June 8, 1926.

1,587,610

R. H. SMITH

TELEPHONE EXCHANGE SYSTEM

Filed June 13. 1923

2 Sheets-Sheet 1

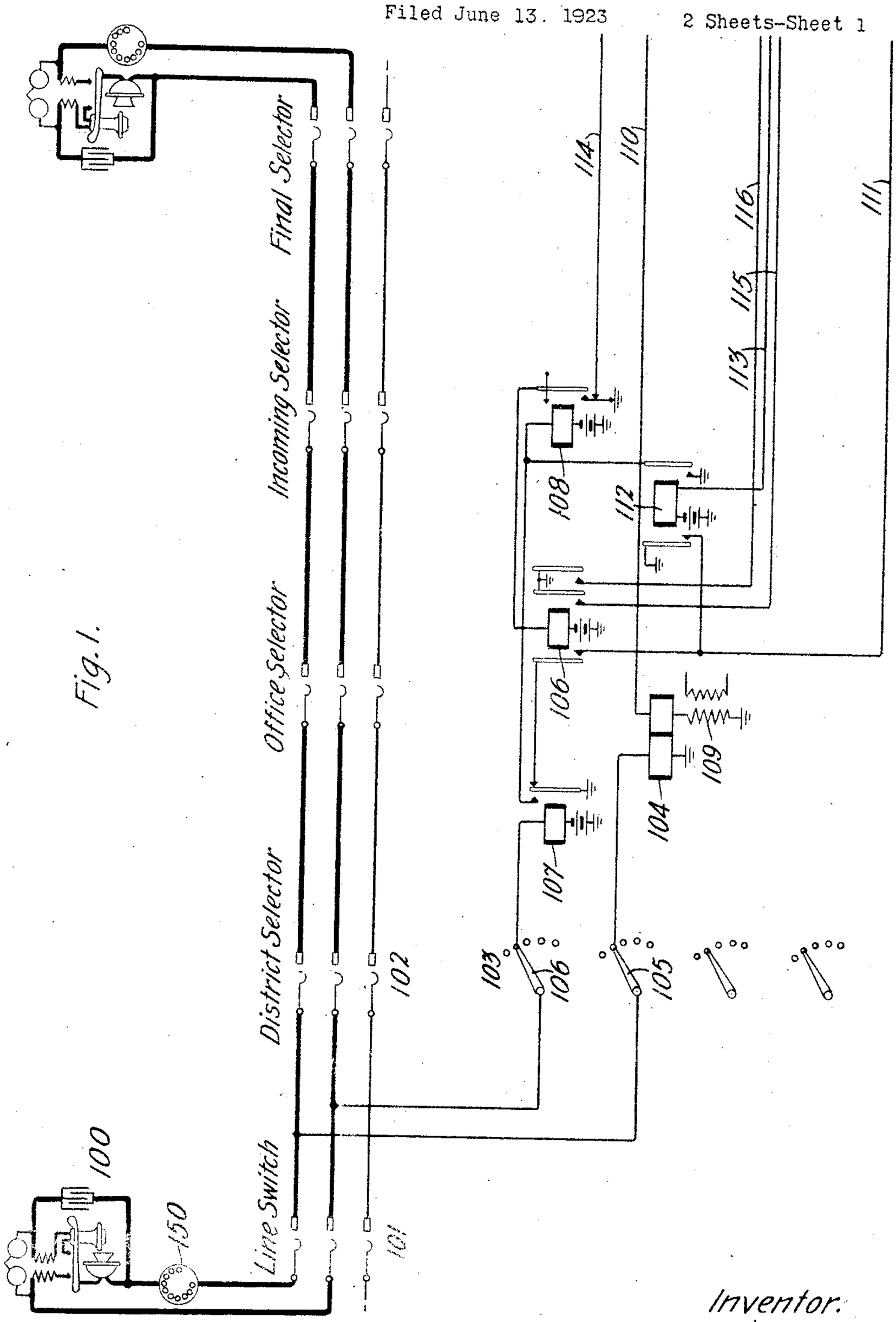

Fig. 1.

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2 Sheets-Sheet 2

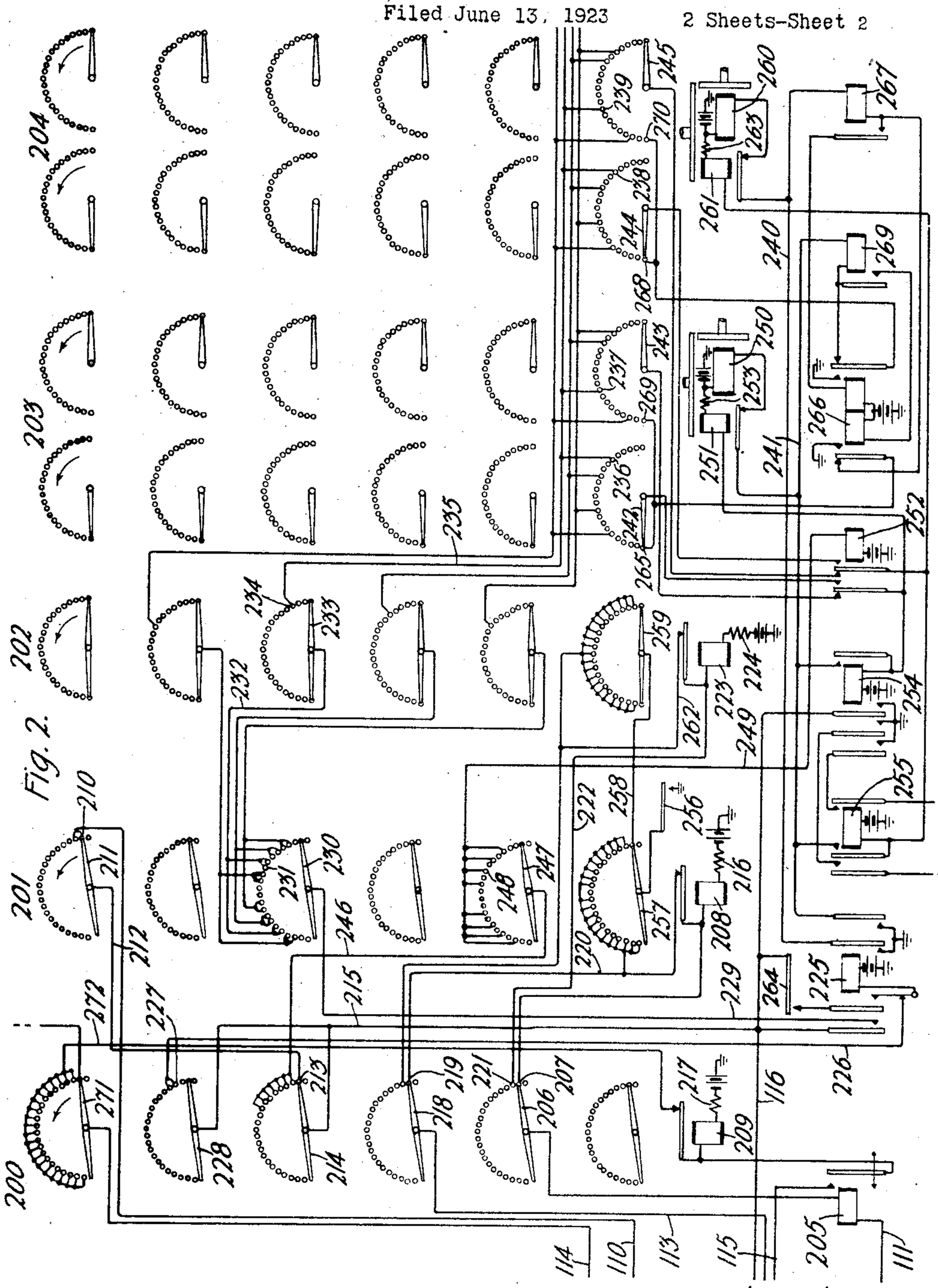

Fig. 2.

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Patented June 8, 1926. 1,587,610

UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE SYSTEM.

Application filed June 13, 1923. Serial No. 645,103.

This invention relates to electrical switching devices and more particularly to circuits for the control of such switching devices.

In the electrical field, particularly in telephony, there is wide use of switches which are operated to hunt for a predetermined condition set up on a particular contact in the bank over which they move. When such condition is met, the switch is brought to rest as a result of changes due to such condition. When, for any reason, no such condition has been set up on the contacts of the bank, there is no normal means for bringing the switch to rest. In the case of switches having a normal position the stopping condition may be permanently connected to the last terminal of the bank. In the case of switches having no normal position, the permanent connection of a stopping condition to any terminal might very well bring the switch to rest before it reaches the terminal for which it is hunting.

It is an object of the present invention to provide alternative means for bringing such continuously operating switch to rest, which means will not interfere with the normal operation of the switch but will become effective on the failure of the normal arresting means.

A feature of the invention lies in the application of the above mentioned means in such a manner that it becomes effective only after the switch has completed a predetermined extent of operation.

A further feature of the invention lies in the arrangement of the above mentioned means in connection with a pair of simultaneously acting switches in such a manner as to be dependent upon the operation of both switches.

In the specific embodiment set forth in the following description, the invention is applied to a translator switch which is adapted to hunt for a ground placed on one of its terminals by the joint setting of registers and to stop when such ground is found, to prepare circuits for the control of the automatic switches used in establishing connections. Obviously the invention is not limited to translator switches.

Since complete telephone exchange systems of the type to which the present invention has been applied have been disclosed in a number of patents and applications, the automatic switches and selecting circuits have been indicated only diagrammatically in the drawings. Reference is made to U. S. Patent No. 1,509,434, granted to Ottmar H. Kopp, September 23, 1924, for a more detailed disclosure of such circuits.

In the drawings, Figure 1 shows a calling subscriber's substation. Switches by means of which the connection may be extended to a called substation are diagrammatically indicated, as is a sender selector and a portion of the sender. Fig. 2 shows the registers, register control switch and translator in the sender.

The general operation of the system is substantially similar to that described in the above mentioned patent of O. H. Kopp, No. 1,509,434. When the called subscriber at substation 100 removes his receiver from the switchhook, a line switch 101 hunts for a trunk leading to an idle district selector such as 102. Seizure of such trunk causes the operation of a sender selector 103 which associates an idle sender with the district selector circuit.

Each sender is provided with a plurality of step-by-step registering devices such as 201 or 202. These registering devices may be of any desired character, but are preferably of the type shown and described in Patent No. 1,472,465, granted October 30, 1923, to O. F. Forsberg and R. M. De Vignier. A register controlling switch is utilized to direct successive series of impulses to the registering devices. The contacts 256 and 264 are controlled by a sequence switch which may be of the type shown and described in U. S. Patent No. 1,127,808 to Reynolds et al. issued February 9, 1915. For the purpose of this description it will be assumed that these contacts are opened and closed at the proper time.

The translator switch is of such simple construction that it has not been necessary to provide a drawing of its mechanism. Two arcuate contact banks each comprising a number of contact sets, each contact set comprising a plurality of contacts are arranged side by side and supported by a suitable frame. The brush shaft carrying two brush sets arranged to cooperate with the contact sets is mounted in operative relation with the contact banks in the same frame. The brush sets are 180° apart in rotation,

that is, they are diametrically opposite one another on the shaft and the arrangement is such that when one brush completes its travel over its associated contact bank, the other brush set will begin its travel over its associated contact bank. The power is transmitted to the shaft from a constantly rotating shaft by means of clutch discs controlled in the manner commonly employed in the construction of sequence switches. The power source is indicated in the present disclosure by the magnet 250 or 260. Since the brushes are driven at high speed, a stop magnet represented in the drawing by magnet 251 or 261 has been provided for each translator switch which opens the circuit of the power magnet and also applies a magnetic pull to the driving disc to insure the brushes stopping at the desired terminal set. As the number of functions to be controlled by the translator switch exceeds the number of arcs usually provided on a switch of this type, two switches 203 and 204 are provided and rotate and stop simultaneously so that they form in combination essentially one translator. The invention would, of course, also be applicable to translators consisting of a single switch structure.

The joint setting of the code registers serves to place ground on a predetermined terminal of the hunting arcs of the translator. When the brushes of the translator switch in rotating over their associated terminal banks, reach the grounded terminals, circuits are established through the stop magnets and the switch brought to rest in position to control the automatic switches which connect the subscriber through to the desired office. If the subscriber through error should dial a code for which there is no corresponding office, means must be provided for informing him that he has dialed incorrectly. It has been the custom heretofore to so connect the registers and translator that for every unused code the subscriber will be connected to an operator's position who can then assist him to complete his call correctly. If such unused codes were not cared for in this manner the translator switch would continue to rotate until stopped by an attendant or by the abandonment of the call. It is obvious that this necessitates a great deal of extra wiring and great care in the selection and the grouping of office names. In spite of these precautions this difficulty would also arise if the absence of ground on the translator terminals were due to other causes, such as a broken wire.

By means of the present invention, as will be more clearly brought out in the detailed description which follows, an auxiliary stopping means is provided by which a ground is placed on a predetermined terminal of the translator hunting bank, which ground is effective after the switch has made at least one complete revolution to bring the switch to rest on a set of terminals such that the subscriber is connected to an operator's position. This eliminates the necessity of connecting registers and the translator for unused codes, since the absence of normal ground on the switch brings the auxiliary stopping means into use and causes the connection to the operator.

The detailed operation of the system is as follows:

When an idle sender is selected and the brush of the sender selector comes to rest on the terminals leading to the sender, a circuit is completed from ground, left-hand winding of balancing coil 104, contact and brush 105 of sender selector 103, contact and brush of line switch 101, through the subscriber's substation 100 and his dial 150, brush and contact of line switch 101, brush 106 and contact of sender selector 103, winding of relay 107 to grounded battery. Relay 107 operates and closes a circuit from ground at its armature and front contact, winding of relay 108 to grounded battery. Relay 108 operates and closes a circuit from ground at its front contact, winding of relay 106 to grounded battery. Relay 106 closes the dialing tone circuit by way of ground, source of dialing tone 109, right-hand winding of balancing coil 104, conductor 110, normal contact 210 and brush 211 of register 201, conductor 212, normal contact 213 and brush 214 of register control switch 200, conductors 215 and 116 to ground at the outer right armature and front contact of relay 106. A tone is induced in the circuit of the left-hand winding of the balancing coil, notifying the subscriber that he may dial. Relay 106 also prepares the pulse circuit extending from the back contact of relay 107, left-hand armature and front contact of relay 106, conductor 111, winding of relay 205, brush 206 and contact 207 of control switch 200, winding of magnet 208, resistance 216 to grounded battery.

When the subscriber dials the first digit of the office code the circuit of relay 107 is opened a number of times corresponding to the digit dialed. At each interruption of the circuit relay 107 deenergizes, opening the circuit of relay 108, which, however, is slow to release and remains energized during these interruptions. The deenergization of relay 107 closes ground from its armature to the pulse circuit above traced causing relay 205 and stepping magnet 208 to operate in series. Magnet 208 releases at the close of each pulse to advance register 201 one step. Relay 205, however, is slow to release and remains energized until the completion of the series of impulses when it also deenergizes. The operation of relay 205 closes a circuit from grounded battery, resistance

217, winding of magnet 209, armature and front contact of relay 205, conductor 115 to ground at the inner right-hand armature and front contact of relay 106. Magnet 209 is energized in this circuit. It will be noted that each deenergization of relay 107 also closes a circuit from grounded battery, winding of relay 112, conductor 113, brush 218 and contact 219 of switch 200, conductor 220, armature and back contact of magnet 208, contact 207 and brush 206, winding of relay 205, conductor 111, left-hand armature and front contact of relay 106, armature back contact of relay 107 to ground. Relay 112 energizes and at its right-hand armature closes ground to relay 108 to assist in holding that relay energized during the interruption of its circuit. At its left-hand armature relay 112 also maintains the circuit of magnet 208 until this magnet completely attracts its armature, thus insuring the operation of magnet 208 and the advance of the register. At the completion of the series of pulses relay 205 releases, permitting the release of magnet 209 and the advance of register control switch 200 to its second position.

With switch 200 in position 2 the pulsing circuit extends from brush 206, contact 221, conductor 222, winding of magnet 223, resistance 224 to grounded battery. Each interruption of the pulsing circuit, due to the dialing of the second digit, advances register 202 one step. The circuit above traced for relay 112 is completed in the second position of switch 200 from brushes 206 and 218 and their second contacts to the armature and back contact of magnet 223, to insure the proper advance of register 202 in response to each impulse. As in the case of register 201, relay 205 remains energized during the series of pulses and holds the circuit of magnet 209 closed. At the completion of the second series of pulses magnet 209 releases and advances switch 200 to its third position, in which position, the pulse circuit is closed through to the thousands register (not shown). The setting of the numerical registers takes place in a manner similar to that of the code registers and is as shown and described in the above identified Patent No. 1,509,434.

Assume that the code dialed, corresponding to the wanted office, is 7—3. The register 201 will come to rest with its brushes on their 7th off-normal contacts and register 202 will come to rest with its brushes on their third off normal contacts. As soon as the register control switch 200 advances to its third position after the setting of register 202, a circuit is closed from grounded battery, winding of relay 225 and its normally closed contact, conductor 226, contact 227 and brush 228 of switch 200, conductors 215 and 116 to ground at the outer right-hand armature and front contact of relay 106. Relay 225 is energized and locks up through its inner left-hand armature and front contact and sequence switch cam 264 to grounded conductor 116. At its outer left-hand armature relay 225 extends ground from conductor 116 to conductor 229, brush 230 and contact 231 of register 201, conductor 232, brush 233 and contact 234 to conductor 235, thus connecting ground to the contacts 236, 237, 238 and 239 of translator switches 203 and 204. Relay 225 also completes a circuit from grounded battery, winding of power magnet 260, armature and back contact of stop magnet 261, conductor 240 to ground at the inner right-hand armature and front contact of relay 225. At its outer right-hand armature and front contact, relay 225 completes a circuit from ground to conductor 241, armature and back contact of stop magnet 251, winding of power magnet 250 to grounded battery. The energization of magnets 250 and 260 causes the brushes 242, 243, 244 and 245 to move off the terminals on which they happen to be standing and pass over their corresponding contacts in search of the ground placed thereon through the registers. Positioning register 201 on its 7th off-normal contact, however, has completed a circuit from grounded conductor 116, conductor 215, brush 214 and its off-normal contacts, conductor 246, brush 247 and contact 248, conductor 249, winding of relay 252 to grounded battery. Relay 252 operates and closes the leads from the stop magnets 251 and 261 through to brushes 242 and 244 and opens the circuit of brushes 243 and 245 so that the ground placed on contacts 237 and 239 will be ineffective.

When brushes 242 and 244 reach terminals 236 and 238 circuits are completed from these grounded terminals, through the brushes 242 and 244, armatures and front contacts of relay 252, windings of stop magnets 251 and 261 and resistances 253 and 263, respectively, to grounded battery. The operation of the stop magnets opens the circuits of power magnets 250 and 260, and brings the translator to rest. A circuit is completed at the same time from grounded contact 236, brush 242, outer armature and front contact of relay 252, winding of relay 254 to grounded battery. Relay 254 operates and closes a locking circuit for itself and magnet 251 in parallel to ground at the outer right-hand armature and front contact of relay 225. A similar circuit is completed from ground on terminal 238, brush 244, inner armature and front contact of relay 252, winding of relay 255 to grounded battery. Relay 255 also operates and closes a locking circuit for itself and magnet 261 to ground at the outer right-hand armature and front contact of relay 225. The operation of relay 254 furnishes a substitute ground for holding relay 225 operated. The joint operation

of relays 254 and 255 closes circuits for causing the advance of the sender and sender control sequence switches (not shown) to their next positions, in which positions the translator exercises its function of control over the connection. The operation of these sequence switches would be the same as that of the corresponding switches in the above mentioned Patent No. 1,509,434.

When the translator has been set and the sender and sender control sequence switches have advanced, the code registers are returned to normal in the following manner. Sequence switch cam 256 is closed, completing a self-interrupting circuit for magnet 208 from ground at cam 256, brush 257 and its associated off-normal contacts, armature, back contact and winding of magnet 208, resistance 216 to grounded battery. Magnet 208 steps the switch 201 back to normal. When brush 257 reaches its normal contact a circuit is completed from grounded cam 256, brush 257 and its normal contact, conductor 258, brush 259 and its off-normal contacts, conductor 262, armature, back contact and winding of magnet 223, resistance 224 to grounded battery. Magnet 223 then steps the switch 202 back to normal. Ground is removed from the terminals of the translator, but the stop magnets are held energized from ground at the front contacts of relay 225 until the translator has completed its operation, at which time the sender sequence switch opens cam 264, releasing relay 225, which, in turn, releases relays 254 and 255 and magnets 251 and 261. This also opens the circuit of the power magnets 250 and 260. The translator remains in the position in which it has been set until the power magnets are again operated to move it to another position in connection with a subsequent call. The restoration of the register control switch 200 takes place on the release of the sender by way of a circuit from ground at the normal contact of relay 108, conductor 114, off normal contacts and brush 271, conductor 272, back contact, armature and winding of magnet 209, resistance 217 to grounded battery.

No attempt has been made to show in detail the manner of cross connecting the registers to the translator, since this is an arbitrary matter to be determined in accordance with the requirements of the particular exchange. However, in any exchange there will probably be some codes which are not in use.

Suppose, for example, that 7—4 is such a code and that the subscriber in dialing the previously discussed office code had accidentally dialed 4 as the second digit instead of 3. The No. 4 terminal to which brush 233 has access is therefore, as shown, not connected to the translator. When, now, the register control switch advances to its third position and brush 228 makes contact with terminal 227, the previously traced circuit for relay 225 is completed and that relay operates and locks as before. At its left-hand armatures relay 225 completes the circuits of the power magnets which move the brushes of the translator over their terminals. The closure of the contact at the outer left-hand armature and front contact of relay 225 connects ground from conductor 116, through to the brush 233, but since terminal 4 is not connected to the translator, no ground can be placed on the translator hunting arcs. Register 201 having been positioned on its 7th off-normal terminal as before, relay 252 is operated and the circuits of stop magnets 251 and 261 are connected through brushes 242 and 244 as before. When brush 242 reaches a terminal such as 265 which has been selected for applying the auxiliary ground, a circuit is completed from grounded battery, resistance 253, winding of stop magnet 251, outer armature and front contact of relay 252, brush 242, terminal 265, left-hand armature and back contact of relay 266, winding of relay 267 to ground at the inner right-hand armature and front contact of relay 225. Relay 267 operates and closes a locking circuit for itself through its armature and front contact and the right-hand winding of relay 266 to grounded battery. Due to the presence of relay 267 in the circuit magnet 251 does not receive enough current to operate at this time. Similarly, when brush 244 reaches terminal 268, corresponding in position to terminal 265, a circuit is completed from grounded battery, resistance 263, winding of stop magnet 261, inner armature and front contact of relay 252, brush 244, terminal 268, right-hand armature and back contact of relay 266, winding of relay 269 to ground at the outer right-hand armature and front contact of relay 225. Relay 269 operates and closes a locking circuit for itself through its armature and front contact and the left-hand winding of relay 266 to grounded battery but stop magnet 261 does not operate. Relay 266 is so adjusted that it will not operate until both windings have been energized, nor will it operate as long as brushes 242 and 244 engage terminals 265 and 268, the circuits through these brushes having sufficient shunting effect on the relay to prevent its operation. Therefore, when both brushes have passed over these contacts, relay 266 operates and closes ground through its front contacts and armatures to the terminals 265, 268, 269 and 270. The brushes 242 and 244 make a complete revolution before again reaching terminals 265 and 268. When the brushes engage these terminals again, a direct ground is connected to the stop magnets which operate to open the circuits of the power magnets and bring the

translator to rest on these terminals. The subscriber is accordingly connected through to an operator who will take care of the call. The contacts 265, 268, 269 and 270 have been indicated at one end of the terminal arc for simplicity of illustration but in practice may be located wherever convenient.

In the course of a correctly dialed call, the brushes 242 and 244 (or 243 and 245) in passing from the terminals on which they are standing to the ones grounded by the call in progress may not pass over contacts 265 and 268 (or 269 and 270), in which case relays 266, 267 and 269 will not be affected. Should the brushes pass over these terminals in their hunt for the grounded terminals, relays 267 and 269 will be operated and, in turn, relay 266, to ground the terminals 265, 268, 269 and 270. However, the brushes will encounter the normally grounded terminals before they again reach the terminals 265 and 268 and will come to rest. Relays 266, 267 and 269 will remain operated until relay 225 is released at the completion of the operation of the translator.

It will be seen that the operation of relay 266 which places an auxiliary ground on the hunting arc is made to depend upon the passage of both brushes over the selected terminals, since it might be possible that one brush lag behind the other to such an extent that the leading brush cause the operation of the relay and placing ground on the arc of the lagging brush, cause that brush to stop and the two translator switches to be brought to rest in different positions. Again, since relay 266 operates only after the brushes have left the selected terminals, the brushes must pass over all the terminals in the hunting arc before they can again reach the selected terminals and stop the translator. Consequently, a call will only be directed to an operator after every terminal has been tested for ground.

What is claimed is:

1. An automatic switch, driving means therefor, electrically operable apparatus to count the number of times said switch regains a particular position and means to arrest said switch when such particular position has been regained a predetermined number of times.

2. An automatic switch, terminals therefor, driving means for said switch, and electrically operable apparatus to arrest said switch only after all of its terminals have been engaged, irrespective of the position of the switch at the time it was put into operation.

3. An automatic switch, driving means therefor, relays to count the number of times said switch regains a particular position, and means to arrest said switch when such particular position has been regained a predetermined number of times.

4. An automatic switch, driving means therefor, means comprising successively operable relays to count the number of times said switch regains a particular position, and means to arrest said switch when such particular position has been regained a predetermined number of times.

5. An automatic switch, driving means therefor, means operable in successive stages to count the number of times said switch regains a particular position and means to arrest said switch when such particular position has been regained a predetermined number of times.

6. A rotary switch, driving means therefor, electrically operable apparatus to count revolutions of said switch, and means to arrest said switch after a predetermined number of revolutions.

7. A rotary switch, driving means therefor, successively operable relays to count revolutions of said switch, and means to arrest said switch after a predetermined number of revolutions.

8. An automatic switch, a set of terminals therefor, a driving circuit for said switch, means for closing said driving circuit, and means for opening said driving circuit when said switch has traversed said terminal set a predetermined number of times.

9. A switch, terminals therefor, a driving circuit for said switch, means for closing said driving circuit, an electromagnetic device for opening said driving circuit, means operative when said switch engages a predetermined one of said terminals to prepare a circuit for said device, and means to render said circuit effective only after said switch has completed a predetermined additional extent of operation.

10. A switch, terminals therefor, a driving circuit for said switch, means for closing said driving circuit, an electromagnetic device for opening said driving circuit, means operative when said switch engages a predetermined one of said terminals to prepare a circuit for said device, and means to render said circuit effective when said switch engages said terminal a second time.

11. A switch, terminals therefor, a driving circuit for said switch, means for closing said driving circuit, an electromagnet for opening said driving circuit, a normally open circuit for said electromagnet, a relay operated when said switch engages a predetermined one of said terminals, a second relay operated under the control of said first relay when said switch leaves said predetermined terminal to complete the circuit of said magnet when said switch engages said terminal a second time.

12. A switch, terminals therefor, a driving circuit for said switch, means for closing said driving circuit, an electromagnet for opening said driving circuit, a normally

open circuit for said electromagnet, a variably operable device effective in certain positions to complete the circuit of said electromagnet, means for preparing an alternative circuit for said electromagnet when said switch passes over a predetermined one of said terminals and means effective on the positioning of said device in other of its positions to complete said alternative circuit for said electromagnet when said switch engages said predetermined terminal a second time.

13. A pair of switches, terminal sets therefor, driving circuits for said switches, means for simultaneously closing said driving circuits, and means for opening said driving circuits only after both of said switches have engaged all the terminals in their respective terminal sets.

14. A pair of switches, driving circuits for said switches, means for simultaneously closing said driving circuits, means for counting the number of times each switch regains a particular position and means to open said driving circuits when both switches have regained such particular position a predetermined number of times.

15. A pair of switches, driving circuits for said switches, means for simultaneously closing said driving circuits, terminals for said switches, normal means for opening said driving circuits, auxiliary means effective on the failure of said normal means, to open said driving circuits only after both of said switches have passed over all of the terminals to which they have access.

16. A pair of rotary switches, a set of terminals for each switch, driving circuits for said switches, means for simultaneously closing said driving circuits, means normally operable to connect ground to corresponding terminals in said sets, electromagnets for opening said driving circuits, circuits for said electromagnets normally completed through said grounded terminals, a relay individual to each switch operated when the corresponding switch passes over a predetermined terminal in its terminal set, means effective on the operation of both of said relays and after both of said switches have passed off said predetermined terminals to connect ground to said terminals to complete alternative circuits for said electromagnets when said switches engage said last mentioned terminals a second time.

17. A translator switch, a driving circuit for said switch, means for closing said driving circuit, a pair of registers, means under the joint control of said registers for normally opening said driving circuit, and auxiliary means, effective on the failure of said normal means, to open said driving circuit after said switch has completed at least one revolution.

In testimony whereof, I have signed my name to this specification this seventh day of June 1923.

ROY H. SMITH.