

T. G. MARTIN.

TRUNKING AND SUPERVISORY SYSTEM.

APPLICATION FILED DEC. 10, 1910. RENEWED JULY 8, 1918.

Patented Jan. 14, 1919.

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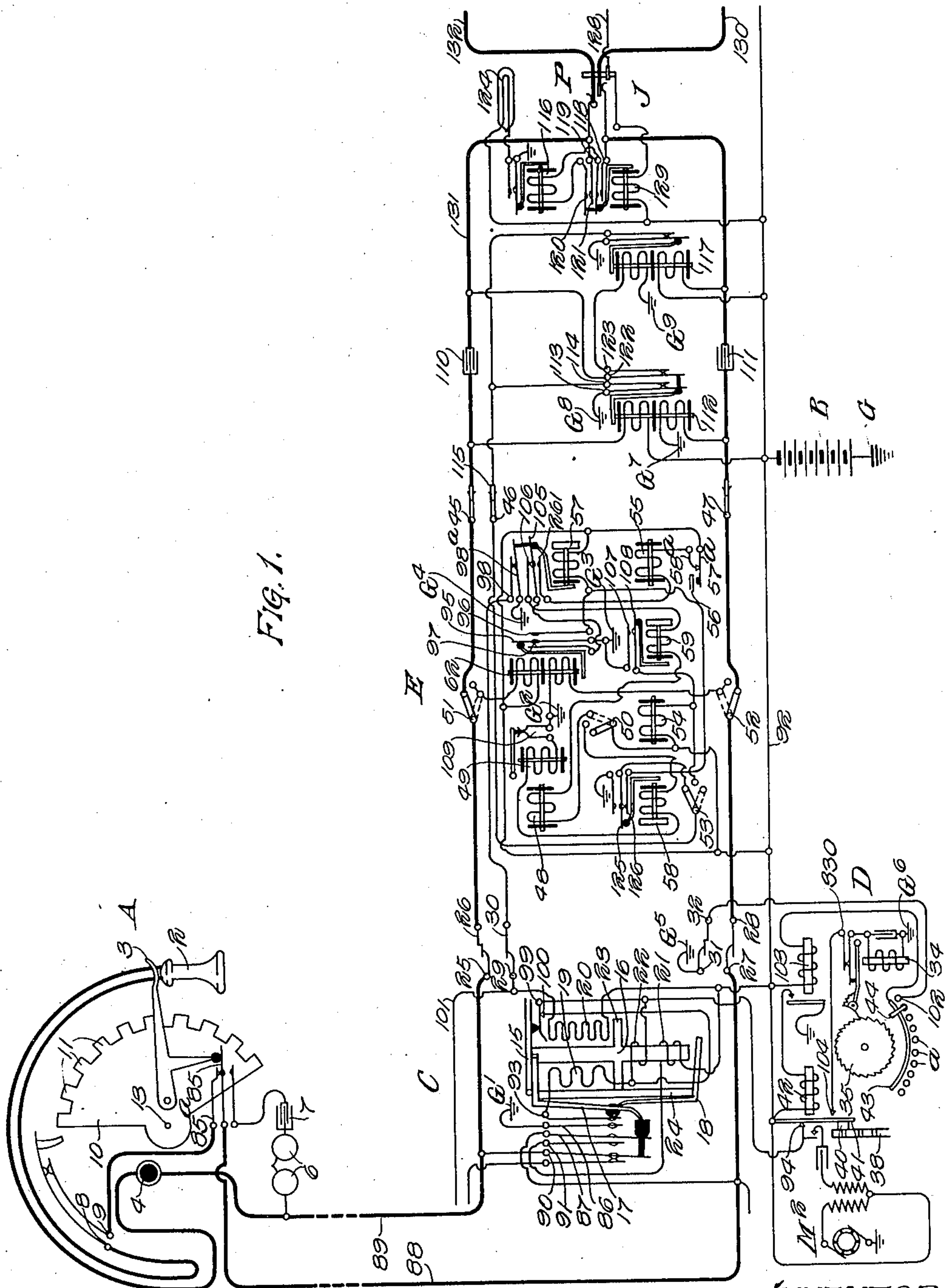


Fig. 1.

WITNESSES

A. Andersen.

A. J. Ray

INVENTOR:

Talbot G. Martin

By Bulkley & Durand

ATTORNEYS,

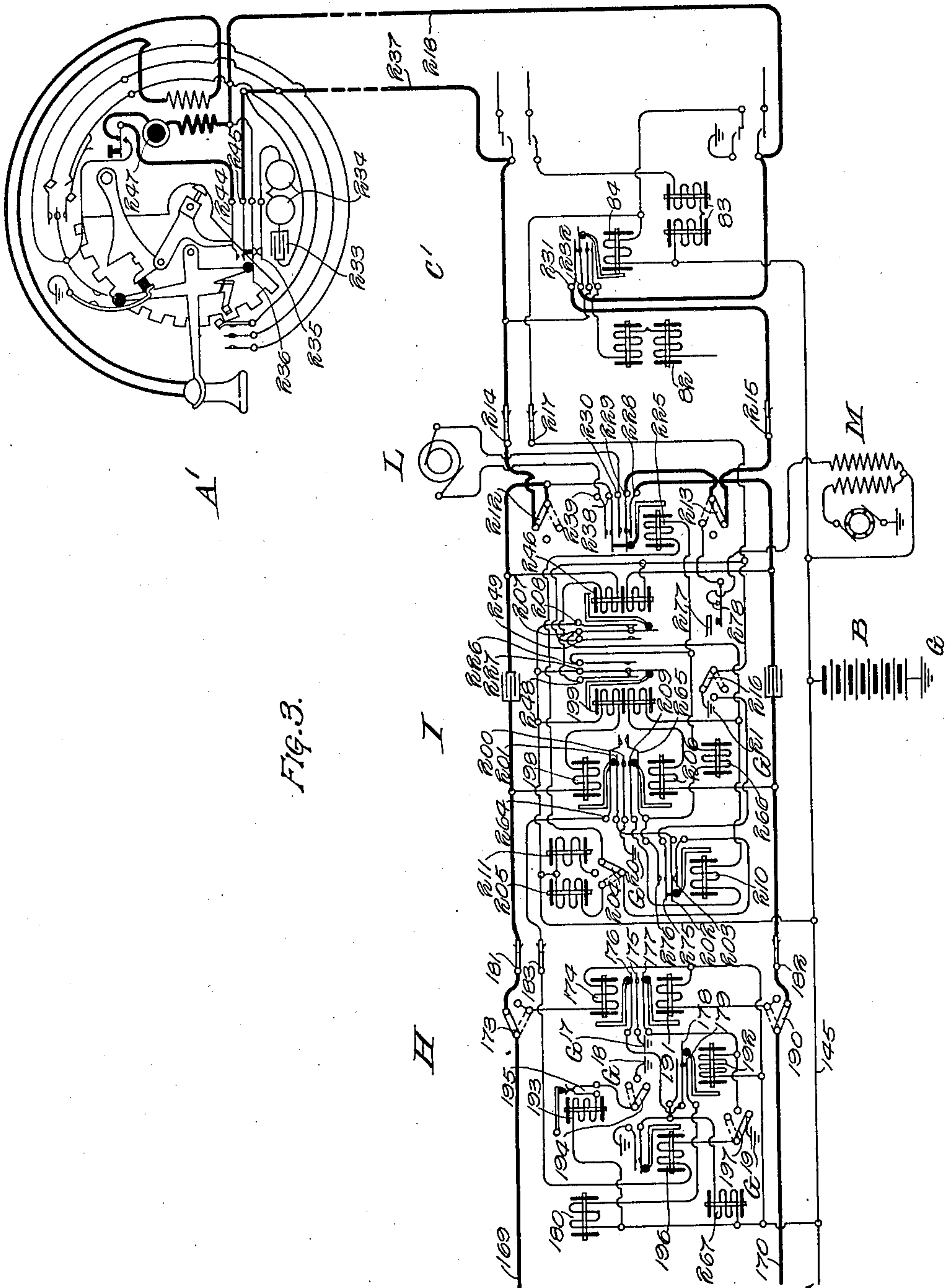
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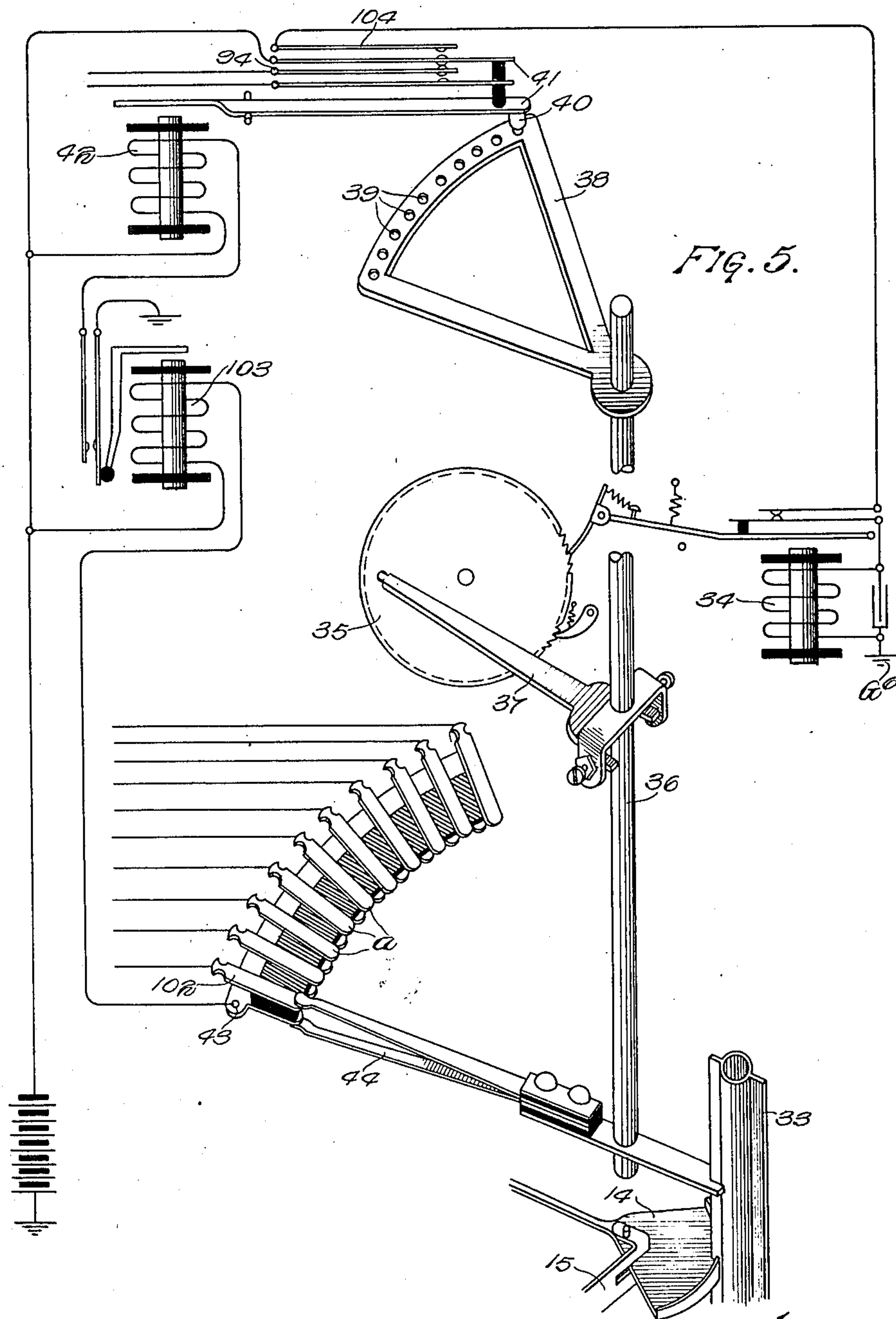


A. Andersen.

A. J. Ray

INVENTOR:

Talbot G. Martin
By Buckley & Durand
ATTORNEYS,



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Talbot G. Martin
By Buckley & Brand
ATTORNEYS.

UNITED STATES PATENT OFFICE

TALBOT G. MARTIN, OF CHICAGO, ILLINOIS, ASSIGNOR TO AUTOMATIC ELECTRIC COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TRUNKING AND SUPERVISORY SYSTEM.

1,291,586.

Specification of Letters Patent.

Patented Jan. 14, 1919.

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To all whom it may concern:

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

My invention relates to telephone systems of that particular character in which automatic switches are employed, such as selectors and connectors, and in which some of said switches are also capable of repeating impulses to other switches. Systems of this kind are sometimes two-wire and sometimes three-wire; and by this I mean that in some cases the switches are operated by controlling the two sides of the calling line in series, in which case the system is known as a two-wire system, while in others the switches are controlled by grounding the line at the calling substation, in which case the system is known as a three-wire system. My invention relates to systems including both modes of operation.

The principal object of my invention is to provide a combined selector and repeater for connecting a two-wire system with a three-wire system, and for controlling the apparatus of the three-wire system to extend connection to the called subscriber's line, the said combined selector and repeater being controlled over the two sides of the calling line in series, whereby the said selector and repeater serves as the medium of connection and control between exchange apparatus of one type and some of another type.

It is also an object to provide an improved arrangement for supervising a connection by reversing the current in the said circuit of a manual switchboard when the called subscriber answers.

Another object is to provide a combined selector and repeater that is controlled over the two sides of the calling line in series, and that will automatically ground one side of the line or talking circuit to cause an automatic signaling of the called subscriber.

A further object is to provide a combined selector and repeater which will, when the called subscriber answers, reverse the current in the direction of the calling subscriber for any useful purpose.

It is also an object to provide certain novel features and combinations tending to increase the general efficiency of a telephone exchange system of this particular character.

To the foregoing and other useful ends my invention consists in matters hereinafter set forth and claimed.

In the accompanying drawings Figures 1, 2 and 3 taken together represent a complete circuit connection between a calling substation A (Fig. 1) and a called substation A' (Fig. 3) of two different automatic exchanges, in a system embodying the principles of my invention.

Fig. 4 represents diagrammatically an automatic connector switch of said system.

Fig. 5 is a diagrammatic representation of the essential features of the so-called master switch D (Fig. 1) of said system.

In Fig. 1 there is shown a line switch C which is individual to the line of substation A. A group of these line switches is controlled by a common mechanism or master switch D. All of the line switches which are controlled by the master switch D have common access to a number of trunk lines leading to selector switches E. These selector switches have access to a number of trunk lines, some of which lead to operators' jacks J. The automatic switches shown in Fig. 1 are of the so-called two-wire type—that is, the kind which are controlled from the calling substation over the two sides of the line in series. At O (Figs. 1 and 2) is represented an operator's cord circuit. At F (Fig. 2) is shown a combined selector and repeater. In Fig. 3 there is shown a selector switch H, connector I, line switch C' and substation A'. The switches H and I (Fig. 3) are of the so-called three-wire type—that is, the type which is controlled from the calling station by impulses over the two sides of the line separately. The connector switch I', Fig. 4, is of the two-wire type.

In the various drawings a number of ringing machines L and L' are represented and also a number of busy signaling machines M, M' and M², each comprising a current interrupter and induction coil, as shown, for supplying the necessary current. For operating the switches and for talking purposes several batteries B are shown hav-

ing one terminal grounded at G. There need be but one battery, however, or preferably one battery in each exchange.

The two-wire substation A, Fig. 1, comprises the usual receiver 2, switch hook 3, transmitter 4, ringer 6 and condenser 7. Since it is an automatic substation it is also provided with the impulse springs 8 and 9 and an impulse wheel 10 which carries upon its periphery a number of impulse teeth 11 and is secured to a shaft 13 to which there is also attached a dial (not shown) provided with finger holes. The teeth 11 on the impulse wheel 10 are so arranged that as they are rotated forward to call any digit the springs 8 and 9 are not affected; but as the impulse wheel returns to normal position the springs 8 and 9 are separated by the teeth 11 a number of times corresponding to the digit called. The line switch C, Fig. 1, which is individual to the line of substation A, and the master switch D are modified forms of the general types of line and master switches disclosed in the British Patent No. 26,301 of 1906, and in the *American Telephone Journal*, of New York, N. Y., of June 6, 1908. As herein represented, the line switch C comprises, among other details, a plunger 14 (Fig. 5) attached to the end of a so-called plunger arm 15 which is controlled by the magnet 16. The magnet 16 also controls the relay armatures 17 and 18, and is composed of four windings, namely, a pull-in winding 19, a holding or cut-off winding 20, line winding 21 and auxiliary winding 22. The core of the magnet is provided near the center of its length with a lateral projection 23, by means of which the magnet is attached to the bracket 24, upon which the armatures 17 and 18 are pivoted. With this method of mounting the magnet the magnetic circuit of the windings 19 and 20 is maintained separate from that of the windings 22 and 21, so that the armatures on one end of the magnet are not affected by the energization of the windings upon the other end. Of the two windings upon the upper end of the magnet only the winding 19 is strong enough to attract the plunger arm 15 from its normal position. Although the winding 20 is not strong enough to operate the plunger arm, it will hold it in its operated position after it has once been drawn down by the winding 19. When the plunger arm is attracted by the magnet 16, the plunger of the switch is forced into the bank of contact springs, forcing the springs 25, 27, 29 and 31 into engagement with the springs 26, 28, 30 and 32, respectively. Although only one set of springs (25—32) is shown, each line switch C is provided with a number of such groups of springs, each group forming the terminal of a trunk line leading to a selector E. Each trunk line is connected in multiple to the

corresponding springs of all the line switches of the group which is controlled by the master switch D. The plungers of the line switches of this group normally engage the plunger shaft 33 (Fig. 5), and through the medium of the master switch D are normally maintained opposite the terminal of an idle trunk line. The master switch consists essentially of a motor magnet 34 for rotating the ratchet wheel 35. The ratchet wheel 35 is so connected with the shaft 36 by means of a link 37 that a rotary motion of the ratchet wheel is transmitted to the plunger shaft 33, imparting to it an oscillatory motion about the shaft 36, so as to move the idle plungers back and forth in front of their trunk terminals. To the shaft 36 there is secured a locking plate 38 provided on its outer edge with a number of openings 39 which are adapted to be engaged by the pin 40 upon the end of the armature 41 of the relay 42. The openings in the plate 38 are so spaced that the pin 40 can engage one of them only when the plungers that are in locking engagement with the plunger shaft are directly in front of the corresponding trunk terminal. The master switch is also provided with a bank of contacts comprising a common segment 43 and one individual segment *a* for each trunk to which the line switches have access. The wiper 44 always keeps the common segment in electrical connection with the individual segment corresponding to the trunk line before which the idle plungers are being held by the master switch.

The 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, being modified, however, in order to operate in a two-wire system. Among its essential details, the selector E comprises the usual line and private wipers 45, 47 and 46 carried upon a shaft (not shown) which has a vertical motion controlled by the vertical magnet 48 and a rotary motion controlled by the rotary magnet 49. The side switch comprising the wipers 50, 51, 52 and 53 is controlled by the private magnet 54 in the usual manner. The release magnet 55 is connected with the battery only when the switch shaft is raised one or more steps from its lowest position, whereby the arm 56 permits the spring 57^a to engage spring 58^a. The shaft and side switch of the selector E are restored to normal position immediately upon the energization of the release magnet, rather than by its deenergization as shown in said selector patent. The operation of the switch is controlled from the calling substation through the double wound line relay 62. The relays 57, 58 and 59 deenergize slowly after their energizing circuits have been broken. This slow action may be accomplished by securing

a ring of copper or other conducting material around one end of the core. The selector is also provided with a bank of contacts which are adapted to be engaged by the wipers 45, 46 and 47.

The operator's cord O (Figs. 1 and 2) is similar to the usual type of cord circuit used in manual switchboard practice, the supervisory circuits being modified, however, to operate in the system disclosed herein. The cord is provided with an automatic calling device similar to that at the substation A and represented diagrammatically by a pair of impulse springs 60 and 61. The supervisory relay 63 is an ordinary polarized relay—that is, it will attract its armature in a direction to close contact between the springs 64 and 65 only when the current flows through it in a particular direction.

The selector-repeater F combines the functions of a selector and a repeater—that is, it operates in response to the impulses for one digit to select a trunk line, and in response to the impulses for the remaining digits to repeat impulses over this trunk line to succeeding switches. The essential features of the selector F are very similar to those of the selector E (Fig. 1), with the addition of a number of relays which are required for the additional function of repeating impulses. Like the selector E, the selector F is adapted to be controlled over the two sides of the line in series, but repeats impulses over the two sides of the trunk line separately. Therefore, the switch F is in the nature of a so-called two-wire selector and two-wire to three-wire repeater. It comprises the usual line and private wipers 66, 67 and 68, vertical magnet 69, rotary magnet 70, private magnet 71 and a side switch comprising the wipers 72, 73, 74, 75 and 76. The switch F is also provided with an auxiliary magnet 77 which operates the ratchet wheel 78. This ratchet wheel 78 so controls a pair of springs 79 that said springs are permitted to come into contact every time the wheel is rotated four steps by the magnet 77. The talking circuit through the selector-repeater contains the condensers 80 and 81.

The selector H (Fig. 3) is similar to the selector described in the said selector Patent No. 815,321, and, like it, is adapted to be operated over the two sides of the line separately. The connector I is of the general type of connector switch disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, the circuits being modified somewhat in order to operate in a common battery system. The line switch C' is of the general type of line switch disclosed in the *American Telephone Journal*, of New York, N. Y., of June 6, 1908, and comprises the usual trip magnet 82, release magnet 83 and cut-off relay 84. The line switch C', together with a

number of other similar switches, is controlled by a master switch similar to the master switch D (Fig. 1). The connector I' (Fig. 4) is similar to the connector I, being modified, however, to operate in a two-wire system.

Having given a general description of the apparatus, I will now explain in detail the operation by which the subscriber at substation A of the two-wire exchange may obtain connection with the substation A' of the three-wire exchange. The switches C and E must first be operated to signal the operator at the cord O, after which connection is completed by said operator through the switches F, H and I to the required substation. The switch C is operated immediately upon the removal of the receiver at the substation A in the following manner: The removal of said receiver permits the switch hook to rise, thereby permitting the spring 85 to engage the spring 85^a, whereby a circuit is completed through the line winding 21 of the line switch C. This circuit extends from ground G' through the springs 86 and 87, line conductor 88, springs 85 and 85^a, impulse springs 9 and 8, receiver 2, transmitter 4, line 89, springs 90 and 91 and line winding 21 to the battery lead 92, thence through the battery B to ground G. The winding 21, upon energizing, attracts the armature 18, which forces the spring 93 into engagement with the spring 86, thereby completing a circuit from ground G' through the springs 86 and 93, windings 19 and 22, contact point 94 and armature 41 to the battery lead 92. The winding 19, upon energizing, attracts the plunger arm 15 and cut-off armature 17. The attraction of the plunger arm 15 causes the line connection to be extended through the springs 25 and 26 and 27 and 28 to the selector E, whereupon the line relay 62 becomes energized over a circuit extending from ground G² through the lower winding of said relay, side switch wiper 52, springs 28 and 27, line 88, thence through the substation A and back over the line 89, springs 25 and 26, side switch wiper 51 and through the upper winding of the relay 62 to the battery lead. The relay 62, upon energizing, operates to complete a circuit extending from ground G³ through the springs 95 and 96 and relay 57 to the battery lead 92. The relay 57, upon energizing, operates to connect the relay 59 with the impulse spring 97 of the relay 62, and to complete a holding circuit for the winding 20 of the line switch C. This circuit extends from ground G⁴ through the springs 98^a and 98, 30 and 29 and winding 20 to the battery lead 92. The energization of the winding 20 serves to hold the plunger arm 15 and cut-off armature 19 in their operated positions after the circuit of the pull-in winding 19 has been broken by the falling back of

the armature 18. The circuit of the line winding 21 by which the armature 18 was attracted is broken as soon as the cut-off armature 17 is pulled up, but the armature 18 is held in its operated position for an instant thereafter, due to the fact that the auxiliary winding 22 is short-circuited at the springs 99 and 100 by the plunger arm, and therefore caused to deenergize slowly. This insures that the circuit of the winding 20 shall be closed before the plunger arm has time to fall back upon the deenergization of the winding 19. The energization of the relay 57 of the selector E also extends a guarding potential from ground G^4 to and through the line switch bank springs 30 and 29, and over the private normal conductor 101 to the connector private bank contacts of the calling line, to prevent said line from being interfered with while it is in use.

The engagement of the springs 31 and 32 upon the operation of the line switch C completes a circuit from ground G^5 through said springs 31 and 32, contact point 102 (which corresponds to the trunk line leading to the selector E), wiper 44 and relay 103 to the battery lead 92. The relay 103, upon energizing, completes a circuit through the relay 42. The relay 42, upon energizing, operates to withdraw the pin 40 from the locking plate 38, and to close a circuit through the motor magnet 34. This circuit extends from ground G^6 through the magnet 34, interrupter springs 330, contact point 104 and armature 41 to the battery lead. The magnet 34 thereupon begins to operate in a manner similar to that of a buzzer to advance the idle plungers away from the trunk seized by the switch C. After the plungers have been advanced a short distance the wiper 44 passes off the contact 102, thereby breaking the circuit of the relay 103, which deenergizes and in turn breaks the energizing circuit of the relay 42. The armature 41 does not fall back immediately upon the deenergization of the relay 42 because the opening in the plate 38 which was engaged by the pin 40 has moved out of register therewith. Therefore, the armature 41 remains in contact with the contact point 104, and the magnet 34 continues to advance the plungers until the next opening in the plate passes under the pin 40. If the next trunk is idle, the pin 40 drops into this opening and allows the circuit of the magnet 34 to be broken. If this next trunk is busy, however, the wiper 44 will find a guarding ground potential upon a corresponding bank contact, causing the relays 103 and 42 to remain energized while the opening in the plate 38 is passing beneath the pin 40, and the plungers will be carried past the busy trunk line to an idle one. While the master switch is operating, the armature 41 is disengaged from the contact point 94,

thereby disconnecting the pull-in winding 19 of the line switch C and the battery lead 92, thus making it impossible for any line switch to be operated while its plunger is being moved from one trunk to another.

It will be assumed that the trunks leading to the jacks J are connected with the second row or level of the bank contacts of the selector E, and, therefore, in order to signal the operator the calling subscriber must operate his calling dial for the digit 2. The operation of the dial for said digit causes the springs 8 and 9 to be momentarily separated twice. Each time these springs are separated, the energizing circuit of the selector line relay 62 is broken momentarily. Since the relay 57 is slow acting it does not have time to deenergize during the momentary interruption of this circuit by the operations of the relay 62 in response to these impulses, and, therefore, each time the relay 62 deenergizes, a circuit is closed from ground G^3 through the springs 95 and 97, 105 and 106, relay 59, vertical magnet 48 and side switch wiper 50 to the battery lead 92. Since the digit called is 2, the vertical magnet receives two impulses over this circuit, operating to raise the shaft wipers two steps to a position opposite the second row of bank contacts. The relay 59, which is included in the energizing circuit of the vertical magnet, is energized by the first impulse, and, being a slow-acting relay, does not deenergize until after the last impulse has been delivered. In its energized position the relay 59 completes a circuit from ground G^3 through the springs 107 and 108 and private magnet 54 to the battery lead 92. When this circuit is broken by the deenergization of the relay 59, after the last impulse is delivered to the vertical magnet, the private magnet deenergizes and permits the side switch to pass from first to second position.

The movement of the side switch wiper 50 from first to second position disconnects the battery from the vertical magnet 48 and completes a circuit through the rotary magnet 49. This circuit extends from ground G^2 through the interrupter springs 109, magnet 49, relay 58 and side switch wiper 50 to the battery lead 92. Since this circuit includes the interrupter springs 109, the rotary magnet 49 will continue to operate in a manner similar to that of a buzzer to rotate the wipers step by step as long as the side switch remains in second position. When the rotary magnet energizes, its armature presses down the armature of the private magnet 54, and if the first trunk line upon which the wipers are rotated is not busy, the armature of the private magnet falls back as soon as the rotary magnet deenergizes the first time, and permits the side switch to pass to third position. If the first trunk is

energizes and permits the side switch to pass to second position. In second position the side switch wiper 76 completes the circuit of the rotary magnet 70, which circuit extends from ground G^{13} through the interrupter springs 154, rotary magnet 70 and side switch wiper 76 to the battery lead. The rotary magnet then operates in the same manner as explained for the magnet 49 of the selector E to rotate the wipers onto the contacts of an idle trunk line leading to the selector H (Fig. 3). The relays 134 and 144 are not disconnected from the line when the side switch passes to third position, but remain energized over the same circuit over which they were originally energized. As soon as the side switch passes to third position, the seized trunk is protected from interference by a guarding potential extending from ground G^{14} through the side switch wiper 73 and private wiper 68 to the private bank contacts in all of the selectors which have access to the said trunk.

When the operator's calling device is operated for the second digit 2, the line relays 134 and 144 operate in the same manner as explained for the first digit, but with a different result. Each time the relay 134 deenergizes, a circuit is closed from ground G^{11} through the springs 156 and 157, 158 and 159, side switch wiper 74, relay 152, resistance 358 and side switch wiper 76 to the battery lead 145. The relay 152, upon energizing, operates to close the circuit of the private magnet 71, which operates to disconnect the condensers 80 and 81 from the trunk conductors 169 and 170. The energization of the relay 152 also completes a circuit from ground G^{15} through the springs 161, relays 162 and 163 and side switch wiper 72 to the battery lead. The relays 162 and 163 are both energized over this circuit and remain operated until the relay 152 deenergizes after the last impulse has been delivered for the digit. Each time the springs 146 and 149 come into engagement, upon the deenergization of the relay 144, the trunk conductor 169 is grounded over a circuit extending from ground G^{12} through the springs 146 and 149, 150 and 151 and wiper 75 to the conductor 326, springs 171 and 172 and wiper 66 to the conductor 169. From the conductor 169 these impulses pass through the side switch wiper 173 of the selector H (Fig. 3) and the vertical line relay 174 to the battery lead 145. Each time the relay 174 energizes, a circuit is closed from ground G^{17} through the springs 175 and 176, 178 and 179 and vertical magnet 180 to the battery lead. Since the digit called is 2, the vertical magnet receives two impulses and operates to raise the wipers 181, 182 and 183 two steps. The line relays of the selector F remain in their energized position after the last impulse for

the digit is delivered by the operator's calling device, and consequently the relay 152 is allowed to deenergize and break the circuits of the private magnet 71 and relays 162 and 163. The private magnet 71 and relay 163 fall back immediately, while the slow acting relay 162 remains in its energized position for a short time. At the instant the relay 163 falls back, a circuit is closed from ground G^{16} through the springs 187, 186, 185 and 184 of the relay 162, springs 188 of the relay 163 and magnet 77 to the battery lead 145. The magnet 77, upon energizing, operates to rotate the wheel 78 one step. Another result of the deenergizing of the relay 163 is the grounding of the trunk conductor 170 over a circuit extending from ground G^{16} through the springs 187 and 186, springs 189 and shaft wiper 67 to said conductor 170. From the conductor 170 this impulse passes through the side switch wiper 190 and line relay 191 of the selector H to the battery lead. The relay 191, upon energizing, operates to close a circuit from ground G^{17} through the springs 175 and 177 and private magnet 192 to battery. When the relay 162 of the switch F deenergizes, the circuits which were closed by the relay 163 are broken. The relay 191 of the selector H thereupon deenergizes and breaks the circuit of the private magnet 192, which in turn deenergizes and permits the side switch to pass to second position, whereby a circuit is closed through the rotary magnet 193. This circuit extends from ground G^{18} through the side switch wiper 194, interrupter springs 195 and magnet 193 to battery. The rotary magnet 193 then operates in the same manner as explained for the rotary magnet of the selector E to rotate the wipers onto the contacts of an idle trunk, after which the side switch passes to third position in the usual manner. In case the wipers have to rotate over busy trunks, the energizing circuit for the private magnet 192, which causes the side switch to be locked in second position, extends from the guarded private bank contacts of the busy trunks through the wiper 183, relay 196, side switch wiper 197 and private magnet 192 to battery. The relay 196 is not energized over this circuit due to the comparatively high resistance of the magnet 192. When the side switch passes to third position the connection is extended through the wipers 181 and 182 to the connector I, and said connector is guarded against being seized by another selector by a ground potential which extends from ground G^{19} through the side switch wiper 197, relay 196 and wiper 183 to the selector private bank contacts of the trunk leading to the connector I.

The operator's calling device is now operated for the third digit 2. The selector-re-

busy, however, the private wiper 46 finds a
 guarding ground potential upon the private
 bank contact, and completes an energizing
 circuit through the side switch wiper 53 and
 5 private magnet 54 to the battery lead 92.
 The private magnet 54 thereupon energizes
 and locks the side switch in second position,
 and the rotary magnet continues to advance
 the wipers step by step until the private
 10 wiper 46 engages the non-grounded contact
 of an idle trunk, whereupon the private
 magnet 54 deenergizes and permits the side
 switch to pass to third position. The move-
 15 ment of the side switch wipers 51 and 52
 from the second to the third position dis-
 connects the line relay 62 from the line, and
 extends a connection through the wipers 45
 and 47 and the condensers 110 and 111 to
 20 the jack J, and also completes an energizing
 circuit for the relay 112. This circuit ex-
 tends from ground G^7 through the lower
 winding of said relay, wipers 47 and 52,
 thence to and through substation A and back
 25 over the other side of the line, and through
 the wipers 51 and 45 and upper winding of
 the relay 112 to the battery lead. The relay
 112, upon energizing, extends a guarding po-
 tential from ground G^8 through the springs
 30 113 and 114 to the selector private bank con-
 tacts 115 of the seized trunk, and also com-
 pletes a circuit through the relay 116 at the
 jack J. This circuit extends from the bat-
 tery lead 92 through the lower winding of
 the relay 117, springs 118, 119, relay 116,
 35 springs 120 and 121, springs 122 and 123 and
 upper winding of the relay 117 to ground G^9 .
 The relay 116, upon energizing, completes
 the circuit of the lamp 124. The relay 117,
 upon energizing, provides a second holding
 40 ground for the selector release relay 57.
 After the side switch of the selector E has
 left second position, the relay 62 deener-
 gizes; but the release relay 57 is maintained
 energized by a circuit extending from ground
 45 G^8 through the springs 113 and 114 of the
 relay 112, private bank contact 115, private
 wiper 46, side switch wiper 53, springs 125
 and 126 and relay 57 to the battery lead.
 Although the relay 58 is slow acting, it is
 50 not as slow as the relay 57, so that the relay
 58 deenergizes soon enough after the last
 energization of the rotary magnet to per-
 mit the closure of the circuit through the
 relay 57 before it has time to deenergize
 55 after its circuit is broken by the relay 62.
 The operator, upon seeing the signal of the
 lamp 124, inserts the plug P into the jack J,
 whereupon the circuit is completed from
 ground G^{31} through the relay 127 of the cord
 60 O, conductor 128, sleeve conductor of the
 plug P and jack J and relay 129 to the bat-
 tery lead 92. The relay 129, upon energiz-
 ing, operates to disconnect the relay 116
 from the line, whereupon said relay deener-
 65 gizes and breaks the circuit of the lamp 124.

The insertion of the plug P into the jack J
 also completes a circuit from ground G^{10} at
 the cord O through the relay 327, conductor
 130, ring conductors of the plug P and jack
 J and the lower winding of the relay 117 to 70
 the battery lead 92; and at the same time a
 second circuit is completed extending from
 ground G^9 through the upper winding of the
 relay 117, springs 122 and 123, tip conduc-
 tors of the jack J and plug P, conductors 131 75
 and 132 and relay 133 to the battery lead 92.
 The relay 117 remains energized and main-
 tains the second holding ground for the
 relay 57 of the selector E, so that said relay
 57 cannot now deenergize until both relays 80
 112 and 117 are deenergized. The energiza-
 tion of the relay 133 at the cord O has no
 particular effect at this time.

After ascertaining the number of the de-
 sired substation, the operator inserts the 85
 plug P' into the jack J', operates the key
 K to bridge the calling device across the
 line, and then operates the calling device
 for the number of the called substation,
 which, in this case, is assumed to be 2220. 90
 When the plug is inserted into the jack, a
 circuit is completed from ground G^{11}
 through the relay 134, springs 135 and 136,
 conductor 137, sleeve conductors of the jack
 J' and plug P', springs 138 and 139, calling 95
 device springs 60 and 61, key springs 141
 and 140, tip of the plug P' and jack J',
 springs 142 and 143 and relay 144 to the bat-
 tery lead 145. The relays 134 and 144 are
 both energized over this circuit, the relay 100
 144 operating to close a circuit from ground
 G^{12} through the springs 146 and 147 and
 relay 148 to the battery lead 145. The ener-
 gization of the relay 134 has no effect at
 this time. When the operator's calling de- 105
 vice is operated for the first digit 2, the
 springs 60 and 61 are separated twice
 momentarily, thereby allowing the relays
 134 and 144 to be deenergized twice. The
 operation of the relay 134 is without effect 110
 at this time. Since the relay 148 is slow
 acting it does not deenergize during the
 momentary interruption of its circuit by the
 relay 144; therefore, each time said relay
 144 deenergizes, a circuit is closed from 115
 ground G^{12} through the springs 146 and 149,
 springs 150 and 151 of the relay 148, side
 switch wiper 75, relay 152, vertical magnet
 69 and side switch wiper 76 to the battery
 lead. The vertical magnet is energized 120
 twice over this circuit, operating to raise the
 wipers 66, 67 and 68 two steps. The private
 magnet relay 152 operates in the same man-
 ner as explained for the relay 59 in the se-
 lector E to close the circuit of the private 125
 magnet 71 while the impulses are being de-
 livered to the vertical magnet 69. After
 the last of these impulses is delivered, the
 relay 152 deenergizes and breaks the circuit
 of the private magnet 71, which in turn de- 130

peater F operates in response to the impulses for the third digit in the same manner as for the previous digit to repeat two ground impulses to the trunk conductor 169, followed by one impulse over the conductor 170, and to energize the magnet 77 once more to rotate the wheel 78 a second step. Since the connection is now extended to the connector I, the impulses for the third digit which are repeated to the conductor 169 pass through the side switch wiper 173 and shaft wiper 181 of the selector H, and through the relay 198 and upper winding of the relay 199 of the connector I to the battery lead 145. The energization of the relay 199 at this time is without function. The relay 198, however, upon energizing, completes a circuit from ground G^{20} through the springs 200 and 201, 202 and 203, side switch wiper 204 and vertical magnet 205 to the battery lead 145. The vertical magnet receives two impulses over this circuit and raises the shaft and wipers two steps. The impulse for the third digit, which is repeated over the conductor 170, passes through the wipers 190 and 182 of the selector H, through the rotary line relay 206 of the connector I, lower winding of the relay 199 and springs 207 and 208 to the battery lead. The relay 206, upon energizing and deenergizing, sends an impulse from ground G^{20} through the springs 200 and 209, private magnet 210 and springs 207 and 208 to battery. The private magnet 210, upon energizing and deenergizing, permits the side switch to pass from first to second position, whereby the connection of the impulse spring 201 is transferred from the vertical magnet 205 to the rotary magnet 211 through the medium of the wiper 204.

The selector-repeater F operates in response to the impulses produced by the operator's calling device for the fourth digit in the same manner as for the previous digit to repeat the impulses to the connector. Since the last digit is 0, ten impulses are transmitted over the conductor 169, and the connector line relay 198 is energized ten times. Since the side switch is in second position, the energization of the relay 198 in response to these impulses transmits ten impulses through the rotary magnet 211, which operates to rotate the shaft wipers ten steps onto the contacts of the line 2220. The rotary line relay 206 is now energized by the impulse over the conductor 170 and sends a second impulse through the private magnet 210, which causes the side switch to pass to third position. When the side switch wipers 212 and 213 reach the third position, the connection is extended through the shaft wipers 214 and 215 to the called line. The engagement of the side switch wiper 216 with its third-position contact point extends a guarding potential from ground G^{21} to the

private wiper 217, and thence to the private bank contact of the called line in the bank of each connector which has access to said line. This guarding potential protects the called line from being seized by any other connector. The side switch wiper 216, in third position, also completes a circuit from ground G^{21} through the wipers 216 and 217 and the cut-off relay 84 of the line switch C' to battery. The relay 84, upon energizing, operates to disconnect the switch C' from the called line, and completes the connection from the wiper 215 to the line 218. At the switch F the magnet 77 is again energized at the time the last impulse is delivered to the conductor 170, whereby the wheel 78 is rotated a third step. This third step of the wheel 78 permits the springs 79 to come into engagement. Thus, as soon as the slow acting relay 162 deenergizes, a circuit is completed from ground G^{22} through the interrupter 219, springs 79, 220 and 221, springs 222 and relay 223 to battery. The relay 223 is energized intermittently over this circuit, operating to transmit a series of impulses from ground G^{23} through the springs 224 and 172 to the conductor 169. These impulses over the conductor 169 cause the relays 198 and 199 of the connector to be energized, as explained in connection with the last two digits. The energization of the relays 198 and 199 at this time completes a circuit from ground G^{20} through the springs 200 and 201, 202 and 203, side switch wiper 204, ringer relay 225 and springs 226 and 227 to battery. Each time the relay 225 energizes, the talking circuit is opened at the springs 228 and 229 and a signaling circuit is completed from one terminal of the generator L through the springs 239 and 238, side switch wiper 212, wiper 214, line 237, condenser 233, ringer 234, springs 235 and 236, line 218, springs 232 and 231, wipers 215 and 213 and springs 229 and 230 to the other terminal of the generator L. Since the circuit of the relay 223 of the selector F includes the interrupter 219, the ringer relay 225 of the connector will be energized only intermittently so as not to ring the called subscriber continuously.

After the calling device at the cord has been operated for the last digit of the called number, the key K is restored to normal position, whereby the calling device is disconnected from the line and the relay 63 substituted therefor in circuit with the relays 144 and 134 of the switch F. The current flows through the relay 63 in such a direction at this time as to cause the armature to be attracted in the proper direction for closing the springs 64 and 65, whereby the lamp 240 is lighted.

When the called subscriber removes his receiver from the switch hook, or as soon thereafter as the relay 225 deenergizes, if

it happens to be energized at the time, a circuit is closed from ground G^{21} through the side switch wiper 216, lower winding of the relay 246, ringer relay springs 228 and 229, wipers 213 and 215, line 218, transmitter 247, springs 244 and 245, line 237, wipers 214 and 212, upper winding of the relay 246 and springs 248 and 227 to the battery lead 145. The closure of this circuit furnishes talking current to the called substation and causes the relay 246 to energize. The relay 246, upon energizing, shifts the connection of the lower winding of the relay 199 from battery to ground, whereby an energizing circuit is completed from ground G^{21} through the side switch wiper 216, springs 249 and 207, lower winding of the relay 199, relay 206, wipers 182 and 190, conductor 170, wiper 67, private magnet springs 250, relays 251 and 252, springs 253, private magnet springs 254, springs 171 and 172, wiper 66, thence to and through the relay 198 and upper winding of the relay 199 to battery. The relay 199 is not energized over this circuit because current flows through its two windings in opposite directions. The relays 198 and 206 are energized, but have no function. At the selector F the energization of the relays 251 and 252 transposes the connections between the line relays 134 and 144 and the two sides of the trunk leading to said selector. This transposition of the connections of the relays 134 and 144 results in the reversal of the current in the relay 63 of the cord O. The relay 63 thereupon attracts its armature in the opposite direction and breaks the circuit of the lamp 240, which signifies to the operator that the called subscriber has answered.

The energization of the relay 251 of the selector F also serves to close a circuit from ground G^{24} through the springs 255 and 256 relay 257 and side switch wiper 72 to the battery lead 145. The relay 257, upon energizing, breaks the circuit of the relay 223 so that the ringer relay of the connector I will not be operated again after the called subscriber answers. When the relay 257 energizes it also forms a locking circuit for itself through its springs 258 and 259, so that it cannot deenergize until the side switch is restored from third position, and therefore the bells at the called station will not be rung again when the called subscriber hangs up his receiver.

After a conversation is completed, the hanging up of the receivers at the calling and called substations gives the operator the usual disconnect signals as follows: The hanging up of the receiver at the calling substation breaks the energizing circuit of the relay 112 (Fig. 1), which, upon deenergizing, breaks the circuit through the upper winding of the relay 117 and relay 133 at

the cord O. The relay 133, upon deenergizing, closes the circuit of the lamp 260. The hanging up of the receiver at the called substation breaks the circuit of the connector back-bridge relay 246, which deenergizes and in turn destroys the energizing circuit of the relays 251 and 252 of the selector F. These relays, upon deenergizing, reverse the current of the relay 63 of the cord O back to its normal direction, whereupon the lamp 240 is again lighted.

The simultaneous glowing of the lamps 260 and 240 signifies to the operator that both subscribers have hung up their receivers, and that the plugs P and P' may be removed from their respective jacks, whereupon the automatic switches employed in the connection are automatically released. The removal of the plug P from the jack J breaks the circuit of the relay 117, which deenergizes and, since the relay 112 is already deenergized, breaks the circuit of the release relay 57 of the selector E. The relay 57, upon deenergizing, destroys the holding circuit of the winding 20 of the line switch C and closes the circuit of the release magnet 55. This circuit extends from ground G^3 through the springs 95 and 97, 105 and 261, magnet 55 and springs 58^a and 57^a to the battery lead 92. The winding 20 of the switch C, upon deenergizing, permits the plunger of said switch to return to normal position. The magnet 55 of the selector E, upon energizing, immediately causes the shaft and side switch of the selector to be restored to normal position. When the shaft reaches its lowest position, the springs 57^a and 58^a are separated and the magnet 55 allowed to deenergize.

When the calling plug P' is removed from the jack J', the circuit of the line relays 134 and 144 of the selector-repeater is broken. The relay 134, upon deenergizing, operates to close the circuit of the relay 152, which in turn closes the circuits of the relays 162 and 163, which circuits have been previously traced. The relay 144, upon deenergizing, breaks the circuit of the relay 148, which breaks the circuit of the relay 152. The relay 152, upon deenergizing, in turn breaks the circuit of the relays 162 and 163. The relay 163 falls back immediately and grounds the conductor 170 and energizes the magnet 77 again in a manner already explained. The magnet 77 operates to advance the wheel 78 another step, which causes the springs 79 to be separated. Since the line relay 134 is deenergized, the deenergization of the relay 163 also grounds the conductor 169 at the same time it grounds the conductor 170. This ground connection extends from ground G^{16} through the springs 187, 186 and 185 of the relay 162, spring 262 of the relay 163, and springs 165 and

164 of the relay 134 to the conductor 169. The simultaneous grounding of the conductors 169 and 170 causes the simultaneous energization of the relays 198, 206 and 199 of the connector I. The current at this time flows through both windings of the relay 199 in the same direction. The energization of these three relays completes a circuit extending from ground G^{19} through the side switch wiper 197 of the selector H, relay 196, wiper 183, springs 264 and 265, release magnet 266 and springs 226 and 227 to the battery lead 145. The magnet 266, upon energizing, causes the shaft and side switch of the connector to be immediately restored to normal position, while the relay 196 closes the circuit of the release magnet 267 of the selector H. The magnet 267 attracts its armature and holds it in readiness to release the selector when its circuit is broken by the deenergization of the relay 196, when the slow acting relay 162 of the selector-repeater F deenergizes and allows the line relays of the connector I to be deenergized. The deenergization of the relay 162 of the selector-repeater F also serves to close the circuit of the release magnet 268 of said selector-repeater. This circuit extends from ground G^{16} through the springs 187 and 269, 270 and 271, magnet 268 and off-normal springs 272 and 273 to the battery lead. The magnet 268, upon energizing, causes the switch F to be restored to normal position, and all the apparatus employed in the connection is left in readiness for another call.

In the releasing operations just described it will be seen that the connector I is not released until both the trunk conductors 169 and 170 are grounded by the deenergization of the relay 163 when its circuit is broken by the relay 152. It will also be seen that the trunk conductor 169 is grounded alone as soon as the line relay 144 deenergizes, and remains grounded until the relay 148 deenergizes. This grounding of the conductor 169 would cause the bells of the called substation to be rung for an instant. This, however, would be of such short duration as not to be liable to be mistaken for a calling signal and, therefore, may not be considered objectionable. If desired, however, this short ring preceding the release may be entirely eliminated if, instead of connecting the third-position contact point of the side switch wiper 75 to the conductor 326 direct, said contact is connected with said conductor through a pair of springs normally closed, but adapted to be opened by the wheel 78 when it reaches the position shown in the drawings. Thus, after the last digit has been called, the impulse spring 149 would be disconnected from the trunk conductor 169, and would not be again connected

therewith until after the connection had been released.

Let it now be assumed that at the time the connector I made connection with the called line, said line was busy. In such case the private bank contacts would be grounded and the energization of the private magnet 210, in response to the final impulse through the rotary line relay 206, would close a circuit from the grounded private bank contact through the wiper 217, side switch wiper 216, private magnet springs 275 and 276, release magnet 266 and springs 226 and 227 to the battery lead 145. The magnet 266, upon energizing, restores the connector to normal position and thus prevents connection with the busy line. Now, when the vertical relay 198 is energized by the impulses delivered by the relay 223 of the switch F, instead of closing the circuit of the ringer relay, it closes the circuit of the vertical magnet, because the side switch has been restored to normal position. As soon as the shaft is raised the first step the arm 277 permits the springs 278 to engage, whereby the busy signaling machine M is connected to one side of the calling line through the side switch wiper 213 and the heavy talking conductor. The calling subscriber, therefore, hears the busy signal and hangs up his receiver, giving the operator the disconnect signal, whereupon the connection is released in the manner explained above.

It having been explained how the operator at the cord O obtains supervision of a call to a three-wire exchange through a selector-repeater F, it will now be explained how supervision is obtained when the call goes to a two-wire exchange. In this case the connection with the called line is through a two-wire connector I' (Fig. 4). The connection from the cord O to the connector I' may be direct from a jack or through one or more selector switches similar to the selector switch E (Fig. 1). As soon as the connection is extended to the connector, the line relay 279 is energized in circuit with the operator's calling device. The relay 279 operates to close the circuit from ground G^{26} through the springs 280 and 281 and the relay 282 to battery. The relay 282 being slow acting remains energized during the momentary interruptions of its circuit by the relay 279, while it is operating in response to impulses. Consequently, each time the relay 279 deenergizes in response to the impulses for the next digit, a circuit is closed from ground G^{26} through the springs 280 and 283, 284 and 285, relay 286, vertical magnet 287 and side switch wiper 288 to battery.

The relay 286 is energized by the first impulse through it in series with the vertical magnet, but being slow acting remains

energized until after the last impulse is delivered. In its energized position the relay 286 closes a circuit from ground G^{27} through the springs 289 and 290 and private magnet 291 to battery. When the private magnet deenergizes after the last impulse has been delivered to the vertical magnet, it allows the side switch to pass to second position, whereby the battery connection is shifted from the vertical magnet 287 to the rotary magnet 292. Each time the line relay 279 deenergizes in response to the impulses for the last digit of the called number, a circuit is closed from ground G^{26} to and through the relay 286, as traced for the previous digit, and thence through the springs 293 and 294, rotary magnet 292 and side switch wiper 288 to battery. The relay 286 operates in response to the impulses for this digit to again close the circuit of the private magnet 291. If the called line is idle the private magnet deenergizes after the last impulse is delivered to the rotary magnet, and the side switch passes to third position, completing the connection with the called line. The called line is immediately protected by a guarding potential which extends from ground G^{28} through the side switch wiper 295 and private wiper 296 to the private bank contacts of the called line in the banks of all connectors which have access to said line. The movement of the side switch wiper 288 to third position completes a circuit from ground G^{29} through the interrupter 297, relay 298, springs 299 and 300 and side switch wiper 288 to battery. The relay 298 is energized intermittently over this circuit, and operates to open the connection between the calling and called lines and bridge the ringer generator L' across the called line.

When the operator at the cord O restores the key K after completing the call, the relay 63 is energized in series with the two windings of the connector line relay 279, and closes the circuit of the lamp 240.

The first time the ringer relay 298 deenergizes, after the called subscriber removes his receiver, the called substation is provided with talking battery current over a circuit extending from ground G^{30} through the right-hand winding of the relay 301, private magnet springs 302, thence over the heavy conductors through the wiper 303 to the line of the called substation, thence back to the wiper 304, over the heavy conductors to the private magnet springs 305 and left-hand winding of the relay 301 to battery. The relay 301, upon energizing, by shifting the springs 306 and 307 into contact with their alternate contacts, transposes the connections between the windings of the relay 279 and the trunk conductors 308 and 309, thereby reversing the current in the relay 63 of the cord O. The relay 63 then attracts its

armature in the opposite direction and extinguishes the lamp 240. When the called subscriber hangs up his receiver the relay 301 deenergizes and restores the current in the relay 63 to its original direction, and the lamp 240 is again lighted. When the back-bridge relay 301 energizes it also closes a circuit from ground G^{26} through the springs 280 and 281, 310 and 311 and relay 312 to battery. The relay 312, upon energizing, breaks the circuit of the relay 298 at the springs 299 and 300, so as not to ring the called subscriber after he has answered. The relay 312 also closes a locking circuit for itself to prevent the ringer relay circuit from being closed again when the called subscriber hangs up his receiver. The locking circuit of the relay 312 extends from ground G^{26} through the springs 280 and 281, side switch wiper 313, springs 314 and 315, 316 and 317 and relay 312 to battery.

When the operator removes the calling plug from its jack after a conversation is completed, the connector line relay 279 deenergizes and breaks the circuit of the relay 282. The relay 282, upon deenergizing, completes a circuit from ground G^{26} through the springs 280 and 283, 284 and 318, release magnet 319 and off normal springs 320 to battery. The magnet 319, upon energizing, causes the shaft and side switch to be returned to normal position, and its own circuit is broken at the springs 320 when the shaft reaches its lowest position.

If the called line had been busy the private wiper 296 would have found the private bank contact grounded, and would have completed a circuit from said grounded contact through the wiper 296, side switch wiper 295 and lower winding of the relay 321 to battery. The relay 321, upon energizing, closes a circuit from ground G^{32} through the side switch wiper 313, springs 314 and 315, 322, and 323, upper winding of the relay 321 and private magnet 291 to battery. This circuit serves to maintain the private magnet energized after the relay 286 deenergizes, and locks the side switch in second position, thereby preventing the completion of connection with the called line. This circuit also prevents the relay 321 from deenergizing in case the guarding potential is removed from the private bank contacts of the called line before the connector is released. As long as the relay 321 is energized, the busy signaling machine M' is connected with the calling line through the springs 324 and side switch wiper 325, whereby the calling subscriber is notified of the busy condition of the called line.

From the foregoing it will be seen that I provide a system in which efficient supervision is obtained for a semi-automatic connection by reversing the current in the

cord circuit of a manual switchboard. It will also be seen that I provide a combined selector and repeater for use in calling from a two-wire system to a three-wire system.

5 In this case the three-wire system is of the kind in which the switches are controlled by alternating one or more impulses over one side of the calling line with a single impulse over the other side thereof. Also, 10 the entire system is of the common battery type in which the exchange is divided into groups, and in which the selectors and connectors have vertical motion to select a predetermined group, and then rotary motion 15 to find a unit in the selected group.

What I claim as my invention is—

1. In a telephone system, a plurality of subscribers' lines, automatic trunking switches one for each of said lines, a 20 plurality of trunks, an automatic switch for each trunk, an automatic trunk selector common to said lines provided with means for grounding any selected trunk to control the switch at the other end thereof by 25 alternating one or more ground impulses over one side of the trunk with a single impulse over the other side thereof, and means for controlling said selector over two sides of a line circuit in series.

30 2. In a telephone system, a plurality of trunks, an automatic switch for each trunk, an automatic trunk selector provided with means for grounding any selected trunk to control the switch at the other end thereof 35 by alternating one or more ground impulses over one side of the trunk with a single impulse over the other side thereof, and means for controlling said selector over two sides of a line circuit in series, the said selector 40 provided with mechanism for automatically causing an intermittent grounding of one side of the selected trunk, and means responsive to said intermittent grounding for transmitting a signal.

45 3. In a telephone system, a plurality of trunks, an automatic switch for each trunk, an automatic trunk selector provided with means for grounding any selected trunk to control the switch at the other end thereof 50 by alternating one or more ground impulses over one side of the trunk with a single impulse over the other side thereof, and means for controlling said selector over two sides of a line circuit in series, said selector 55 having means controlled by a called party for reversing the current in the said line circuit.

4. In a telephone system, a plurality of trunks, an automatic switch for each trunk, 60 an automatic trunk selector provided with means for grounding any selected trunk to control the switch at the other end thereof by alternating one or more ground impulses over one side of the trunk with a single 65 impulse over the other side thereof, and

means for controlling the selector over two sides of a line circuit in series, said selector having means controlled by a called party for reversing the current in the said line circuit, and a supervisory signal mechanism 70 responsive to the said reversal of current.

5. In a telephone system, a plurality of subscribers' lines, automatic trunking switches one for each of said lines, a set of trunks, a combined automatic trunk selector 75 and impulse repeater common to said lines provided with means for automatically grounding the so-called vertical side of any selected trunk to signal the called party, and means for controlling said selector and re- 80 peater over two sides of a line circuit in series.

6. In a telephone system, a set of trunks, a combined automatic trunk selector and impulse repeater, and a suitable subscriber's 85 talking circuit over which said selector and repeater is controlled over the two sides of said circuit in series, said selector and repeater having means controlled by a called party for reversing the current in said line, 90 said selector-repeater operating to first select a trunk and to then repeat impulses over said trunk.

7. In a telephone system, a cord circuit provided with supervisory signal mechanism, 95 and a relay controlled by the called party for reversing the current in said cord circuit to control said mechanism.

8. In a telephone system, means including a cord circuit and one or more automatic 100 switches for semi-automatically extending a calling connection, supervisory signal mechanism for said cord circuit, and means controlled by the called party for reversing 105 the current in said cord circuit to control said mechanism.

9. In a telephone system, a plurality of trunks divided into groups, an automatic switch for each trunk, an automatic trunk selector provided with means for grounding 110 any selected trunk to control the switch at the other end thereof by alternating one or more ground impulses over one side of the trunk with a single impulse over the other side thereof, means for directly controlling 115 said selector over two sides of a line circuit in series, said trunk selector having motion in one plane to select groups and motion in a plane at right angles thereto to find a trunk in a selected group, a plurality of 120 lines, and automatic trunking switches therefor having access in common to said trunk selector.

10. In a telephone system, a plurality of trunks divided into groups, an automatic 125 switch for each trunk, an automatic trunk selector provided with means for grounding any selected trunk to control the switch at the other end thereof by alternating one or more ground impulses over one side of the 130

trunk with a single impulse over the other side thereof, and means for controlling said selector over two sides of a line circuit in series, the said selector provided with mechanism for automatically causing an intermittent grounding of one side of the selected trunk, and means responsive to said intermittent grounding for transmitting a signal, said trunk selector having motion in one plane to select groups and motion in a plane at right-angles thereto to find a trunk in a selected group.

11. In a telephone system, a plurality of trunks divided into groups, an automatic switch for each trunk, an automatic trunk selector provided with means for grounding any selected trunk to control the switch at the other end thereof by alternating one or more ground impulses over one side of the trunk with a single impulse over the other side thereof, and means for controlling said selector over two sides of a line circuit in series, said selector having means controlled by a called party for reversing the current in the said line circuit, said trunk selector having motion in one plane to select groups and motion in a plane at right-angles thereto to find a trunk in a selected group.

12. In a telephone system, a plurality of trunks divided into groups, an automatic switch for each trunk, an automatic trunk selector provided with means for grounding any selected trunk to control the switch at the other end thereof by alternating one or more ground impulses over one side of the trunk with a single impulse over the other side thereof, and means for controlling the selector over two sides of a line circuit in series, said selector having means controlled by a called party for reversing the current in the said line circuit, and a supervisory signal mechanism responsive to the said reversal of current, said trunk selector having motion in one plane to select groups and motion in a plane at right-angles thereto to find a trunk in a selected group.

13. In a telephone system, a plurality of subscribers' lines, automatic trunking switches one for each of said lines, a set of trunks divided into groups, a combined automatic trunk selector and impulse repeater common to said lines provided with means for automatically grounding the so-called vertical side of any selected trunk to signal the called party, and means for directly controlling said selector and repeater over two sides of a line circuit in series, said trunk selector having one motion to select groups and a second motion to find a trunk in a selected group.

14. In a telephone system, a set of trunks divided into groups, a combined automatic trunk selector and impulse repeater, and a suitable line over which said selector and repeater is controlled, said selector and re-

peater having means controlled by a called party for reversing the current in said line, said trunk selector having motion in one plane to select groups and motion in a plane at right-angles thereto to find a trunk in a selected group.

15. In a telephone system, means including a cord circuit and one or more automatic switches for semi-automatically extending a calling connection, supervisory signal mechanism for said cord circuit, and means controlled by the called party for reversing the current in said cord circuit to control said mechanism, said automatic switch having motion in one plane to select groups and motion in a plane at right-angles thereto to find a trunk in a selected group.

16. In a telephone system, a plurality of subscribers' lines, automatic trunking switches one for each of said lines, a plurality of trunks, an automatic switch for each trunk, an automatic trunk selector common to said lines provided with means for grounding any selected trunk to control the switch at the other end thereof by alternating one or more ground impulses over one side of the trunk with a single impulse over the other side thereof, means for directly controlling said selector over two sides of a line circuit in series, and one or more central sources of operating and talking current.

17. In a telephone system, a plurality of trunks, an automatic switch for each trunk, an automatic trunk selector provided with means for grounding any selected trunk to control the switch at the other end thereof by alternating one or more ground impulses over one side of the trunk with a single impulse over the other side thereof, means for controlling said selector over two sides of a line circuit in series, the said selector provided with mechanism for automatically causing an intermittent grounding of one side of the selected trunk, means responsive to said intermittent grounding for transmitting a signal, and one or more central sources of operating and talking current.

18. In a telephone system, a plurality of trunks, an automatic switch for each trunk, an automatic trunk selector provided with means for grounding any selected trunk to control the switch at the other end thereof by alternating one or more ground impulses over one side of the trunk with a single impulse over the other side thereof, means for controlling said selector over two sides of a line circuit in series, said selector having means controlled by a called party for reversing the current in the said line circuit, and one or more central sources of operating and talking current.

19. In a telephone system, a plurality of trunks, an automatic switch for each trunk, an automatic trunk selector provided with

means for grounding any selected trunk to control the switch at the other end thereof by alternating one or more ground impulses over one side of the trunk with a single impulse over the other side thereof, means for controlling the selector over two sides of a line circuit in series, said selector having means controlled by a called party for reversing the current in the said line circuit, a supervisory signal mechanism responsive to the said reversal of current, and one or more central sources of operating and talking current.

20. In a telephone system, a plurality of subscribers' lines, automatic trunking switches one for each of said lines, a set of trunks, a combined automatic trunk selector and impulse repeater common to said lines provided with means for automatically grounding the so-called vertical side of any selected trunk to signal the called party, means for controlling said selector and repeater over two sides of a line circuit in series, and one or more central sources of operating and talking current.

21. In a telephone system, a set of trunks, a combined automatic trunk selector and impulse repeater, a suitable subscriber's talking circuit over which said selector and repeater is controlled over the two sides of said circuit in series, said selector and repeater having means controlled by a called party for reversing the current in said line, and one or more central sources of operating and talking current, said selector-repeater operating to first select a trunk and to then repeat impulses over said trunk.

22. In a telephone system, a cord circuit provided with supervisory signal mechanism, a relay controlled by the called party for reversing the current in said cord circuit to control said mechanism, and one or more central sources of operating and talking current.

23. In a telephone system, means including a cord circuit and one or more automatic switches for semi-automatically extending a calling connection, supervisory signal mechanism for said cord circuit, means controlled by the called party for reversing the current in said cord circuit to control said mechanism, and one or more central sources of operating and talking current.

24. In a telephone system, a plurality of trunks, an automatic switch for each trunk, an automatic trunk selector provided with means for grounding any selected trunk to control the switch at the other end thereof by alternating one or more ground impulses over one side of the trunk with a single impulse over the other side thereof, and means for controlling said selector over two sides of a line circuit in series, the said selector provided with mechanism for automatically causing an intermittent grounding of one

side of the selected trunk, and means responsive to said intermittent grounding for controlling the application of ringing current onto the called line.

25. In a telephone system, a plurality of trunks, an automatic switch for each trunk, an automatic trunk selector provided with means for grounding any selected trunk to control the switch at the other end thereof by alternating one or more ground impulses over one side of the trunk with a single impulse over the other side thereof, and means for controlling said selector over two sides of a line circuit in series, the said selector provided with a step-by-step switch, contacts controlled by said switch, means for closing said contacts after said switch has been moved a predetermined number of steps, and means controlled by the closing of said contacts for controlling the application of ringing current to the called line.

26. In a telephone system, a plurality of trunks, an automatic switch for each trunk, an automatic trunk selector provided with means for grounding any selected trunk to control the switch at the other end thereof by alternating one or more ground impulses over one side of the trunk with a single impulse over the other side thereof, and means for controlling said selector over two sides of a line circuit in series, the said selector provided with a step-by-step switch, means for operating said switch one step in response to each series of impulses representing the various digits of the called number, a pair of contacts controlled by said switch, means for closing said contacts after said switch has been moved a predetermined number of steps, and means controlled by the closing of said contacts for controlling the application of ringing current to the called line.

27. In a telephone system, a plurality of trunks, an automatic switch for each trunk, an automatic trunk selector provided with means for grounding any selected trunk to control the switch at the other end thereof by alternating one or more ground impulses over one side of the trunk with a single impulse over the other side thereof, and means for controlling said selector over two sides of a line circuit in series, the said selector provided with a step-by-step switch, contacts controlled by said switch, means for closing said contacts after said switch has been moved a predetermined number of steps, means controlled by the closing of said contacts for automatically causing an intermittent grounding of one side of the selected trunk, and means responsive to said intermittent grounding for controlling the application of ringing current to the called line.

28. In a telephone system, a plurality of trunks, an automatic switch for each trunk, an automatic trunk selector provided with

means for grounding any selected trunk to control the switch at the other end thereof by alternating one or more ground impulses over one side of the trunk with a single im-
 5 pulse over the other side thereof, and means for controlling said selector over two sides of a line circuit in series, the said selector provided with a step-by-step switch, means
 10 for operating said switch one step in response to each series of impulses representing the various digits of the called number, a pair of contacts controlled by said switch, means for closing said contacts after said
 15 switch has been moved a predetermined number of steps, means controlled by the closing of said contacts for automatically causing an intermittent grounding of one side of the selected trunk, and means respon-
 20 sive to said intermittent grounding for controlling the application of ringing current to the called line.

29. In a telephone system, a plurality of subscribers' lines, means for establishing a connection between two of said lines, said
 25 means including a cord circuit and one or more automatic switches, a pair of line relays bridged across one of said automatic switches, a supervisory signal in said cord circuit, means controlled by the response of
 30 the called subscriber for energizing said line relays, and circuit connections controlled by said line relays upon energizing for reversing the current to control said supervisory signal.

30. In a telephone system, a plurality of subscribers' lines, means for extending a connection between two of said lines, said
 35 means including a cord circuit and one or more automatic switches, a polarized relay in said cord, a supervisory signal controlled

by said polarized relay, a pair of line relays bridged across one of said automatic switches, means for energizing said line re-
 lays upon response of the called subscriber, and means controlled by the energization of
 45 said line relays for reversing the current through said polarized relay to thereby operate said supervisory signal.

31. In a telephone system, a plurality of subscribers' lines, means for extending a
 50 connection between two of said lines, said means including a cord circuit and one or more automatic switches, a pair of line relays bridged across the line at one of said automatic switches, a supervisory relay in
 55 said cord circuit, means operated upon the response of the called subscriber for transmitting talking current back from the called line, means controlled by said talking cur-
 rent for energizing said line relays, means
 65 controlled by the energization of said line relays for reversing the current through said supervisory relay, and a supervisory signal controlled by said supervisory relay.

32. In a telephone system, a non-numerical
 65 trunking switch controlled over two sides of a talking circuit in series for trunking a connection to an operator, a repeater controlled over two sides of the talking circuit in series for repeating impulses to one side
 70 of a section of the talking circuit, and a cord circuit for connecting said extended connection to the manual board with the repeater.

Signed by me at Chicago, Cook county, Illinois, this 1st day of December, 1910.

TALBOT G. MARTIN.

Witnesses:

ARTHUR J. RAY,
 E. D. FALES.