E. A. MELLINGER.

SEMI-AUTOMATIC TELEPHONE EXCHANGE TRUNKING SYSTEM.

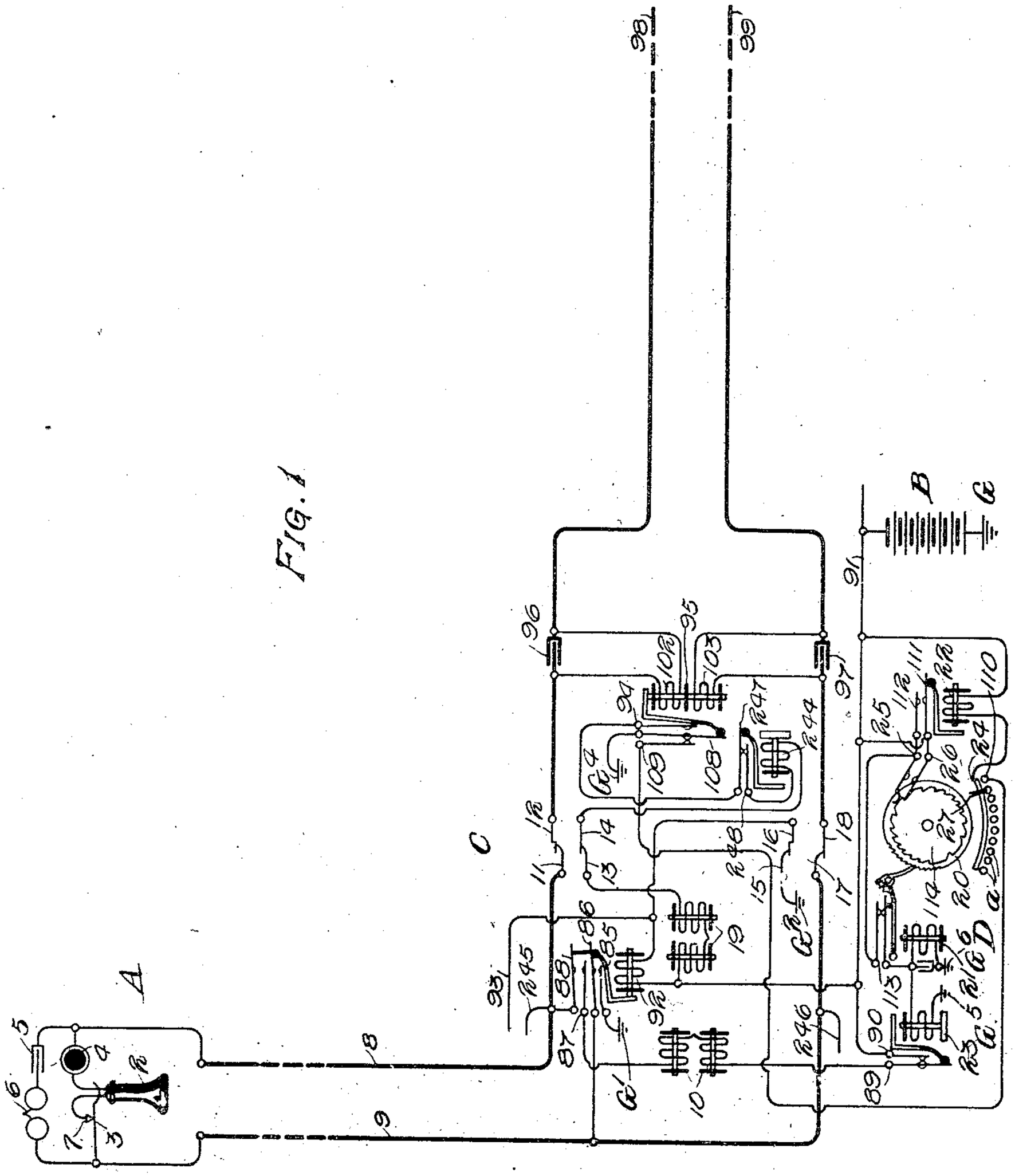
APPLICATION FILED FEB. 5, 1910.

1,134,978.

Patented Apr. 6, 1915.

4 SHEETS-SHEET 1.

FIG. 1



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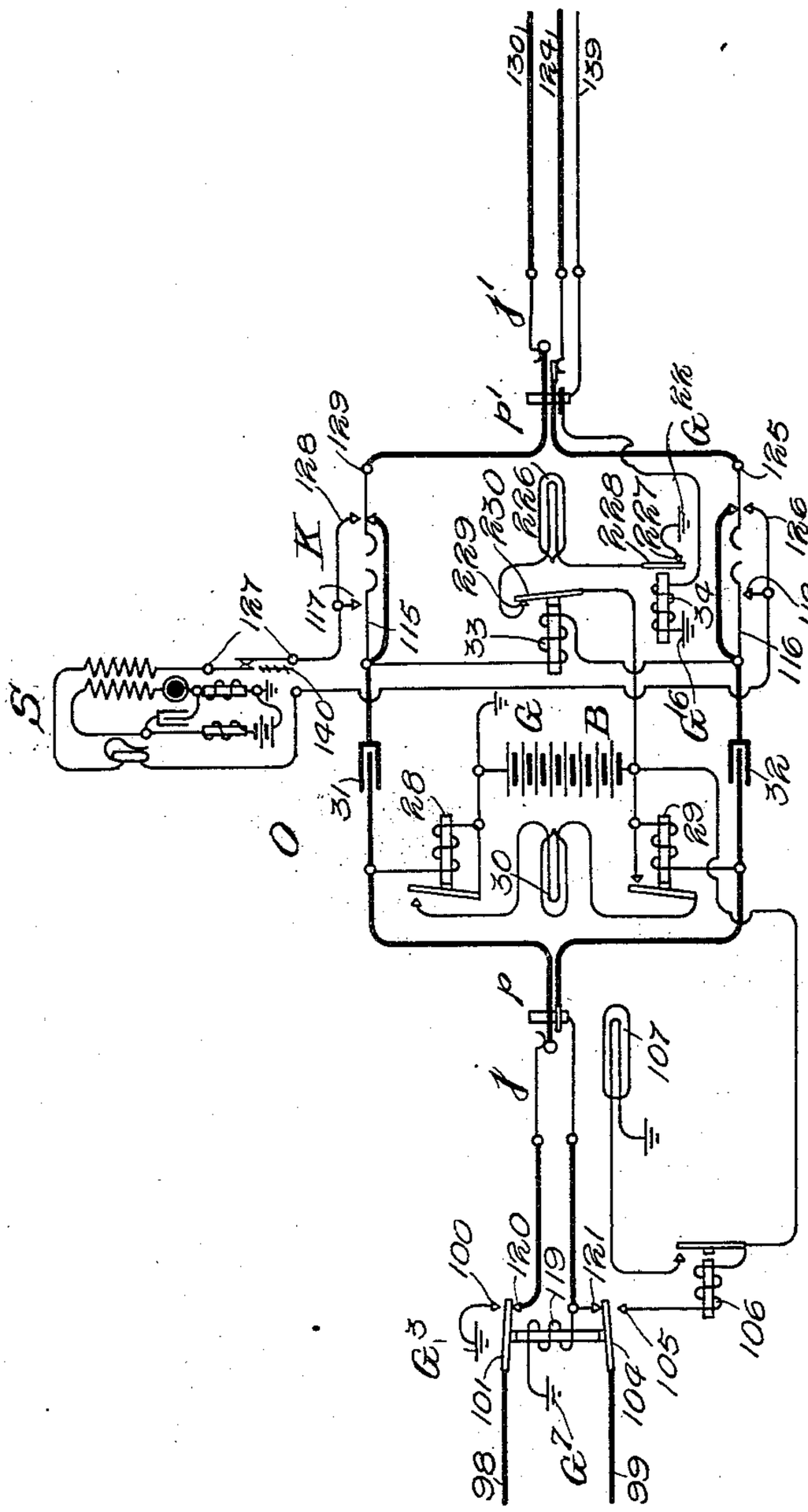
4 SHEETS—SHEET 2.

FIG. 2.



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4 SHEETS—SHEET 3.

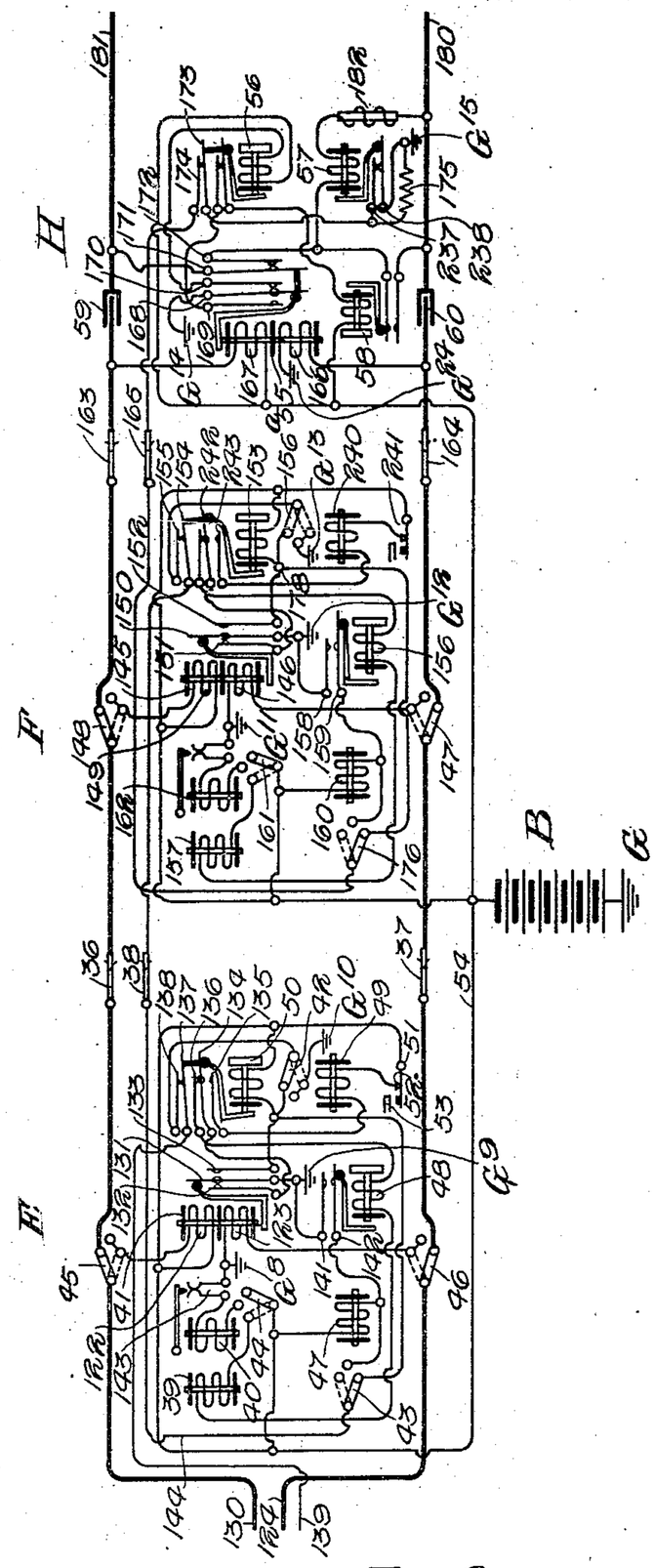

FIG. 3.

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4 SHEETS—SHEET 4.

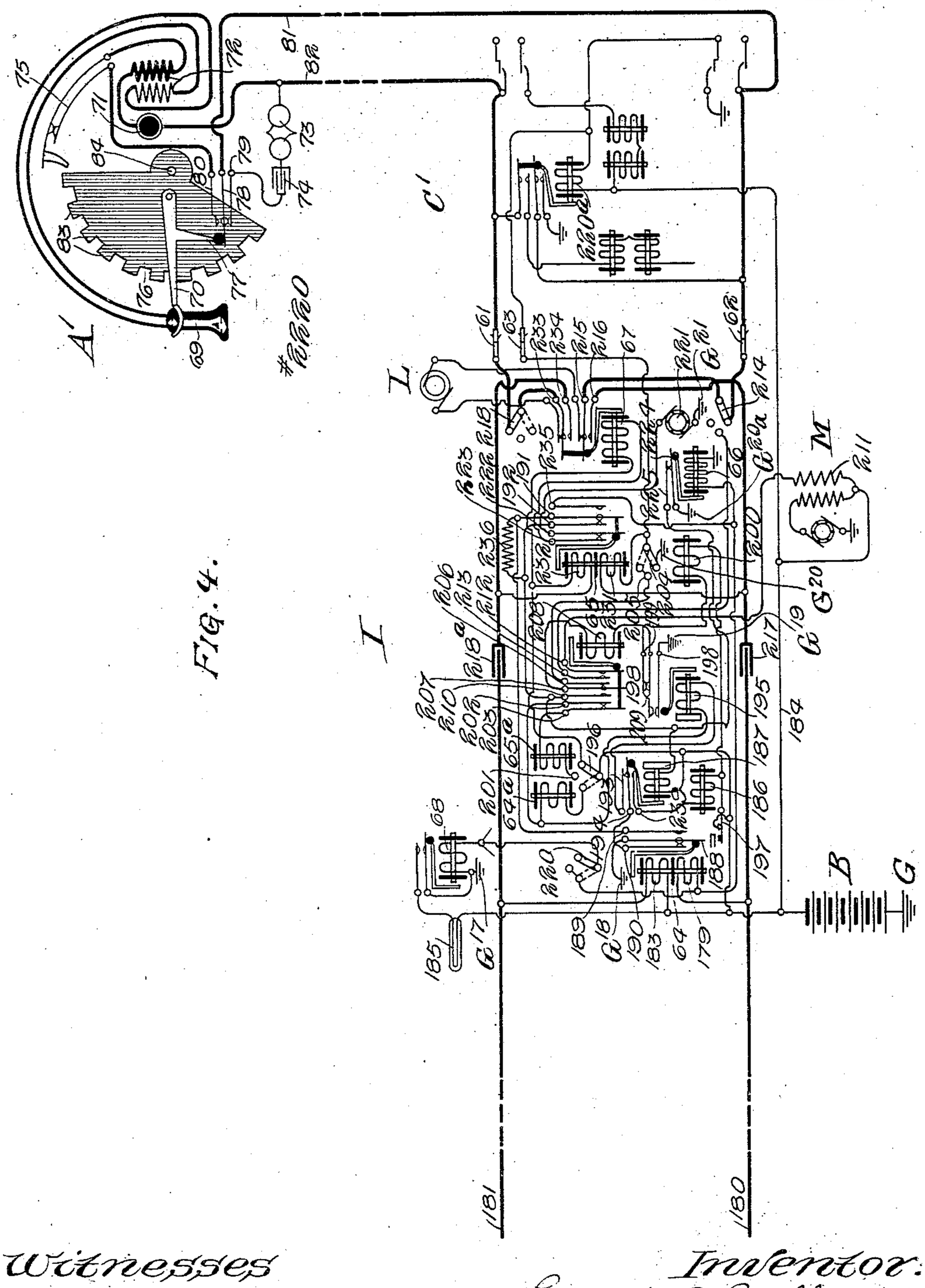

FIG. 4.

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SEMI-AUTOMATIC TELEPHONE-EXCHANGE TRUNKING SYSTEM.

1,134,973. Specification of Letters Patent. Patented Apr. 6, 1915.

Application filed February 5, 1910. Serial No. 542,304.

To all whom it may concern:

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

My invention relates to telephone systems of that kind in which both manual and automatic trunking is employed for extending connection from a calling line to a called line and is in the nature of an improvement of my co-pending applications Ser. #369,637, #364,698, #369,012, #382,914, #413,044, #451,674, #501,261 and #522,111. In systems of this character it is desirable, of course, that the manual switchboard operator through whose board the call passes shall have supervision of the connection, as, for example, by receiving a signal when the called subscriber hangs up his receiver. The operator may also be equipped with means for receiving a signal when the calling subscriber hangs up his receiver. In this way the switchboard operator supervises the semi-automatically established trunking connection between the two substations. It is obvious, however, that a supervisory arrangement which will answer for one kind of combined automatic and manual trunking service will not answer for one where the situation is more or less different.

One of the objects of my invention is, therefore, the provision of a supervisory arrangement for use in conjunction with a semi-automatic service in which only two-wire trunks are employed between the selectors and the connectors, which is often necessary, as, for example, in systems which are organized on the district plan, each district having a subcentral station which is connected with the central station by means of main or auxiliary trunks, and each subcentral station having thereat only the lines of those subscribers who are within that particular district. In such case, of course, the supervision of the connection, so far as the called subscriber is concerned, must be over the two-wire trunks between the main and subcentral stations, and then for the balance of the distance over any suitable circuits to the manual switchboard. Thus, in a system characterized by my invention the called subscriber, when he hangs up his receiver, transmits the supervisory signal over the two sides of a portion of the talking circuit in series, and for the remainder of the distance over third conductors that are excluded from the talking circuit, and which form a circuit extending to the manual switchboard. In this way the manual switchboard operator receives a signal when the called subscriber hangs up his receiver which indicates that the subscribers are through talking.

Another object is to provide a supervisory connector switch, and means for switching a high resistance into circuit with the trunk line leading to such connector when the called subscriber answers, thus retiring the supervisory signal and thereby indicating to the operator that the call has been answered; and whereby, when the called subscriber hangs up his receiver, the resistance of the supervisory circuit over the trunk line will be reduced by short-circuiting said resistance, thereby causing the supervisory signal to be again displayed, indicating that the subscribers are through talking.

Another object is to provide a repeater of such character that it will not only repeat the calling impulses, but will also serve as the medium for transferring the supervisory signals from the talking circuit to the trunk-release circuit when the called subscriber answers, or when the called subscriber hangs up his receiver, whereby the supervision is, as previously stated, partly over the talking circuit, and then for the balance of the distance over the third conductors of the trunk lines to the manual switchboard.

It is also an object to provide certain details and features of improvement and combinations tending to increase the general efficiency of a semi-automatic or combined manual and automatic telephone exchange system.

In the accompanying drawings Figures 1, 2, 3 and 4 taken together represent a complete circuit connection between a manual substation A (Fig. 1) and an automatic substation A′ (Fig. 4), said connection employing apparatus embodying the principles of my invention.

In Fig. 1 is shown a manual substation A with an automatic individual or line switch

C for extending connection from the substation line conductors to trunk conductors leading to the manual exchange. At D is shown a master switch for controlling a group of line switches C.

In Fig. 2 there is shown a cord circuit O for connecting jacks *j* and *j'*. The jack *j* is connected to a trunk line leading from the sub-exchange of Fig. 1. The jack *j'* is connected to a trunk line leading to an automatic selector switch E (Fig. 3). At S is shown an operator's talking set.

In Fig. 3 there is shown automatic switching apparatus consisting of a so-called first selector E, second selector F and my improved repeater H.

In Fig. 4 there is shown an automatic connector switch I for completing connection with a group of lines of which that of substation A' is a member. To the automatic substation A' there is allotted at the exchange a line switch C' similar to the line switch C of Fig. 1. At L a ringer generator is shown, and at M is represented a busy signaling machine.

In the drawings several batteries B are shown, each having one terminal grounded. There need be only one such battery, however, or preferably one in each exchange.

The manual substation A may be of any suitable or approved type and, as here shown, comprises the usual receiver 2, switch hook 3, transmitter 4, condenser 5 and ringer 6. When the receiver is on the hook the circuit of the transmitter and receiver is open, but when the receiver is removed the switch hook 3 engages the contact point 7, thereby bridging the transmitter and receiver across the line conductors 8 and 9.

The line switch C and master switch D may be of the general type disclosed in British Patent No. 26,301 of 1906, in *The American Telephone Journal* of New York, N. Y., of June 6, 1908, and in the *Western Electrician* of Chicago, Ill., of January 25, 1908, being adapted, however, to operate in a system in which no ground connection is required at the substation. The line switch consists essentially of a plunger (not shown) adapted, when released by the energization of the trip magnet 10, to enter a bank of contacts to force springs 11, 13, 15 and 17 into contact with springs 12, 14, 16 and 18, respectively. If the release magnet 19 be energized after the plunger has been tripped the apparatus will be placed in condition to withdraw the plunger upon the following deënergization of the said magnet 19. In the system here illustrated it is assumed that the lines of a number of substations lead to a branch or subexchange where each line is provided with a line switch C. Although only one set of springs 11, 12, 13, 14, 15, 16, 17 and 18 is shown, each line switch is in reality provided with a bank containing a number of such sets of springs, each set forming the terminal of a trunk line leading to the main exchange (Fig. 2). Each trunk is multiplied through the similar bank contacts of a number of line switches C. Thus a number of trunks may be made common to a group of substations larger in number than the number of trunks. In order that each line switch may always obtain connection with an idle trunk, the group of switches that have access to a particular group of trunks is provided with a master switch D.

The master switch D comprises, among other details, a ratchet wheel 20, a motor magnet 21, circuit controlling relays 22 and 23, and a bank of contacts comprising a common segment 24 and a number of individual contacts *a*, one for each trunk. The ratchet wheel 20 is mechanically connected to a shaft (not shown) in such a manner that a rotary motion of said wheel produces a oscillatory motion of the shaft. The plunger of each line switch is adapted to normally rest in locked engagement with this plunger shaft, and the master switch maintains the shaft always in such position that the plungers locked therewith will be opposite the terminal of an unoccupied or idle trunk. Secured to the ratchet wheel 20 is a notched wheel 114 which controls the springs 25 and 26. The notches in the wheel 114 are so spaced that the springs 25 and 26 will be held in contact for all positions of the master switch except when the plungers that are in locked engagement with the plunger shaft are in a position directly in front of a trunk terminal.

The cord circuit O is a modified form of the usual operator's cord circuit. The left-hand end of the cord O is similar to many ordinary cords used in manual systems and, as shown, comprises the plug *p*, two supervisory relays 28 and 29 and the lamp 30. The cord is divided into two parts by the condensers 31 and 32. The right-hand end of the cord comprises a key K, supervisory relays 33 and 34, lamp 226 and a three-conductor plug *p'*.

The first selector E is of the general type disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, the circuits being modified in order that the switch may operate in connection with a two-wire system—that is, a system in which no operating ground is used at the substation. As here represented, the selector E comprises, among other details, the wipers 36, 37 and 38 carried upon a shaft (not shown) having a vertical motion controlled by the vertical magnet 39 and a rotary motion controlled by the rotary magnet 40. The operation of the selector is controlled by the calling operator through the medium of the double-wound

line relay 41. The side switch comprising the wipers 42, 43, 44, 45 and 46 is well known and is controlled by the private magnet 47, which in turn is under the control of the private magnet relay 48. Means for releasing the switch are provided in the release magnet 49. The selector E is provided with the so-called connector release—that is, the shaft and side switch are restored immediately upon the energization of the release magnet, rather than by its deënergization, as shown in the said selector patent. The off-normal spring 51 is normally held out of engagement with spring 52 by the arm 53 which is attached to the switch shaft. As soon as the shaft is raised one or more steps the arm 53 allows the spring 51 to engage point 52, thus connecting the release magnet 49 to the battery lead 54. The relays 48 and 50 are slow acting relays—that is, slow to deënergize after their circuits have been broken. The selector E is also provided with a bank of contacts which are in position to be engaged by the wipers 36, 37 and 38, and to which are connected trunks leading to second selectors F.

The second selector F is similar to the first selector E.

My improved repeater H comprises a double-wound line relay 55, a release relay 56, a supervisory relay 57, and an auxiliary relay 58 for short-circuiting the relay 57 while the repeater is operating. The circuit through the repeater H is divided into two parts by the condensers 59 and 60.

The connector I (Fig. 4) is of the general type disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, but, like the selectors E and F, is modified to operate in a two-wire system. Like the selectors the connector is provided with a shaft (not shown) carrying wipers 61, 62 and 63 and controlled by the vertical magnet 64^a and rotary magnet 65^a. The operation of the switch as a whole is controlled through the medium of the double-wound line relay 64. A back-bridge relay 65 is provided through which the called substation is provided with talking battery current. A high resistance relay 66 provides means whereby the central office operator may obtain supervision of a call through the said connector. The ringing relay 67 is provided for the purpose of switching ringing current onto the called line after the connection has been completed. The supervisory relay 68 is common to a number of connectors and serves to indicate to an exchange attendant when the circuit of the line relay of any connector becomes closed accidentally.

The line switch C′ is similar to the line switch C and is controlled by a master switch similar to the master switch D.

The automatic substation A′ may be of any suitable or approved type. As here shown, it comprises a receiver 69, switch hook 70, transmitter 71, induction coil 72, ringer 73, condenser 74, impulse springs 75 and impulse wheel 76. When the receiver is on the hook the cam arm 77 maintains the spring 78 in contact with the spring 79, whereby the ringer 73 is bridged across the line conductors 81 and 82 in series with the condenser 74. When the receiver is removed from the hook the spring 78 disengages from the spring 79 and comes into contact with the spring 80, whereby the ringer circuit is opened and the transmitter and primary winding of the induction coil is bridged across the line instead.

A better understanding of my invention may be had from a description of its operation when employed in a complete connection. It will be assumed that the manual subscriber at substation A desires connection with the automatic substation A′, the number of which latter will be assumed to be 2220. When the subscriber at substation A removes the receiver from the hook the switch hook rises into engagement with the contact point 7, thus bridging the transmitter and receiver across the line conductors 8 and 9. When the talking set is thus bridged across the line an energizing circuit is closed through the trip magnet 10 of the line switch C. This circuit extends from ground G′ through springs 85 and 86 of the cut-off relay 92, line conductor 9, switch hook 3, contact point 7, receiver 2, transmitter 4, line conductor 8, cut-off springs 88 and 87, trip magnet 10, springs 89 and 90 to battery lead 91, thence through the battery B to ground G. The magnet 10, upon energizing, releases the plunger of the switch C, allowing it to enter the bank and force springs 11 and 12, 13 and 14, 15 and 16, 17 and 18 into contact in pairs. The engagement of bank springs 15 and 16 furnishes a guarding potential from ground G^2 over the private normal conductor 93 to the connector private bank contacts of the calling line. It is to be understood that the normal conductors 93, 245 and 246 lead to bank contacts of automatic connector switches similar to the switch I (Fig. 4), by means of which the substation A may be called automatically. This guarding potential protects the lines of substation A from being seized by a connector while the said line is in use. The engagement of bank springs 13 and 14 extends a connection from the release magnet 19 to the spring 94 of relay 95. When the bank springs 11 and 17 are forced into contact with springs 12 and 18, respectively, by the plunger, the substation lines 8 and 9 are extended through the condensers 96 and 97 and windings of relay 95 to the trunk conductors 98 and 99. When the substation

lines are thus extended to the trunk a circuit is completed extended from ground G^3 (Fig. 2) through contact point 100, armature 101, trunk conductor 98, winding 102 of relay 95, bank springs 12 and 11, line conductor 8, thence through the substation A and back over line conductor 9, bank springs 17 and 18, winding 103 of relay 95, trunk conductor 99, armature 104, contact point 105 and line relay 106, and thence through the battery B to ground G. The relays 95 and 106 which are included in the circuit just traced are both energized to attract their respective armatures. The energization of the line relay 106 results in the closure of a circuit through the lamp 107, thereby signaling to the operator that her attention is desired on this trunk. The energization of the relay 95 shifts spring 108 out of engagement with spring 94 and into contact with spring 109, whereby the circuit of the release magnet 19 is maintained opened, and the ground G^4 is connected with the master switch bank contact 110 corresponding to the trunk seized. As has been previously explained, when the idle line switch plungers are opposite the contacts of any trunks, in this case trunks 98—99, the wiper 27 maintains the corresponding master switch bank contact 110 in electrical connection with the common segment 24. Consequently, when contact point 110 is grounded, as above explained, an energizing circuit is completed extending therefrom through wiper 27, common segment 24, motor magnet relay 22 to battery lead 91, thence through the battery B to ground G. The relay 22 energizes upon closure of this circuit and forces spring 111 into contact with spring 112, thereby closing an energizing circuit through the motor magnet 21 and relay 23. This circuit extends from ground G^5 and G^6 through relay 23 and motor magnet 21 in parallel, interrupter springs 113 and relay springs 112 and 111 to battery lead 91, thence through the battery B to ground G. The motor magnet, upon energizing, attracts its armature, which rotates the ratchet wheel 20 one step and also opens the circuit of its own magnet at the interrupter springs 113. The armature of the motor magnet then falls back and again closes the energizing circuit, and the motor magnet continues to operate in a manner similar to that of a buzzer as long as the springs 111 and 112 or 25 and 26 remain in contact.

As soon as the ratchet wheel 20 is rotated its first step the spring 26 is forced into contact with spring 25 by a tooth of the notched wheel 114, and maintains the energizing circuit of the motor magnet 21, irrespective of the springs of relay 22. By the time the spring 26 drops into the next notch of the wheel 114 the idle line switch plungers will have reached a position directly opposite the bank contacts of the next trunk, and the wiper 27 will have left the guarded contact 110, allowing the relay 22 to deënergize. The relay 22 being deënergized, and the springs 25 and 26 separated, the motor magnet ceases to operate and leaves the plungers in their positions in front of the next trunk after the one just seized. If this next trunk had been busy, however, the wiper 27 would have found a guarding potential upon the contact succeeding the contact 110, and consequently the relay 22 would still have been energized when the springs 25 and 26 were separated, the motor magnet would have continued to operate, the springs 25 and 26 would again have been forced into contact by the next tooth, and the plungers would have been carried past the busy trunk to an idle one. The relay 23, which is connected in multiple with the motor magnet 21, energizes when its circuit is first closed, but being a relay that is slow to deënergize it remains in an operated position as long as the said magnet is operating. In its operated position the relay 23 disconnects battery from the trip magnets 10 of all the line switches to which the master switch D is allotted. With this arrangement it will be seen that no line switch can be operated while its plunger is being moved to an idle trunk.

When the operator at the main exchange notices the glowing of the lamp 107 she inserts the plug *p* in the jack *j* and throws the key K to close the springs 115 and 116 into contact with the springs 117 and 118, respectively, which bridges the operator's talking set S across the cord O. When the plug *p* is inserted into the jack *j* an energizing circuit is closed through the cut-off relay 119. This circuit of the relay 119 extends from ground G^7 through relay 119, sleeve springs of jack *j* and plug *p* and relay 29 to battery B. The relay 119, upon energizing, attracts its armatures 101 and 104 away from the contacts 100 and 105 and onto contacts 120 and 121, respectively, whereby the trunk conductors 98 and 99 are disconnected from ground G^3 and relay 106, respectively, and are extended through the jack *j* to the cord O. The cutting off of the relay 106 allows said relay to deënergize and extinguish the lamp 107. The relay 29, which is included in the energizing circuit of the relay 119, also energizes, and would close a circuit through the lamp 30 but for the fact that the relay 28 is energized at the same time over a circuit extending from the grounded terminal of battery B through relay 28, tip springs of plug *p* and jack *j*, contact point 120, armature 101, trunk conductor 98, thence through substation A and back over trunk conductor 99, armature 104, contact point 121, sleeve springs of jack *j*

and plug *p* and through relay 29 to the non-grounded pole of battery B. This latter circuit also serves to provide the calling substation with talking battery current. After the operator has ascertained the number of the desired line the key K is thrown over to the opposite position and the plug *p'* inserted into the jack *j'*. With the key K in this position the supervisory relay 33 is cut off and the operator's set S is bridged across the cord circuit. The insertion of plug *p'* into jack *j'* completes an energizing circuit for the line relay 41 of the first selector E. This circuit extends from ground G^8 through winding 123 of relay 41, side switch wiper 46, trunk conductor 124, ring contacts of jack *j'* and plug *p'*, key contacts 125 and 126, secondary circuit of the operator's set including the impulse springs 127, thence through the key contacts 128 and 129, tip springs of the plug *p'* and jack *j'*, trunk conductor 130, side switch wiper 45 and winding 122 of the relay 41 to battery lead 54, thence through battery B to ground G. The relay 41, upon energizing, shifts the spring 131 out of engagement with the spring 132 and into contact with the spring 133, whereby ground is disconnected from the release magnet 49 and an energizing circuit is closed through the release relay 50. This circuit extends from ground G^9 through the springs 131 and 133 and relay 50 to battery lead 54, thence through battery B to ground G. The relay 50 upon energizing, shifts the spring 134 out of engagement with the spring 135 and into contact with the spring 136, and closes the spring 137 into contact with the spring 138. The shifting of the spring 134 shifts the connection of the impulse spring 132 from the release magnet 49 to the vertical magnet 39. The engagement of the springs 137 and 138 extends a connection from ground G^{10} through the side switch wiper 42, springs 138 and 137, trunk conductor 139, sleeve contacts of the jack *j'* and plug *p'* to the relay 34. This ground connection to the relay 34 serves no purpose at this time except to short-circuit same. The selector E is now in position to receive impulses for the first digit of the desired number.

The operator now operates the dial of her calling device for the digit 2 and, as the impulse wheel 140 returns to normal position, the impulse springs 127 are separated twice. Each time the springs 127 are separated they break the energizing circuit of the line relay 41 of the selector E. Each time relay 41 deënergizes the spring 131 leaves spring 133 and momentarily engages spring 132. As before explained, the relay 50 is slow to deënergize, and consequently it remains in its operated position during the short interval that the springs 131 and 133 are disengaged. The engagement of springs 131 and 132 closes an energizing circuit extending from ground G^9 through springs 131 and 132, 134 and 136, private magnet relay 48, vertical magnet 39 and side switch wiper 44 to battery lead 54, thence through battery B to ground G. Since the digit called was 2 the vertical magnet receives two impulses of the circuit just traced, and operates to raise the switch shaft and wipers two steps to a position opposite the second bank level. Also, as soon as the shaft is raised the first step the off-normal spring 51 is allowed to engage the contact point 52, thus connecting the release magnet 49 with battery. The private magnet relay 48, which was included in the energizing circuit of the vertical magnet, is energized by the first impulse, but being a slow-acting relay, like the relay 50, does not have time to deënergize between impulses. When the relay 48 energizes it operates to close an energizing circuit extending from ground G^9 through springs 141 and 142 and private magnet 47 to the battery lead 54, thence through the battery B to ground G. After the last impulse of the series the line relay 41 remains in its energized position, thus maintaining the energizing circuit of release relay 50, and permanently opening the circuit of the vertical magnet 39 and private magnet relay 48. After a short time the private magnet relay 48 deënergizes and breaks the energizing circuit of the private magnet 47, which in turn allows its armature to fall back and release the side switch to second position. The movement of side switch wiper 44 from first to second position shifts the battery connection from the vertical magnet 39 to the rotary magnet 40. The rotary magnet is then energized over a circuit extending from ground G^8 through interrupter springs 143, magnet 40, side switch wiper 44 to battery lead 54, thence through the battery B to ground G; and attracts its armature, which rotates the shaft wipers one step onto the first contacts of the second level, presses down the private magnet armature and opens the energizing circuit of its own magnet. When the rotary magnet circuit is thus opened the rotary armature drops back, and if the first trunk leading from the second level is idle the armature of the private magnet drops back also and allows the side switch to pass to third position. If, however, the first trunk of the second level is busy on account of having been seized by some other selector similar to the selector E, the private wiper 38 finds the first contact which it engages connected to ground through the second selector of the busy trunk. This ground is extended by said wiper over the conductor 144 and through the side switch wiper 43 (now in second position) and private magnet 47 to battery lead 54, thence

through battery B to ground G. The private magnet becomes energized over this circuit and maintains the side switch in second position after the rotary armature falls back. The side switch thus remaining in second position, the rotary magnet circuit will be again closed at the interrupter springs 143 by the falling back of the rotary armature. The rotary magnet will thus continue to be intermittently energized and deënergized to rotate the shaft and wipers step by step until the private wiper 38 reaches a non-grounded contact of an idle trunk. When an idle line is found the private magnet deënergizes and allows the side switch to pass from second to third position. When the side switch wiper 44 leaves its second-position contact point it permanently opens the circuit of the rotary magnet 40. The movement of the side switch wipers 45 and 46 from second to third position cuts off the line relay 41 and extends the trunk conductors 130 and 124 through the shaft wipers 36 and 37 to the second selector F. As soon as the connection is thus extended to the second selector the line relay 145 is energized over a circuit extending from ground G^{11} through winding 146 of relay 145, side switch wiper 147, shaft wiper 37, side switch wiper 46 to trunk conductor 124, thence through the operator's calling device and back over trunk conductor 130, side switch wiper 45, shaft wiper 36, side switch wiper 148 and winding 149 of relay 145 to battery lead 54, thence through battery B to ground G.

The relay 145, when energized, operates to shift spring 150 out of engagement with spring 151 and into contact with spring 152, whereby an energizing circuit is closed through the release relay 153. This circuit extends from ground G^{12} through spring 150 and 152, and through relay 153 to battery lead 54, thence through battery B to ground G. The relay 153, upon energizing, by closing the contact between springs 154 and 155, furnishes a new holding ground for the release relay 50 of the first selector E, its former ground being cut off by the deenergization of relay 41. The energizing circuit of relay 50 now extends from ground G^{13} at the selector F, side switch wiper 156^a, relay springs 155 and 154, private bank contact of the seized trunk and shaft wiper 38, side switch wiper 43 (in third position), and through relay 50 to battery lead 54, thence through battery B to ground G. This ground potential furnished by ground G^{13} to the private bank contact upon which the wiper 38 is resting, is extended to the corresponding contact in each of the first selector banks that are multiplied with that of selector E, for the purpose of protecting the busy trunks from being seized by any other switch. The foregoing is the position of the switches immediately after the operation of the operator's calling device for the first digit 2.

When the calling device is operated for the second digit the second selector F is affected in the same manner as was the first selector for the first digit, and operates to extend the connection to a repeater H which is included in a trunk line leading to a connector I. Briefly, the operation of the second selector is as follows: Each time the line circuit is broken by the impulse springs 127 of the operator's calling device, the line relay 145 deënergizes and closes a circuit from ground G^{12} through the private magnet relay 156 and vertical magnet 157 to battery. The second digit being 2 the vertical magnet thus receives two impulses and operates to raise the shaft wipers two steps to a position opposite the second row or level of bank contacts. The relay 153 being slow-acting remains energized during the entire time the second selector is operating. The private magnet relay 156 is energized by the first impulse to the vertical magnet, but, being a slow-acting relay, its circuit is not opened long enough to permit it to deënergize until after the last impulse. When the relay 156 energizes, by the closure of contact between springs 158 and 159, it closes an energizing circuit for the private magnet 160. This energizing circuit is broken when the relay 156 deënergizes after the last impulse, the private magnet 160 deënergizes and the side switch passes to second position. The movement of side switch wiper 161 from first to second position shifts the battery connection from the vertical magnet 157 to the rotary magnet 162. The rotary magnet then operates in the manner explained for the rotary magnet 40 of the selector E to advance the shaft wipers 163, 164 and 165 onto the contacts of an idle trunk. After the wipers have reached an idle trunk the side switch is tripped to third position, and by means of its wipers 147 and 148 extends the line connection through the shaft wipers 164 and 163 to the repeater H. At the instant the connection is completed to the repeater the relay 55 is energized over a circuit extending from ground G^{24} through winding 166, through shaft wiper 164, thence over the heavy conductors through selectors F and E and the operator's calling device, and thence back through switches E and F, and through winding 167 of relay 55 to battery lead 54, thence through battery B to ground G. The relay 55, upon energizing, shifts spring 168 out of engagement with spring 169 and into contact with spring 170, and forces spring 171 into contact with spring 172. The engagement of springs 168 and 170 closes an energizing circuit from ground G^{14} through said springs 168 and 170, and through the slow-acting relay 56 to

battery lead 54, thence through battery B to ground G. The relay 56 energizes upon closure of this circuit and, by forcing springs 173 and 174 into contact, furnishes a new holding ground for the release relays 153 and 50 of the selectors F and E. The circuit of these relays now extends from ground G^{15} through resistance 175 (the relay 57 being energized, as will be explained later), springs 173 and 174, shaft wiper 165, side switch wiper 176 to contact point 178, whence one branch extends through relay 153 to battery, and another branch extends through side switch wiper 156, and through relay 50 of selector E over a circuit already traced. Since the resistance 175 is included in this circuit, current also flows from ground G^{16} through the relay 34 of the cord circuit O, through the plug p' and jack j', conductor 139, springs 137 and 138, side switch wiper 42, and thence through relays 50 and 153 to battery. The relay 34 is energized by this current, but its operation at this time is without utility.

The closure of springs 171 and 172 of the relay 55 closes an energizing circuit through the line relay 64 of the connector I. This circuit extends from ground G^{17} through the relay 68, winding 179 of relay 64, trunk conductor 180, impedance coil 182, relay 57, springs 172 and 171, trunk conductor 181, and winding 183 of relay 64 to battery lead 184, thence through battery B to ground G. The relay 57, which was included in the circuit just traced, energizes and removes the short-circuit from the resistance 175, with the result previously described. The relay 68 is also energized by the closure of this circuit, and operates to close a circuit through the lamp 185. The line relay 64, upon energizing, disconnects ground from the release magnet 186 and closes an energizing circuit through the release relay 187. This circuit extends from ground G^{18} through springs 188 and 189, 191 and 192, and through relay 187 to battery lead 184, thence through battery B to ground G. The relay 187, upon energizing, connects the impulse spring 190 with the vertical magnet 64^a, thus placing the connector in position to receive impulses for the last two digits of the desired number.

When the calling device is operated for the third digit 2 the circuit of the line relay 55 of the repeater H is opened twice. Each time the relay 55 deënergizes it closes an energizing circuit through the slow-acting relay 58 and opens the circuit of the line relay 64 of the connector I. The relay 58 being slow-acting is energized the first time its circuit is closed, and remains in its operated position until after the last impulse is delivered, thus maintaining the relay 57 and impedance coil 182 short-circuited while the line relay of the connector is being operated. Each time the relay 64 deënergizes, a circuit is closed through the vertical magnet 64^a. This circuit extends from ground G^{18} through springs 188 and 189, springs 194 and 193 of the slow-acting relay 187, private magnet relay 195, vertical magnet 64^a, side switch wiper 196 to battery lead 184, thence through battery B to ground G. Since the digit called is 2 the vertical magnet 64^a receives two impulses over the circuit just traced, operates to raise the shaft wipers two steps, and allows the off-normal springs 197 to close and connect battery to the release magnet 186. The private magnet relay 195 is energized by the first impulse to the vertical magnet and, being a slow relay, remains in its operated position until all impulses are delivered, when it again returns to normal. While in its operated position the relay 195 closes an energizing circuit from ground G^{19} through springs 198 and 199 and private magnet 200 to battery lead 184, thence through battery B to ground G. When the private magnet deënergizes after the operation of the vertical magnet it allows the side switch to pass from first to second position. The passage of side switch wiper 196 from first to second position shifts the battery connection from the vertical magnet to the rotary magnet 65^a, so that the rotary magnet may be operated for the second digit.

When the calling device is operated for the last digit 0 the line relay 64 operates in the same manner as for the third digit. Each time the relay 64 deënergizes for the last digit it closes a circuit from ground G^{18} through springs 188 and 190, 194 and 193, relay 195, springs 202 and 203, rotary magnet 65^a, contact point 201 and side switch wiper 196 to battery lead 184, thence through battery B to ground G. The rotary magnet 65^a thus receives ten impulses and operates to rotate the shaft wipers ten steps onto the tenth contacts of the second level, which contacts are the terminals of the desired line #2220. The private magnet relay 195, which is included in the energizing circuit of the rotary magnet 65^a, is energized by the first one of this last series of impulses and again closes the energizing circuit of the private magnet 200. The relay 195 deënergizes in the manner previously explained, and if the called line is idle the private magnet 200 in turn deënergizes and allows the side switch to pass from second to third position. If, however, the line #2220 is busy when called the connector side switch does not pass to third position, and the operator is given the busy signal in the following manner: Whenever a line is busy, by reason of either having made a call or by having been called, a guarding ground potential is present upon the connector private banks of that particular line. In the

case of busy calling lines this guarding potential is furnished by the line switch C′ in the same manner as the line switch C (Fig. 1) furnishes a guarding potential to the private normal conductor 93 of substation A. The guarding potential for busy called lines is furnished by the connector in a manner to be explained. Thus, it will be seen that when the connector wipers are rotated onto the contacts of a busy line, a ground potential is extended from the guarded private bank contact through the shaft wiper 63, side switch wiper 204, contact 205, relay springs 206 and 207 and relay 208 to the spring 209 of the private magnet relay 195. Now, when the private magnet relay deenergizes, the spring 199 engages the spring 209 before it breaks contact with the spring 198, thus substituting the ground from the private bank contact for ground G^{19} and maintaining the private magnet in its energized position, which locks the side switch in its second position, thus preventing the completion of connection with the busy line. The relay 208, which is included in this last holding circuit of the private magnet energizes and, by shifting the spring 207 out of contact with the spring 206 and into engagement with spring 210, transfers the holding ground of the private magnet from the guarded bank contact to the ground G^{18} at the line relay 64. This shifting of the holding ground is for the purpose of preventing two or more connectors being advanced to a busy line, and then all of them completing connection with the line if the guarding potential should be removed before the said connectors have been released. As long as the connector side switch is thus locked in second position the operator will receive the busy signal over a circuit extending from battery lead 184, through secondary winding of induction coil 211, relay springs 212 and 213, side switch wiper 214, ringer relay springs 215 and 216, condenser 217, thence over the heavy conductors through the operator's talking set and back to the connector, and through winding 183 of relay 64 to the starting point. Upon hearing the busy signal, the operator notifies the calling subscriber and, by removing the plug *p′*, causes the release of the switches, as will be explained later.

Returning now to that stage of the operation when the connector wipers had found the desired line, and before the private magnet relay 195 was energized, it will be explained how the connection is completed to an idle line. When the private magnet relay 195 deënergizes with the wipers resting on an idle line, it simply opens the energizing circuit of the private magnet 200. When the private magnet deënergizes, it allows the side switch to pass from second to third position, whereby, by means of wipers 218 and 214, connection is completed from trunk conductors 180 and 181, through condensers 217 and 218ª and shaft wipers 61 and 62 to the line conductors 81 and 82. When the side switch wiper 204 passes into third position, it extends a guarding potential from ground G^{20} to wiper 63, and thence to the connector private bank contacts of the called line. The side switch wiper 204 (in third position) also closes an energizing circuit for the cut-off relay 220ª of the line switch C′, which relay then energizes and disconnects the switch C′ from the called line.

When the side switch wiper 196 passes from second to third position it transfers the battery connection from the rotary magnet 65ª to the ringer relay 67. When the ringer relay is thus connected with battery, said relay begins to be intermittently energized over a circuit extending from ground G^{21} through interrupter 221, springs 222 and 223 of relay 65, ringer relay 67 and side switch wiper 196 to battery lead 184, thence through the battery B to ground G. Each time the relay 67 energizes it disconnects the calling line from the called line and bridges the ringer generator L across the called line for the purpose of ringing the bell at the called substation. As long as the side switch wiper 220 remains in first or second position the high resistance relay 66 is practically short-circuited by the relay 68, which has a very low resistance. However, as soon as the wiper 220 passes into third position the short-circuit is removed from relay 66, and said relay is then energized in series with the line relay 64 of the connector and relay 57 of the repeater H. As previously stated, the relay 66 is of high resistance, and consequently when it enters the circuit of relays 64 and 57 these two relays deënergize. In its deënergized position the relay 57 maintains the short-circuit of the resistance 175 and relay 34 of the cord circuit O. To prevent the release of the connector when the relay 64 deenergizes, the relay 66 is provided with two springs 224 and 225, which furnish a new holding ground for the release relay 187 when the relay 66 energizes. It is seen that the relay 68 energizes and lights the lamp 185 as soon as the connection is completed to the connector, but will be deënergized as soon as the side switch passes to third position. Thus, with normal operation of the connector the lamp 185 remains lighted only a short time. If, however, the trunk conductors 181 and 180 should become accidentally crossed, the lamp will glow continuously, indicating to the attendant that the trunk is in trouble.

As soon as the operator completes the connection the key K is restored to normal position, whereby the supervisory relay 33 is

bridged across the line in place of the operator's set. The relay 33 thereupon energizes in series with the line relay 55 of the repeater H, and operates to close a circuit through the lamp 226. This circuit extends from ground G^{22} through contact 227, armature 228, lamp 226, contact 229 and armature 230 to battery B.

When the subscriber at the called substation removes his receiver from the switch hook, that substation is provided with talking battery current over a circuit extending from ground G^{20} through side switch wiper 204, winding 231 of relay 65, ringer relay springs 216 and 215, side switch wiper 214, shaft wiper 62, line conductor 81, spring 78 and 80, primary of induction coil 72, transmitter 71, line conductor 82, shaft wiper 61, side switch wiper 218, ringer relay springs 233 and 234 and winding 232 of relay 65 to battery lead 184, thence through battery B to ground G. The relay 65 energizes upon the completion of this circuit, opens the circuit of the ringer relay 67 at a point between springs 222 and 223 and, by closing springs 191 and 235 into contact, connects the resistance 236 in multiple with the relay 66. The resistance 236 is comparatively low and permits enough current to flow through relay 64 to energize it. As soon as the spring 188 comes into contact with spring 189, upon energization of relay 64, the relay 66 becomes completely short-circuited and deënergizes. The short-circuit of relay 66 extends from ground G^{20a} through the said relay, springs 235 and 191, 189 and 188 to ground G^{18}. Since the winding 179 of relay 64 is now connected to ground direct through springs 235 and 191, 189 and 188, the relay 57 of the repeater H also receives sufficient current to energize. When the relay 57 energizes it separates springs 237 and 238, thus removing the short-circuit from the resistance 175 and the relay 34 of the cord circuit O. The relay 34 and the resistance 175 are thus included in multiple in the circuit of the release relays of the selectors. The relay 34 receives sufficient current over this circuit to energize and breaks the circuit of lamp 226 by separating armature 228 from contact 227. The extinguishing of lamp 226 signifies to the operator that the called subscriber has answered.

When the calling subscriber hangs up his receiver upon completion of the conversation, the energizing circuit of relays 95 (Fig. 1) and 28 (Fig. 2) is broken, causing the said relays to deënergize. The deenergization of relay 28 completes the circuit of the supervisory lamp 30, and the relay 95 causes the line switch C to be released in the following manner: When the relay 95 deënergizes, the spring 108 engages spring 94, whereby an energizing circuit is closed through the relay 244 and release magnet 19. This circuit extends from ground G^4 through springs 108 and 94, 247 and 248, relay 244, bank springs 14 and 13, and magnet 19 to battery B. The magnet 19, upon energizing, places the mechanism of the line switch C in position to withdraw the plunger from the bank upon the following deënergization of said magnet. The energization of relay 244 serves to break the circuit through itself and the magnet 19; resulting in the deënergization of the said magnet and consequent release of the switch C. When the line switch plunger is withdrawn from the bank, the separation of bank springs 14 and 13 serve to prevent further energization of the magnet 19 upon the deënergization of relay 244.

When the called subscriber hangs up his receiver the energizing circuit of the back-bridge relay 65 is broken and the said relay again deënergizes. When the springs 191 and 235 are separated by the deënergization of relay 65 the short-circuit is removed from the relay 66, and said relay is again included in the circuit of relays 64 and 57. When the relay 66 again enters the circuit the relay 57 deënergizes and short-circuits the relay 34 of the cord O, which in turn deenergizes and again closes the circuit of the lamp 226. The simultaneous glowing of lamps 30 and 226 signifies to the operator that the plugs p and p' may be removed from their jacks. When the plug p is removed from the jack j the circuit of relays 119 and 29 is broken and both relays return to normal position. When the plug p' is removed from the jack j' the relay 33 deenergizes and opens the circuit of lamp 226, and the release of the automatic switches is initiated in the following manner: When the plug p' is removed from the jack j' it also breaks the energizing circuit of the line relay 55 of the repeater H. The relay 55, upon deënergizing, opens the energizing circuit of the release relay 56 at a point between the springs 168 and 170 and, by separating springs 171 and 172, opens the energizing circuit of the relay 66 of the connector I. The relay 66, upon deënergizing, operates to open the circuit of the release relay 187. The relay 187, upon deënergizing, closes the energizing circuit of release magnet 186. This circuit extends from ground G^{18} through springs 188 and 190, 194 and 239, magnet 186 and off-normal springs 197 to battery lead 184, thence through battery B to ground G. The magnet 186 energizes upon completion of this circuit and restores the connector mechanism to normal position. When the switch shaft reaches its normal position the springs 197 are separated to allow the magnet 186 to deënergize. When the circuit of the relay 56 of the repeater H is opened it deenergizes and opens the circuit of the re-

lease relays 153 and 50 of the selectors F and E at a point between the springs 173 and 174. The relays 153 and 50 thereupon deënergize and operate to close the energizing circuit of the release magnet of their respective switches. The circuit of the release magnet 240 of the selector F extends from ground G^{12} through springs 150 and 151, 242 and 243, magnet 240 and off-normal springs 241 to battery lead 54, thence through the battery B to ground G. The release circuit for the switch E extends from ground G^{9} through springs 131 and 132, 134 and 135, release magnet 49 and off-normal springs 52 and 51 to battery lead 54, thence through battery B to ground G. The magnets 240 and 49, upon energizing, cause the release of the mechanism of their respective switches, and the said magnets are deënergized by the separation of the off-normal springs when the switch shafts reach normal position.

From the foregoing it will be seen that I provide a semi-automatic or combined manual and automatic trunking service between a calling manual subscriber and a called automatic subscriber, and that the said connection is supervised by the manual switchboard operator through the medium of a signal at the manual board, and by means of circuits controlled by the called subscriber, one of which circuits includes the two sides of the trunk line extending between the second selector and the connector. In this way the supervisory signal is transferred from the talking circuit to the third conductor or trunk-release circuit by the repeater H when the called subscriber answers, or when the called subscriber hangs up his receiver. When the called subscriber answers, the resistance 236 at the connector I is switched into circuit with the conductors of the two-wire trunk extending from the repeater to the connector, with the result that the relay 57 is deënergized. The deënergizing of this relay closes a short-circuit around the resistance 175 which is in series with the trunk-release conductors extending back from the repeater to the manual switchboard, whereby the relay 34 is energized. This, of course, serves to retire the supervisory signal 226 at the manual switchboard, advising the operator that the call is answered. When the called subscriber hangs up his receiver, then the operation is reversed, the resistance 236 being short-circuited to reduce the resistance of the trunk-release circuit, whereby the relay 57 is energized. This, of course, brings the resistance 175 into circuit with the trunk-release conductors, causing the deënergizing of the relay 34, which results in the closure of the local circuit through the supervisory lamp signal 226. The signal thus displayed indicates to the operator that the subscribers are through talking. With this arrangement the selectors can be at one station and the connector at another station, which stations are some distance apart, and only two-conductor trunks are necessary between said stations. Between the manual switchboard and the repeaters H, however, the trunk lines have third conductors for releasing purposes and for supervision as well. Thus the operator has complete supervision of a semi-automatic connection involving only a two-wire trunk between the connector and the selectors. The selectors and the manual switchboard can be at the same exchange, or the said switchboard can be at a distant exchange.

What I claim as my invention is:—

1. In a telephone system, a talking circuit including a plurality of trunk lines, means for transmitting a supervisory signal over a portion of the talking circuit, a supervisory circuit associated with one of said trunk lines, and means for transferring the signal from the talking circuit to said supervisory circuit.

2. In a telephone system, a talking circuit including a plurality of trunk lines, means for transmitting a supervisory signal over a portion of said circuit, a supervisory circuit, associated with one of said trunk lines, all portions of which are excluded from the path of the voice-currents, and means for transferring said signal from the talking circuit to said supervisory circuit.

3. In a telephone system, a manual switchboard, a three-conductor trunk line extending therefrom, a connector, a two-conductor trunk line extending to said connector, means for connecting the three-conductor trunk line with the two-conductor trunk line, means at the connector responsive to the called subscriber for transmitting a supervisory signal over the two-conductor trunk line, means for transferring the signal from the two-conductor trunk line to the third conductor of the other trunk line, which third conductor is excluded from the path of voice-currents, and a supervisory device located at said switchboard and responsive to said signal.

4. In a telephone system, a manual switchboard, a three-conductor trunk line extending from said switchboard, an automatic connector switch, a two-conductor trunk line extending to said connector switch, means including first and second selectors for extending connection from the three-conductor trunk line to the two-conductor trunk line, a repeater for the two-conductor trunk line, said repeater provided with means for controlling the connector over the said two-conductor trunk line, means for transmitting a supervisory signal over the two-conductor trunk line, said repeater provided with means for then transferring said signal to the third conductor of the other trunk line,

and a supervisory device located at said switchboard and responsive to said signal.

5. In a telephone system, a manual switchboard, a trunk leading to said board, a calling subscriber's line, means for automatically connecting the subscriber's line with said trunk, said trunk having only two conductors, a three-conductor trunk leading from said switchboard, means by which an operator connects the two-conductor trunk with the three-conductor trunk, a called subscriber's line, means including selectors and a connector for finding the called line, there being a two-conductor trunk leading to the said connector, means for transmitting a supervisory signal over the last-mentioned two-conductor trunk, means for then transferring the signal to the third conductor of the three-conductor trunk, means at said switchboard for receiving said signal, means for transmitting a supervisory signal over the first-mentioned two conductor trunk, and a supervisory device of said switchboard responsive to this signal.

6. In a telephone system, a trunk line having talking and a third conductor, a repeater provided with a resistance, a relay for switching said resistance into circuit with said third conductor, and with another relay for controlling a short-circuit around said resistance.

7. In a telephone system, a trunk line, an automatic connector switch provided with a resistance, a relay for switching said resistance into circuit with a talking conductor of said trunk line, and another relay for controlling a short-circuit around said resistance.

8. In a telephone system, a trunk line having only two conductors, a trunk line having more than two conductors, means for transmitting a supervisory signal over the two-conductor trunk line, means for transferring the signal from the two-conductor trunk line to a conductor of the other trunk line which is not in the path of the voice-currents, and means for receiving said signal.

9. In a telephone system, a called subscriber's line, an automatic connector switch for finding the called line, a trunk line having only two conductors leading to said connector switch, means for transmitting a supervisory signal over a talking conductor of said trunk line, another trunk line, and means for transferring the signal from said first trunk line to a conductor of the other trunk line which is not in the path of the voice-currents.

10. In a telephone system, a called subscriber's line, an automatic connector switch for finding said line, a trunk line leading to said connector switch, means controlled by the called subscriber for transmitting a supervisory signal over the two sides of said trunk line in series, another trunk line provided with more than two conductors, means for transferring said signal from said first trunk line to a conductor of said other trunk line which is not in the path of the voice-currents, and means for receiving said signal.

11. In a telephone system, a manual switchboard, a three-conductor trunk line extending therefrom, a connector, a two-conductor trunk line extending to said connector, means for connecting the three-conductor trunk line with the two-conductor trunk line, means at the connector responsive to the called subscriber for transmitting a supervisory signal over the two-conductor trunk line, means for transferring the signal from the two-conductor trunk line to the third conductor of the other trunk line, which third conductor is excluded from the path of voice-currents, a supervisory device located at said switchboard and responsive to said signal, a battery with connections at said manual switchboard for supplying talking current to the calling subscriber, and another battery for supplying current to the called subscriber.

12. In a telephone system, a manual switchboard, a three-conductor trunk line extending from said switchboard, an automatic connector switch, a two-conductor trunk line extending to said connector switch, means including first and second selectors for extending connection from the three-conductor trunk line to the two-conductor trunk line, a repeater for the two-conductor trunk line, said repeater provided with means for controlling the connector over the said two-conductor trunk line, means for transmitting a supervisory signal over the two-conductor trunk line, said repeater provided with means for then transferring said signal to the third conductor of the other trunk line, a supervisory device located at said switchboard and responsive to said signal, a battery with connections at said manual switchboard for supplying talking current to the calling subscriber, and another battery for supplying current to the called subscriber.

13. In a telephone system, a manual switchboard, a trunk leading to said board, a calling subscriber's line, means for automatically connecting the subscriber's line with said trunk, said trunk having only two conductors, a three-conductor trunk leading from said switchboard, means by which an operator connects the two-conductor trunk with the three-conductor trunk, a called subscriber's line, means including selectors and a connector for finding the called line, there being a two-conductor trunk leading to the said connector, means for transmitting a supervisory signal over the last-mentioned two-conductor trunk, means for then transferring the signal to the third conductor of

the three-conductor trunk, means at said switchboard for receiving said signal, means for transmitting a supervisory signal over the first-mentioned two-conductor trunk, a supervisory device at said switchboard responsive to this signal, a battery with connections at said manual switchboard for supplying talking current to the calling subscriber, and another battery for supplying current to the called subscriber.

14. In a telephone system, a manual switchboard, means including a connector for completing a calling connection through the board to the line of a called subscriber, there being a two-conductor trunk line leading to said connector, a supervisory circuit including the two sides of said trunk line in series, means by which the called subscriber controls said circuit, a supervisory device located at said switchboard and responsive to said signal, a battery with connections leading through said connector for supplying talking current to the called subscriber, and another battery for supplying current to the calling subscriber.

15. In a telephone system, an automatic connector switch, a trunk line having only two conductors which lead to said connector switch, means controlled by the called subscriber for transmitting a supervisory signal over said trunk line, suitable means for receiving said signal, a battery with connections leading through said connector switch for supplying talking current to the called subscriber, and another battery for supplying current to the calling subscriber.

16. In a telephone system, a manual switchboard, a three-conductor trunk line extending therefrom, a connector, a two-conductor trunk line extending to said connector, means for connecting the three-conductor trunk line with the two-conductor trunk line, means at the connector responsive to the called subscriber for transmitting a supervisory signal over the two-conductor trunk line, means for transferring the signal from the two-conductor trunk line to the third conductor of the other trunk line, which third conductor is excluded from the path of voice-currents, a supervisory device located at said switchboard and responsive to said signal, a battery with connections leading through said connector for supplying talking current to the called subscriber, and another battery for supplying current to the calling subscriber.

17. In a telephone system, a manual switchboard, a three-conductor trunk line extending from said switchboard, an automatic connector switch, a two-conductor trunk line extending to said connector switch, means including first and second selectors for extending connection from the three-conductor trunk line to the two-conductor trunk line, a repeater for the two-conductor trunk line, said repeater provided with means for controlling the connector over the said two-conductor trunk line, means for transmitting a supervisory signal over the two-conductor trunk line, said repeater provided with means for then transferring said signal to the third conductor of the other trunk line, a supervisory device located at said switchboard and responsive to said signal, a battery with connections leading through said connector switch for supplying talking current to the called subscriber, and another battery for supplying current to the calling subscriber.

18. In a telephone system, a manual switchboard, a trunk leading to said board, a calling subscriber's line, means for automatically connecting the subscriber's line with said trunk, said trunk having only two conductors, a three-conductor trunk leading from said switchboard, means by which an operator connects the two-conductor trunk with the three-conductor trunk, a called subscriber's line, means including selectors and a connector for finding the called line, there being a two-conductor trunk leading to the said connector, means for transmitting a supervisory signal over the last-mentioned two-conductor trunk, means for then transferring the signal to the third conductor of the three-conductor trunk, means at said switchboard for receiving said signal, means for transmitting a supervisory signal over the first-mentioned two-conductor trunk, a supervisory device at said switchboard responsive to this signal, a battery with connections leading through said connector for supplying talking current to the called subscriber, and another battery for supplying current to the calling subscriber.

19. In a telephone system, means for establishing a connection between a calling and a called subscriber's line, said means including a trunk line, an automatic connector switch provided with a resistance, a relay for switching said resistance into circuit with a talking conductor of said trunk line, another relay for controlling a short-circuit around said resistance, a battery with connections leading through said connector switch for supplying talking current to the called subscriber, and another battery for supplying current to the calling subscriber.

20. In a telephone system, means for establishing a connection between a calling and a called subscriber's line, said means including an automatic connector switch for finding the called line, a trunk line having only two conductors leading to said connector switch, means for transmitting a supervisory signal over a talking conductor of said trunk line, another trunk line, means for transferring the signal from said first

trunk line to a conductor of the other trunk line which is not in the path of the voice-currents, a battery with connections leading through said connector switch for supplying talking current to the called subscriber, and another battery for supplying current to the calling subscriber.

21. In a telephone system, means for establishing a connection between a calling and a called subscriber's line, said means including an automatic connector switch for finding said line, a trunk line leading to said connector switch, means controlled by the called subscriber for transmitting a supervisory signal over the two sides of said trunk line in series, another trunk line provided with more than two conductors, means for transferring said signal from said first trunk line to a conductor of said other trunk line which is not in the path of the voice-currents, means for receiving said signal, a battery with connections leading through said connector switch for supplying talking current to the called subscriber, and another battery for supplying current to the calling subscriber.

22. In a telephone system, a manual switchboard, means including a connector for completing a calling connection through the board to the line of a called subscriber, there being a two-conductor trunk line leading to said connector, a supervisory circuit including the two sides of said trunk line in series, means by which the called subscriber controls said circuit, a supervisory device located at said switchboard and responsive to said signal, and a calling mechanism for controlling the two sides of said trunk line in series to control said connector.

23. In a telephone system, an automatic connector switch, a trunk line having only two conductors which lead to said connector switch, means controlled by the called subscriber for transmitting a supervisory signal over said trunk line, a supervisory device for receiving said signal, and a calling mechanism for controlling the two sides of said trunk line in series to control said connector switch.

24. In a telephone system, a manual switchboard, a three-conductor trunk line extending therefrom, a connector, a two-conductor trunk line extending to said connector, means for connecting the three-conductor trunk line with the two-conductor trunk line, means at the connector responsive to the called subscriber for transmitting a supervisory signal over the two-conductor trunk line, means for transferring the signal from the two-conductor trunk line to the third conductor of the other trunk line, which third conductor is excluded from the path of voice-currents, a supervisory device located at said switchboard and responsive to said signal, and a calling mechanism for controlling the two sides of said trunk line in series to control said connector.

25. In a telephone system, a manual switch-board, a three-conductor trunk line extending from said switchboard, an automatic connector switch, a two-conductor trunk line extending to said connector switch, means including first and second selectors for extending connection from the three-conductor trunk line to the two-conductor trunk line, a repeater for the two-conductor trunk line, said repeater provided with means for controlling the connector over the said two-conductor trunk line, means for transmitting a supervisory signal over the two-conductor trunk line, said repeater provided with means for then transferring said signal to the third conductor of the other trunk line, a supervisory device located at said switchboard and responsive to said signal, and a calling mechanism for controlling the two sides of said trunk line in series to control said connector switch.

26. In a telephone system, a manual switch-board, a trunk leading to said board, a calling subscriber's line, means for automatically connecting the subscriber's line with said trunk, said trunk having only two conductors, a three-conductor trunk leading from said switchboard, means by which an operator connects the two-conductor trunk with the three-conductor trunk, a called subscriber's line, means including selectors and a connector for finding the called line, there being a two-conductor trunk leading to the said connector, means for transmitting a supervisory signal over the last-mentioned two-conductor trunk, means for then transferring the signal to the third conductor of the three-conductor trunk, means at said switchboard for receiving said signal, means for transmitting a supervisory signal over the first-mentioned two-conductor trunk, a supervisory device at said switchboard responsive to this signal, and a calling mechanism for controlling the two sides of said trunk line in series to control said connector.

27. In a telephone system, means for establishing a connection between a calling and a called subscriber's line, said means including a trunk line, an automatic connector switch provided with a resistance, a relay for switching said resistance into circuit with a talking conductor of said trunk line, another relay for controlling a short-circuit around said resistance, a metallic line circuit, and a calling mechanism for controlling the two sides of said metallic line circuit in series to control said connector switch.

28. In a telephone system, means for establishing a connection between a calling and a called subscriber's line, said means

including an automatic connector switch for finding the called line, a trunk line having only two conductors leading to said connector switch; means for transmitting a supervisory signal over a talking conductor of said trunk line, another trunk line, means for transferring the signal from said first trunk line to a conductor of the other trunk line which is not in the path of the voice-currents, a metallic line circuit, and a calling mechanism for controlling the two sides of said metallic line circuit in series to control said connector switch.

29. In a telephone system, means for establishing a connection between a calling and a called subscriber's line, said means including an automatic connector switch for finding said line, a trunk line leading to said connector switch, means controlled by the called subscriber for transmitting a supervisory signal over the two sides of said trunk line in series, another trunk line provided with more than two conductors, means for transferring said signal from said first trunk line to a conductor of said other trunk line which is not in the path of the voice-currents, means for receiving said signal, a metallic line circuit, and a calling mechanism for controlling the two sides of said metallic line circuit in series to control said connector switch.

30. In a telephone system, a manual switchboard, a three-conductor trunk line extending from said switchboard, an automatic connector switch, a two-conductor trunk line extending to said connector switch, means including first and second selectors for extending connection from the three-conductor trunk line to the two-conductor trunk line, a repeater for the two-conductor trunk line, said repeater provided with means for controlling the connector over the said two-conductor trunk line, means for transmitting a supervisory signal over the two-conductor trunk line, said repeater provided with means for then transferring said signal to the third conductor of the other trunk line, a supervisory device located at said switchboard and responsive to said signal, and a calling mechanism for controlling the two sides of said trunk line in series to control said selectors.

31. In a telephone system, a manual switchboard, a trunk leading to said board, a calling subscriber's line, means for automatically connecting the subscriber's line with said trunk, said trunk having only two conductors, a three-conductor trunk leading from said switchboard, means by which an operator connects the two-conductor trunk with the three-conductor trunk, a called subscriber's line, means including selectors and a connector for finding the called line, there being a two-conductor trunk leading to the said connector, means for transmitting a supervisory signal over the last-mentioned two-conductor trunk, means for then transferring the signal to the third conductor of the three-conductor trunk, means at said switchboard for receiving said signal, means for transmitting a supervisory signal over the first-mentioned two-conductor trunk, a supervisory device at said switchboard responsive to this signal, and a calling mechanism for controlling the two sides of said trunk line in series to control said selectors.

32. In a telephone system, an automatic connector switch, a trunk line having only two conductors leading to said switch, a manual switchboard, automatic means controlled by the operator for extending connection from said switchboard to said trunk line, means at said board for controlling said connector over a metallic circuit to find the line of the called subscriber, and means at said switchboard for supervising said connection.

33. In a telephone system, an automatic connector switch, a trunk line having only two conductors leading to said connector switch, a repeater provided with means for controlling the two sides of said trunk line in series to control said connector, a manual switchboard, means for connecting said switchboard with the said trunk line, and means at said switchboard for controlling said repeater to control the connector switch.

Signed by me at Chicago, Cook county, Illinois, this 26 day of January, 1910.

EDWARD A. MELLINGER.

Witnesses:
EDWARD D. FALES,
ARTHUR J. RAY.