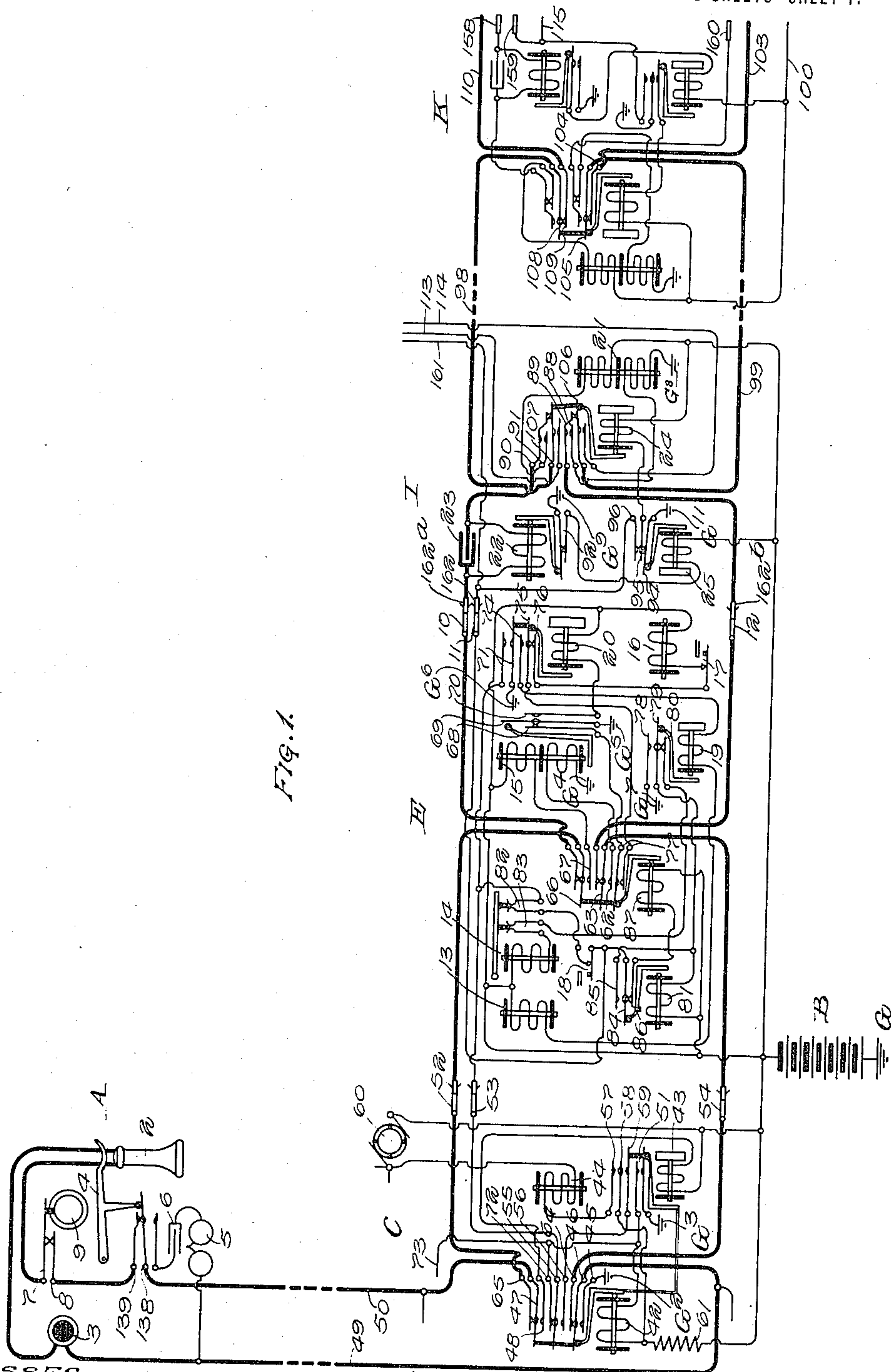


T. G. MARTIN.
AUTOMATIC TELEPHONE SYSTEM.
APPLICATION FILED FEB. 18, 1914.

3 SHEETS—SHEET 1.



C. W. Bull
G. A. Yanochowski

J.B. Bulkley & Son
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1,293,499.

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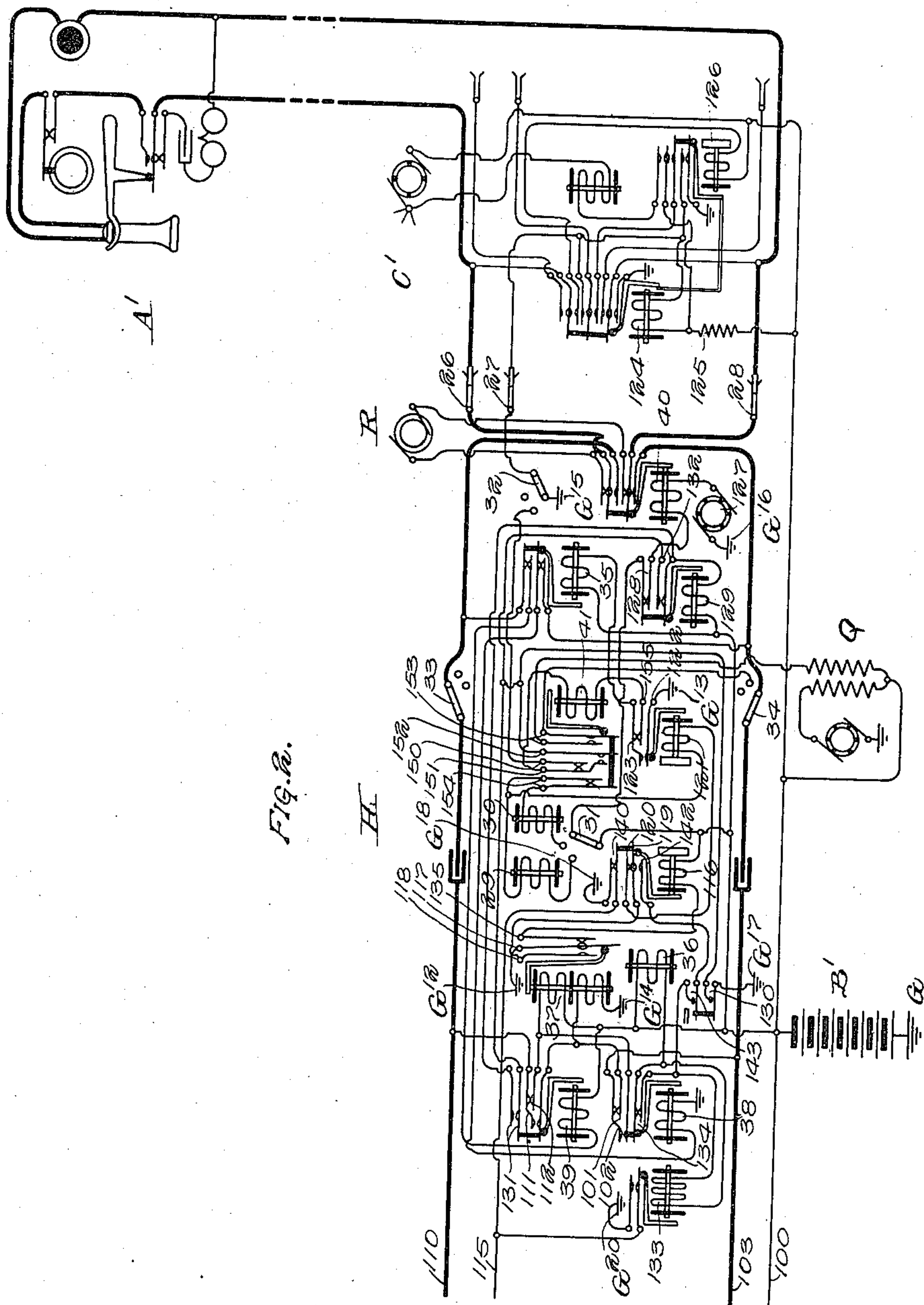


Fig. 2.

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3 SHEETS-SHEET 3.

Fig. 3.

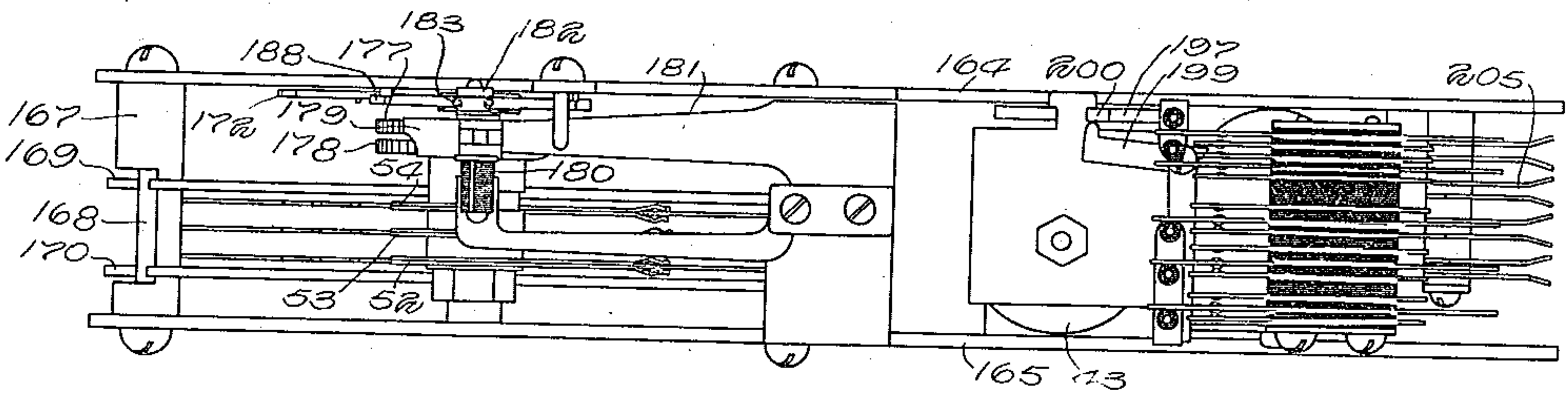


Fig. 4.

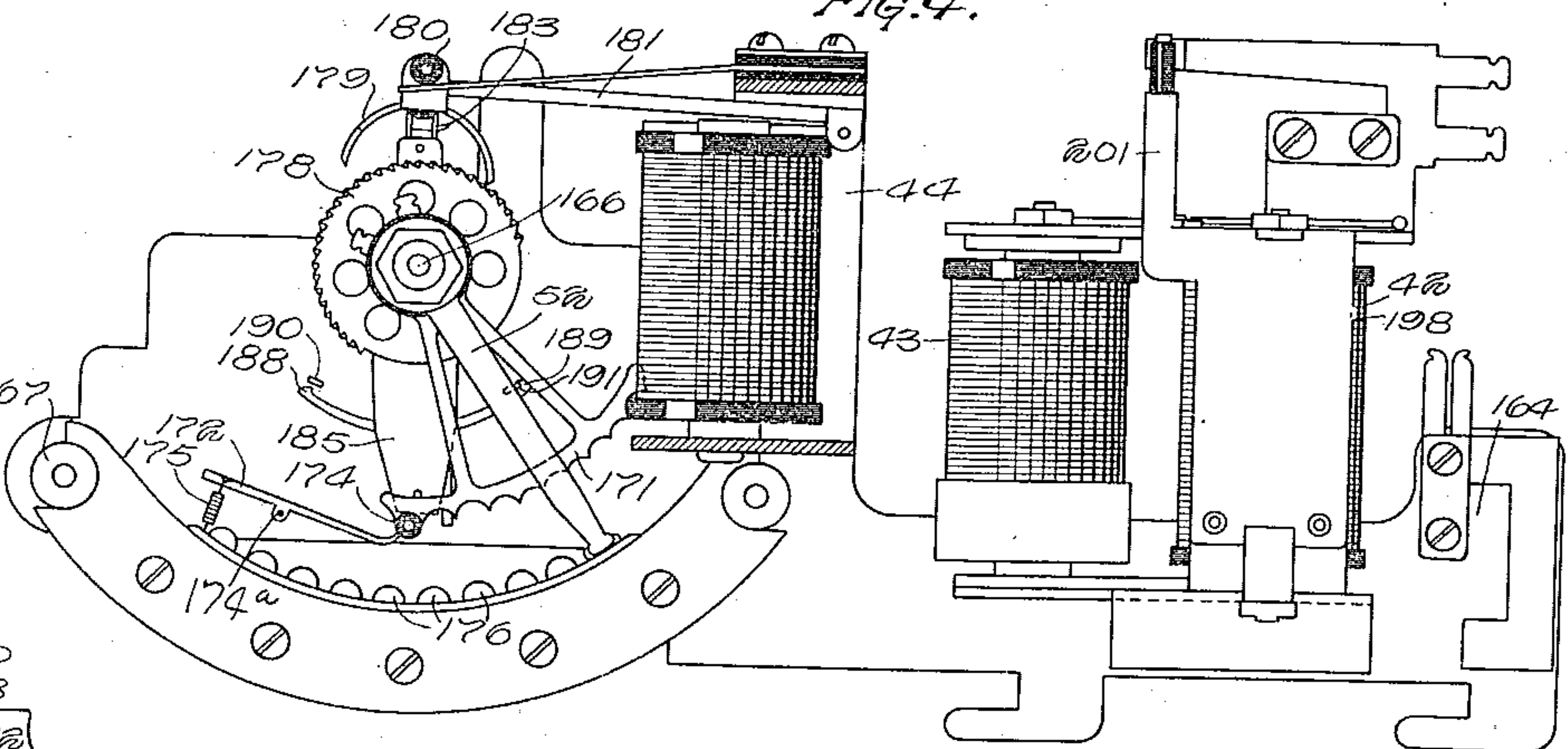
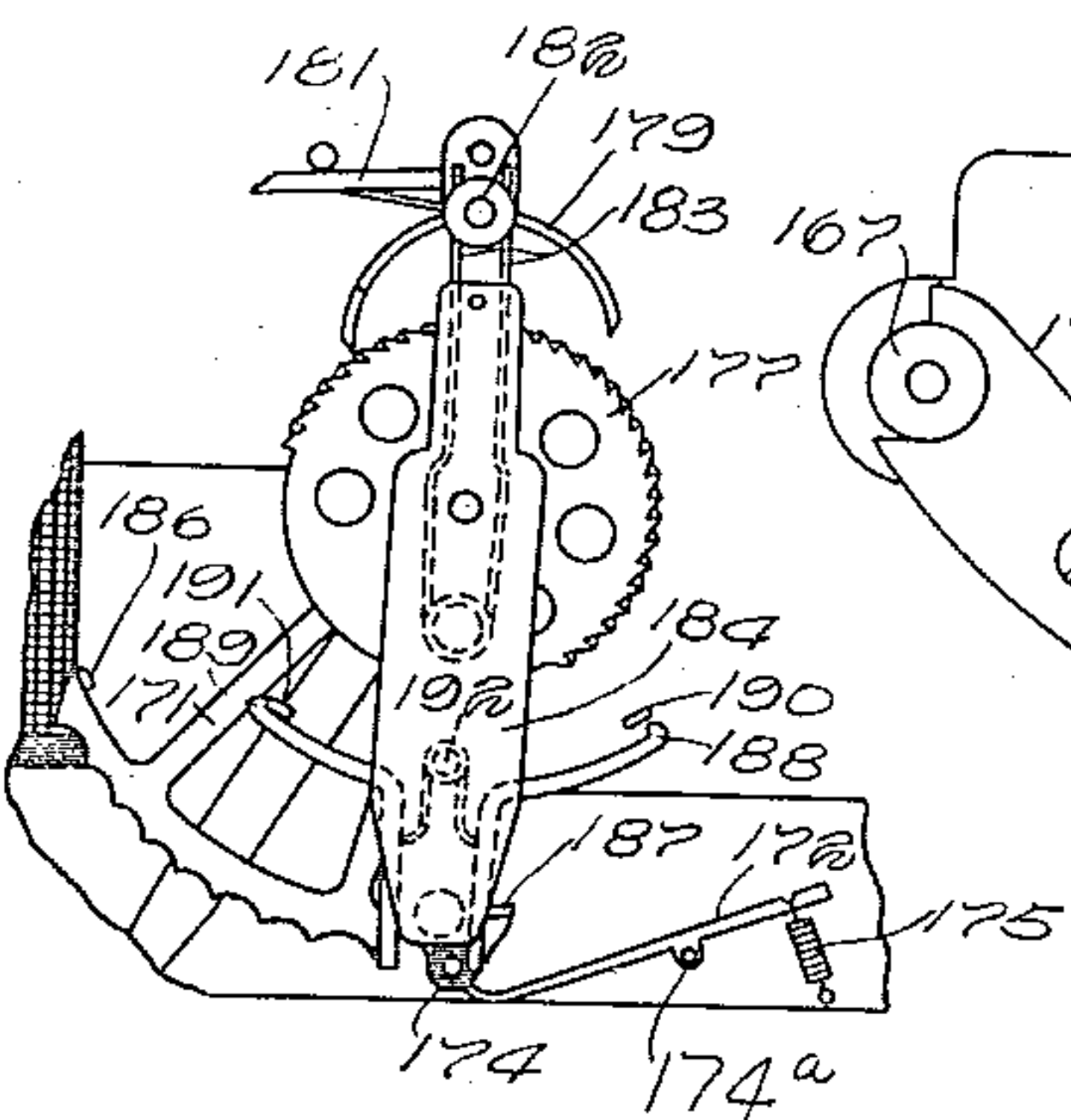


Fig. 5.



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UNITED STATES PATENT OFFICE.

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AUTOMATIC TELEPHONE SYSTEM.

1,293,499.

Specification of Letters Patent.

Patented Feb. 4, 1919.

Application filed February 18, 1914. Serial No. 819,379.

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 certain new and useful Improvements in Automatic Telephone Systems, of which the following is a specification.

My invention relates to improvements in automatic telephone systems and has for its object certain improvements in such systems whereby the trunking efficiency is increased and whereby the operation of the switches is improved.

More specifically, my invention relates to an improved construction of the line switch. This line switch is in the nature of an improvement on the line switch shown and described in the application of John Erickson for improvement in trunk-selecting switches, Serial No. 777,675, filed July 7, 1913. Instead of employing an individual interrupter, however, for the rotary magnet of each individual switch as employed in that application, I provide an interrupter which is common to a plurality of switches for interrupting the circuit of the various rotary magnets of the switches.

Further improvements in my system relate to a new and improved two-way trunk over which a connection can be established in either direction, means being provided to prevent a second connection being established over said trunk when either end of this trunk has been seized.

A further feature of my invention relates to the means for releasing a connection which has been established between two lines. Heretofore, in systems where the calling subscriber has initiated the release, difficulty has been experienced in that when the connector was released the line switch of the called line would be tripped if the called subscriber had not hung up his receiver at that time. This would not only cause an unnecessary operation of this line switch, but would be apt to cause an objectionable click in the receiver of the called subscriber. To prevent this I provide in my system means

whereby the calling subscriber releases all the switches of the connection up to the connector, but the connector switch is not released until the called subscriber hangs up his receiver. Means are also provided for preventing the connector switch from being again seized when the same has been operated, after the switches which were used for establishing a connection to this connector are released.

These and other features and objects of my invention will be more readily understood by reference to the accompanying drawings, in which I have illustrated one embodiment of my invention in connection with automatic switches of well-known types.

In the drawings Figures 1 and 2 show a complete circuit connection between a calling substation A in one exchange and a called substation A' in a second exchange a system embodying the principles of my invention.

Fig. 3 is a front elevation of an automatic trunk-selecting switch C.

Fig. 4 is a right-hand view of the same with the side plate removed.

Fig. 5 is a fragmentary left-hand view with the side plate removed.

In Figs. 1 and 2 there is shown a subscriber's substation A connected to conductors terminating at the central office in an individual or line switch C. This switch is provided with a plurality of wipers 52, 53 and 54, together with a bank of contacts by means of which this switch extends the line connection of the calling subscriber to a first selector switch E. A number of line switches C have common access to trunks leading to the above-mentioned selector. The said selector switch E is provided with banks of contacts arranged in horizontal rows or levels, usually ten in number. When the selector switch E is operated to raise its shaft wipers to a certain level it extends the connection to a group of relays I, thence over the trunk conductors 98 and 99 to a second group of relays K located in the second exchange, thence through to the connector

switch H, by means of which connection may be completed with the called substation A'.

The groups of relays I and K form the terminals of a two-way trunk line extending 5 between the two exchanges. These relays are so arranged that the instant the trunk line is seized at one exchange to extend the connection to the second exchange, the terminals in the second exchange are made busy 10 to any calling subscriber from the said second exchange to the first exchange. The further operation of these relays will be hereinafter more fully described.

The substation A may be of any suitable 15 common battery type. As shown herein, it comprises the usual receiver 2, transmitter 3, switch-hook 4, ringer 5 and condenser 6. It is also provided with an impulse-sending device which is herein represented by a pair of 20 impulse springs 7 and 8 and an impulse wheel 9, which latter is assumed to be controlled through the medium of a finger hole dial (not shown) in such a manner that the impulse springs 7 and 8 may be momentarily 25 separated a number of times corresponding to the digit called.

The line switch C is shown in detail in Figs. 3, 4 and 5. As there shown, it comprises a bank of contacts secured between 30 two plates 164 and 165, which bank comprises three rows of contacts. A set of wipers 52, 53 and 54 is provided for wiping over and making contact with these contacts. These wipers are mounted on a shaft 166 35 journaled between the plates 164 and 165. The shaft is adapted to be oscillated through a portion of a revolution so as to carry the wipers back and forth over their respective rows of contacts. The complete bank of con- 40 tacts is readily removed from the switch by revolving the post 167 until the flat portion 168 of the post is facing the edge of the plates 169 and 170, thereby removing the means of support from this end of the bank, 45 which thus permits the bank to be removed. There is also secured to the shaft 166 a notched segment 171 with which a retaining pawl 172 engages. This retaining pawl is pivoted at 174^a and at its end is provided 50 with a bushing 174 which is pressed into the notches of the segment 171 by pressure exerted by the spring 175. The pressure on the segment 171 is sufficient to prevent the wipers 52, 53 and 54 from prematurely mov- 55 ing off one of the contacts 176 by a possible jar. The pressure, however, is not enough to retard the ordinary operation of the wipers. There is also secured to the shaft 166 two ratchet wheels 177 and 178 having their 60 respective teeth facing in opposite directions. Associated with the ratchet wheels 177 and 178 is a double pawl 179 pivoted at 180 on the armature 181 of the rotary magnet 44. One end of the pawl 179 engages one

ratchet wheel to rotate the wipers in one 65 direction, while the other end engages the other ratchet wheel to rotate the wipers in the opposite direction. Secured to the center of the pawl 179 is a grooved projection 182 adapted to slide between the guide 70 springs 183 for the purpose of tilting the pawl one way or the other into engagement with one or the other of the ratchet wheels. The springs 183 are securely fastened be- 75 tween the plates 184 and 185, which are loosely mounted on one end of the shaft 166.

The manner in which the pawl 179 is tilted is as follows: When the wipers reach the end of the row of contacts, one or the other 80 of the lugs 186 and 187 (depending on the way the wipers are traveling) on the segment 171 strikes the lower end of the arm composed of the plates 184 and 185 and moves said arm slightly in the same direc- 85 tion in which the wipers are traveling. This causes the upper end of the arm and the springs 183 to swing in the opposite direction to turn the pawl 179 on its pivot and reverse the position of the pawl 179, so that it now becomes operative to drive the shaft 90 in the opposite direction. In order to hold the arm composed of the plates 184 and 185 in either of its positions, two locking dogs 188 and 189 are provided at its lower end, 95 which dogs are adapted to engage the lugs 190 and 191, respectively, which project from the side plate. These locking dogs are in the shape of a bell-crank lever pivoted at their elbows between the plates 184 and 185. One arm of each of the levers extends down into 100 the path of the lugs 186 and 187 on the segment 171, so that before either of these lugs strikes the arm composed of the plates 184 and 185 it first engages the locking dog and disengages it from its lug 190 or 191, as the 105 case might be. A small spring 192 between the dogs 188 and 189 serves to bring them into engagement with their respective lugs when the arm is in the proper position. During the time when the wipers are rotat- 110 ing, the end of the pawl 179 which is not doing the driving engages its ratchet wheel when the armature 181 is in its fully attracted position, which prevents the wipers from being carried by their inertia after the arma- 115 ture 181 completes its stroke.

The switch C is also provided with a slow acting line relay 43 bridged across the line through contacts controlled by the cut-off relay 42 (Fig. 1). The line relay 42 con- 120 trols the circuit of the rotary magnet 44 by means of the contact springs 57 and 58, the circuit of which magnet is further controlled by an interrupter 60, which interrupter is common to a number of line switches. Piv- 125 otally mounted on a plate above the coils of the relays 43 and 42 there is a bell-crank lever 199, one end of which engages a lug 200

on the armature 197 of the relay 43, while the other end is provided with a notch which lies in the path of the upwardly-extending arm 201 of the armature 198 of the relay 42. This end of the lever 199 normally forms an obstruction for the armature 198, so that it can be attracted far enough to break the back contacts for the relay springs, but not far enough to close the front contacts. When the relay 43 is energized, its armature 197 rocks the lever 199 far enough to carry its ends out of the path of the armature 198, so that if the relay 42 is energized at this time, it may attract its armature all the way and close its front contacts. The springs 205 are the usual jack springs, through the medium of which connections are made with the switch.

The selector switch E is of the general type of selector switch disclosed in United States Letters Patent No. 815,321, granted March 13, 1906, to Keith, Erickson and Erickson, except that the so-called side switch is omitted and the circuits are modified to adapt the switch to operate in a system in which it is controlled by impulses delivered over the two sides of the line in series. Among other details, the selector E comprises a bank of contacts arranged in horizontal rows or levels, which contacts are adapted to be engaged by a set of wipers 10, 11 and 12 carried upon a shaft (not shown) which has a vertical movement controlled by the vertical magnet 13 and a rotary movement controlled by the rotary magnet 14. The operations of the various parts of the switch are controlled through the medium of the double-wound line relay 15. Means for permitting the switch to be restored to normal position are provided in the release magnet 16, which, upon energizing, withdraws the retaining pawls from the shaft. The springs 17 and 18 close only when the switch shaft has been raised one or more steps from its lowest position. The relays 19 and 20 are slow acting—that is, they deenergize slowly after their energizing circuits are broken.

The two-way trunk 98 and 99 is provided at one end with a series of contacts 162, 162^a and 162^b by which connection is adapted to be made with this trunk, which contacts are normally disconnected from the trunk line through contacts controlled by a cut-off relay 24. This cut-off relay likewise controls the normally closed connections to the lines 113, 114 and 161 which extend to a connector switch and which are adapted to be disconnected from the trunk line when the contacts 162, 162^a and 162^b are connected to this line. Similarly, at the opposite end of the trunk there is a series of contacts 158, 159 and 160 through which the trunk can be seized, which contacts are normally disconnected

from the trunk. A connector switch H is likewise normally connected to this end of the trunk through the lines 103 and 110. In addition to the cut-off relay 24, the group of relays I includes a relay 22 connected in series with one side of the trunk and shunted by a condenser 23. A double-wound impedance coil 21 is likewise bridged across the trunk through contacts controlled by the cut-off relay 24, which cut-off relay is slow acting and is controlled by a second slow acting relay 25 whose circuit in turn is controlled by the relay 22. The group of relays K at the opposite end of the trunk is similar to the group of relays I.

The connector H is of the general type of connector switch disclosed in United States Letters Patent No. 815,176, granted March 13, 1906, to Keith, Erickson and Erickson, the circuits, however, being modified to adapt the switch to operate in a system in which the central office apparatus is controlled by impulses delivered over the two sides of the line in series. Like the selector, the connector is provided with a shaft (not shown) carrying the wipers 26, 27 and 28, which is controlled by the vertical magnet 29 and the rotary magnet 30. The line relay 37 is connected with the line through the reversing springs of the so-called back-bridge relays 38 and 39, through the windings of which latter relays the called line is provided with talking current. The usual side switch comprising the wipers 31, 32, 33 and 34 is controlled by the private magnet 35 in the usual and well-known manner. The magnet 36 is the usual release magnet, the circuit of which is controlled by the slow acting relay 116. A high resistance relay 133 is adapted to be connected in series with the release magnet, the circuit for this relay being controlled by the back-bridge relay 38. The ringing relay 40 is the means through which ringing current is supplied to the called line. At Q there is shown a busy signaling machine which provides a busy signal, said busy signal being applied to the calling line through the medium of the busy relay 41 in case the called line is in use.

The line switch C' and the substation A are similar in all respects to the line switch C and the substation A.

In order to give a clearer understanding of the invention, I will describe in detail how the subscriber at substation A may obtain connection with the subscriber at substation A'. We will assume the number of the called substation to be 220. In the system shown herein, the subscribers' lines are divided into groups, and the individual switch C of all the lines belonging to the same group has common access to the same group of selectors—that is, each trunk line

leading to a first selector is connected in multiple with the corresponding bank contact of all the individual switches of the group. The switches C shown herein do not release and return to normal position upon the termination of a conversation, but remain on the contact of the trunk line which was last used by the switch. Therefore, when the subscriber at the substation A makes a call, the wipers of the switch C may be standing on the contacts of a busy trunk, or on the contacts of an idle trunk. If the wipers are standing on the contacts of an idle trunk when the subscriber at the substation A makes a call, they remain stationary and the relay 42 operates to connect the line through to the selector E. If the trunk upon which the wipers are standing is busy, they will be rotated to an idle trunk line before the line is connected with them.

When the subscriber at the substation A removes his receiver from the switch-hook preparatory to making a call, the engagement of the switch-hook springs closes a circuit through the line relay 43 of the line switch C. This circuit extends from ground G^2 through the contact of springs 45 and 46 to and through the substation A, springs 47 and 48 and the line relay 43 to battery B. If the bank contact upon which the private wiper 53 of the line switch is resting is busy, i. e., is provided with a guarding ground potential, when the line relay 43 energizes, a circuit is completed extending from ground at the said bank contact through the contact of springs 55 and 56 to the spring 59. Here the circuit divides, one branch extending through the springs 59, 58 and 57, the rotary magnet 44 and the group interrupter 60 to battery B, the other branch extending through the springs 59 and 58 to one terminal of the relay 42. A further result of the energization of the relay 43 is to close a circuit extending from ground G^3 through the contacts of springs 51 to the opposite terminal of the relay 42. Both terminals of the relay 42 being connected to ground, the said relay is unable to operatively energize at this time. The rotary magnet 44, upon energizing, rotates the wipers one step. If the next contact which the wiper 53 engages is also busy, the rotary magnet 44, through the medium of the interrupter 60, will cause the wipers to rotate another step. This operation will continue as long as the private wiper 53 engages a busy contact. As soon as the wipers reach an idle trunk line, the relay 42 being no longer short-circuited immediately energizes over the following circuit: from ground G^3 through the contacts of springs 51, the said relay 42 and the resistance 61 to battery B. The relay 42, upon energizing, disconnects the line relay 43 from the line and extends the line connec-

tion to the selector E. The line relay 15 of the selector E immediately energizes over a circuit extending from ground G^4 through the lower winding of the relay 15, springs 62 and 63, wiper 54, springs 64 and 46 to and through the substation A, springs 47 and 65, wiper 52, springs 66 and 67 and the upper winding of the relay 15 to battery B. The relay 15, upon energizing, completes a circuit from ground G^5 through the contacts of the springs 69 and 70 and the relay 20 to battery B. The relay 20, upon energizing, extends a guarding potential from ground G^6 through the contact of springs 71 to the private bank contacts of the trunk leading to the selector E in all the individual switches which have access to said trunk. The wiper 53 being in contact with one of these contacts, a holding circuit is closed through the relay 42. This circuit extends from ground G^6 through the contact of springs 71, wiper 53, springs 55 and 72 and the relay 42 to battery B. The relay 20 thus provides a holding circuit for the relay 42 to prevent it from being de-energized when the relay 43 deenergizes. A guarding potential is also provided from ground G^6 at the selector to the private bank contacts of the connector of the calling line. This circuit extends over the circuit above traced through the springs 55 and 72 and the conductor 73 to the said bank contacts. The line relay 43 is slow acting, so as to maintain the circuit of the relay 42 closed until after the relay 20 of the selector E has had time to send back a holding ground. A further result of the energization of the relay 20 is to prepare a circuit for the vertical magnet through the springs 74 and 75 and to open the circuit of the release magnet 16 at the springs 75 and 76.

The above operations take place upon the subscriber removing his receiver from the switch-hook preparatory to making a call. The subscriber now operates his dial for the transmission of the first series of impulses for the digit 2, whereby the substation impulse springs are operated twice momentarily, each time breaking the circuit of the selector line relay 15. The relay 20 of the selector being slow acting does not deenergize during the momentary interruptions of its circuit by the line relay 15, and consequently each time the latter relay deenergizes, an impulse is transmitted over the circuit extending from ground G^5 through the contact of springs 69 and 68, springs 77, springs 75 and 74, relay 19 and the vertical magnet 13 to battery B. The vertical magnet receives two impulses over this circuit and operates to raise the switch shaft and wipers two steps to a position opposite the second row or level of bank contacts. The off-normal springs 17 and 18 close as soon as the shaft is raised one step. The slow acting

relay 19 is maintained in its energized position while impulses are being transmitted through it to the vertical magnet, and in its energized position closes a circuit extending
 5 from ground G^7 through the contact of springs 78 and 79 and the relay 81 to battery B. The relay 81, upon energizing, closes a locking circuit for itself extending from ground G^6 through the contact of springs
 10 71, rotary magnet springs 82, off-normal springs 18, springs 84 and 85 and the relay 81 to battery B. Thus upon the deenergization of the relay 19 after the last impulse is delivered to the vertical magnet, the relay
 15 81 remains energized and the circuit of the rotary magnet is closed. This circuit extends from ground G^6 through the contacts of the springs 71, springs 82, off-normal springs 18, springs 84 and 85, springs 79
 20 and 80, springs 83 and the rotary magnet 14 to battery B. The rotary magnet, upon energizing, rotates the wipers one step and, by opening the springs 82, disconnects ground G^6 from itself and the relay 81. If the first
 25 trunk line of the second level is idle, the relay 81 deenergizes as soon as the springs 82 are opened. If this trunk line is busy, however, the private wiper 11 finds the contact with which it engages provided with a
 30 guarding ground potential which is transmitted to the relay 81 through the springs 84 and 85, thereby preventing it from deenergizing. The rotary magnet, however, deenergizes when the springs 83 disengage,
 35 regardless of whether the relay 81 remains energized or not. If the relay 81 remains energized, the circuit of the rotary magnet will be again closed as soon as the armature drops back far enough to close the springs
 40 82. The rotary magnet will, therefore, operate in a manner similar to that of a buzzer to advance the wipers step by step over the contacts until the non-grounded contact of an idle trunk line is reached by the wiper
 45 11, whereupon the relay 81 deenergizes. The relay 81, upon deenergizing, whether after one or several operations of the rotary magnet, permanently breaks the circuit of the magnet 14 and closes the circuit of the
 50 switching relay 87. The circuit through said relay 87 extends from ground G^6 through the springs 71, springs 82, off-normal springs 18, springs 84 and 86 and the relay 87 to battery B. The relay 87, upon energizing,
 55 disconnects the line relay 15 from the line and extends the line connection over the heavy conductors to the impedance coil 21 of the group of relays I. This circuit extends from ground G^8 through the lower
 60 winding of the impedance coil 21, contact of springs 88 and 89, wiper 12 to and through the substation A, return conductor 50, wiper 10, relay 22, springs 90 and 91 and the upper winding of the impedance coil 21 to battery
 65 B. The relay 22 thereupon energizes and

closes a circuit extending from ground G^9 through the contact of springs 92 and the relay 25 to battery B. The relay 25, upon energizing, closes a holding circuit for the
 70 relay 87 of the selector E and the relay 42 of the line switch C. The circuit for the relay 87 of the selector E extends from ground G^{11} through the contact of springs 94, 95 and 96, bank contact 162, wiper 11, springs
 75 84 and 86 and the relay 87 to battery B. The holding circuit for the relay 42 of the line switch C extends over the above-traced circuit to the spring 84, thence through the spring 18, springs 82, wiper 53 and the relay
 80 42 to battery B. This connection from ground G^{11} to the contact 162 also places a guarding ground potential on the bank contact of every selector switch having access to the group of relays I, which contacts are
 85 multiplied together in the usual manner. A further result of the energization of the relay 25 is the closure of a circuit extending from ground G^{11} through the contact of springs 94 and 95 and the relay 24 to battery
 90 B. The relay 24 thereupon energizes and extends the connections to the trunk conductors 99 and 98, thence through the group of relays K to the connector H in the second exchange. This circuit extends from ground
 95 G^{14} through the lower winding of the relay 37, springs 101 and 102, conductor 103, springs 104 and 105, trunk conductor 99, springs 106 and 89, over a before-traced circuit to and through the substation A, relay
 100 22, springs 90 and 107, trunk conductor 98, springs 108 and 109, conductor 110, springs 111 and 112 and the upper winding of the relay 37 to battery B'. A further result of the energization of the relay 24 is to dis-
 105 connect the conductors 113 and 114 that lead to a connector switch not shown from the trunk conductors 98 and 99. The relay 37, upon energizing, closes a circuit through the slow acting relay 116. The relay 116, upon
 110 energizing, provides a guarding potential to the bank contacts of every selector switch (not shown in the second exchange) that has access to the group of relays K. The circuit for this guarding potential extends from
 115 ground G^{18} to the contacts 140 of the relay 116, thence over the conductor 115 to the contact 159 (Fig. 1) associated with the trunk conductors 98 and 99. The function of said guarding potential is to prevent any
 120 selector from establishing connection with the group of relays K in making a call to the first exchange. The apparatus is now in readiness to receive impulses for the last two
 digits of the called number.

When the substation calling device is op-
 125 erated for the second digit 2, the circuit of the connector line relay 37 and the relay 22 of the group of relays I is broken twice. Since the relay 25 controlled by the relay 22 of the group of relays I is slow acting, it
 130

does not deenergize during the momentary interruptions of its circuit by the relay 22. Each time the connector line relay is deenergized, a circuit is closed extending from
 5 ground G^{12} through the contact of springs 117 and 118, springs 119 and 120, relay 121, vertical magnet 29 and the side switch wiper 31 (in first position) to battery B' . The vertical magnet 29 receives impulses over
 10 this circuit and operates to raise the switch wipers 26, 27 and 28 to a position opposite the second level of bank contacts. The relay 121, which was included in series with the vertical magnet, remains in its energized po-
 15 sition during the entire time that impulses are being sent through it and operates to close the circuit of the private magnet 35. This circuit extends from ground G^{13} through the contact of springs 122 and 123
 20 and the said private magnet 35 to battery B . After the last impulse is delivered, the relay 121 opens the circuit of the private magnet 35, which, upon deenergizing, permits the side switch to advance from first to second
 25 position. The movement of the side switch wiper 31 from first to second position transfers the battery connection from the vertical magnet to the rotary magnet. The calling subscriber now operates his dial for the last
 30 digit 0, in response to which the connector line relay operates to transmit ten impulses through the rotary magnet 30 in series with the relay 121, whereby the shaft wipers are rotated onto the contacts of the desired line.
 35 If the called line is idle, the private magnet 35 deenergizes when its circuit is broken by the relay 121 after the last impulse is delivered to the rotary magnet. The deenergization of the private magnet allows the
 40 side switch to advance one more position—that is, from second to third position. By the engagement of the side switch wipers 33 and 34 with their third-position contact points, the connection is completed with the
 45 called substation. The side switch wiper 32, upon passing to third position, places a guarding potential on all the private contacts in multiple with the one on which the wiper 27 is resting. This guarding potential
 50 extends from ground G^{15} through the side switch wiper 32 (in third position) and the wiper 27 to said contacts. A circuit also extends from the contact on which the wiper 27 is resting through the relay 124, resist-
 55 ance 125 to battery B' . The line relay 126 not being energized at this time, when the armature of the relay 124 is attracted it is only permitted by the armature of the relay 126 to pull up half the distance between its
 60 back and front contacts, thus cutting the line relay 126 out of the line circuit, but at the same time not connecting the line to the wipers of the switch C' . By the engagement of the side switch wiper 31 with its
 65 third-position contact point, the circuit of

the ringing relay 40 is closed. This circuit extends from ground G^{16} through the interrupter 127, ringing relay 40, contact of springs 128 and the side switch wiper 31 (in third position) to battery B' . The ring- 70
 ing relay, upon energizing, disconnects the calling line from the called line and bridges the ringing generator R across the called line. The ringing relay is energized only in- 75
 termittently through the medium of the interrupter 127. Upon the response of the called subscriber, his line is provided with talking current through the back-bridge re-
 lays 38 and 39. The relay 39, upon energiz- 80
 ing, closes the circuit of the ringer cut-off relay 129. This circuit extends from ground G^{17} through the off-normal springs 130, springs 131 and the ringer cut-off relay 129
 to battery B' . The relay 129, upon ener- 85
 gizing, interrupts the circuit of the ringer relay at the springs 128 and closes a locking circuit for itself through the springs 132 in-
 dependent of the springs 131. The relay 38, upon energizing, removes the shunt from
 around the relay 133 and places the said relay 90
 in series with the release magnet 36. A further result of the energization of the relays
 38 and 39 upon the response of the called subscriber is the transposition of the battery
 connection of the windings of the line relay 95
 37 with regard to battery B' , whereby the direction of the current in the calling line is reversed.

After the conversation is completed, the connection is released in the following man- 100
 ner: Assuming that the called subscriber replaces his receiver upon the receiver-hook before the calling subscriber replaces his, the back-bridge relays 38 and 39 will deenergize. The relay 38, upon deenergizing, closes a 105
 shunt around the relay 133 at the springs 134, thus putting the release of the apparatus under the control of the calling sub-
 scriber. When the calling subscriber re- 110
 places his receiver, the circuit of the connector line relay 37 and the line relay 22 of the group relay I is broken at the hook-
 switch springs 138 and 139 of the substa-
 tion A . The relay 37, upon deenergizing, opens the circuit of the relay 116 at the 115
 springs 117 and 135. The relay 116, upon deenergizing, removes the guarding poten-
 tial from the connector H and the group of relays K at the springs 140, and also closes
 the circuit of the connector release magnet 120
 36. This latter circuit extends from ground G^{12} through the contact of springs 117 and 118, springs 120 and 142, off-nor-
 mal springs 143, springs 134 and the re-
 lease magnet 36 to battery B' . The release 125
 magnet, upon energizing, restores the switch shaft and side switch wipers to normal posi-
 tion, and its own circuit is broken at the
 springs 143 when the shaft reaches its low-
 est position. The relay 22 of the group of 130

relays I, upon deenergizing, opens the circuit of the relay 25 at the springs 92. The relay 25, upon deenergizing, opens the circuit of the relay 24 of the group of relays I; of the relay 87 of the selector E and of the relay 42 of the line switch C. The relay 42, upon deenergizing, restores the line switch C to its normal position. The relay 87 of the selector E, upon deenergizing, closes a circuit through the release magnet 16. This circuit extends from ground G⁵ through the contact of springs 69 and 68, springs 77, springs 75 and 76, off-normal springs 17 and the release magnet 16 to battery B. The release magnet 16, upon energizing, restores the selector E to normal and opens its own circuit at the springs 17 when the switch shaft reaches its lowest position.

If the calling subscriber replaces his receiver before the called subscriber replaces his receiver, the connector line relay 37, upon deenergizing, will not allow the connector switch H to release, as the high resistance relay 133 is in series with the release magnet 36. However, all the switches preceding the connector switch H will be released. We will assume that a selector (not shown) similar to the selector E is inserted between the group of relays K and the connector H. Now when the calling subscriber replaces his receiver upon the switch-hook before the called subscriber replaces his receiver, the relay 22 and the relay 37 will deenergize. The relay 22, upon deenergizing, allows the selector E and the line switch C to release in the same manner as hereinbefore described. The relay 37, upon deenergizing, allows the slow acting relay 116 to deenergize. The relay 116, upon deenergizing, removes ground from the private conductor 115, thus allowing the selector (not shown) inserted between the group of relays K and the connector H to release in a manner similar to that described for the release of the selector E. A further result of the deenergization of the relay 37 is to close a circuit from ground G¹² through the contact of springs 117 and 118, springs 119 and 142, off-normal springs 143, relay 133 and the release magnet 36 to battery B'. The release magnet 36 does not receive sufficient current when in series with the relay 133 to operatively energize. The relay 133, upon energizing, places ground G²⁰ upon the conductor 115 to guard the connector switch H against being seized. A sufficient interval of time elapses between the removal of ground from the conductor 115 by the deenergization of the relay 116 and the connection of ground to the conductor 115 by the energization of the relay 133 to permit the release of the preceding switches. As soon as the called subscriber replaces his

receiver upon the receiver-hook, allowing the relays 38 and 39 to deenergize, the relay 133 is short-circuited and the release magnet 36 receives sufficient current to operatively energize.

If the number called is busy, there will be a guarding potential upon the connector private bank contact, just as explained in connection with the line switch C. The connector private wiper, upon engaging this guarding contact, and before the side switch wipers have passed to third position, completes an energizing circuit through the busy relay 41. This circuit extends from ground at the private wiper 27 through the side switch wiper 32 (in second position), springs 150 and 151, relay 41, springs 155 and 123 and the private magnet 35 to battery B'. The private magnet is thus held energized, which disconnects the wipers 26 and 28 from battery and holds the side switch in second position. The relay 41, upon energizing, completes a locking circuit for itself and for the magnet 35 independent of the ground at the private bank contacts. The locking circuit for the relay 41 and the magnet 35 extends from ground G¹⁷ through the springs 130, springs 152 and 151, relay 41, springs 155 and 123 and the magnet 35 to battery B'. The circuit of the rotary magnet 30 is opened at the springs 154 to prevent a further rotation of the shaft and wipers. A further result of the energization of the relay 41 is to supply a busy signal to the calling subscriber. This circuit extends from the busy machine Q through the contact of springs 153 and the side switch wiper 34 (in second position) to and through the calling substation A, over the return conductor, through the springs 111 and 112 of the relay 39 and the upper winding of the relay 37 to battery B'.

If the subscriber A' desires to call the subscriber A, the operation is similar to the operation hereinbefore described, i. e., he operates a selector switch to make contact with the bank contacts 158, 159 and 160 of the group of relays K, which then extends the connection through the group of relays K, over the conductors 161, 113 and 114 to a connector switch similar to the connector switch H, which then completes the connection to the substation A. As soon as the said connector switch is seized, it operates to place a guarding potential upon the selector bank contact 162 over the conductor 161, thus preventing a selector such as the selector E from seizing the end of the trunk.

It will thus be seen that I have devised a very efficient telephone system in which a two-way trunk line is provided which can be seized at either end, and in which means are provided for preventing a second connection from being established over this trunk when

either end of the same has been seized. Furthermore, it will be seen that I have provided improved means for operating the line switches and have also provided an improved manner of releasing a connection whereby the operation of the line switch on the called line is prevented if the calling subscriber should hang up his receiver before the called subscriber has replaced his receiver on the hook.

While I have illustrated my invention in connection with one particular type of automatic telephone system and in connection with automatic switches of certain types, it will, of course, be understood that I do not wish to limit myself to the exact construction of these switches, but that various other types of switches can be employed and still come within the contemplated scope of my invention. It will likewise be understood that in larger exchanges, selector switches can be inserted between the two-way trunk line and the connector switch H, and various other changes and modifications will readily suggest themselves to those skilled in the art without departing from the spirit and intent of my invention.

What I claim as my invention is:—

1. In a telephone system, a plurality of trunk-selecting switches, a series of trunk terminals, line wipers for said switches, operating magnets therefor, an interrupter common to said switches for intermittently energizing said magnets, and means for moving one set of said line wipers to and fro over said trunk terminals in response to a continued series of intermittent energizations of one of said magnets.

2. In a telephone system, a two-way trunk line, an automatic switch normally connected to each end of said trunk, contacts through which said trunk is adapted to be seized normally disconnected from each end of said trunk, means for seizing either end of said trunk, and means for connecting the normally disconnected contacts with said trunk and disconnecting the automatic switch associated with that end of said trunk when the corresponding end of said trunk is seized.

3. In a telephone system, a two-way trunk line, an automatic switch normally connected to each end of said trunk, contacts through which said trunk is adapted to be seized normally disconnected for each end of said trunk, means for seizing either end of said trunk, means for connecting the normally disconnected contacts with said trunk and disconnecting the automatic switch associated with that end of said trunk when the corresponding end of said trunk is seized, and means for placing a guarding potential on each end of said trunk to prevent a second connection being established therewith.

4. In a telephone system, a calling and a

called subscriber's line, an automatic connector switch for seizing the called line having a relay for controlling the operation thereof, means for extending a talking circuit connection from said calling line to said connector switch and for energizing said relay over two sides of the talking circuit in series, means controlled by the calling subscriber for releasing said connection from the calling line to said connector switch, and means controlled by the called subscriber for releasing said connector switch.

5. In a telephone system, a calling and a called subscriber's line, a connector switch for establishing a connection with the called line having a relay for controlling the operation thereof, means for establishing a talking circuit connection from the calling line to said connector switch and for energizing said relay over two sides of the talking circuit in series, means controlled by said calling subscriber for initiating the release of said connection to the connector, and means for preventing such release from releasing said connector.

6. In a telephone system, a calling and a called subscriber's line, a connector switch for establishing a connection with the called line having a relay for controlling the operation thereof, means for establishing a talking circuit connection from the calling line to said connector switch and for energizing said relay over two sides of the talking circuit in series, means controlled by said calling subscriber for initiating the release of said connection to the connector, means for preventing such release from releasing said connector, and means for preventing said connector from being again seized after it has been operated and before it is released when the connection thereto has been released.

7. In a telephone system, a calling and a called subscriber's line, a connector switch for establishing a connection with the called line having a relay for controlling the operation thereof, means including automatic switches for establishing a talking circuit connection from the calling line to said connector and for energizing said relay over two sides of the talking circuit in series, a release magnet for said connector switch, means controlled by the calling subscriber for closing a circuit through said magnet without operating the same, and means controlled by the called subscriber for operating said magnet to release said connector switch.

8. In a telephone system, a plurality of subscribers' lines, means including an automatic connector switch for establishing a connection between two of said lines, a release magnet for said connector switch, a high resistance relay connected in series with said release magnet, means controlled by the calling subscriber for closing a circuit

through said release magnet in series with said high resistance relay, whereby said release magnet is not energized, and means controlled by the called subscriber for short-circuiting said high resistance relay, whereby said release magnet is energized and said connector switch released.

9. In a telephone system, a plurality of subscribers' lines, means including an automatic connector switch for establishing a connection between two of said lines, a release magnet for said connector switch, a high resistance relay connected in series with said release magnet, means controlled by the calling subscriber for closing a circuit through said release magnet in series with said high resistance relay, whereby said release magnet is not energized, means controlled by the called subscriber for short-circuiting said high resistance relay, whereby said release magnet is energized and said connector switch released, and means controlled by said high resistance relay for placing a guarding ground potential on the private contacts of said connector switch.

10. In a telephone system, a calling and a called subscriber's line, a connector switch for establishing a connection with the called line having a relay for controlling the operation thereof, means for establishing a talking circuit connection from the calling line to said connector switch and for energizing said relay over two sides of the talking circuit in series, means controlled by said calling subscriber for initiating the release of said connection to the connector, means for preventing such release from releasing said connector, and means controlled by the called subscriber for causing the release of said connector.

11. In a telephone system, a calling and a called subscriber's line, a connector switch for establishing a connection with the called line having a relay for controlling the operation thereof, means for establishing a talking circuit connection from the calling line to said connector switch and for energizing said relay over two sides of the talking circuit in series, means controlled by said calling subscriber for initiating the release of said connection to the connector, means for preventing such release from releasing said connector, means controlled by the called subscriber for causing the release of said connector, and means for preventing said connector from being again seized after it has been operated and before it is released when the connection thereto has been released.

12. In a telephone system, a plurality of trunking switches, trunk lines, said switches having line wipers always in electrical connection with some one of said trunks, each trunk always the last one employed for extending a call therefrom, means for moving

said switch to and fro over said trunks to select an idle trunk if the connected trunk is busy, and a circuit interrupter common to said switches for controlling said last means.

13. In a telephone system, trunking switches, a plurality of trunk lines, said switches having wipers normally in contact with one of said trunk lines, said trunk being the last one employed for extending a call therefrom, means for moving said switches in one direction over said trunks to select an idle one when one or more of said trunks are busy, means for reversing the movement of said switch and for moving the same in the opposite direction over said trunks to select an idle one when the limit of movement of the switch is reached, and a circuit interrupter common to said switches for controlling said last means.

14. In a telephone system, a plurality of trunk selecting switches, a series of trunk terminals, a line wiper for each one of said switches, an operating magnet for each wiper, means common to all of said magnets for intermittently energizing any one of said magnets, and means for moving the line wiper associated with said magnet in one direction, and likewise in the opposite direction over the trunk terminals in response to a continued series of intermittent energizations of said magnet.

15. In a telephone system, a plurality of trunking switches, trunk lines associated with said switches, said switches having line wipers always in electrical connection with some one of said trunks, which trunk is always the last one employed for extending a connection therefrom, an operating magnet for each switch, means common to all of said magnets for intermittently energizing said magnets, and means for moving the line wipers of the corresponding switch to and fro over said trunk terminals in response to a continued series of intermittent energizations of said magnet under the control of said common means to select an idle trunk when any of the trunks are busy.

16. In a telephone system, a trunk line, an automatic progressively movable trunking switch for said line, lines associated with said switch, means for moving said switch to connect said trunk with any one of said lines, a terminal for said trunk, another line, means in said other line for seizing said terminal to connect said other line to said terminal, said terminal normally disconnected from said trunk, means associated with said terminal for connecting said terminal with said trunk, another terminal for said trunk, means for seizing said other terminal, and means for disconnecting said switch from said trunk when said other terminal is seized.

17. In a telephone system, a trunk line,

an automatic progressively movable trunking switch for said line, lines associated with said switch, means for moving said switch to connect said trunk with any one
 5 of said lines, a terminal for said trunk, another line, means in said other line for seizing said terminal to connect said other line to said terminal, said terminal normally disconnected from said trunk, means
 10 comprising a switching relay associated with said terminal for connecting said terminal with said trunk, another terminal for said trunk, means for seizing said other terminal, and means for disconnecting said switch
 15 from said trunk when said other terminal is seized.

18. In a telephone system, a trunk line, an automatic progressively movable trunking switch for said line, lines associated with
 20 said switch, means for moving said switch to connect said trunk with any one of said lines, a terminal for said trunk, another line, means in said other line for seizing said terminal to connect said other line to
 25 said terminal, said terminal normally disconnected from said trunk, means comprising a slow acting switching relay associated with said terminal for connecting said terminal with said trunk, another terminal
 30 for said trunk, means for seizing said other terminal, and means for disconnecting said switch from said trunk when said other terminal is seized.

19. In a telephone system, a trunk line,
 35 an automatic progressively movable trunking switch for said line, lines associated with said switch, means for moving said switch to connect said trunk with any one of said lines, a terminal for said trunk, another
 40 line, means in said other line for seizing said terminal to connect said other line to said terminal, said terminal normally disconnected from said trunk, means comprising a switching relay associated with said
 45 terminal for connecting said terminal with said trunk, said relay controlled over two sides of the trunk in series, another terminal for said trunk, means for seizing said other terminal, and means for disconnecting said
 50 switch from said trunk when said other terminal is seized.

20. In a telephone system, a trunk line, an automatic progressively movable trunking switch for said line, lines associated with
 55 said switch, means for moving said switch to connect said trunk with any one of said lines, a terminal for said trunk, another line, means in said other line for seizing said terminal to connect said other line to said
 60 terminal, said terminal normally disconnected from said trunk, means comprising a slow acting switching relay associated with said terminal for connecting said terminal with said trunk, said relay controlled over
 65 two sides of the trunk in series, another

terminal for said trunk, means for seizing said other terminal, and means for disconnecting said switch from said trunk when said other terminal is seized.

21. In a telephone system, a two way
 70 trunk line, a pair of progressively movable trunking switches normally connected with said trunk, one of said switches for extending calls that pass over said trunk in one direction and the other of said switches for
 75 extending calls that pass over said trunk in the opposite direction, a set of terminals for said trunk for seizing the trunk for calls in one direction, said terminals normally disconnected from said trunk, and another
 80 set of terminals for said trunk for calls in the opposite direction, means controlled over the first set of terminals for disconnecting said second switch from the trunk, and means controlled over the second
 85 set of terminals for disconnecting the first switch from the trunk.

22. In a telephone system, a two way
 90 trunk line, a pair of progressively movable trunking switches normally connected with said trunk, one of said switches for extending calls that pass over said trunk in one direction and the other of said switches for
 95 extending calls that pass over said trunk in the opposite direction, a set of terminals for said trunk for seizing the trunk for calls in one direction, and another set of terminals for said trunk for calls in the opposite
 100 direction, means controlled over the first set of terminals for disconnecting said second switch from the trunk, means controlled over the second set of terminals for disconnecting the first switch from the trunk, and
 105 means for operating either of said switches over two sides of the trunk in series.

23. In a telephone system, a two way
 110 trunk line, a pair of progressively movable trunking switches normally connected with said trunk, one of said switches for extending calls that pass over said trunk in one direction and the other of said switches for
 115 extending calls that pass over said trunk in the opposite direction, a set of terminals for said trunk for seizing the trunk for calls in one direction, and another set of terminals for said trunk for calls in the opposite
 120 direction, means controlled over the first set of terminals for disconnecting said second switch from the trunk, means controlled over the second set of terminals for disconnecting the first switch from the trunk, and
 125 means for operating either of said switches over two sides of the trunk in series, and for establishing a talking circuit over two sides of said trunk in series.

24. In a telephone system, a plurality of
 130 trunking switches, trunk lines, each of said switches having line wipers always in electrical connection with some one of said trunks, each trunk always the last one em-

played for extending a call thereover from the switch, the wipers of which are in electrical connection with such trunk, means for moving each switch to and fro over said
5 trunks to select an idle trunk and for initiating a trunk selecting movement if the trunk to which the switch wipers are connected is busy when a call is made, and a

circuit interrupter common to said switch for controlling said last means.

Signed by me at Chicago, Cook county, Illinois, this 10th day of February, 1914.

TALBOT G. MARTIN.

Witnesses:

C. W. BUELL,

G. A. YANOSHOWSKI.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."