T. G. MARTIN.

TELEPHONE TRUNKING SYSTEM.

APPLICATION FILED DEC. 2, 1910. RENEWED MAY 24, 1918.

1,291,585.

Patented Jan. 14, 1919.

7 SHEETS—SHEET 1.

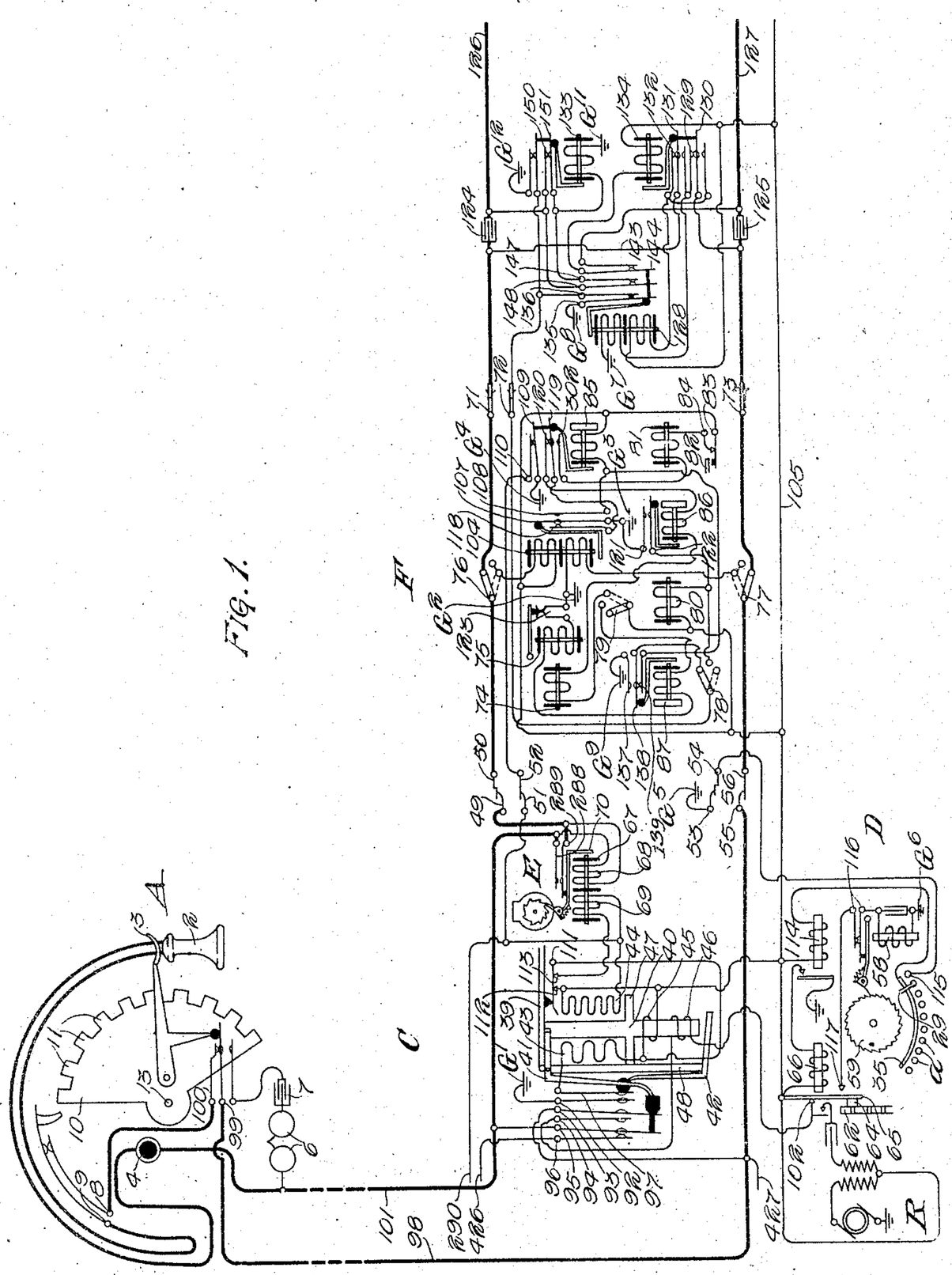

FIG. 1.

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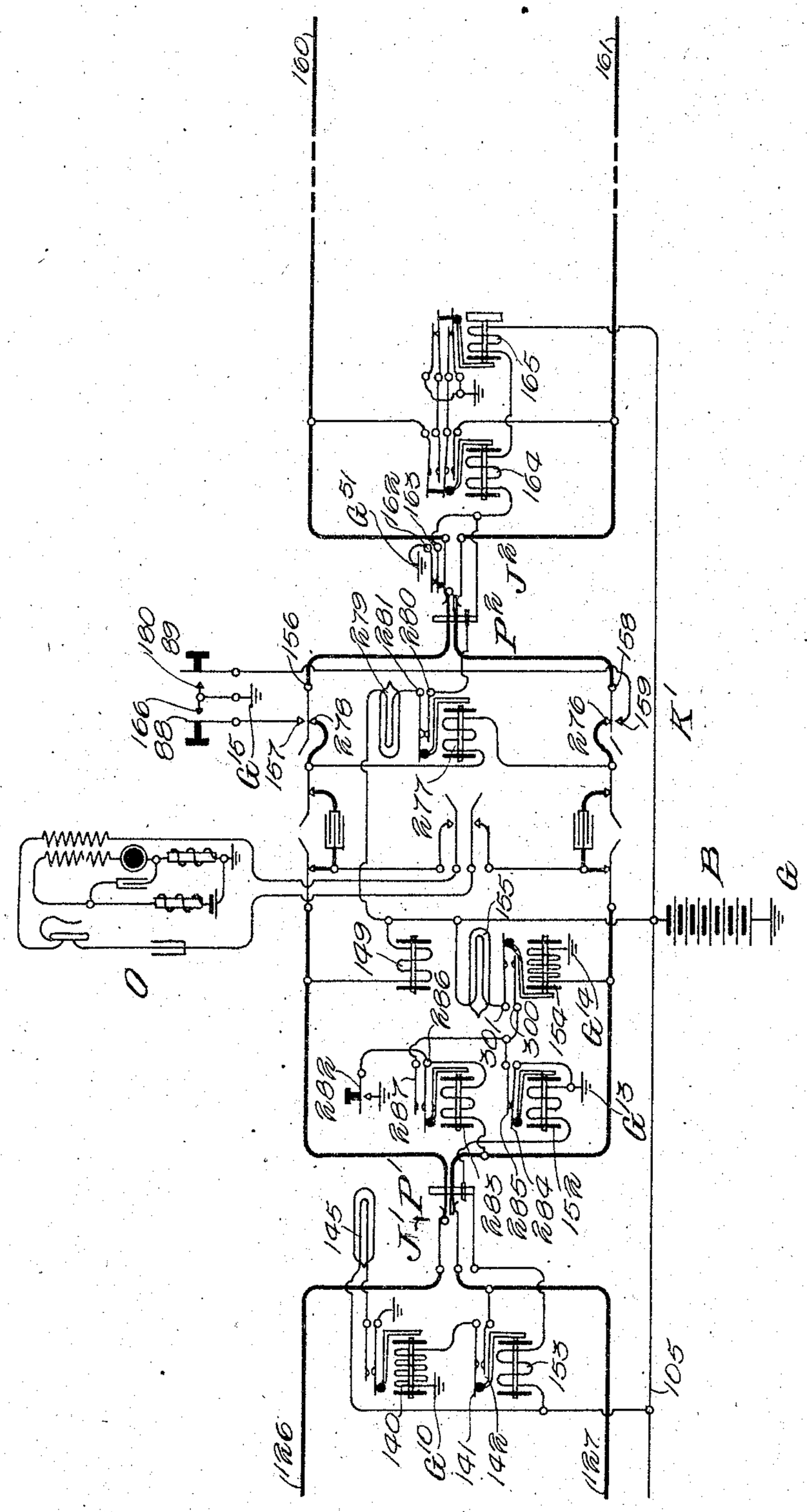
7 SHEETS—SHEET 2.

FIG. 2.



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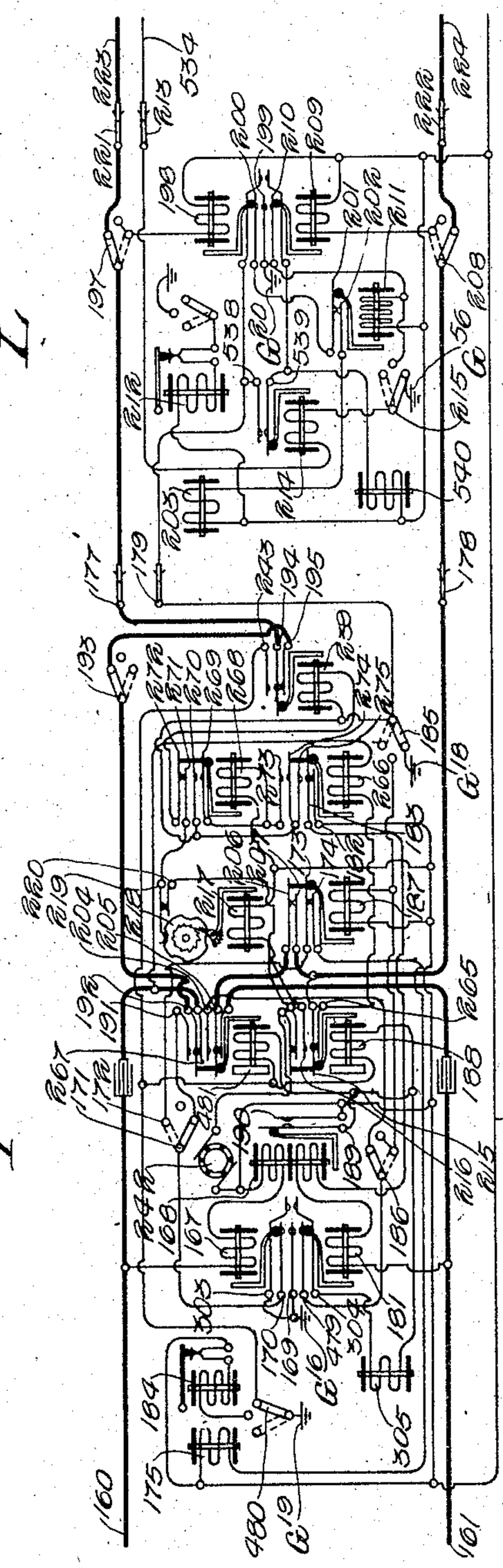
7 SHEETS—SHEET 3.

FIG. 3.



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7 SHEETS—SHEET 4.

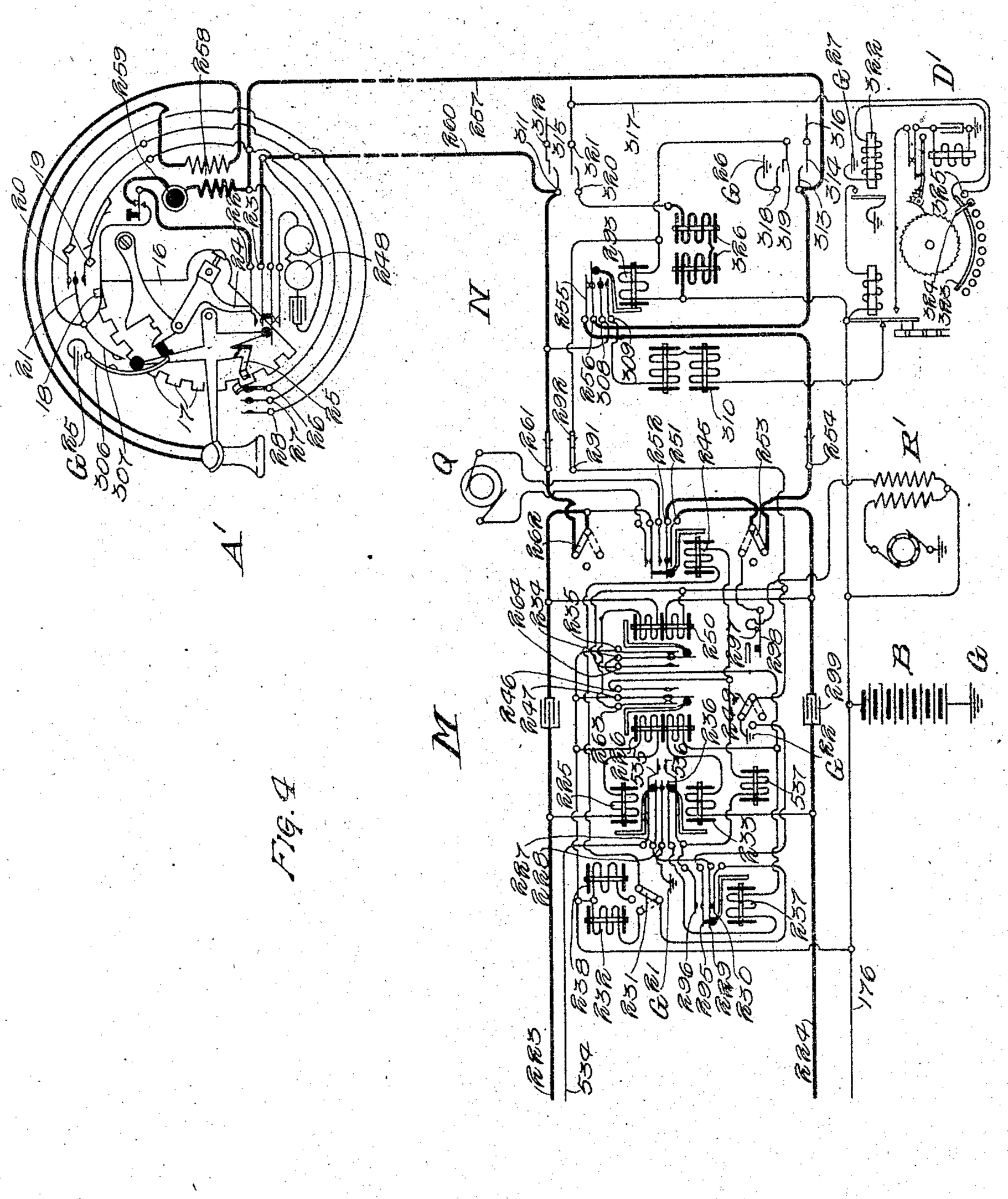

Fig. 4.

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7 SHEETS—SHEET 5.

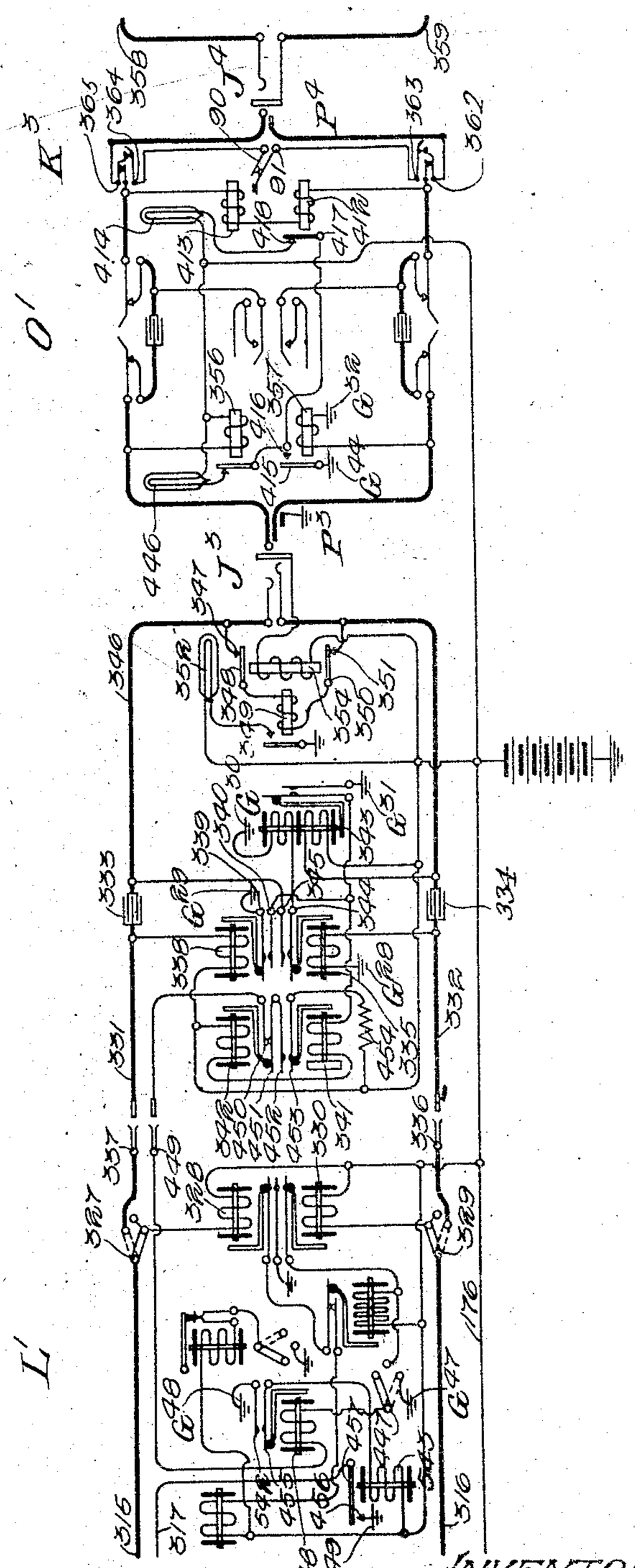

FIG. 5.

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7 SHEETS—SHEET 6.

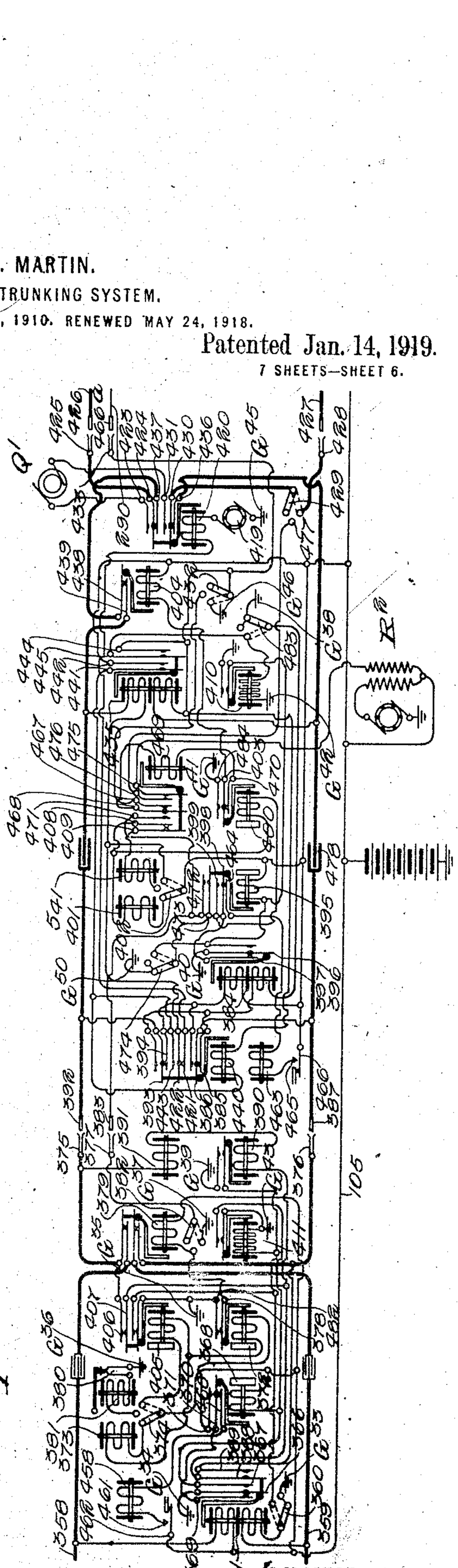

FIG. 6.

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1,291,585. Patented Jan. 14, 1919

7 SHEETS—SHEET 7.

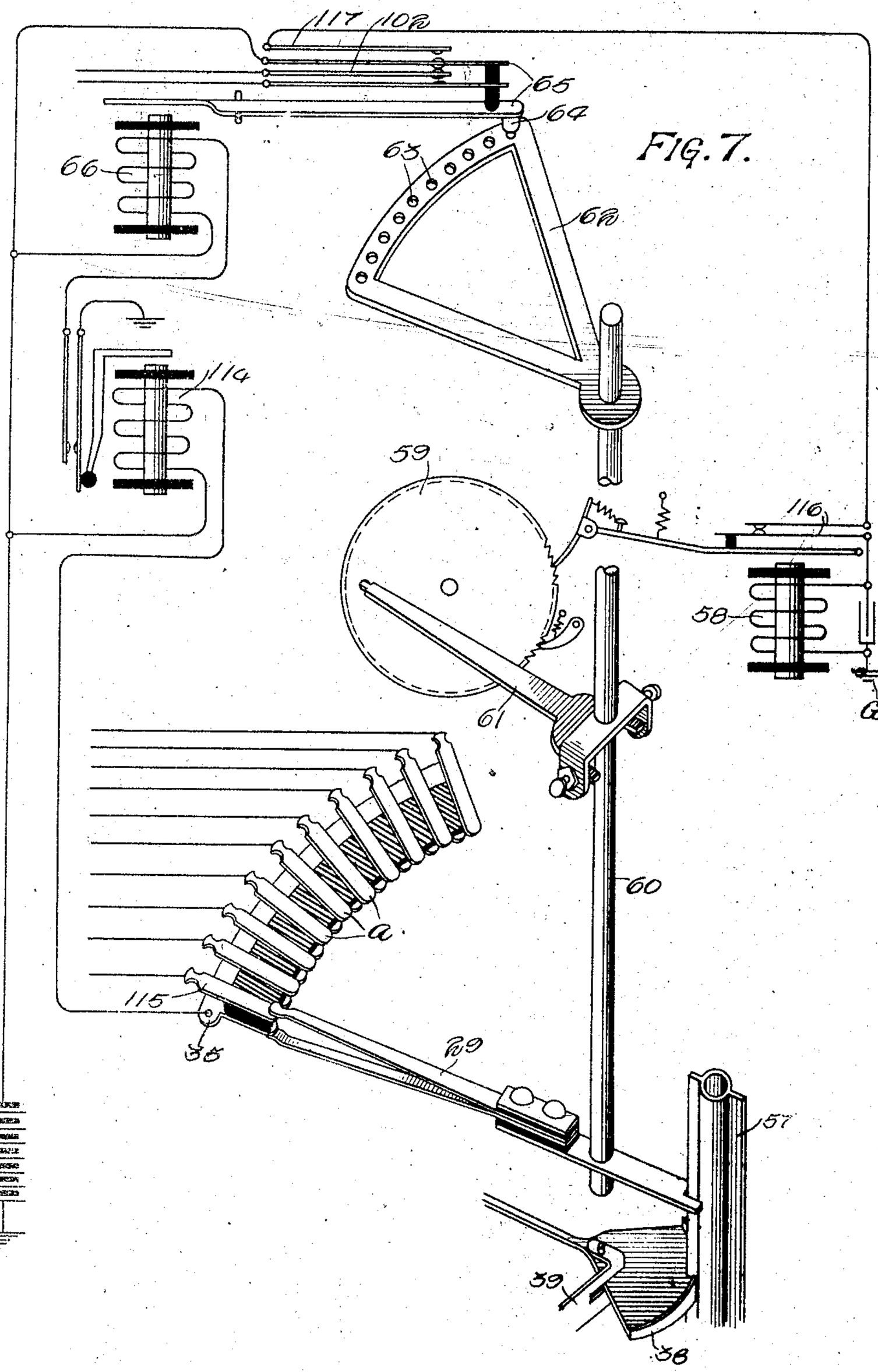

FIG. 7.

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UNITED STATES PATENT OFFICE.

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TELEPHONE TRUNKING SYSTEM.

1,291,585. Specification of Letters Patent. Patented Jan. 14, 1919.

Application filed December 2, 1910, Serial No. 595,237. Renewed May 24, 1918. Serial No. 236,411.

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 Telephone Trunking Systems, of which the following is a specification.

My invention relates to telephone exchange systems in general, but more particularly to automatic or semi-automatic systems, and more especially to systems of this kind in which combined trunk selectors and repeaters are employed for automatically finding idle trunks and repeating calling impulses to the next switch.

My invention also relates to automatic or semi-automatic telephone exchange systems in which either three-wire or two-wire line circuits are employed, or both, in which there are automatic switches that can be controlled over these circuits. By a "three-wire system" is meant one in which the line circuit is grounded to control the automatic switch, such as a selector or a connector, a common method being to ground first one side of the line and then the other to cause the switch to operate in accordance with some digit or digits of the called number. By a "two-wire system" is meant one in which the switches are controlled over metallic line circuits—that is to say, by controlling the two sides of a line circuit in series, and without grounding the line.

An object of my invention is to provide an improved combined trunk selector and repeater, for use in a three-wire system, having means for automatically controlling a ringing apparatus, the said ringing apparatus, as herein disclosed, being located in the connector by which the called line is found, and the control of said apparatus being exercised by the means in said selector and repeater as soon as the operation of the connector is completed, the automatic and intermittent ringing operation continuing until the called party answers.

Another object of my invention is to provide an improved combined trunk selector and repeater, for use in a two-wire system, having means for repeating electrical impulses over the two sides of the selected trunk in series—that is to say, for controlling the two sides of the selected line in series to in turn control a switch at the other end of said trunk, or at some point farther on in the calling connection.

Another object is to provide an improved combined trunk selector and repeater provided with means responsive to the called party for the purpose of reducing the resistance of the line circuit to restore a supervisory signal at the manual board through which the semi-automatic connection has been made.

Another object is to provide an improved construction and arrangement whereby it is possible to call semi-automatically from a three-wire exchange to a two-wire exchange, and from the said two-wire exchange to the said three-wire exchange, with double supervision in each case.

It is also an object to provide certain details and features of improvement and general combinations tending to increase the 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, 3 and 4 taken together represent a complete circuit connection between a calling substation A (Fig. 1) and a called substation A′ (Fig. 4) in a system embodying the principles of my invention.

Figs. 5 and 6 show additional apparatus by means of which a call may be extended from the substation A′ to substation A of said system, which apparatus is shown in normal position.

Fig. 7 is a diagrammatic representation of a portion of the central office apparatus of said system.

The substations A and A′ are represented as being in different exchanges. The substation A is in an exchange of the so-called two-wire type—that is, the type in which the central office apparatus is controlled from the calling substation over the two sides of the line in series. The exchange to which the substation A′ belongs is of the so-called three-wire type—that is, of the type in which the central office apparatus is controlled from the calling substation by ground impulses transmitted over each side of the line separately.

In Fig. 1 there is shown a line switch C which is individual to the line of the substation A. A group of these line switches is

controlled by a common mechanism D, the principal features of which are more fully shown in Fig. 7. Allotted to the line of substation A there is also a meter or call-registering device E. All the line switches which are controlled by the master switch D have common access to a number of selector switches F. These selectors have access to a number of trunk lines, at least some of which lead to operators' jacks J' (Fig. 2). At O, Fig. 2, there is shown an operator's cord circuit, which is the medium of connection between the two-wire and the three-wire exchanges. At I, Fig. 3, there is shown a combined selector and repeater for a three-wire system. At L an ordinary three-wire selector switch is shown. At M (Fig. 4) a three-wire connector is shown. The substation A' is provided with an individual line switch N at the central office. This line switch has access to trunk lines which terminate in three-wire selectors L', Fig. 5. These selectors have access to trunk lines, some of which lead to jacks J^s. The operator's cord O' is the connecting link between the three-wire exchange and the two-wire exchange. At I' (Fig. 6) there is represented a combined selector and repeater for a two-wire system. At M' is represented a two-wire connector.

In the various drawings a number of ringing current generators Q and Q' and busy signaling machines R, R' and R^2 are shown. A number of batteries B are represented having one terminal grounded. There need be but one battery, however, or preferably one battery in each exchange.

The two-wire substation A 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 secured 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 when the impulse wheel is returned to normal position, then the springs 8 and 9 are separated by the teeth 11 a number of times corresponding to the digit called.

In the substation A' (Fig. 4) the impulse wheel 16 is provided with ten so-called vertical impulse teeth 17 and one rotary impulse tooth 18. These teeth are so arranged that as the impulse wheel is rotated forward through the medium of the dial, the rotary tooth 18 forces the so-called rotary impulse spring 19 into engagement with the ground spring 21. As the wheel 16 returns to normal position the vertical impulse spring 20 is forced into engagement with the ground spring 21 a number of times, corresponding to the digit called, after which the rotary spring 19 is once more forced into contact with spring 21 by the tooth 18. While impulses are being transmitted the connection between the two sides of the line are broken between the springs 22 and 23, which come into engagement when the receiver is removed from the switch hook, but are permitted to disengage by the dog 24 whenever the dial is out of normal position. As the switch hook descends the arm 25 momentarily presses springs 26, 27 and 28 into engagement.

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 British Patent #26,301 of 1906, and in the *American Telephone Journal* of New York, of June 6, 1908. As herein represented, the line switch C comprises, among other details, a plunger 38 (Fig. 7) attached to the end of a so-called plunger arm 39 which is controlled by the magnet 40. The magnet 40 also controls the relay armatures 41 and 42, and is composed of four windings, namely, a pull-in winding 43, a holding or cut-off winding 44, line winding 46 and an auxiliary winding 45. The core of the magnet is provided near the center of its length with a lateral projection 47, by means of which the magnet is mounted upon the bracket 48, upon which the armatures 39, 41 and 42 are pivoted. With this method of mounting the magnet, the magnetic circuit of the windings 43 and 44 is maintained separate from that of the windings 45 and 46, 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 43 is strong enough to attract the plunger arm 39 from its normal position. The winding 44 is not strong enough to thus operate the plunger arm, but will hold it in an operated position after it has been drawn down by the winding 43. When the plunger arm 39 is attracted by the magnet 40 the plunger of the switch is forced into a bank of contact springs, forcing springs 49, 51, 53 and 55 into engagement with springs 50, 52, 54 and 56, respectively. Although only one set of springs 49—56 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 F. Each trunk line is multipled through 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 57 (Fig. 7), and through the medium of the master switch D are nor-

mally maintained opposite the terminal of an idle trunk line. The master switch consists essentially of a motor magnet 58 for rotating the ratchet wheel 59. The ratchet wheel 59 is connected with the shaft 60 by means of a link 61 in such a manner that a rotary motion of the ratchet wheel is transmitted to the plunger shaft 57, imparting to it an oscillatory motion about the shaft 60, so as to move the idle plungers back and forth in front of their trunk terminals. To the shaft 60 there is secured a locking plate 62 provided near its outer edge with a number of openings 63 which are adapted to be engaged by the pin 64 upon the end of the armature 65 of the relay 66. The openings in the plate 62 are so spaced that the pin 64 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 35 and one individual segment *a* for each trunk to which the line switches have access. The wiper 29 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 meter E is operated by a magnet 67, comprising two windings 68 and 69, which is so adjusted that neither winding alone can attract the armature 70, but one winding can hold it in its operated position after it has once been attracted by both windings.

The selector F is of the general type disclosed in United States Letters Patent #815,321, granted March 13, 1906, to Keith, Erickson & Erickson, being somewhat modified, however, in order to operate in a two wire system. Among its essential details the selector F comprises a set of wipers 71, 72 and 73 carried upon a shaft (not shown) which has a vertical motion controlled by the vertical magnet 74 and a rotary motion controlled by the rotary magnet 75. The side switch comprising the wipers 76, 77, 78 and 79 is controlled by the private magnet 80 in the usual manner. The release magnet 81 is connected with the battery only when the switch shaft is raised one or more steps from its lowest position. whereby the arm 82 permits the spring 83 to engage the spring 84. The shaft and side switch of the selector are restored to normal position immediately upon the energization of the release magnet rather than by its deënergization, as shown in said selector patent. The relays 85, 86 and 87 deënergize slowly after their energizing circuits have been broken. This slow action may be obtained by securing a ring of copper or other conducting material around one end of the core.

The operator's cord O (Fig. 2) is similar to the usual type of cord circuit used in manual switchboard practice, the supervisory circuits being particularly adapted, however, to operate in the system disclosed herein. The cord is provided with a calling device which may be of any suitable character, but is represented diagrammatically by two push buttons 88 and 89.

The selector-repeater I combines the functions of a selector and a repeater—that is, it operates in response to one digit to select an idle trunk out of a particular group, corresponding to the digit called, and then operates in response to the following digits to repeat impulses over the selected trunk to the succeeding switches.

The three-wire connector M (Fig. 4) is of the general type of connector disclosed in United States Letters Patent #815,176, granted March 13, 1906, to Keith, Erickson & Erickson, the circuits being modified somewhat in order operate in a common battery system.

The line switch N is of the general type disclosed in British Patent #26,301 of 1906, and in the *American Telephone Journal* of New York of June 6, 1908.

The operator's cord O′ (Fig. 5) is a modified form of the usual cords employed in manual switch board practice. It is provided with an automatic calling device represented by the two impulse springs 90 and 91.

The selector repeater I′ (Fig. 6) is like the selector repeater I, Fig. 3, in that it combines the features of a selector and repeater, but differs from it in that it is adapted to be controlled over the two sides of the calling line in series. The connector M is also adapted to be controlled over the two sides of the line in series.

Having given a general description of the apparatus I will now explain in detail the operations by which a subscriber of one exchange can call a subscriber at the other exchange. It will first be explained how the subscriber at substation A can call substation A′.

Upon the removal of the receiver at the substation A a circuit is closed through the line winding 46 of the line switch C. This circuit extends from ground G′ through springs 92 and 93, line 98, springs 99 and 100, 8 and 9, receiver 2, transmitter 4, line 101, springs 95 and 94, winding 46, contact point 102 and armature 65 to battery lead 105. The winding 46 attracts the armature 42, which forces spring 97 into contact with spring 92, closing a circuit from ground G′ through springs 92 and 97, windings 43 and 45 to battery lead 105. The winding 43 attracts the plunger arm 39 and armature 41. The attraction of the plunger arm 39 causes the line connection to be extended through the contact springs 49 and 50, and 55 and

56 to the selector F, whereupon the relay 104 becomes energized over a circuit extending from ground G^2 through the lower winding of said relay, side switch wiper 77, springs 56 and 55, thence over line conductor 98 to and through substation A and back over the other side of the line, through winding 68 of the meter magnet, springs 49 and 50, side switch wiper 76 and upper winding of relay 104 to the battery lead 105. The relay 104, upon energizing, closes a circuit from ground G^3 through springs 107 and 108 and relay 85 to battery lead 105. The relay 85, upon energizing, completes a circuit from ground G^4 through springs 109 and 110, 52 and 51, and winding 44 to battory lead 105. This energization of the winding 44 serves to hold the plunger arm 39 and armature 41 in their operated positions after the circuit of winding 43 is broken by the falling back of the armature 42. The line winding 46, by which the armature 42 was attracted, is deënergized as soon as the armature 41 is attracted by winding 43, but the armature 42 remains held up for an instant by the winding 45, which is energized in series with the winding 43 and is then caused to deënergize slowly by being short-circuited through springs 111 and 112 by the plunger arm. This insures that the circuit of winding 44 shall be closed before the circuit of winding 43 is broken.

When the line switch C operates, a circuit is also closed through the winding 69 of the meter magnet. This circuit extends from ground G^4 through springs 109 and 110, 52 and 51, winding 69 and springs 113 and 112 to battery lead 105. The current in this winding is opposed by the current flowing in the winding 68, and the magnet 67 is not operated at this time.

The closure of contact between the bank springs 53 and 54 by the plunger of the line switch C closes a circuit through the relay 114 of the master switch D. This circuit extends from ground G^5 through springs 53 and 54, contact point 115, wiper 29, common segment 35 and relay 114 to the battery lead. The relay 114, upon energizing, closes a circuit through the relay 66, which attracts the armature 65, withdrawing pin 64 from the plate 62 and closing the circuit of the motor magnet 58. This circuit extends from ground G^6 through magnet 58, interrupter springs 116, contact point 117 and armature 65 to the battery lead. Since this circuit includes the interrupter springs 116, the magnet 58 operates in a manner similar to that of a buzzer to rotate the ratchet wheel and advance the idle plungers as long as the armature 65 engages contact point 117. The relay 66 is maintained energized until the wiper 29 passes off the contact corresponding to the last successive busy trunk and breaks the circuit of relay 114. After the relay 66 deënergizes the master switch continues to operate until the pin 64 registers with one of the openings in the plate 62, whereupon the armature 65 falls back, breaking the circuit of the motor magnet 58 and locking the plunger shaft, with the idle plungers standing in front of an idle trunk. If the next trunk after the one seized by the switch C is idle, the master switch will stop opposite this trunk, as indicated in the drawings.

It will be assumed that the trunk lines which lead to the jacks J′ are connected to the fourth level of the bank contacts of the selector F. In order to obtain connection with one of these trunks, the calling subscriber operates his calling dial for the digit 4. As the impulse wheel 10 returns to normal position after being rotated for this digit, the impulse springs 8 and 9 are separated four times. Each time these springs are separated the relay 104 at the selector F deënergizes momentarily. Since the relay 85 is slow acting, it does not have time to deënergize during the momentary interruption of its circuit by relay 104; consequently, each time the relay 104 deënergizes a circuit is closed through the vertical magnet 74. This circuit extends from ground G^3 through springs 107 and 118, 119 and 120, relay 86, vertical magnet 74 and side switch wiper 79 to battery lead 105. The vertical magnet receives four impulses over this circuit and operates to raise the shaft four steps. The relay 86, which is included in circuit with the vertical magnet, is energized by the first of these impulses, but, being slow acting, does not deënergize until after the last impulse is delivered. When the relay 86 energizes, a circuit is closed from ground G^3 through springs 121 and 122 and private magnet 80 to battery lead 105. When the relay 86 deënergizes, the private magnet in turn deënergizes and allows the side switch to pass to second position.

The side switch wiper 79, in passing from first to second position, disconnects the battery from the vertical magnet 74 and closes a circuit through the rotary magnet 75. This circuit extends from ground G^2 through interrupter springs 123, magnet 75, relay 87 and side switch wiper 79 to battery lead 105. Since this circuit includes the interrupter springs 123, the magnet 75 operates in a manner similar to that of a buzzer to advance the wipers step by step as long as the side switch remains in second position. When the rotary magnet energizes, its armature also presses down the armature of the private magnet 80, which, when it falls back, causes the side switch to be tripped to third position. If the first trunk of the fourth level is idle, the side switch is tripped to third position as soon as the shaft wipers have been rotated one step. If the first trunk is busy, however, the private

wiper 72 finds the first private bank contact grounded, and forms a circuit extending through side switch wiper 78 and private magnet 80 to battery lead 105. The private magnet thus becomes energized and locks the side switch in second position, causing the rotary magnet to continue advancing the shaft wipers step by step until the private wiper 72 finds the non-grounded contact of an idle trunk, whereupon the private magnet 80 deënergizes and the side switch passes to third position. The movement of the side switch from second to third position breaks the circuit of the rotary magnet 75, disconnects the line relay 104 from the line and extends the connection to the jack J′ through the condensers 124 and 125 and conductors 126 and 127. Also, at the instant the side switch of the selector passes to third position a circuit is closed from ground G^7 through the upper winding of the trunk relay 128, springs 129 and 130, shaft wiper 73, side switch wiper 77, thence to and through the substation A and back over the other side of the line, through side switch wiper 76, shaft wiper 71, relay springs 131 and 132 and lower winding of relay 128 to the battery lead 105. The relay 128, upon energizing, connects the relays 133 and 134 with the trunk conductors 126 and 127, respectively, and provides a guarding ground potential for the selector private bank contacts of the seized trunk. This potential extends from ground G^8 through springs 135 and 136 to said private bank contacts.

It will be remembered that the relay 87 of the selector F is included in the energizing circuit of the rotary magnet 75. This relay, being slow acting, remains energized for a short time after the rotary magnet has deënergized for the last time. At the instant the side switch passes to third position the selector private bank contacts of the trunk are provided with a guarding ground from ground G^9 through springs 137 and 138 and wiper 72. This ground protects the trunk until the relay 128 has time to pull up. The relay 87 deënergizes after a short time and completes a holding circuit for relay 85, said circuit extending from ground G^8 through springs 135 and 136, wiper 72, side switch wiper 78, springs 138 and 139 and relay 85 to battery. This circuit is closed before relay 85 has time to fall back after its former circuit is broken by the deënergization of relay 104 when the side switch passes from second position.

When the relay 134 is connected to the trunk conductor 127 a circuit is closed from ground G^{10} (Fig. 2) through relay 140, springs 141 and 142, conductor 127, springs 143 and 144 and relay 134 to battery lead 105. The relay 140 is energized over this circuit but, being of a comparatively high resistance, prevents sufficient current from flowing to cause the relay 134 to operate. The relay 140, upon energizing, closes the circuit of lamp 145 to signal the operator. The operator thereupon inserts the plug P′ into the jack J′. The engagement of the tip of plug P′ with the tip spring of jack J′ completes a circuit from ground G^{11} (Fig. 1) through relay 133, springs 147 and 148, conductor 126, tip of jack J′ and plug P′ and impedance coil 149 to battery lead 105. The relay 133, upon energizing, provides a new holding ground G^{12} for the selector release relay 85, and connects itself with conductor 126 through its own springs 150 and 151, so that it cannot be deënergized until the plug P′ is removed from jack J′.

The engagement of the sleeve conductors of the plug P′ and jack J′ completes a circuit from ground G^{13} through relays 152 and 153 to battery lead 105. The relay 153, upon energizing, breaks the circuit of relay 140, allowing it to deënergize and extinguish lamp 145. The engagement of the ring springs of plug P′ and jack J′ completes a circuit from ground G^{14} through relay 154, said springs of plug P′ and jack J′, conductor 127, thence to and through relay 134 to battery, as previously traced. The relay 134 is not operated over this circuit. The relay 154, however, attracts its armature and prevents the closure of the circuit of lamp 166 by relay 152.

After ascertaining the number of the desired line the operator inserts the plug P^2 into the jack J^2 and operates key K′ to place springs 156 and 158 in engagement with springs 157 and 159, respectively, whereby the calling device buttons 88 and 89 are connected with the selector repeater I over conductors 160 and 161. When the plug P^2 is inserted in the jack J^2 the spring 163 is forced into contact with spring 162, thereby closing a circuit from ground G^{51} through the relays 164 and 165 to battery lead 105. The energization of these relays has no direct effect at this time.

Assuming that the number of the desired line is #2220, the operator now presses the button 88 twice for the first digit and then presses the button 89 once. Each time the button 88 is pressed a circuit is closed from ground G^{15} through springs 166 and 88, 157 and 156, tip of plug P^2 and jack J^2, trunk conductor 160, vertical line relay 167 of selector I (Fig. 3) and upper winding of relay 168 to battery lead 176. The energization of relay 168 at this time is functionless. Each time relay 167 is energized a circuit is closed from ground G^{16} through springs 169 and 170, side switch wiper 171, contact point 172, springs 173 and 174 and vertical magnet 175 to battery lead 176. The vertical magnet receives two impulses over this circuit and raises the wipers 177, 178 and 179

two steps. The depression of the key 89 by the operator completes a circuit from ground G^{15} through springs 180 and 89, 158 and 159, ring conductors of plug P^2 and jack J^2, conductor 161, relay 181, lower winding of relay 168 and springs 183 and 182 to battery lead 176. The relay 181, upon energizing and deënergizing, sends an impulse from ground G^{16} through springs 169 and 479, side switch wiper 186 and private magnet 187 to battery lead 176. The private magnet, upon energizing and deënergizing, permits the side switch to pass from first to second position, whereby the vertical magnet is disconnected from the impulse spring 170, and a circuit is closed through the rotary magnet 184. The rotary magnet 184 operates in the same manner as the rotary magnet 75 of the selector F (Fig. 1) to rotate the wipers onto an idle trunk line leading to a selector L, after which the side switch passes to third position. After the side switch has passed to third position, the seized trunk is protected from seizure by any other selector by a guarding ground extending from ground G^{18} through side switch wiper 185 and private wiper 179 to the selector private bank contacts of the said trunk.

The operator now presses the button 88 twice and button 89 once for the second digit 2. Each time the button 88 is pressed a circuit is closed through the relays 167 and 168 of the selector I, as previously traced. Since the side switch is now in third position, the energization of relay 168 closes a circuit from ground G^{19} through side switch wiper 480, relays 481 and 188 in multiple and springs 189 and 190 to battery lead 176. These relays are energized the first time the button 88 is pressed and, being slow acting, do not deënergize between impulses, but remain in their operated position until the last impulse is delivered. In its energized position, the relay 481 opens the circuit through the selector and connects the impulse spring 170 with the vertical side of the trunk leading to the selector L. Thus each time the relay 167 energizes, a circuit is closed from ground G^{16} through springs 169 and 170, side switch wiper 171, springs 191 and 192, side switch wiper 193, springs 194 and 195, wiper 177, side switch wiper 197 and vertical line relay 198 to battery lead 176. The relay 198, upon energizing, closes a circuit from ground G^{20} through springs 199 and 200, 201 and 202 and vertical magnet 203 to battery lead 176. The vertical magnet receives two impulses over this circuit and operates to raise the shaft wipers two steps. When the button 89 is pressed by the operator the relays 181 and 168 of the selector I are energized over a circuit which has been traced before. The relay 181, upon energizing, completes a circuit from ground G^{16} through springs 169 and 479, side switch wiper 186 (in third position), springs 204 and 205, 206 and 207; wiper 178, side switch wiper 208 and rotary relay 209 to battery lead 176. The relay 209, upon energizing, completes a circuit from ground G^{20} through springs 199 and 210 and private magnet 211 to the battery lead 176. The private magnet, upon energizing and deënergizing, causes the side switch to pass to second position, whereupon a circuit is closed through the rotary magnet 212. The rotary magnet then operates in the manner explained for the rotory magnet of the selector F to rotate the wipers onto the contacts of an idle trunk line leading to a connector M (Fig. 4). In the selector L the circuit over which the private magnet 211 is energized to lock the side switch in second position while the shaft wipers are being rotated over busy trunks extends from the guarded private bank contacts of said trunks over the wiper 213, relay 214, side switch wiper 215 and magnet 211 to the battery lead 176. The relay 214 is not energized over the circuit on account of the comparatively high resistance of the magnet 211.

Since the relay 188 of the selector I is energized at the time the rotary line relay 181 is energized, a circuit is also closed from ground G^{16} to and through the private magnet springs 206 and 207, as before traced, and thence through the springs 215 and 216 and the magnet 217 to the battery lead 176. The magnet 217, upon energizing, rotates the wheel 218 one step. This wheel is so arranged that after it receives three such steps the springs 219 and 220 engage each other.

When the operator operates her calling apparatus for the third digit 2 the selector-repeater I operates in the manner just explained to repeat two impulses to the vertical side and one impulse to the rotary side of the trunk with which it has made connection. Since the side switch wipers 197 and 208 of the selector L are in third position, these impulses pass through the shaft wipers 221 and 222 and the trunk conductors 223 and 224 to the connector M (Fig. 4). The two vertical impulses for this digit pass from the conductor 223 through the relay 225 and the upper winding of the relay 226 to the battery lead 176. The relay 225 operates in response to these impulses to transmit two impulses from ground G^{21} through the springs 228 and 227, 229 and 230, side switch wiper 231 and vertical magnet 232 to the battery lead 176. The vertical magnet operates to raise the wipers of the selector two steps.

The rotary impulse for the third digit 2 passes from conductor 224 through the rotary line relay 233, lower winding of the relay 226 and springs 234 and 235 to battery.

The energization of the relay 233 closes a circuit from ground G^{21} through springs 228 and 236, private magnet 237 and springs 234 and 235 to battery lead 176. The private magnet 237, upon energizing and deenergizing, causes the side switch to pass to second position, whereby the rotary magnet 238 is brought under the control of the vertical relay 225. At the selector I the magnet 217 is energized by the rotary impulse delivered by the operator's calling device and rotates the wheel 218 one more step.

The selector-repeater I operates in response to the impulses for the last digit 0 in the manner just explained, except that, since the digit called is 0, ten impulses instead of two are repeated over the vertical side of the trunk. The operations of the vertical relay 225 for these impulses cause the rotary magnet 238 to be energized ten times over a circuit which, with the exception of the magnet itself, is the same as that traced for the vertical magnet 232. The rotary magnet operates in response to these impulses to rotate wipers of the connector ten steps onto the contacts of line #2220. The rotary impulse for this last digit operates the rotary relay 233, as for the previous digit, and causes the private magnet 237 to trip the side switch to third position. At the selector I the magnet 217 is energized once more by the last rotary impulse and rotates the wheel 218 one more step. This last step of the wheel 218 closes the contact between springs 219 and 220, whereby, as soon as the relay 188 deënergizes, a circuit is completed from ground G^{18} through side switch wiper 185, relay 239, springs 272 and 271, 219 and 220 and interrupter 242 to battery. The relay 239 is energized intermittently over this circuit and operates to open one side of the connection between the springs 194 and 195, and to close a circuit from ground G^{19} through side switch wiper 480, springs 243 and 194, and thence over the heavy conductors to and through the vertical relay 225, and upper winding of relay 226 of the connector M, over a circuit which has previously been pointed out. Since the side switch of the connector is now in third position, the energization of these relays completes a circuit from ground G^{21} through springs 228 and 227, 229 and 230, side switch wiper 231, ringer relay 245 and springs 246 and 247 to the battery lead 176. The relay 245, upon energizing, connects the generator Q with the called line to ring the bells 248. Since the relay 239 at the selector I is energized intermittently, the ringer relay 245 of the connector M is energized intermittently also. The first time the relay 245 deënergizes after the called subscriber removes his receiver in response to the call, a circuit is closed from ground G^{22} at the connector through side switch wiper 249, lower winding of relay 250, ringer relay springs 251 and 252, side switch wiper 253, shaft wiper 254, springs 255 and 256, line 257, primary winding of induction coil 258, transmitter 259, springs 22 and 23, line 260, wiper 261, side switch wiper 262, upper winding of relay 250 and springs 263 and 247 to battery lead 176. The closure of this circuit furnishes the called substation with talking current and causes the relay 250 to be energized. The relay 250, upon energizing, shifts the spring 234 out of engagement with spring 235 and into contact with spring 264, whereby a circuit is closed from ground G^{22} through side switch wiper 249, springs 264 and 234, lower winding of relay 226, rotary relay 233, thence over the heavy conductors through the selector L (Fig. 3) to the selector repeater I, thence through springs 215 and 265, relay 266, springs 267 and 192, side switch wiper 193, springs 195 and 194, wipers 177, 197 and 221, conductor 223 and relays 225 and 226 to battery. The relay 226 is not energized over the circuit just traced, because the current flows through its two windings in opposite directions. All the other relays included in this circuit are energized, the relays 225 and 233 of the connector M, however, having no function at this time. The relay 266 of the selector I, upon energizing, shifts the connection of the rotary line relay 181 and lower winding of relay 168 from battery lead 176 to ground at G^{18} and closes the circuit of relay 268. The relay 268, upon energizing, separates springs 271 and 272 and closes contact between springs 269 and 270. The separation of springs 271 and 272 opens the circuit of the relay 239 so as not to cause the called subscriber to be rung again after he has answered. The closure of springs 270 and 269 provides a locking circuit for relay 268 so that it will not deënergize when the called subscriber hangs up his receiver and allows the relay 266 to deënergize. This locking circuit extends from ground G^{18} through side switch wiper 185, springs 270 and 269 and relay 268 to battery. The circuit which is closed through the relay 268 by relay 266 is the same as that just traced, except that it includes springs 273 and 274 instead of springs 269 and 270.

The shifting of the spring 183 of relay 266 completes a circuit from ground G^{18} through side switch wiper 185, springs 275 and 183, lower winding of relay 168, relay 181, trunk 161, ring conductors of jack J^2 and plug P^2, springs 158 and 276 (the key K′ is restored as soon as the operator completes the call), relay 277, springs 278 and 156, tip of plug P^2 and jack J^2, conductor 160 and relays 167 and 168 to battery. The relay 277 at the cord circuit O ex-

tinguishes the lamp 279 to signify to the operator that the called subscriber has answered. (The lamp 279 is lighted as soon as the plug P^2 is inserted in the jack J^2 over a circuit extending from ground G^{51} through springs 162 and 163, sleeve of jack J^2 and plug P^2, springs 280 and 281 and lamp 279 to battery B.) At the selector I the relay 168 is not energized, because current flows through its two windings in opposite directions. The relays 167 and 181 are energized but without function at this time.

When the operator is notified that the called subscriber has answered by the extinguishment of lamp 279, the button 282 is pressed to cause the calling subscriber's meter (Fig. 1) to register. This is accomplished in the following manner: When the button 282 is pressed the relay 283 is connected in multiple with the relay 154. This increases the current in the relay 134 (Fig. 1) sufficiently to cause it to operate, and the relay 283 is operatively energized also. The relay 283, upon energizing, completes a circuit for itself from ground G^{13} through springs 284 and 285, 287 and 286, relay 283 and thence through plug P', trunk 127 and relay 134, as has been previously traced. The relay 283 thus remains locked in multiple with the relay 154 after the button 282 is released. The energization of the relay 134 (Fig. 1) transposes the connections between the windings of the relay 128 and the line conductors, and thereby reverses the current in the calling line. This reversal of current causes the winding 68 of the meter magnet 67 to assist the winding 69, and therefore the armature 70 is attracted and registers the call on the meter E. When the armature 70 is attracted the winding 68 is short-circuited by the springs 288 and 289, and the armature is held up by the winding 69 alone.

The line of the calling subscriber is protected from being seized by any other calling subscriber as soon as the line switch C operates. This protection is furnished by a ground potential which extends from ground G^4 throuh the springs 109 and 110 of the selector F, springs 52 and 51 and conductor 290 to the private bank contact of the substation A in the bank of each connector which has access to that line. The called line is protected in a similar manner as soon as the side switch of the connector M passes to third position, whereby a guarding ground potential extends from ground G^{22} through the side switch wiper 249 and the private shaft wiper 291 to the private bank contact 292, and thence to the corresponding contact in the bank of each connector which has access to the line of the substation A'. From the contact point 292 a circuit also extends through the cut-off relay 293 to battery. The relay 293, upon energizing, disconnects the switch N from the called line and completes connection between the contact upon which wiper 254 is resting and the line 257.

The manner in which the guarding potential at the private bank contacts prevents a connector M from connecting with a busy line is as follows: If there is a guarding ground potential on the connector private bank contact of the called line at the time the private magnet 237 is operated by the rotary relay 233 in response to the rotary impulse for the last digit of the number of that line, an energizing circuit is closed from said guarded bank contact through wiper 291, side switch wiper 249 (in second position), private magnet springs 295 and 296 and release magnet 537 to battery lead 176. The magnet 537, upon energizing, causes the mechanism of the connector to be restored to normal position, whereby its wipers are removed from contact with the called line. Now, since the connector is in normal position, the ground impulses which are sent over the vertical side of the line by the selector repeater I for ringing the called substation do not operate the ringing relay 245 of the connector, but operate the vertical magnet 232 instead, causing the switch shaft to be raised one or more steps. As soon as the shaft is raised the first step the springs 297 and 298 are permitted to come into engagement, thereby connecting the busy signaling machine R' with the calling line through said springs, side switch wiper 253, ringer relay springs 251 and 252, condenser 299, and thence over the heavy conductors shown in Figs. 4, 3, 2 and 1 to substation A. The return circuit is over the other side of the line and through relays 225 and 226 of the connector M to the battery lead 176 to which one terminal of the busy signaling machine R' is connected. The busy signaling current in this circuit produces the usual busy buzz in the receiver of the calling subscriber.

When the called subscriber hangs up his receiver upon the termination of a conversation, the connector back bridge relay 250 deënergizes. The relays 225 and 233 of the connector and relay 266 of the selector I which were energized by the operation of relay 250 thereupon deënergize. The deënergization of the relay 266 breaks the circuit of the relays 167 and 181 of the selector I and relay 277 of the cord O. The relay 277, upon deënergizing, closes the circuit of lamp 279.

When the calling subscriber hangs up his receiver, whether after a conversation or after having received the busy signal, the circuit of relay 128 (Fig. 1) is broken. The relay 128 thereupon deënergizes and breaks the circuit of relay 134 and of relays 283 and 154 at the cord O. The relay 154, upon de-

energizing, closes a circuit from ground G^{13} through springs 284 and 285, 300 and 301 and lamp 155. The simultaneous glowing of lamps 155 and 279 signifies to the operator that the connection may be taken down. When the plugs are removed from the jacks all the automatic switching apparatus employed in the connection is released. The removal of the plug P′ from jack J′ breaks the circuit of the relay 133 (Fig. 1). The relay 133 thereupon deënergizes and breaks the holding circuit of the selector release relay 85. The relay 85, upon deënergizing, closes a circuit from ground G^{3} through springs 107 and 118, 119 and 302, release magnet 81 and springs 84 and 83 to battery. The magnet 81, upon energizing, immediately restores the selector F to normal position. The deënergization of the relay 85 also breaks the holding circuit of the winding 44 of the line switch C, allowing it to be restored to normal position, and at the same time the circuit of the winding 69 of the meter magnet 67 is broken, allowing said magnet to be restored also.

The removal of the plug P^{2} from the jack J^{2} by the operator causes the circuit of the relays 164 and 165 to be broken. The relay 164 deënergizes immediately, while the slow acting relay 165 holds its armature up for an instant. At the instant the relay 164 deënergizes, both trunk conductors 161 and 162 are grounded through the springs of relay 165. The grounding of these conductors energizes the relays 167, 181 and 168 of the selector-repeater I. The energization of these relays grounds both sides of the trunk leading to the selector L over circuits which have already been pointed out, and the magnet 217 is also energized to rotate the wheel 218 one more step to allow springs 219 and 220 to disengage. The energization of relays 167, 181 and 168 also closes a circuit from ground G^{16} through springs 303 and 304, release magnet 305 and springs 189 and 190 to battery lead 176.

The impulses which are transmitted to the trunk line leading to the selector L by the simultaneous energization of the relays 167 and 181 of the selector I pass through said selector L and through the relays 225, 233 and 226 of the connector M. The simultaneous energization of these relays closes a circuit from ground G^{56} at selector L through side switch wiper 215, relay 214, wiper 213, conductor 534, springs 535 and 536, release magnet 537 and springs 246 and 247 to battery lead 176. The magnet 537, upon energizing, restores the shaft and side switch of the connector M to normal position. The energizing of the relay 214 of the selector L completes a circuit from ground G^{18} at the selector I through side switch wiper 185, shaft wiper 179 and springs 538 and 539 and release magnet 540 to the battery lead 176.

The release magnets 540 and 305 of the switches L and I, upon energizing, attract their armatures and hold them in readiness to release their respective switches upon the subsequent deënergization of the magnets. These magnets remain energized until the slow-acting relay 165 (Fig. 2) deënergizes. This relay, upon deënergizing, causes the deenergization of all the relays and magnets, including the magnets 540 and 305, which were energized as a result of the deënergization of the relay 164, whereupon the switches L and I are released simultaneously.

It having been explained how a two-wire substation A may obtain connection with a three-wire substation A′, it will now be explained how a connection may be extended from the three-wire substation A′ to the two-wire substation A. As the dial at the substation A′ is rotated forward preparatory to calling the first digit after the receiver has been removed from the hook, the rotary impulse spring 19 is momentarily forced into contact with the ground post 21, whereby a circuit is closed from ground G^{25} through the springs 306 and 307, springs 21 and 19, line conductor 257, springs 256, 308 and 309, trip magnet 310 to the battery lead 176. The trip magnet, upon energizing, releases the plunger, which operates to extend a connection from the line of the substation A′ through the springs 311 and 312 and 313 and 314 and over the conductors 315 and 316 to the selector L′ (Fig. 5). The closure of contact between the bank springs 318 and 319 by the plunger of the line switch N completes a circuit from ground G^{26} through the said springs 318 and 319 and cut-off relay 293 to the battery lead 176. The cut-off relay 293 thereupon energizes and opens the bridge across the line conductors 260 and 257. The closure of contact between the bank springs 320 and 321 by the line switch plunger completes a circuit from ground G^{27} through the relay 322, common segment 323, wiper 324, contact point 325, springs 321 and 320, release magnet 326 to battery lead 176. The relay 322 is energized over this circuit, but on account of its comparatively high resistance does not permit sufficient current to flow to energize the release magnet 326. The relay 322 corresponds to the relay 114 of the master switch D (Fig. 1) and, upon energizing, causes the master switch D′ to operate in the same manner as explained for the master switch D to advance the plungers of the idle line switches to an idle trunk line.

As the dial and impulse wheel at substation A′ return to normal position after being rotated for this digit, which in this case will be assumed to be 4, the vertical impulse spring 20 is pressed into engagement with the ground post 21 four times and then the rotary impulse spring 19 is once more grounded. Each time the spring 20 engages

the ground post 21 the circuit is closed from ground G^{25} through the springs 306 and 307, 21 and 20, line 260, bank springs 311 and 312, trunk conductor 315, side switch wiper 327 and vertical line relay 328 of selector L′ to the battery lead 176. The grounding of the rotary impulse spring 19 at the substation completes a circuit which extends over line conductor 257 through springs 313 and 314, trunk conductor 316, side switch wiper 329 and rotary line relay 330 to the battery lead 176. The selector L′ is essentially the same as the selector L, Fig. 3, and operates in response to the impulses through its line relays 328 and 330 in the same manner as explained for the selector L to extend the connection over the trunk conductors 331, 332, through the condensers 333 and 334 to an idle jack J^3. When the side switch of the selector L′ reaches third position, a circuit is closed from ground G^{28} through the relay 335, trunk conductor 332, selector wiper 336, side switch wiper 329, trunk conductor 316, line 257, thence through the substation A′ and back over line conductor 260, trunk conductor 315, side switch wiper 327, shaft wiper 337 and relay 338 to the battery lead. The relays 338 and 335 thereupon energize, the relay 338 operating to close a circuit from ground G^{29} through springs 339 and 340 and relays 341 and 342 to the battery lead. The energization of the relays 341 and 342 is without any direct effect. The energization of the relay 335 completes a circuit from ground G^{30} through the upper winding of relay 343, springs 344 and 345, conductor 346, contact point 347, armature 348, relay 349, armature 350, contact point 351 and lower winding of relay 343 to the battery lead. The relay 349 thereupon energizes and completes a circuit through the lamp 352. The relay 343 is also energized over the circuit just traced and connects the ground G^{31} with the relays 341 and 342. Upon seeing the signal of the lamp 352, the operator inserts the plug P^3 into the jack J^3, thereby connecting the cord O′ with the line of the calling subscriber. The engagement of the sleeve conductors of the plug P^3 and jack J^3 completes a circuit through the cut-off relay 354, which energizes and disconnects the relay 349 from the trunk, thereby allowing the lamp 352 to be extinguished. When the plug is inserted in the jack the supervisory relays 356 and 357 are both energized. The energizing circuit for the supervisory relay 357 extends from ground G^{32} through the said relay, ring conductors of plug P^3 and jack J^3, thence through the lower winding of relay 343 to the battery lead. The energizing circuit for the relay 356 extends from the battery lead 176 through the said relay, tip springs of plug P^3 and jack J^3, conductor 346, springs 345 and 344, thence through the upper winding of relay 343 to ground G^{30}. Upon finding that the substation A of the two-wire exchange is wanted, the operator inserts the plug P^4 into the jack J^4 and operates the key K^3, whereby the impulse springs 90 and 91 of the operator's calling device are bridged across the trunk conductors 358 and 359, which lead to the selector repeater I′, Fig. 6. When this occurs a circuit is closed from ground G^{33}, Fig. 6, through side switch wiper 360, lower winding of relay 361, trunk conductor 359, sleeve contact of jack J^4 and plug P^4, springs 362 and 363, impulse springs 91 and 90, key springs 364 and 365, tip conductors of plug P^4 and jack J^4, trunk conductor 358 and upper winding of relay 361 to battery lead 105. The relay 361, upon energizing, completes a circuit from ground G^{34} through the springs 366 and 367 and relay 368 to the battery lead 105. The operator at the cord O′ now operates the calling device for the first digit of the number of the substation A, which will be assumed to be 220. The operation of the calling device for the first digit 2 causes the impulse springs 90 and 91 to be momentarily separated twice. Each time these springs are separated the relay 361 of the selector repeater I′ deënergizes momentarily. Since the relay 368 is slow acting it does not have time to deënergize during the momentary interruption of this circuit by the realy 361. Consequently, the engagement of springs 366 and 369 completes the circuit from ground G^{34} through springs 366 and 369, 370 and 371, relay 372, vertical magnet 373 and side switch wiper 374 to battery lead 105. The vertical magnet 373 receives two impulses over this circuit and operates to raise the shaft wipers 375, 376 and 377 two steps. The relay 372, which is included in the energizing circuit of the vertical magnet 373, is energized by the first impulse, but being a slow acting relay, does not deënergize until after the last impulse has been delivered. In its energized position, the relay 372 closes a circuit from ground G^{35} through springs 482 and 378 and private magnet 379 to the battery lead 105. This circuit is broken when the relay 372 deënergizes, and the private magnet permits the side switch to pass to second position. When in second position the side switch wiper 374 completes a circuit from ground G^{36} through interrupter springs 380, rotary magnet 381 and side switch wiper 374 to the battery lead. The rotary magnet then operates in the same manner as explained for the rotary magnet of the selector I, Fig. 3, to rotate the wipers onto the contacts of an idle trunk line, after which the side switch passes to third position. After the side switch passes to third position, a guarding potential is extended from ground G^{37} through side switch wiper

382, private wiper 377, private bank contact 383, thence to the corresponding contact in the banks of all selectors which have access to the trunk line which has been seized by the selector I'. When a connection is thus extended by way of the selector I' to the connector M', a circuit is completed from ground G^{38} at the connector through side switch wiper 483, lower winding of relay 384, springs 385 and 386, contact point 387, wiper 376, springs 389 and 388, relay 390, retardation coil 391, wiper 375, contact point 392, springs 393 and 394 and upper winding of relay 384 to the battery lead 105. The relay 384, upon energizing, completes a circuit through the relay 395 in the same manner in which a circuit was completed through the relay 368 of the selector I'. The energization of the relay 390 of the selector I' connects the ground G^{39} with the lower winding of relay 361, to take the place of ground G^{33} which is disconnected when the side switch passes to third position. Each time the relay 361 of the selector I' deënergizes in response to the impulses for the second digit 2, the separation of the springs 388 and 389 breaks the circuit of the line relay 384 of the connector M'. The relay 395 of the connector, being slow acting, does not deënergize during the momentary interruption of the circuit by the relay 384, and, therefore, each time relay 384 deënergizes a circuit is closed from ground G^{40} through springs 396 and 397, 398 and 399, relay 400, vertical magnet 401, side switch wiper 402, to battery lead 105. The vertical magnet 401 receives two impulses over this circuit and operates to raise the wipers of the connector two steps. The relay 400, which is included in the energizing circuit of the vertical magnet 401, is energized by the first impulse, and completes a circuit from ground G^{41} through springs 484 and 403 and private magnet 404 to the battery lead 105. The relay 400 being slow acting, remains energized until after the last impulse is delivered to the vertical magnet. When it deënergizes it breaks the circuit of the private magnet 404, which then allows the side switch to pass to second position. Each time the relay 361 of the selector I' deënergizes to repeat an impulse to the line relay 384 of the connector M', a circuit is closed from ground G^{34} through springs 366 and 369, 370 and 371, relay 372, relay 405 and side switch wiper 374 to battery lead 105. The operation of the relay 372 at this time is functionless. The relay 405 is energized by the first impulse for the digit and, being slow acting, does not deënergize until after the last impulse is delivered. In its energized position the relay 405 short circuits the relay 390 and the retardation coil 391 through the springs 406 and 407, thereby removing the resistance of said relay and retardation coil from the circuit of the connector line relay 384 while it is operating. In its energized position the relay 405 also connects the ground G^{35} with the lower winding of relay 361 to take the place of ground G^{39}, which is disconnected by the deënergization of the relay 390 when it is short circuited.

When the operator's calling device is operated for the last digit 0 the line relay 361 of the selector repeater I' is deënergized ten times and operates in the same manner as explained for the previous digit to repeat ten impulses to the line relay 384 of the connector M'. Each time the relay 384 deënergizes in response to this last series of impulses, a circuit is closed from ground G^{40} through springs 396 and 397, 398 and 399, relay 400, springs 408 and 409, rotary magnet 541 and side switch wiper 402 to the battery lead 105. The rotary magnet thus receives ten impulses and operates to rotate the wipers of the connector ten steps onto the contacts of the desired line #220. The relay 400 operates in the same manner as explained for the previous digit to maintain the circuit of the private magnet 404 closed during the time the impulses are being delivered through the rotary magnet 541. After the last impulse is delivered, the private magnet 404 deënergizes, if the called line is idle, and allows the side switch to pass to third position, whereby the connection is extended to the called line. When the side switch wiper 483 of the connector passes from second to third position the ground G^{38} is disconnected from the lower winding of relay 384 and said winding is connected to ground G^{42} through the relay 410. The relay 410 is therefore included in the circuit of the relay 390 of the selector I' and is of sufficiently high resistance to reduce the current in the relay 390 enough to allow its armature to fall back. When the armature of the relay 390 falls back, the ground G^{39} is disconnected from the lower winding of the relay 361 and the only remaining ground connection for this winding is through relay 411 to ground G^{43}. After the operator at the cord O' has operated the calling device for the last digit, the key K^3 is restored to normal position, whereby the calling device is disconnected from the cord and the supervisory relay 412, and impedance coil 413 are substituted. The relay 412 is therefore included in circuit in series with the line relay 361 of the selector I' and relay 411. The relay 411, being of comparatively high resistance, does not permit sufficient current to flow through the relay 412 of the cord circuit to cause it to attract its armature, and therefore the lamp 414 remains lighted by a circuit which was closed as soon as the plug P^3 was inserted in the jack J^3. This circuit extends

from ground G[44] through the armature 415 and contact point 416 of relay 357, armature 417 and contact point 418 of relay 412 and lamp 414 to the battery lead 176. When the side switch of the connector M′, Fig. 6, passes to third position, the circuit is closed from ground G[45] through interrupter 419, ringer relay 420, springs 421 and 422 and side switch wiper 402 to battery lead 105. Since this circuit includes the interrupter 419, the ringer relay 420 is energized intermittently. Each time this relay is energized the connection between the calling and called line is opened, and the ringer generator Q′ is bridged across the line of the called subscriber. Ringing current then flows from one terminal of the generator Q′ through ringer relay springs 423 and 424, wiper 425, conductor 426, springs 96 and 95 of line switch C, Fig. 1, line conductor 101, thence through the bell to substation A and back over line 98, conductor 427, shaft wiper 428, side switch wiper 429, ringer relay springs 430 and 431 to the other terminal of the generator Q′. The circuit for this ringing current includes the springs 95 and 96 of the line switch C, Fig. 1. These springs are closed by the energization of the winding 44 as soon as the side switch of the connector M′ reaches third position. The circuit of winding 44 extends from ground G[46] to side switch wiper 432 of the connector, private wiper 433, contact 466[a], conductor 290 and winding 44 to the battery lead 105. When the called subscriber removes the receiver, or as soon thereafter as the ringer relay 420 deënergizes, a circuit is closed from ground G[46] through side switch wiper 432 of the connector, lower winding of back bridge relay 435, ringer relay springs 436 and 430, thence through the substation A, through the talking circuit, back to the connector M′ over the other side of the line, through ringer relay springs 424 and 437, private magnet springs 438 and 439, upper winding of relay 435 and side switch wiper 402 to the battery lead 105. The relay 435, upon energizing, short-circuits the high resistance relay 410 and closes the circuit of the relay 440, which circuit extends from ground G[46] through side switch wiper 432, relay 440 and springs 441 and 442 to battery lead 105. The relay 440, upon energizing, opens the circuit of the ringer relay 420, reverses the connections between the windings of relay 384 and the line conductors and also completes the locking circuit for itself through the springs 443 and 422, which circuit is independent of the springs 441 and 442 of the back bridge relay 435. This transposing of the connections of the windings of the relay 384 reverses the current through the relay 390 which is bridged across the line to the selector P′, but this reversal of the current, however, is without effect. The short-circuiting of the high resistance relay 410 at the connector by the engagement of the springs 444 and 445 of the back bridge relay 435, however, increases the current through the relay 390 of the selector I′ sufficiently to cause it to attract its armature. The attraction of the armature of the relay 390 connects the ground G[39] to the lower winding of the relay 361 without interposed resistance, and therefore decreases the resistance in series with the supervisory relay 412 of the cord O′ sufficiently to cause it to attract its armature. When the armature 417 is attracted the circuit of the lamp 414 is broken, which signifies to the operator that the called subscriber has answered.

When the calling and called subscribers hang up their receivers upon the termination of the conversation, the operator at the cord O′ is given the usual disconnect signal in the following manner:—The hanging up of the receiver at the calling substation A′ breaks the energizing circuit of the relays 338 and 335, Fig. 5. The relay 335, upon deënergizing, breaks the circuit of the supervisory relay 356 of the cord O′, which relay thereupon deënergizes and closes the circuit of the lamp 446. When the receiver at the called substation A is restored, the circuit of the back bridge relay 435 is broken. This relay, upon deënergizing, removes the short circuit from the high resistance relay 410, which is thus again included in the circuit of the relay 390 of the selector I′. The relay 390 thereupon deenergizes sufficiently to allow its armature to drop back and remove the short-circuit from the relay 411. This causes the relay 412 of the cord O′ to deënergize sufficiently to allow its armature to drop back and close a circuit through the lamp 414. The simultaneous glowing of the lamps 414 and 446 indicates to the operator that both subscribers have hung up their receivers and that the connection may be released. The automatic switches employed in the connection are released by the removal of the plugs P[3] and P[4] from the jacks J[3] and J[4] in the following manner: When the plug P[3] is removed from the jack J[3] the energizing circuit of the relay 343 is broken. Since the relay 338 is already deënergized, the deënergization of the relay 343 breaks the energizing circuit of the relays 341 and 342. The relay 342, being quick acting, deenergizes immediately and completes a circuit from ground G[47] at the selector L′ through side switch wiper 447, relay 448, private wiper 449, springs 450 and 451, 452 and 453 and resistance 454 to battery lead 176. The relay 448, upon energizing, completes a circuit from ground G[48] through the springs 542 and 455 and release magnet 543 to the

battery lead 176. The release magnet thereupon attracts its armature and holds it in readiness to release the selector L′, and also completes a circuit from ground G[49] to the contact point 456, armature 457, conductor 317, springs 321 and 320 (Fig. 4) and release magnet 326 to the battery lead 176. The release magnet 326 thereupon attracts its armature and holds it in readiness to release the line switch N. The relay 341 (Fig. 5), being a slow relay, deënergizes shortly after the relay 342 and opens the circuit through the relay 448 of the selector L′. This relay, upon deënergizing, opens the circuit through the release magnet 543. When the release magnet 543 deënergizes, it releases the selector L′ and breaks the circuit of the release magnet 326 of the line switch N (Fig. 4), which deënergizes and allows the plunger to be restored to normal position. When the plug P[4] is removed from the jack J[4] the circuit of the line relay 361 of the selector I′ is broken. This relay upon deënergizing, breaks the circuit of the relay 368 and of the line relay 384 of the connector M′. The relay 368, upon deënergizing, completes the circuit for the release magnet 458. This circuit extends from ground G[34] through the springs 366 and 369, 370 and 460, magnet 458, and springs 461 and 462 to the battery lead 105. The magnet 458, upon energizing, causes the mechanism of the selector I′ to be restored to normal position immediately, and when the shaft reaches its lowest position the springs 461 and 462 are separated and the magnet 458 allowed to deënergize. When the line relay of the connector M′ deënergizes it breaks the circuit of the slow acting relay 395, which in turn deënergizes and closes the circuit of the release magnet 463. This circuit extends from ground G[40] through the springs 396 and 397, 398 and 464, magnet 463 and springs 465 and 466 to the battery lead 105. The magnet 463, upon energizing, restores the connector M′ to normal position, whereupon the springs 465 and 466 are separated and the release magnet allowed to again deenergize.

In the foregoing it has been explained how the connector M′ completes connection with an idle line. If the called line is busy, however, at the time the wipers of the connector are brought into engagement with the contacts thereof, the connector will not complete the connection and the calling subscriber will be given the busy signal in the following manner: If the line of substation A is busy the private wiper 433 of the connector finds a guarding ground on the private bank contact 466[a]. This being the case, when the private magnet relay 400 deenergizes, after the last impulse has been delivered to the rotary magnet 541, the circuit is closed from said guarded contact point 466[a] to the wiper 433, side switch wiper 432 (in second position), springs 467 and 468, relay 469, springs 470 and 403 and private magnet 404 to battery lead 105. As the relay 400 deënergizes, the spring 403 engages the spring 470 before it disengages spring 484, so that the latter circuit through the private magnet 404 is closed before its former circuit is broken. Thus the private magnet 404 remains energized, locking the side switch in second position and at the same time the relay 469 is energized. The relay 469, upon energizing, disconnects the rotary magnet 541 from the impulse spring 397, transfers the holding ground of the private magnet 404 from the guarded private bank contacts to ground G[50], which is connected to springs 471 through springs 472 and 473 and side switch wiper 474, and closes a busy signaling circuit from the busy signaling machine R[2] to the calling line. The circuit over which the busy signaling current flows extends from one terminal of the busy signaling machine R[2] through the springs 475 and 476, contact point 477, side switch wiper 429, ringer relay springs 430 and 436, condenser 478, thence over the heavy conductors through the switch I′, cord O′, selector L′, thence through the substation A and back over the other side of the line to and through the upper winding of the line relay 384 of the connector to the battery lead 105, thence to the other terminal of the busy signaling machine. The busy signaling current flowing over this circuit produces a buzz in the receiver of the calling subscriber, which signifies that the called line is busy, and he thereupon hangs up the receiver and gives the operator the disconnect signal.

It has been explained how subscribers of either exchange may obtain connection with subscribers of the other exchange through the medium of an operator. Referring to Fig. 1, it will be evident that, besides having access to trunk lines leading to jacks J′, the selector F may also have access to trunk lines leading to connectors M′, Fig. 6, whereby subscriber A may obtain connection with any subscriber in his own exchange without requiring the services of an operator. Likewise, any of the subscribers A′, Fig. 4, of the three-wire exchange may obtain connection with any other subscriber of his own exchange without an operator—that is, the first selector L′, Fig. 5, might have access to second selectors L, Fig. 3, and, through them, to connectors M by means of which connection may be obtained automatically with any subscriber in the three-wire exchange.

From the foregoing it will be seen that I provide an improved system in which it is possible to call semi-automatically from a

three-wire system to a two-wire system, or from the said two-wire system to the said three-wire system, with double supervision in each case. The three-wire selector and repeater I is equipped with means for automatically and intermittently controlling the ringing mechanism in the connector to automatically and intermittently project ringing current onto the called line until the called party answers, or until the calling party hangs up. The two-wire selector and repeater I′ is capable of controlling the two sides of the selected trunk in series, while in use as a repeater, for the purpose of controlling the switch at the other end of said trunk, or for the purpose of controlling a switch at a point farther along in the calling connection. The selector and repeater I′ is, moreover, controlled over the two sides of a line circuit in series. The selector and repeater I, however, is controlled by grounding first one side and then the other of the line circuit leading thereto. The selector and repeater I′ is, it will be seen, equipped with means for reducing the resistance of a semi-automatic line circuit, when the called party answers, to restore a supervisory signal at the manual board through which the semi-automatic connection has been made. In this way an efficient and highly satisfactory system is provided for giving service between subscribers of different exchanges. It will be seen, however, that various features of my invention may be employed for giving service between subscribers of the same exchange. I do not, therefore, limit myself to the exact construction shown and described.

What I claim as my invention is:—

1. In a telephone trunking system, a combined trunk selector and repeater, and a connector provided with ringing mechanism, said combined selector and repeater being provided with mechanism automatically operative to intermittently ground the selected trunk upon the completion of the operation of said connector to control said ringing mechanism to intermittently signal the called party.

2. In a telephone trunking system, a combined trunk selector and repeater, and a connector provided with ringing mechanism, said combined selector and repeater being provided with mechanism automatically operative to intermittently ground the selected trunk upon the completion of the operation of said connector to control said ringing mechanism to intermittently signal the called party, said selector mechanism including a ratchet device, and a relay controlled by said ratchet device.

3. In a telephone trunking system, a combined trunk selector and repeater, and a connector provided with ringing mechanism, said combined selector and repeater being provided with mechanism automatically operative to intermittently ground the selected trunk upon the completion of the operation of said connector to control said ringing mechanism to intermittently signal the called party, a line circuit, and means for grounding said circuit to control said combined selector and repeater.

4. In a telephone trunking system, a combined trunk selector and repeater, and a connector provided with ringing mechanism, said combined selector and repeater being provided with mechanism automatically operative to intermittently ground the selected trunk upon the completion of the operation of said connector to control said ringing mechanism to intermittently signal the called party, the said combined selector and repeater being provided with means for grounding both sides of said trunk to release the connector.

5. In a telephone system, means including a combined trunk selector and repeater for extending a connection from a calling to a called subscriber's line, and a line circuit, said combined selector and repeater being provided with means for reducing the resistance of said circuit when the called party answers.

6. In a telephone system, means including a combined trunk selector and repeater for extending a connection from a calling to a called subscriber's line, and a line circuit provided with a supervisory signal, said combined selector and repeater being provided with means for reducing the resistance of said circuit to restore said signal when the called party answers.

7. In a telephone system, a three-wire exchange, a two-wire exchange, and means for calling semi-automatically from either exchange to the other.

8. In a telephone system, a three-wire exchange, a two-wire exchange, supervisory apparatus, means for calling semi-automatically from either exchange to the other, and means for giving double supervision in each case.

9. In a telephone trunking system, a combined trunk selector and repeater, and a connector provided with ringing mechanism, said combined selector and repeater being provided with mechanism automatically operative to intermittently ground the selected trunk upon the completion of the operation of said connector to control said ringing mechanism to intermittently signal the called party, and common battery means for supplying current for talking purposes to the called party.

10. In a telephone trunking system, a combined trunk selector and repeater, and a connector provided with ringing mechanism, said combined selector and repeater being provided with mechanism automatically op-

erative to intermittently ground the selected trunk upon the completion of the operation of said connector to control said ringing mechanism to intermittently signal the called party, said selector mechanism including a ratchet device, a relay controlled by said ratchet device, and common battery means for supplying current for talking purposes to the called party.

11. In a telephone trunking system, a combined trunk selector and repeater, and a connector provided with ringing mechanism, said combined selector and repeater being provided with mechanism automatically operative to intermittently ground the selected trunk upon the completion of the operation of said connector to control said ringing mechanism to intermittently signal the called party, a line circuit, means for grounding said circuit to control said combined selector and repeater, and common battery means for supplying current for talking purposes to the called party.

12. In a telephone trunking system, a combined trunk selector and repeater, and a connector provided with ringing mechanism, said combined selector and repeater being provided with mechanism automatically operative to intermittently ground the selected trunk upon the completion of the operation of said connector to control said ringing mechanism to intermittently signal the called party, the said combined selector and repeater being provided with means for grounding both sides of said trunk to release the connector, and central office means for supplying current for talking purposes to the called party.

13. In a telephone system, means for establishing a connection between a calling and a called subscriber, said means including a plurality of trunks, a combined trunk selector and repeater, a line circuit, said combined selector and repeater being provided with means for reducing the resistance of said circuit when the called party answers, and common battery means for supplying current for talking purposes.

14. In a telephone system, means for establishing a connection between a calling and a called subscriber, said means including a plurality of trunks, a combined trunk selector and repeater, a line circuit provided with a supervisory signal, said combined selector and repeater being provided with means for reducing the resistance of said circuit to restore said signal when the called party answers, and common battery means for supplying current for talking purposes.

15. In a telephone system, a three-wire exchange, a two-wire exchange, means for calling semi-automatically from either exchange to the other, and means for supplying current for talking purposes to the calling party.

16. In a telephone system, a three-wire exchange, a two-wire exchange, supervisory apparatus, means for calling semi-automatically from either exchange to the other, means for giving double supervision in each case, and means for supplying current for talking purposes to the calling party.

17. In a telephone trunking system, a combined trunk selector and repeater, and a connector provided with ringing mechanism, said combined selector and repeater being provided with mechanism automatically operative to intermittently ground the selected trunk upon the completion of the operation of said connector to control said ringing mechanism to intermittently signal the called party, said selector and repeater having motion first in one direction to find a predetermined group, and then motion in a direction at right-angles thereto for the purpose of automatically selecting an idle trunk before serving as a repeater.

18. In a telephone trunking system, a combined trunk selector and repeater, and a connector provided with ringing mechanism, said combined selector and repeater being provided with mechanism automatically operative to intermittently ground the selected trunk upon the completion of the operation of said connector to control said ringing mechanism to intermittently signal the called party, said selector mechanism including a ratchet device, and a relay controlled by said ratchet device, said selector and repeater having motion first in one direction to find a predetermined group, and then motion in a direction at right-angles thereto for the purpose of automatically selecting an idle trunk before serving as a repeater.

19. In a telephone trunking system, a combined trunk selector and repeater, and a connector provided with ringing mechanism, said combined selector and repeater being provided with mechanism automatically operative to intermittently ground the selected trunk upon the completion of the operation of said connector to control said ringing mechanism to intermittently signal the called party, a line circuit, and means for grounding said circuit to control said combined selector and repeater, said selector and repeater having motion first in one direction to find a predetermined group, and then motion in a direction at right-angles thereto for the purpose of automatically selecting an idle trunk before serving as a repeater.

20. In a telephone trunking system, a combined trunk selector and repeater, and a connector provided with ringing mechanism, said combined selector and repeater being provided with mechanism automatically operative to intermittently ground the selected trunk upon the completion of the

operation of said connector to control said ringing mechanism to intermittently signal the called party, the said combined selector and repeater being provided with means for grounding both sides of said trunk to release the connector, said selector and repeater having motion first in one direction to find a predetermined group, and then motion in a direction at right-angles thereto for the purpose of automatically selecting an idle trunk before serving as a repeater.

21. In a telephone system, means for establishing a connection between a calling and a called subscriber, said means including a plurality of trunks, a combined trunk selector and repeater, and a line circuit, said combined selector and repeater being provided with means for reducing the resistance of said circuit when the called party answers, said selector and repeater having motion first in one direction to find a predetermined group, and then motion in a direction at right-angles thereto for the purpose of automatically selecting an idle trunk before serving as a repeater.

22. In a telephone system, means for establishing a connection between a calling and a called subscriber, said means including a plurality of trunks, a combined trunk selector and repeater, and a line circuit provided with a supervisory signal, said combined selector and repeater being provided with means for reducing the resistance of said circuit to restore said signal when the called party answers, said selector and repeater having motion first in one direction to find a predetermined group, and then motion in a direction at right-angles thereto for the purpose of automatically selecting an idle trunk before serving as a repeater.

23. In a telephone trunking system, means for establishing a connection between a calling and a called subscriber, said means including a plurality of trunks, a combined trunk selector and repeater, and a connector provided with ringing mechanism, said combined selector and repeater being provided with mechanism automatically operative to intermittently ground the selected trunk upon the completion of the operation of said connector to control said ringing mechanism to intermittently signal the called party, and common battery means for supplying current for talking purposes to the calling party, said selector and repeater having motion first in one direction to find a predetermined group, and then motion in a direction at right-angles thereto for the purpose of automatically selecting an idle trunk before serving as a repeater.

24. In a telephone trunking system, means for establishing a connection between a calling and a called subscriber, said means including a plurality of trunks, a combined trunk selector and repeater, and a connector provided with ringing mechanism, said combined selector and repeater being provided with mechanism automatically operative to intermittently ground the selective trunk upon the completion of the operation of said connector to control said ringing mechanism to intermittently signal the called party, said selector mechanism including a ratchet device, a relay controlled by said ratchet device, and common battery means for supplying current for talking purposes to the calling party, said selector and repeater having motion first in one direction to find a predetermined group, and then motion in a direction at right-angles thereto for the purpose of automatically selecting an idle trunk before serving as a repeater.

25. In a telephone trunking system, means for establishing a connection between a calling and a called subscriber, said means including a plurality of trunks, a combined trunk selector and repeater, and a connector provided with ringing mechanism, said combined selector and repeater being provided with mechanism automatically operative to intermittently ground the selected trunk upon the completion of the operation of said connector to control said ringing mechanism to intermittently signal the called party, a line circuit, means for grounding said circuit to control said combined selector and repeater, and common battery means for supplying current for talking purposes to the calling party, said selector and repeater having motion first in one direction to find a predetermined group, and then motion in a direction at right-angles thereto for the purpose of automatically selecting an idle trunk before serving as a repeater.

26. In a telephone trunking system, means for establishing a connection between a calling and a called subscriber, said means including a plurality of trunks, a combined trunk selector and repeater, and a connector provided with ringing mechanism, said combined selector and repeater being provided with mechanism automatically operative to intermittently ground the selected trunk upon the completion of the operation of said connector to control said ringing mechanism to intermittently signal the called party, the said combined selector and repeater being provided with means for grounding both sides of said trunk to release the connector, and common battery means for supplying current for talking purposes to the calling party, said selector and repeater having motion first in one direction to find a predetermined group, and then motion in a direction at right-angles thereto for the purpose of automatically selecting an idle trunk before serving as a repeater.

27. In a telephone system, means for establishing a connection between a calling and a called subscriber, said means including

a plurality of trunks, a combined trunk selector and repeater, a line circuit. said combined selector and repeater being provided with means for reducing the resistance of said circuit when the called party answers, and common battery means for supplying current for talking purposes to the calling party, said selector and repeater having motion first in one direction to find a predetermined group, and then motion in a direction at right-angles thereto for the purpose of automatically selecting an idle trunk before serving as a repeater.

28. In a telephone system, means for establishing a connection between a calling and a called subscriber, said means including a plurality of trunks, a combined trunk selector and repeater, a line circuit provided with a supervisory signal, said combined selector and repeater being provided with means for reducing the resistance of said circuit to restore said signal when the called party answers, and common battery means for supplying current for talking purposes to the calling party, said selector and repeater having motion first in one direction to find a predetermined group, and then motion in a direction at right-angles thereto for the purpose of automatically selecting an idle trunk before serving as a repeater.

29. In a telephone system, a calling line and a called line, links and a progressively movable automatic switch for connecting the two in a talking circuit, one of said links being a cord circuit and another of said links having a repeater individual thereto for repeating impulses from one part of the link to the other, said repeater controlled over both sides of said link in series, and a coil individual to said switch through which current for talking purposes is supplied to the talking circuit.

30. In a telephone system, a calling line and a called line, links and a progressively movable automatic switch for connecting the two in a talking circuit, one of said links being a cord circuit and another of said links having a repeater individual thereto for repeating impulses from one part of the link to the other, said repeater controlled over both sides of said link in series, a circuit closer for said link circuit, trunk lines having terminals associated with said circuit closer, and step-by-step mechanism for moving said circuit closer to connect the link with one of said lines, and a coil individual to said switch through which current for talking purposes is supplied to the talking circuit.

31. In a telephone system, a calling line and a called line, links and a progressively movable automatic switch for connecting the two in a talking circuit, one of said links being a cord circuit and another of said links having a repeater individual thereto for repeating impulses from one part of the link to the other, said repeater controlled over both sides of said link in series, a circuit closer for said link circuit, other lines having terminals associated with said circuit closer, step-by-step mechanism for moving said circuit closer to connect the link with one of said lines, said step-by-step mechanism responsive also to impulses over the two sides of the link in series, and a coil individual to said switch through which current for talking purposes is supplied to the talking circuit.

32. In a telephone system, a calling line and a called line, links and a progressively movable automatic switch for connecting the two in a talking circuit, one of said links being a cord circuit and another of said links having a repeater individual thereto for repeating impulses from one part of the link to the other, said repeater controlled over both sides of said link in series, said link having a wiper, a plurality of lines each having a contact associated with said wiper, step-by-step mechanism for advancing said wiper into engagement with one of said contacts whereby connection may be established between the link and any one of said lines, and a coil individual to said switch through which current for talking purposes is supplied to the talking circuit.

33. In a telephone system, a calling line and a called line, links and a progressively movable automatic switch for connecting the two in a talking circuit, one of said links being a cord circuit and another of said links having a repeater individual thereto for repeating impulses from one part of the link to the other, said repeater controlled over both sides of said link in series, said link having a wiper, a plurality of lines each having a contact associated with said wiper, step-by-step mechanism for advancing said wiper into engagement with one of said contacts whereby connection may be established between the link and any one of said lines, said step-by-step mechanism responsive also to impulses over the two sides of the link circuit in series, and a coil individual to said switch through which current for talking purposes is supplied to the talking circuit.

34. In a telephone system, a calling line and a called line, links and a progressively movable automatic switch for connecting the two in a talking circuit, one of said links being a cord circuit and another of said links having a repeater individual thereto for repeating impulses from one part of the link to the other, said repeater controlled over both sides of said link in series, a supervisory signal for said cord controlled from one of said lines, and a coil individual to said switch through which current for talking purposes is supplied to the talking circuit.

35. In a telephone system, a calling line and a called line, links and a progressively movable automatic switch for connecting the two in a talking circuit, one of said links being a cord circuit and another of said links having a repeater individual thereto for repeating impulses from one part of the link to the other, said repeater controlled over both sides of said link in series, a circuit closer for said link circuit, other lines having terminals associated with said circuit closer, step-by-step mechanism for moving said circuit closer to connect the link with one of said lines, a supervisory signal for said cord controlled from one of said lines, and a coil individual to said switch through which current for talking purposes is supplied to the talking circuit.

36. In a telephone system, a calling line and a called line, links and a progressively movable automatic switch for connecting the two in a talking circuit, one of said links being a cord circuit and another of said links having a repeater individual thereto for repeating impulses from one part of the link to the other, said repeater controlled over both sides of the link in series, a circuit closer for said link circuit, other lines having terminals associated with said circuit closer, step-by-step mechanism for moving said circuit closer to connect the link with one of said lines, said step-by-step mechanism responsive also to impulses over the two sides of the link in series, a supervisory signal for said cord controlled from one of said lines, and a coil individual to said switch through which current for talking purposes is supplied to the talking circuit.

37. In a telephone system, a calling line and a called line, links and a progressively movable automatic switch for connecting the two in a talking circuit, one of said links being a cord circuit and another of said links having a repeater individual thereto for repeating impulses from one part of the link to the other, said repeater controlled over both sides of said link in series, said link having a wiper, a plurality of lines each having a contact associated with said wiper, step-by-step mechanism for advancing said wiper into engagement with one of said contacts whereby connection may be established between the link and any one of said lines, a supervisory signal for said cord controlled from one of said lines, and a coil individual to said switch through which current for talking purposes is supplied to the talking circuit.

38. In a telephone system, a calling line and a called line, links and a progressively movable automatic switch for connecting the two in a talking circuit, one of said links being a cord circuit and another of said links having a repeater individual thereto for repeating impulses from one part of the link to the other, said repeater controlled over both sides of said link in series, said link having a wiper, a plurality of lines each having a contact associated with said wiper, step-by-step mechanism for advancing said wiper into engagement with one of said contacts whereby connection may be established between the link and any one of said lines, said step-by-step mechanism responsive also to impulses over the two sides of the link in series, a supervisory signal for said cord controlled from one of said lines, and a coil individual to said switch through which current for talking purposes is supplied to the talking circuit.

39. In a telephone system, a calling line and a called line, links for connecting the two, one of which is a cord circuit and the other one having a repeater individual thereto for repeating impulses from one part of the link to the other, said repeater controlled over both sides of said link and a return conductor common to the sides of the said link, a circuit closer for said link circuit, other lines having terminals associated with said circuit closer, step-by-step mechanism for moving said circuit closer to connect the link with one of said lines, a source of signaling current for signaling the called line associated with said links, a relay for controlling the application of said signaling current to the called line, and an automatic interrupter in said repeater link for controlling said relay.

40. In a telephone system, a calling line and a called line, links for connecting the two, one of which is a cord circuit and the other one having a repeater individual thereto for repeating impulses from one part of the link to the other, said repeater controlled over both sides of said link and a return conductor common to the sides of the said link, a circuit closer for said link circuit, other lines having terminals associated with said circuit closer, step-by-step mechanism for moving said circuit closer to connect the link with one of said lines, said step-by-step mechanism responsive also to impulses over the two sides of the link and a return conductor common to the sides of the said link, a source of signaling current for signaling the called line associated with said links, a relay for controlling the application of said signaling current to the called line, and an automatic interrupter in said repeater link for controlling said relay.

41. In a telephone system, a calling line and a called line, links for connecting the two, one of which is a cord circuit and the other one having a repeater individual thereto for repeating impulses from one part of the link to the other, said repeater controlled over both sides of the link and a return conductor common to the sides of the said link, said link having a wiper, a plurality of lines

each having a contact associated with said wiper, step-by-step mechanism for advancing said wiper into engagement with one of said contacts whereby connection may be established between the link and any one of said lines, a source of signaling current for signaling the called line associated with said links, a relay for controlling the application of said signaling current to the called lines, and an automatic interrupter in said repeater link for controlling said relay.

42. In a telephone system, a calling line and a called line, links for connecting the two, one of which is a cord circuit and the other one having a repeater individual thereto for repeating impulses from one part of the link to the other, said repeater controlled over both sides of said link and a return conductor common to the sides of the said link, said link having a wiper, a plurality of lines each having a contact associated with said wiper, step-by-step mechanism for advancing said wiper into engagement with one of said contacts whereby connection may be established between the link and any one of said lines, said step-by-step mechanism responsive also to impulses over the two sides of the link circuit and a return conductor common to the sides of the said link, a source of signaling current for signaling the called line associated with said links, a relay for controlling the application of said signaling current to the called line, and an automatic interrupter in said repeater link for controlling said relay.

43. In a telephone system, a calling and a called line, a cord circuit and progressively movable automatic switches for establishing a talking circuit between said lines, one of said switches operated over two sides of the calling line in series to extend the connection to said cord circuit, another of said switches operated first over one conductor of said talking circuit and then the other conductor to complete said connection, and a relay individual to said last switch through which current for talking purposes is supplied to the talking circuit.

44. In a telephone system, a calling and a called line, a cord circuit and progressively movable automatic switches for establishing a talking circuit between said lines, one of said switches operated over first one side of the calling line and then the other side to extend the connection to said cord circuit, another of said switches operated over two sides of the talking circuit in series to complete said connection, and a relay individual to said last switch through which current for talking purposes is supplied to the talking circuit.

45. In a telephone system, a trunk line terminating in an automatic connector switch, means including a selector switch and the said trunk line and connector switch for connecting a calling and a called line, a ringing relay in the connector switch, and means in the selector switch for automatically and intermittently operating said relay over a conductor of said trunk line to signal the subscriber on the calling line.

Signed by me at Chicago, Cook county, Illinois, this 21 day of Nov., 1910.

TALBOT G. MARTIN.

Witnesses:
A. J. RAY,
E. D. FALES.