen that the relay 16 will remain energized and the master switch continue to operate until the wiper 26 finds the non-grounded terminal of the first idle trunk line, when the circuit of the relays 87 and 16 will be broken and the locking dog allowed to drop back into one of the notches of the cam 13. If the idle plungers are standing opposite the last trunk line and said trunk line is seized, or if the plungers reach said trunk line and find it busy, they will move a short distance beyond said trunk, when the arm 18 on the master switch will press the spring 19 into contact with the spring 20, whereby a circuit will be closed from ground G^8 through the springs 89 (bearing in mind that the relay 87, as well as the relay 16, is at this time energized), springs 19 and 20, relay 23 and the contact 90 to the battery lead 65. The relay 23, upon energizing, closes the contact between springs 24, 91 and 92, whereby a locking circuit is closed through the relay 87 and the energizing circuit of the solenoid 11 is closed. The springs of the relay become locked in their energized positions by the engagement of the spring 24 with the detent on the spring 21. The solenoid 11, upon energizing, moves the plunger guide shaft and the idle plungers back in the opposite direction until the arm 17 raises the spring 21 to unlock the springs of the relay 23, whereupon the circuits of the solenoid 11 and the relays 87 and 16 are broken and the plungers are brought to rest opposite the first trunk line, ready to begin their selecting operations over again.

It has been explained how, when connection is extended to the manual switchboard upon the operation of the line switch C, the circuit of the line lamp 27 is closed in series with the pilot relay 28. This not only lights the lamp 27, but the relay 28 is energized to close the circuit of the pilot lamp 29. It has heretofore been explained that the relay 28 is connected in series with all the line lamps, such as the lamp 27, of all the trunk lines entering any particular operator's position, and that the relay 28 is provided with a contact for each trunk line which leads from the groups of subscribers whose trunk lines are distributed among the different operators, as shown at A^4 and A^5 in Fig. 1. In Fig. 2 only the contact of the relay 28 which is allotted to the trunk line illustrated is actually shown connected to its master switch bank contact 186. With this arrangement it will be seen that whenever any lamp 27 in any operator's position is burning, or, in other words, whenever there is an unanswered call in that position, the pilot relay will supply a ground potential to the master switch bank contact of all the distributed trunks coming into that position, whereby no call will be permitted to come into said position over said trunk lines at this time, but will be diverted to a position at which there is no unanswered call. Since the relay 28 is common to all the trunk lines in a position, but has contacts for only the distributed trunks, it will be seen

that a call from any of the subscribers' groups which have access to a plurality of operators will always be trunked to an idle operator, while a call from one of the groups which has access only to one operator will be trunked to that operator immediately, even though there are one or more unanswered calls in her position already.

Upon receiving the signal of the lamp 27, the operator inserts the plug *p* into the jack *j*, whereby the calling subscriber's connection is extended to the cord O and a circuit is closed through the cut-off relay 93 of the trunk and the calling supervisory relay 32 of the cord. The circuit of the relay 93 extends from ground G^9 through the resistances 94 and 95, sleeve contacts of the plug *p* and the jack *j* and the relay 93 to the battery lead 65. The relay 93, upon energizing, destroys the circuit of the lamp 27 and the pilot relay 28 and connects the battery lead 65 with the upper winding of the relay 81. The relay 32 has two energizing circuits, one extending from ground G^{10} through the lower winding of said relay, ring conductors of the plug *p* and the jack *j*, contact 80 and the impedance coil 82 in the trunk to the battery lead 65. The other circuit extends from ground G^{11} at the cord relay 73 through the contact 96, relay 99, tip conductors of the jack *j* and the plug *p* and the upper winding of the relay 32 to the battery lead 65. In its energized position the relay 32 maintains the circuit of the lamp 34 open and short-circuits the resistance 94. The relay 99 in the cord, upon energizing, extends a second holding ground from ground G^{12} to the holding winding 79 of the line switch C.

Upon learning that a connection is desired with one of the subscribers who is called automatically from the board M, the operator at the cord O depresses her order wire key *k'*. The closure of the contact 101 of this key completes a circuit from ground G^{13} through said contact, conductor 102, pull-down winding 103 of the switch D, springs 104 and 105 and the contact 106 to the battery lead 65. The winding 103, upon energizing, draws down the plunger arm 110, whereby the operator's order wire conductors 206 and 107 are extended through the contacts 108 and 109 to an idle operator's set S at the board M. Upon the attraction of the plunger arm 110, the spring 111 is forced into contact with the spring 104, and the spring 104 is carried out of contact with the spring 105, whereby the winding 112 is inserted in series with the winding 103, so as to cut down the holding current for the switch. The closure of the contact 113, upon the operation of the switch D, causes the master switch F' to move the plungers of the idle switches to a position opposite an order wire leading to an idle operator's set S. In case there are more contacts in the bank of the master switch F' than there are operators' sets S, the superfluous contacts may be permanently grounded, as indicated at G^{14}, whereby the master switch will be driven past said contacts. If all the order wires are busy, all the contacts in the master switch bank F' will be grounded and the master switch will operate continuously. During this operation the contact 106 will be open, thereby disconnecting the battery from all the idle switches D. The contact 115 will at the same time be closed, whereby the busy signaling machine Q is connected with the conductor 206 through the contacts 116 of the idle switches D. Therefore, any operator at the board M who depresses her order wire key while there is no idle set S will obtain a busy signal. The operators who have actually operated their switches D to obtain connection with an order wire will receive no busy signal, because the contacts 117 and 116 in their switches will be open.

Upon receiving an order for a connection over the order wire selected in the manner explained above, the operator at the board M assigns an idle trunk line to an operator at the board M', whereupon the operator at the board M' releases her key *k'* and inserts the plug *p'* (Fig. 3) into the jack j^4 of the trunk assigned. Upon the insertion of this plug a circuit is closed from ground G^{16} at the cord O through the springs 118 and 119, lamp 35, conductor 120, sleeve contacts of the plug *p'* and the jack j^4 and the relay 121 to the battery lead 65. The relay 121, upon energizing, closes the circuit of the lamp 36. The plug p^2 is then inserted into the jack j^5 of a trunk line leading to a connector having access to the proper group of subscribers, and the key *k* is operated to connect the calling device 40 with the trunk. A circuit is thereby completed extending from ground G^{17} (Fig. 4) through the lower winding of the connector line relay 51, back contact of the spring 122, trunk conductor 123, contact 124 of the key *k*, impulse springs 40, key contact 125, tip conductors of the plug p^2 and the jack j^5, trunk conductor 126, back contact of the spring 127 and the upper winding of the relay 51 to the battery lead 130. The relay 51, upon energizing, closes the circuit of the slow acting relay 54. The closure of the contact 131 at the key *k* (Fig. 3) closes the circuit of the relay 132, which, upon energizing, forms a locking circuit for itself through its own springs 133 and the contact 134 of the relay 121. The closure of the contacts 135 of the relay 132 bridges the polarized relay 38 across the calling end of the cord R.

The operator at the cord R now operates her calling device for the two digits of the number of the called substation, which, in

this case, will be assumed to be 20. Upon the first operation of the calling device the impulse springs 40 are separated twice momentarily, whereby the connector line relay 51 is permitted to deënergize twice. The relay 54, being a slow acting relay, does not deënergize upon the momentary interruption of its circuit by the relay 51. Therefore, each time the relay 51 deënergizes an impulse of current is transmitted through the vertical magnet 46 in series with the slow acting private magnet relay 55. The magnet 46 operates in response to these impulses to raise the switch shaft and wipers two steps, while the slow acting relay 55 operates to close the circuit of the private magnet 49 and maintain it closed until after the last impulse is delivered. Upon the cessation of the impulses the relay 55 deënergizes and breaks the circuit of the private magnet 49, whereupon it permits the side switch to pass to second position. The operator now operates her calling device for the second digit O, whereby the circuit of the connector line relay 51 is interrupted ten times. The relay 51 operates in response to these impulses (since the side switch is in second position) to transmit ten impulses to the rotary magnet 245, whereby the shaft wipers of the connector switch are rotated on to the contacts of the called line and the private magnet is caused to trip the side switch to third position. Upon the engagement of the side switch wiper 47 with its third-position contact point, a circuit is closed from ground G^{19} through said side switch wiper, shaft private wiper 45, bank contact 58 and cut-off winding 136 to the battery lead 130. The winding 136, upon energizing, attracts the armature 137, whereby the switch C′ is disconnected from the called line and the contact 238 in the talking circuit is closed. The current flowing through the winding 136 is not strong enough of itself to attract the armature 237. In the circuit just traced there is also provided a guarding ground potential from ground G^{19} to all the connector private bank contacts corresponding to the contact 58 of the called line. Upon the movement of the side switch wiper 138 of the connector to third position, a circuit is closed from ground G^{20} through the interrupter 139, springs 141 and 142, ringing relay 140 and the side switch wiper 138 to the battery lead 130. The relay 140 thereupon begins to operate to intermittently connect the ringing current generator X with the called line to signal the called subscriber. After the operator has completed the operation of her calling device for the last digit, the key *k* is restored to its normal position, whereby the calling device is disconnected and a bridge is substituted therefor across the trunk through the relay 38. The current flowing through the relay 38 at this time, in series with the line relay 51 of the connector, is in the proper direction to maintain the contact 143 open.

Upon the response of the subscriber at the called substation T′, said substation is provided with talking current over a circuit extending from ground G^{19} at the connector E through the side switch wiper 47, lower winding of the relay 53, private magnet springs 144, ringer relay contact 145, wiper 44, hence over the line to and through the substation T′ and back over the other side of the line through the contact 238 at the switch C′, connector wiper 43, side switch wiper 48, ringer relay contact 146, upper winding of the relay 53 and the side switch wiper 138 to the battery lead 130. The relay 53, upon energizing, closes the circuit of the relay 175 at the contact 176. The relay 175, upon energizing, opens the circuit of the ringing relay and forms a locking circuit for itself at the contact 177 to prevent the ringing relay from becoming operative again when the called subscriber hangs up his receiver. The relay 53, upon energizing, also closes a circuit extending from ground G^{19} through the side switch wiper 47, reversing relay 52 and the contact 147 to the battery lead 130. The relay 52, upon energizing, transposes the connection between the windings of the relay 51 and the trunk conductors 126 and 123. This latter operation causes a reversal of the current in the relay 38 (Fig. 3), whereby said relay is operated to close the contact 143. The closure of this contact provides an energizing circuit for the calling supervisory relay 33 at the cord O, which, upon energizing, extinguishes the lamp 35 to signify to the operator that the called subscriber has answered.

If the called line had been busy, the connector switch E would not have made connection therewith, as described above, and the calling subscriber would have been given the busy signal in a manner which is well known and which it is not thought necessary to describe herein.

Upon the termination of the conversation the operator at the cord O is given the usual calling and answering disconnect signals in the following manner: Upon the hanging up of the receiver at the calling substation the energizing circuit of the cord relays 72 and 73 is broken. The relay 72, upon deënergizing, disconnects the battery from the ring side of the cord, while the relay 73, upon deenergizing, disconnects ground G^{11} from the tip side of the trunk, but leaves it grounded at G^{21} through the relay 148. The relay 148 is a high resistance relay and does not permit sufficient current to flow through it and through the upper winding of the relay 32

in the cord to maintain the latter relay energized. The relay 32, upon deënergizing, closes the circuit of the lamp 34 in series with the cut off relay 93 of the trunk. The high resistance relay 148 in the trunk, however, is energized and, by closing the contact 149, furnishes a new holding circuit for the line switch C to prevent it from releasing until the plug *p* is removed from the jack *j*. When the called subscriber hangs up his receiver, the back-bridge relay 53 of the connector E deënergizes and permits the relay 52 to in turn deënergize, whereby the direction of current in the polarized relay 38 (Fig. 3) is restored to its original direction. The relay 38 thereupon operates to open the contact 143, whereby the energizing circuit of the calling supervisory relay 33 at the cord O (Fig. 2) is broken. The relay 33, upon deënergizing, reëstablishes the circuit of the lamp 35. Upon the simultaneous glowing of the lamps 34 and 35 the operator removes the plugs *p* and *p'* from the jacks *j* and j^4, respectively. Upon the removal of the plug *p* from the jack *j* the circuit of the trunk relay 148 is broken and it deënergizes and removes the last holding ground from the line switch C, whereby said switch is permitted to restore to normal position. Upon the removal of the plug *p'* from the jack j^4 the circuit of the relay 121 of the trunk R is broken and said relay, upon deënergizing, opens the circuit of the lamp 36. When the light 36 ceases to glow, the operator removes the plug p^2 from the jack j^5, whereby the energizing circuit of the connector line relay 51 is broken. The relay 51, upon deënergizing, destroys the holding circuit of the relay 54, which in turn deënergizes and closes the circuit of the release magnet 50, said circuit extending from ground G^{22} through the contacts 151 and 152, magnet 50 and contact 153 (which is closed upon the first vertical movement of the switch shaft) to the battery lead 130. The magnet 50, upon energizing, immediately restores the mechanism of the connector to normal position and allows the cut-off winding of the switch C' to deënergize, whereby all the apparatus employed in the connection is left in readiness for another call.

In the above description of the operation of establishing a connection between the telephones T and T' the operation of all the apparatus which is required to establish connection between any of the two subscribers in Fig. 1 has been explained. For instance, if the subscriber T had desired a connection with some other subscriber in the switchboard M', the operator would simply have inserted the plug *p'* into one of the multiple jacks of the subscriber called for and signaled the subscriber through the medium of the ringing key K^3 in the cord in the usual manner. If the subscriber at the telephone T' (Fig. 4), which may be taken to represent any of the telephones in the groups A^6 or A^7 of the board M (Fig. 1), wishes to make a call, he operates his line switch C' in the same manner as explained for the line switch C (Fig. 2) to obtain connection with a trunk line, which may be the same as shown in Fig. 2, to signal his operator. The operator answers with a cord O and may then complete the connection either with a subscriber of the board M' by plugging directly into a multiple jack of one of the subscribers of said board, or connection may be completed with another subscriber of a board M through the medium of the cord O, trunk R and the connector E in the same manner as when the subscriber at the telephone T was the calling subscriber.

While I have illustrated and described one particular embodiment of my invention, it is to be understood that I do not wish to be limited to the exact construction shown and described, nor to the use of switches of the character with which I have chosen to illustrate my invention, but that many changes will readily suggest themselves to those skilled in the art.

What I claim as my invention is:—

1. In a telephone system, a plurality of groups of subscribers' lines, a plurality of operators' positions, trunk lines extending from one group to one operator's position and from a second group to a second operator's position, trunk lines from a third group distributed throughout a plurality of operators' positions, and a relay common to said trunk lines and controlled from a subscriber's line in any group for preventing a subscriber in said third group from obtaining connection with an operator's position at which there is an unanswered call.

2. In a telephone system, a group of subscribers' lines, a plurality of operators' positions, trunk lines extending from said subscribers' lines and distributed throughout said operators' positions, means on said subscribers' lines for preselecting an idle trunk, and means for preventing the trunk being seized which extends to an operator's position at which there is an unanswered call.

3. In a telephone system, a plurality of subscribers' lines, an operator's board, a plurality of trunk lines terminating in jacks on said board, automatic selecting switches for connecting said subscribers' lines with a preselected one of said trunk lines, and means for preventing seizure of a trunk extending to said operator's board when a connection has been established with said

board over a second of said trunks until after the operator has answered said last-mentioned call, said means common to said trunk lines and controlled from any subscriber's line.

4. In a telephone system, a plurality of groups of subscribers' lines, a plurality of operators' positions, trunk lines extending from said subscribers' lines and distributed throughout a plurality of said operators' positions, and master switches controlling a group of said line switches for selecting a trunk extending to an idle operator's position.

5. In a telephone system, a plurality of subscribers' lines divided into groups, a plurality of operators' positions, trunk lines extending from said subscribers' lines and distributed throughout a plurality of said operators' positions and terminating in jacks thereat, an operator's plug adapted to be connected with one of said jacks in answering a call, an automatic selecting switch for connecting with a preselected idle one of said trunks to extend a connection from a subscriber's line to said operator's position, means common to said trunk lines and controlled from a subscriber's line in any group for placing a guarding potential on the other trunks leading to said operator's position when said connection is established, and means for removing said guarding potential when an operator's plug is inserted in said jack in response to the call.

6. In a telephone system, a plurality of subscribers' lines divided into groups, a plurality of operators' positions, trunk lines extending from said subscribers' lines and distributed throughout a plurality of said operators' positions and terminating in jacks thereat, an operator's plug adapted to be connected with said jack in answering a call, an automatic selecting switch for connecting with a preselected idle one of said trunks to extend a connection from a subscriber's line to said operator's position, a relay in said operator's position common to said trunk lines and controlled from a subscriber's line in any group, means for energizing said relay when said call is established to prevent a second call to said operator's position, and means for deënergizing said relay upon the response of the operator to thereby permit the second call.

7. In a telephone system, a plurality of groups of subscribers' lines, a plurality of operators' positions, trunk lines extending from one group to one operator's position and from a second group to a second operator's position, trunk lines from a third group distributed throughout a plurality of operators' positions, and circuits and a relay for preventing a subscriber in said third group from obtaining connection with an operator's position at which there is an unanswered call, said relay common to all of said trunk lines and controlled from a subscriber's line in any group.

8. In a telephone system, a group of subscribers' lines, a plurality of operators' positions, trunk lines extending from said subscribers' lines and distributed throughout said operators' positions, a progressively movable switch under the control of said subscribers' lines for preselecting an idle trunk, and circuits and a relay for preventing the trunk being seized which extends to an operator's position at which there is an unanswered call.

9. In a telephone system, a plurality of subscribers' lines, an operator's board, a plurality of trunk lines terminating in jacks on said board, automatic selecting switches for connecting said subscribers' lines with a preselected idle one of said trunk lines, and circuits and a relay common to said trunk lines and controlled from any subscriber's line for preventing seizure of a trunk extending to said operator's board when a connection has been established with said board over a second of said trunks until after the operator has answered said last-mentioned call.

10. In a telephone system, a plurality of groups of subscribers' lines, a plurality of operators' positions, trunk lines extending from said groups of subscribers' lines and distributed throughout a plurality of said operators' positions, a relay at each of said operators' positions common to the trunks extending to said positions, circuits controlled by said subscribers for energizing said relay when a connection is established with one of its trunks, potential circuits and a controlling automatic switch controlled by the energization of said relay for preventing a second trunk extending to that position being seized, and means for deënergizing said relay when the operator plugs in to answer the call.

Signed by me at Chicago, Cook county, Illinois, this 28th day of August, 1912.

EDWARD D. FALES.

Witnesses:
J. NORBY,
E. A. CLEGG.