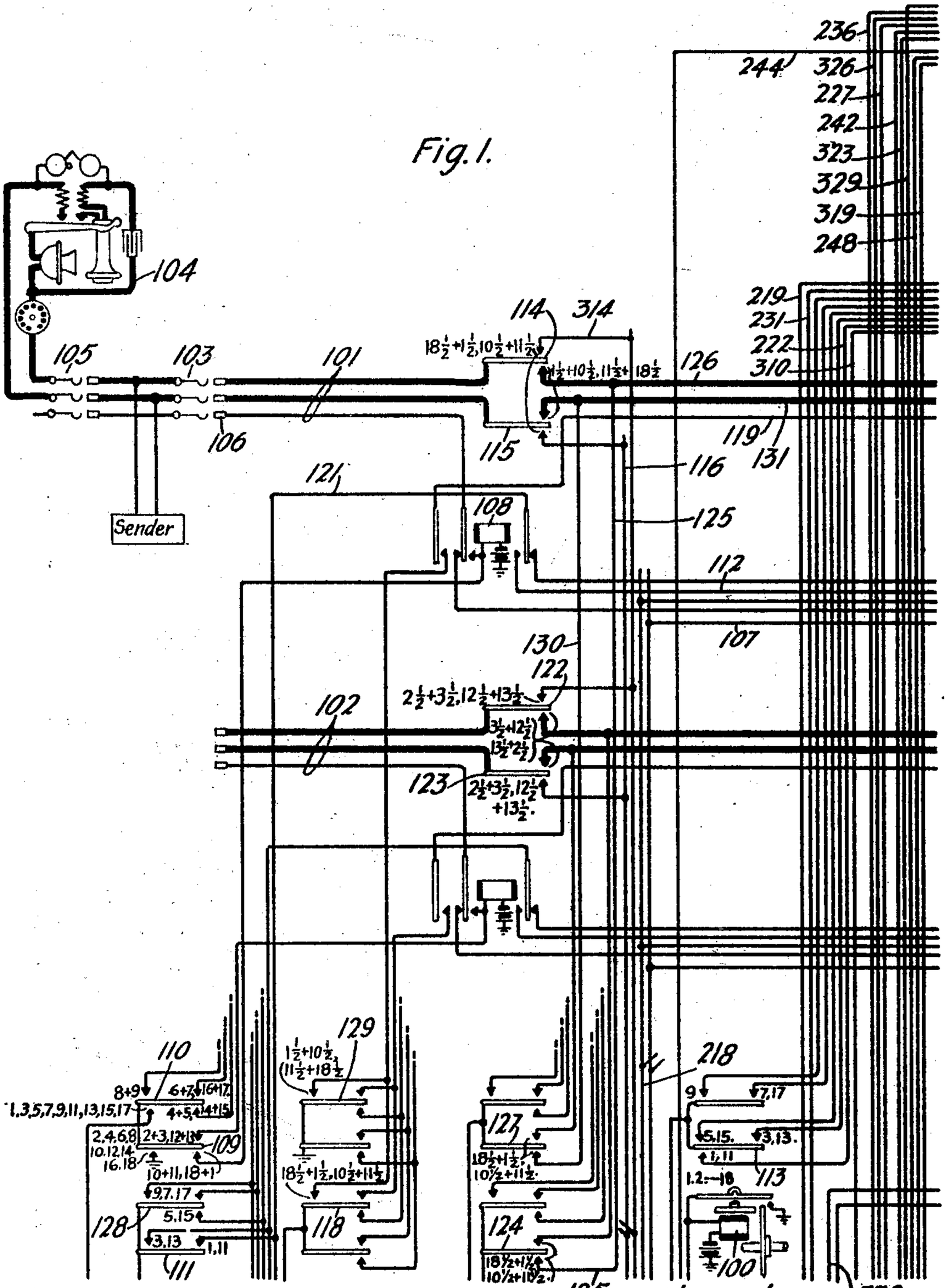
March 23, 1926. 1,577,513

W. G. BLAUVELT

TELEPHONE EXCHANGE SYSTEM

Filed Dec. 11, 1923 3 Sheets-Sheet 1.

Fig. 1.



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by

Att'y.

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TELEPHONE EXCHANGE SYSTEM

Filed Dec. 11, 1923 3 Sheets-Sheet 2

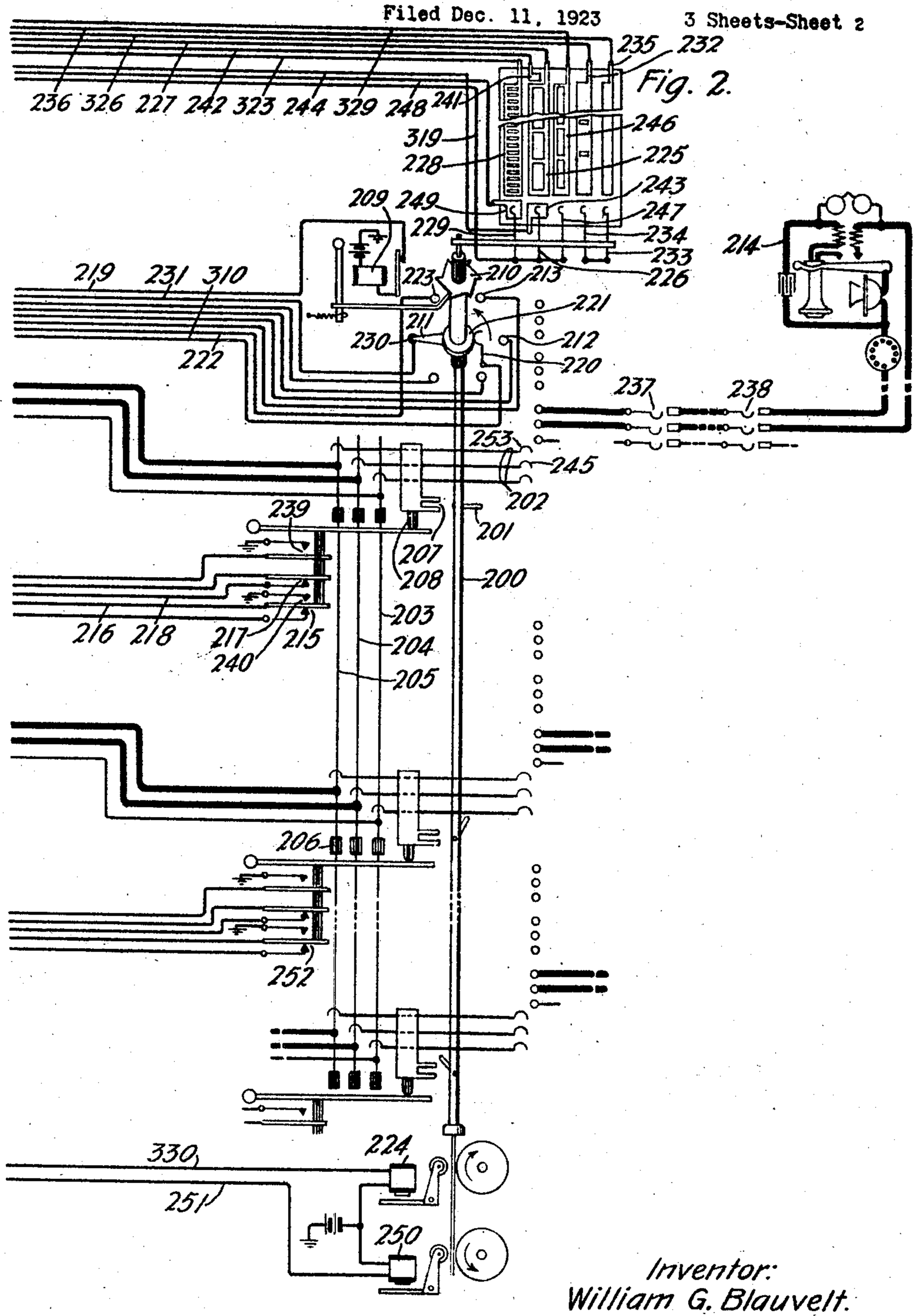

Fig. 2.

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TELEPHONE EXCHANGE SYSTEM

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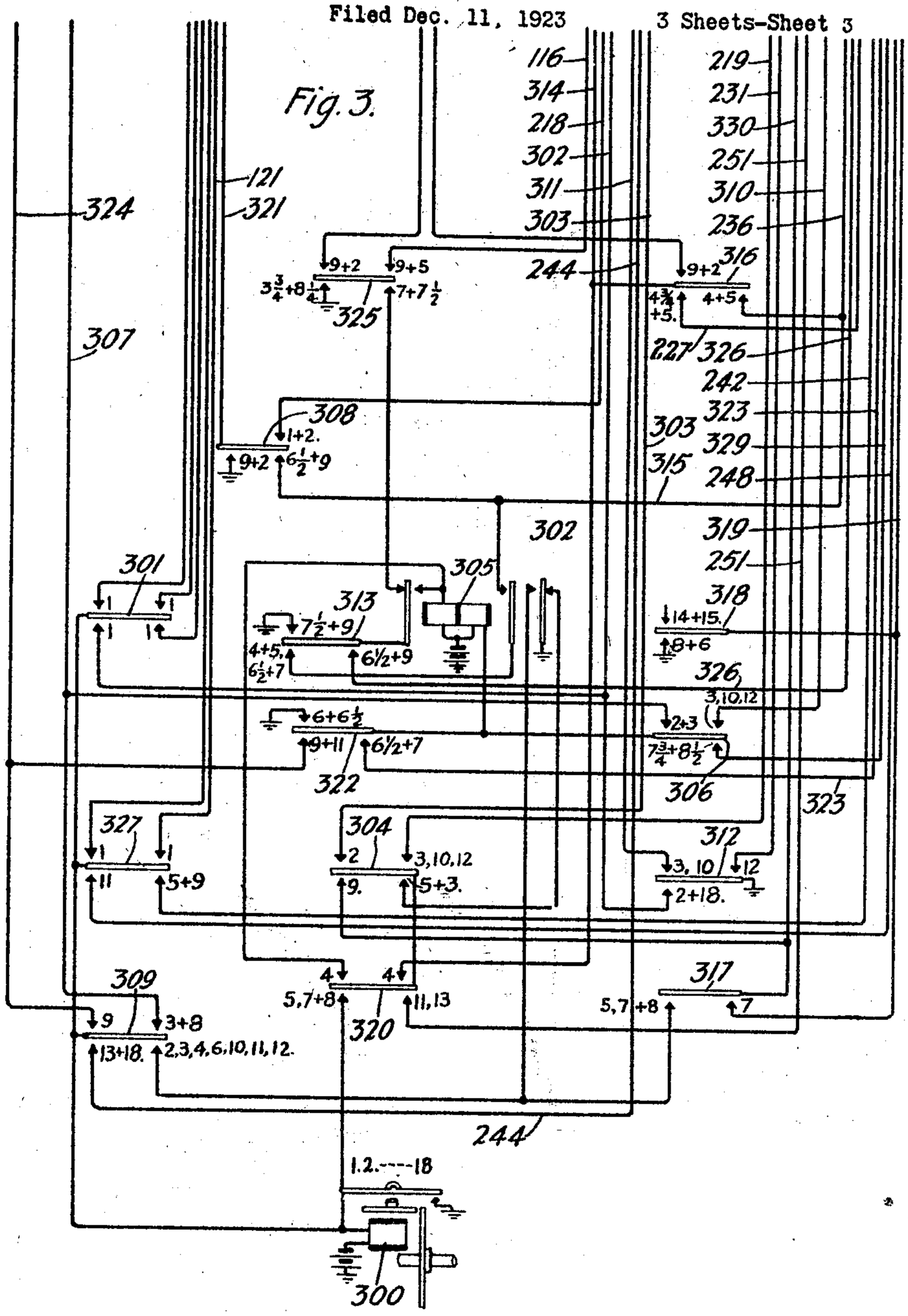
Fig. 3.



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by

Att'y

Patented Mar. 23, 1926. 1,577,513

UNITED STATES PATENT OFFICE.

WILLIAM G. BLAUVELT, OF NEW YORK, N. Y., ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TELEPHONE-EXCHANGE SYSTEM.

Application filed December 11, 1923. Serial No. 680,029.

To all whom it may concern:

Be it known that I, WILLIAM G. BLAUVELT, residing at New York, in the county of New York and State of New York, have invented certain Improvements in Telephone-Exchange Systems, of which the following is a specification.

The present invention relates to telephone exchange systems and more particularly to such systems in which connections are established by automatic switches.

Automatic switches of the power driven type having terminal banks in panels and a plurality of brush sets for each switch are well known in the art. Formerly only one such set of brushes could be employed at any one time in a completed connection.

It is an object of the present invention to provide an arrangement whereby a switch of the power driven panel type may be utilized to establish a plurality of simultaneous connections.

A feature of the invention lies in providing an arrangement by which each set of brushes acts as an individual selector switch under the control of a common brush rod.

A further feature of the invention lies in the use of a pair of sequence switches to control the operation of a plurality of selector switches associated with a common brush rod.

A still further feature of the invention lies in means to indicate which one of the group of selector switches is ready to be moved and to cause the brush rod to find such selector and operate it.

An additional feature of the invention lies in means to discriminate between selector switches ready to be operated and those ready to be returned to normal and to cause the brush rod to be variably operated in accordance with the function to be performed.

These and other features of the invention will be more clearly understood from a consideration of the following description taken in connection with the drawings and appended claims.

In the drawings, Figure 1 shows a calling subscriber's line extended by means of a line switch and a district selector to one of a group of office selectors in connection with which the present invention has been disclosed. The sequence switch of the circuit of Fig. 1 serves to connect any one of the selectors to the common control circuits which are shown in Fig. 3. Fig. 2 shows schematically a form which the switch structure may take and an incoming and final selector to extend the call to the called subscriber's line. Fig. 3 shows a common control circuit for controlling the office selectors of Fig. 2.

The switch structure shown in Fig. 2 is merely indicative of the features to be embodied in a switch to carry out this invention, and it is not intended that the invention be limited to the precise form of switch shown therein. The switch is of the general type shown and described in the patent to E. B. Craft and J. N. Reynolds, 1,123,696, issued January 5, 1915. However, the elevator rod 200 is not permanently connected to the brush sets but is provided with projecting pins 201 which, upon rotation, engage the brush sets. The brush sets, such as 202, may be mounted in any convenient manner upon a supporting rod or rods with means for holding the brush sets in any desired position. This has been indicated by the rods 203, 204 and 205 against which projections of the brushes press and which also serve as lead-in wires for the brushes. These supporting rods are divided into sections by means of insulation as indicated at 206 so that each brush set practically forms a separate selector. Each brush carriage is provided with a slot 207 which is engaged by the pin 201 when the brush set is to be used, as well as with a plurality of normal and off-normal contacts which are controlled by a projection 208 on the carriage. The elevator rod is driven up and down in the same manner as in the above mentioned patent to Craft and Reynolds. It is rotated by means of magnet 209 acting on a ratchet wheel 210. The brush 211 is fastened to the upper end of the brush rod and moves over contacts 212 and 213, etc., to control the engagement of the pins with the slots of the brush sets. The elevator rod moves freely in a vertical direction through the ratchet wheel but is rotated thereby in any suitable manner.

Each of the trunk lines 101, 102, etc., appears as usual in the terminal banks of district selectors. Ordinarily five trunks would be served by a common drive, that is, one for each brush set of the usual type of switch, but one of the advantages of this

invention is the possibility of employing any desired number of brush sets to meet various conditions. The group of trunks and selectors are controlled and operated by two sequence switches 100 and 300. These sequence switches are of the type described in the patent to Reynolds, et al., 1,127,808, issued February 9, 1915. The function of the sequence switch 100 is to connect the trunks 101, 102, etc., to the control sequence switch 300. The extension of a call to one of these trunks causes sequence switch 100 to take the position corresponding to the trunk selected, after which sequence switch 300 will control the operation of elevator rod in the selection of an idle outgoing trunk to the desired office. While the completed connection is in use, sequence switches 100 and 300 may be used by another trunk of the group to establish a second connection. When the call is finished and the district selector released, sequence switch 100 again functions to bring the trunk under the control of sequence switch 300 which sequence switch causes the brush shaft to find the brush set and return it to normal.

A detailed description will now be given of the extension of a call from substation 104 to substation 214. When the subscriber at substation 104 initiates a call, his line is extended by line switch 105 to district selector 103 and a register sender is associated with the district selector. The subscriber then dials the number of the wanted subscriber which is registered on the sender and the sender thereupon acts to control the district selector in picking a trunk leading to an office selector. This operation takes place in substantially the manner described in Patent 1,395,977 to F. A. Stearn and F. J. Scudder, issued November 1, 1921.

Let us assume that the trunk selected is trunk 101. When the brushes of the district selector come to rest on the terminals belonging to trunk 101, ground is connected to the sleeve terminal 106 from the district selector, and a circuit may then be traced from battery, winding of sequence switch magnet 300, left lower contact of sequence switch cam 301, conductors 302 and 107, normal contact 215, conductor 216, left back contact of relay 108 to ground on sleeve terminal 106. The magnet of sequence switch 300 is energized in this circuit to move the sequence switch out of position 1, into position 2.

The sleeve conductors of the trunks served by a single brush rod 200 are connected together through normal contacts 215, 252, etc., of the brush sets, so that the ground connected to sleeve terminal 106 by district selector 103 as above described immediately makes all the trunks 101, 102, etc., busy. When sequence switch 300 reaches position 2, ground from cam 312 is connected by way of lower contact of this cam, conductor 302, normal contacts of the brush sets, corresponding to contact 215, and back contact of the relay, corresponding to relay 108 of each idle trunk, to the sleeve conductor of such trunks preventing their seizure until sequence switch 300 returns to normal.

Also in position 2 of the sequence switch 300 a circuit is closed for sequence switch 100 extending from battery, winding of sequence switch 100, conductor 303, left upper and right lower contacts of cam 304, right back contact of relay 305 to ground.

Each of the trunks 101, 102, etc., is connected through to the sequence switch 300 in a definite position of sequence switch 100. For example, trunk 101 is brought under the control of sequence switch 300 in position 1 and also in position 11; trunk 102 in positions 3 and 13; the third trunk of the group in positions 5 and 15 and the fourth trunk in positions 7 and 17. The fifth trunk is brought under the control of sequence switch 300 only in position 9 since the sequence switch shown has only 18 positions. It would, of course, be possible to use a switch having its cams cut to give 20 positions, and if less than five trunks were used, not all of the 18 positions of this sequence switch would be used. Sequence switch 100 remains in the position to which it has last been moved until driven out of that position.

Assuming that sequence switch 100 is standing in position 9, sequence switch 100 will move out of position 9 and continue to rotate until the above traced circuit is opened. When sequence switch 100 reaches position 10 ground from the left contact of cam 109 is extended by way of the right lower contact of cam 109 to the winding of relay 108. Relay 108 energizes and locks to ground on the sleeve terminal 106. When the sequence switch 100 reaches position 11 a circuit is completed for relay 305 extending from battery, right winding of that relay, left contact of cam 306, conductor 307, right contact of cam 111, conductor 121, right front contact of relay 108, conductor 112, normal contact 217, conductor 218, right upper and left lower contacts of cam 308 to ground. Relay 305 operates and opens the circuit of switch 100 which comes to rest in position 11.

The energization of relay 305 also closes a circuit from ground at its outer right front contact, right lower contact of cam 309, winding of magnet of sequence switch 300 to battery, in which circuit sequence switch 300 moves into position 3. As soon as sequence switch 300 leaves position 2, the circuit of relay 305 is opened, and that relay releases.

In position 3, a circuit is completed for rotary magnet 209 extending from battery,

winding and back contact of relay 209, conductor 219, right contacts of cam 304 to ground at the right back contact of relay 305. Magnet 209 operates in this self-interrupting circuit to turn the brush rod one step at a time. When brush 211 reaches contact 223, corresponding to trunk 101, a circuit is completed for relay 305 extending from battery, right winding of relay 305, right upper contact of cam 306, conductor 310, feed brush 220, conducting ring 221 and brush 211, which are electrically connected together and insulated from the ratchet 210 and the brush rod 200, contact 223, conductor 222, lower contact of cam 113, conductor 311, left upper contact of cam 312 to ground. Relay 305 operates and at its outer right armature, opens the circuit of rotary magnet 209 bringing the brush rod to rest with pin 201 in engagement with the slot 207 on the carriage of brush set 202, which is associated with trunk 101, thus making ready for the selective operations.

The operation of relay 305 also completes a circuit for the magnet of sequence switch 300 extending from battery, winding of that magnet, right lower contact of cam 309, outer right front contact of relay 305 to ground. Magnet 300 operates and advances the sequence switch from position 3 to position 4. As soon as sequence switch 300 leaves position 3 the above traced circuit for relay 305 is opened and that relay releases.

In position 4, a fundamental circuit is completed in a manner similar to that described in the above identified patent to Stearn and Scudder, extending from battery through the left winding of relay 305, upper contacts of cam 320, conductor 314, upper contact of cam 114, over the tip side of the trunk 101 through the district selector to the sender and back over the ring side of the trunk, lower contact of cam 115, conductor 116, upper right and lower left contacts of cam 325 to ground. Relay 305 is energized in this circuit and locks in a circuit from battery through its left winding and left front contact, left lower contact of cam 313, inner right contact of relay 305, conductor 315, right contact of cam 316 to conductors 314 and then over the above traced fundamental circuit and back to ground. At its outer right front contact relay 305 closes a circuit by way of sequence switch cam 309 for sequence switch magnet 300 which moves this switch out of position 4 into position 5.

In position 5, the energizing circuit of relay 305 is opened but this relay remains operated over the locking circuit just traced. A circuit is also closed for the updrive magnet 224 extending from battery, winding of updrive magnet, conductor 330, left contact of cam 317 to ground at the outer right front contact of relay 305. Magnet 224 operates in the well known manner to move the brush shaft upwardly. The brushes are in position to engage the contact sets of the terminal bank, but since the trunk is disconnected from the brushes at this time at cams 114 and 115 no undesirable effect is produced by the movement of the brushes over their contacts. As the brush shaft moves upwardly, commutator brush 226 encounters conducting segments in the commutator strip 225, and a circuit is closed which may be traced from ground, lower contact of cam 318, conductor 319, brush 226, conducting segments of strip 225, conductor 227, lower contacts of cam 316, conductor 315, inner right front contact of relay 305, left lower contact of cam 313, left front contact and left winding of relay 305 to battery. In the manner set forth in the above mentioned patent to Stearn and Scudder, this path to ground shunts the stepping relay of the sender each time a conducting segment is encountered until the condition set up on the sender has been satisfied, at which time the fundamental circuit is opened in the sender, and, as soon as brush 226 encounters the next insulating segment, relay 305 releases opening the circuit of the updrive magnet, and bringing the brush set to rest on the first of a group of trunks leading to the desired office. Relay 305 in releasing also completes a circuit for sequence switch magnet 300 by way of cams 304 and 320, advancing the sequence switch to position 6.

As soon as sequence switch 300 reaches position 6, an obvious circuit is completed for relay 305 which relay operates and, at its outer right front contact closes a circuit by way of cam 309 for moving sequence switch 300 out of position 6 into position 7.

In position 7, trunk hunting takes place. If the first trunk of the group on which the brush set has come to rest is busy, the sleeve of that trunk will be grounded from the sleeve brush to the office selector which is in use with the trunk, and relay 305 will be held operated when sequence switch 300 leaves position 6½, over a path from battery, left winding and left front contact of relay 305, left lower contact of cam 313, inner right front contact of relay 305, right lower contact of cam 308, conductor 321, left upper contact of cam 118, outer left contact of relay 108, sleeve conductor 119, feed rod 203, sleeve brush 202 and thence to ground at the office selector with which the trunk is busy. When sequence switch 300 arrives in position 7 the updrive magnet is again energized over a circuit from battery, winding of magnet 224, conductor 330, left contact of cam 317 to ground on the outer right front contact of

relay 305. As the shaft moves upwardly, relay 305 will be held energized until an idle trunk, characterized by the absence of ground on its sleeve terminal is reached. Relay 305 will be maintained energized between busy trunk terminals, and until the brushes are properly centered, over a path extending through the right winding of that relay, right contact of cam 322, conductor 323, centering strip 228, commutator brush 229, conductor 319, lower contacts of cam 317 to ground on the outer right front contact of relay 305. When the brushes are properly centered brush 229 engages an insulating segment of strip 228 and relay 305 releases. As soon as relay 305 releases, ground is placed on the sleeve of the outgoing trunk from the lower contacts of cam 325, left back contact of relay 305, right contact of cam 313, conductor 326, metallic segment of overflow strip 232 of the commutator, brushes 233 and 234, which are strapped together, strip 235, conductor 236, right lower contact of cam 308, conductor 321, left upper contact of cam 118, outer left contact of relay 108, sleeve conductor 119, feed rod 203, sleeve brush 202 to the sleeve of the outgoing trunk. Relay 305 also closes a circuit by way of cams 304 and 320 to move sequence switch 300 out of position 7 into position 9. In the interval between positions 7½ and 9 ground is supplied to the sleeve conductor 119 from the left upper contact of cam 313 and thence over the right lower contact of cam 313 and the path previously traced. As soon as sequence switch 300 reaches position 9 ground is fed to the sleeve terminals of the outgoing trunk from the left lower contact of cam 308 to conductor 321 and thence as above traced to sleeve conductor 119.

In position 9 the conductors of the trunk are extended to the brush set; the tip conductor by way of the upper contact of cam 114, conductor 314, upper contact of cam 316, lower contact of cam 124, conductors 125 and 126, to the tip brush 253 and the ring conductor by way of the lower contact of cam 115, conductor 116, upper contacts of cam 325, lower contact of cam 127, conductors 130 and 131, to ring brush 245.

Sequence switch 300 is driven out of position 9 and into position 10 over a path extending from battery, winding of sequence switch magnet 300 upper left contact of cam 309, conductor 324, left lower contact of cam 110, right lower contact of cam 109, inner left front contact of relay 108 to ground on the sleeve terminal 106 from the district selector. Relay 305 is also energized at this time in a circuit from battery through the right winding of the relay, lower left contact of cam 322 to conductor 324 and thence over the circuit just traced for magnet 300 to ground. Relay 305 remains energized in this circuit in positions 10 and 11. With relay 305 energized, a circuit is completed from ground at the outer right front contact of relay 305, lower right contact of cam 309, winding of magnet 300 to battery, so that the sequence switch is advanced into position 12.

In position 12 relay 305 releases and closes a circuit from ground at its right back contact, right contacts of cam 304, conductor 219, back contact and winding of rotary magnet 209 to battery. The magnet 209 is energized in this circuit and operates to rotate the brush shaft 200 to normal. When the brush shaft reaches its normal angular position, brush 211 engages contact 230 and a circuit is completed from battery, right winding of relay 305, right upper contact of cam 306, conductor 310 brush 220, ring 221, brush 211, contact 230, conductor 231, right contact of cam 312 to ground. Relay 305 is operated in this circuit and opens the circuit of magnet 209 so that the brush shaft is arrested in its normal angular position. The energization of relay 305 closes a circuit from ground, outer right front contact of relay 305, right lower contact of cam 309, winding of magnet 300 to battery whereupon the sequence switch advances to position 13.

Relay 305 releases in position 13 and closes a circuit for the downdrive magnet 250 from battery, winding of that magnet, conductor 251, right lower contact of cams 320 and 304, right back contact of relay 305 to ground. Under the control of magnet 250 the brush shaft is lowered to normal. Since it is now in its normal angular position, none of the pins 201 engage any of the brush carriages and brush set 202 is left in engagement with the trunk on the terminals of which it has been positioned. When the brush shaft reaches normal, brush 226 engages commutator segment 243 and a circuit is completed from ground at the lower contact of cam 318, conductor 319, brush 226, segment 243, conductor 244, left lower contact of cam 309, winding of magnet 300 to battery. Sequence switch 300 advances through positions 13 to 18 and back to position 1.

Meanwhile the connection has been extended by means of incoming selector 237 and final selector 238 to the called subscriber's substation 214. These operations take place in a manner substantially the same as that described in the above identified patent to F. A. Stearn and F. J. Scudder, but since they do not affect the office selector they are of no interest in the present disclosure.

When conversation is completed and the calling subscriber hangs up the receiver, the restoration of the line switch, and the district selector removes the ground

from the sleeve terminal 106 whereupon the locking circuit of relay 108 is opened and that relay deenergizes. Assuming that no intervening call has been, or is in process of being extended, sequence switch 300 is in position 1 and a circuit may be traced from ground at the off normal contact 239, right back contact of relay 108, conductor 121, right upper contact of cam 327, winding of magnet 300 to battery. Sequence switch 300 advances into position 2. Meanwhile ground from the off normal contact 240 through the inner left back contact of relay 108 has been connected to terminal 106 to hold the trunk busy to other calls during restoration.

In position 2 a circuit is completed for sequence switch 100 from ground at the outer right back contact of relay 305, right lower and left upper contacts of cam 304, conductor 303, winding of magnet 100 to battery. However, since we have assumed that sequence switch 100 is still standing in position 11, corresponding to trunk 101, a circuit for relay 305 is also completed as soon as sequence switch 300 reaches position 2 which circuit may be traced from battery, right winding of relay 305, left contact of cam 306, conductor 307, right upper contact of cam 111, conductor 121, right back contact of relay 108 to ground at the off normal contact 239. Therefore the circuit of magnet 100 is immediately opened at the outer right armature of relay 305 and sequence switch 100 does not leave position 11. Relay 305 closes a circuit from ground at its outer right front contact, right lower contact of cam 309, winding of sequence switch magnet 300 to battery, to advance the sequence switch into position 3.

In position 3 a circuit is completed for magnet 300 from battery, winding of that magnet, right upper contact of cam 309, conductor 307, right contact of cam 111, conductor 121, right back contact of relay 108 to ground at off normal contact 239. Magnet 300 operates in this circuit to drive the sequence switch into position 9. Relay 305 releases as soon as sequence switch leaves position 3. In position 9 a circuit is completed for the updrive magnet extending from battery, winding of magnet 224, conductor 330, lower contacts of cam 304 to ground at the right back contact of relay 305. The brush shaft is elevated under the control of magnet 224 in its normal angular position until it reaches its uppermost or telltale position. When the brush shaft reaches this position commutator brush 226 engages segment 241 and a circuit is completed from grounded brush 226, segment 241, conductor 242, right lower contact of cam 327, winding of magnet 300 to battery. This curcuit also extends in parallel over the right lower contact of cam 327, left upper contact of cam 309, left lower contact of cam 322 and winding of relay 305 to battery. Magnet 300 operates and advances the sequence switch to position 10. Relay 305 operates and opens the circuit of updrive magnet 224 but releases as soon as position 10 is reached.

In position 10 a circuit is completed for the rotary magnet extending from battery, winding and back contact of magnet 209, conductor 219, right contacts of cam 304 to ground on the right back contact of relay 305. Magnet 209 operates in this circuit and rotates the brush shaft. When brush 211 reaches contact 223 corresponding to trunk 101, a circuit is completed through the right winding of relay 305, right upper contact of cam 306, conductor 310, brush 220, ring 221, brush 211, contact 223, conductor 222, lower contact of cam 113, conductor 311, left upper contact of cam 312 to ground. Relay 305 operates and opens the circuit of magnet 209 so that the brush shaft stops in such a position that pin 201 is directly above the slot on brush set 202. The energization of relay 305 also closes a circuit from ground at its outer right front contact, right lower contact of cam 309, winding of magnet 300 to battery, and sequence switch 300 advances to position 11. Relay 305 releases as soon as sequence switch 300 leaves position 10 and in position 11 closes a circuit from ground at its right back contact, right lower contact of cams 304 and 320, conductor 251, winding of downdrive magnet 250 to battery. Magnet 250 operates to lower the brush shaft, and the pin 201 engages the top of the brush set 202 and drives it down. When the brush set reaches normal, off normal contact 240 is opened, but normal contact 215 immediately closes to extend ground from cam 312 to terminal 106 to maintain the trunk busy until restoration is completed. Commutator brush 229 now engages segment 249 and a circuit is completed from ground at the lower contact of cam 318, conductor 319, brush 229, commutator segment 249, conductor 248, left lower contact of cam 327, winding of magnet 300 to battery. Sequence switch 300 moves out of position 11 into position 12.

In position 12 the circuit of the rotary magnet is again completed as previously traced to ground at the outer right back contact of relay 305 and that magnet operates to rotate the brush shaft back to normal. When brush 211 encounters contact 230 a circuit is completed from ground, right contact of cam 312, conductor 231, contact 230, brush 211, ring 221, brush 220, conductor 310, right upper contact of cam 306, right winding of relay 305 to battery. Relay 305 operates and opens the circuit of the rotary magnet thus bringing the brush shaft to rest in its normal angular position. The opera-

tion of relay 305 closes a circuit from ground, outer right front contact of this relay, right lower contact of cam 309, winding of magnet 300 to battery. Magnet 300 operates and advances the sequence switch to position 13. In position 13 the down-drive magnet 250 is again energized in the circuit previously traced and the shaft is brought to its lowermost position with the pins opposite the slots on the brush carriages. When the shaft reaches this position, brush 226 encounters segment 243 and a circuit is closed from ground at the lower contact of cam 318, conductor 319, brush 226, segment 243, conductor 244, left lower contact of cam 309, winding of magnet 300 to battery. Sequence switch 300 advances in this circuit out of position 13 and back to position 1 and the selectors are ready to receive subsequent calls.

During the time that sequence switch 300 is busy extending a call over a trunk such as trunk 101, none of the other trunks of the group can be selected by a district selector. As soon as sequence switch 300 returns to position 1, having placed the brush set 202 in engagement with a trunk leading to an idle incoming selector, the group-busy ground, furnished from cam 312 over conductor 302, is removed from the sleeve terminals of the group, trunk 101 being kept busy from the district selector connected therewith. Another trunk may now be selected to extend a subsequent call. If a second trunk, say trunk 102, is selected during the time conversation is taking place on trunk 101, sequence switch 300 will be operated as before to cause sequence switch 100 to move to a position corresponding to trunk 102. As soon as sequence switch 100 reaches position 11½, the incoming ends of the tip and ring conductors of trunk 101 are connected, through the lower contact of cam 114 and upper contact of cam 115 respectively, to the outgoing ends of the same conductors. Hence the circuit over which the conversation takes place is not interrupted and the parties to that conversation will not be conscious that the common apparatus is in use in connection with another call. The outgoing end of the trunk will be maintained busy over a circuit from ground, left upper contact of cam 129, outer left front contact of relay 108 to sleeve conductor 119.

From the foregoing description, it will be noted that in the process of positioning a switch, the brush shaft is first rotated to engage the brush set of the proper switch, next elevated to position the brush set and then restored to normal. When a switch is to be restored, the brush shaft is raised to a position above the brush set, rotated to a position corresponding to the brush set, lowered to restore the brush set, and then is itself restored. The shaft is returned to normal after each use, whether a restoration operation follows a setting operation or a second setting follows the first. This is true even in the case where all trunks are busy, as will be more clearly explained later.

It may also be noted that these different operations are initiated in response to discriminatory conditions set up on the trunks. A selector to be positioned is characterized by ground through a back contact of the trunk relay and a normal contact of the brush set, which ground is cut off as soon as the trunk is associated with the common apparatus. A selector to be restored is characterized by ground through a back contact of the trunk relay and an off normal contact which ground is maintained after the trunk has been associated with the common apparatus.

To make clear the operation of trunk groups in the various conditions which may arise, let us assume that a call is extended to trunk 101, corresponding to position 1 of sequence switch 100; that sequence switch 100 is standing in position 3; the trunk corresponding to position 5 is idle: the trunk corresponding to position 7 in use; and that the trunk corresponding to position 9 is released after sequence switch 100 is started in motion and, when the sequence switch reaches position 9 is awaiting disconnect. Ground on the sleeve terminal of trunk 101 moves sequence switch 300 into position 2 in which position the circuit of sequence switch 100 is completed at the back contact of relay 305. When sequence switch 100 moves into position 4, ground is connected by way of left lower contact of cam 109, right lower contact of cam 110 to the winding of the relay of trunk 3 corresponding to relay 108. This relay operates but since there is no ground on the sleeve conductor of that trunk it releases when sequence switch 100 reaches position 5. In position 6 ground is connected to the winding of the relay of trunk 4. This relay is already operated and locked, since trunk 4 is in use, and, since the normal contact corresponding to contact 217 is open, the closure of the circuit of relay 305 is prevented, and sequence switch 100 continues to move out of position 7. When the sequence switch reaches position 8, the relay of trunk 5 is operated, but this relay releases in position 9. However, in position 9, ground from the off normal contact corresponding to contact 239 is extended over the back contact of the trunk relay, left contact of cam 128, conductor 307, left upper contact of cam 306 to the winding of relay 305, which relay operates and opens the circuit of sequence switch 100. The apparatus now functions to restore selector 5 in the manner previously described, after which sequence switch 300 returns to position 1. In position 1 ground, which is still present on ter-

minal 106, again moves sequence switch 300 into position 2. Sequence switch 100 now moves into position 10 energizing relay 108 which locks to the ground on the sleeve 106. The circuits now operate as previously described to extend the connection to an idle interoffice trunk.

Let us suppose now, that, at the time the selector 202 is hunting over the outgoing trunks, all the trunks in that group are busy. It will be remembered that trunk hunting takes place in position 7 of sequence switch 300. If none of the trunks of the group are idle the selector will pass over all the terminals of the group until it encounters the overflow set of terminals. Since no ground is present on the sleeve terminal of the overflow set, the selector comes to rest as if an idle trunk had been reached, and, when brush 229 engages an insulating segment of commutator 228, relay 305 releases. The sleeve of the overflow terminal set is not made busy, since the circuit for so doing, extending from ground at the lower left contact of cam 325, lower right contact of cam 325, back contact of relay 305, right lower contact of cam 313, conductor 326, commutator strip 232, brushes 233 and 234, feed strip 235, conductors 236 and 315, right lower contact of cam 308, conductor 321, left upper contact of cam 118, outer left front contact of relay 108 to sleeve conductor 119, is opened since brush 234 engages an insulating segment of strip 232 whenever the brush shaft is in an overflow position. The release of relay 305 moves sequence switch 300 out of position 7 into position 8. In position 8 a circuit is closed for relay 305 extending from battery, right winding of that relay, lower contact of cam 306, conductor 329, commutator strip 246, brush 247, conductor 319, lower contact of cam 318 to ground. Relay 305 operates and locks through its left winding and front contact to ground at the upper contact of cam 313. Relay 305 now closes a circuit for the updrive magnet 224, from battery, winding of magnet 224, conductor 330, left contact of cam 317, outer right front contact of relay 305 to ground. The brush shaft moves, under the control of the updrive magnet, to its uppermost or telltale position. As sequence switch 300 is in position 8, the tip and ring conductors are open at this time and the passage of the brushes over terminals in other groups which may be in use will not cause any disturbance of such connections. The sleeve brush is closed to ground over the outer left front contact of relay 108, left contact of cam 118, right lower contact of cam 308, conductors 315 and 236, commutator strip 235, brushes 234 and 233, strip 232, conductor 326, right lower and left upper contact of cam 313 to ground. But this does no harm, since the above traced circuit is opened at the commutator strip 232 whenever the brush set passes over overflow terminals.

When brush 226 encounters telltale commutator segment 241, a circuit is closed from battery, winding of magnet 300, right lower contact of cam 327, conductor 242, segment 241, brush 226, conductor 319, to ground on the lower contact of cam 318, and sequence switch 300 moves into position 10. The locking circuit of relay 305 is opened at cam 313 when the sequence switch leaves position 9, but a second circuit is provided extending from battery, right winding of that relay, left lower contact of cam 322, conductor 324, left lower contact of cam 110, right lower contact of cam 109, inner left front contact of relay 108, to ground on sleeve conductor 106. In positions 10 and 11 relay 305 remains operated and closes a circuit from ground at its outer right front contact to drive the sequence switch into position 11 and then in position 12. In position 12 relay 305 releases and causes the magnet 209 to rotate the brush shaft to normal. When the brush shaft reaches its normal angular position, relay 305 operates and advances sequence switch 300 to position 13 in which position the brush shaft is lowered to normal, after which the sequence switch 300 returns to position 1. The selector remains positioned on the terminals corresponding to telltale position over which any desired means may be provided to send a signal back to the sender to indicate that all trunks were busy, after which the sender operates to inform the calling subscriber that the call could not be completed. When the subscriber hangs up and releases the district selector, the common apparatus will function as before to return the brush set to normal. Since the brush set is in its uppermost position when the brush shaft is rotated, the pin 201 engages slot 207 and when the brush shaft is lowered to normal, brush 226 makes contact with segment 243 immediately after brush 229 makes contact with segment 249. The engagement of brush 229 and segment 249 moves the sequence switch into position 12 in which position the magnet 209 rotates the shaft to normal, whereupon relay 305 operates, moving sequence switch 300 into position 13. Since brush 226 and segment 243 are already in engagement, sequence switch 300 is immediately moved out of position 13, into position 1.

Although this invention has been disclosed in connection with an office selector it is obvious that it is equally applicable to other selectors and the disclosure in this form serves merely to illustrate the broader aspects of the invention. The application of the invention to selectors having a greater

number of auxiliary functions or to non-numerical selectors, such as line finders, is easily possible to those skilled in the art.

What is claimed is:

1. In a telephone exchange system, a group of switches, a common shaft, means to associate any one of said switches with said common shaft, means for operating said shaft to position said switch, means for restoring said common shaft, and means for again associating said shaft with said switch to restore said switch.

2. In a telephone exchange system, a plurality of switches, a common shaft for said switches, means to associate said shaft with one of said switches only when said switch is to be set or restored, and means to discriminatively operate said shaft according to whether it is set or to restore one of said switches.

3. In a telephone exchange system, a group of switches, a common shaft for said switches, controlling means for said shaft, means for associating any one of said switches with said controlling means, means to indicate to said controlling means whether said switch is to be set or to be restored, and means to operate said controlling means to vary the movement of said shaft in accordance with said indication.

4. In a telephone exchange system, a plurality of switches, a common operating shaft, means for operatively associating any one of said switches with said shaft, means for moving said shaft in one manner to set the associated switch on a set of terminals, means for moving said shaft in a different manner to restore said switch, and means for discriminating between a switch ready to be set and one ready for restoration.

5. In a telephone exchange system, a plurality of switches, operating means common to said switches, means to operatively associate any one of said switches with said operating means only when said switch is to be set or restored, means for giving a discriminating indication when a switch is in condition for setting and when in condition for restoration, and means to variably move said operating means to effect said setting or said restoration.

6. In a telephone exchange system, a plurality of switches, a shaft common to said switches, means to associate said shaft with any one of said switches to position said switch or to restore said switch, and means to return said shaft to its normal position after each use thereof.

7. In a telephone exchange system, a calling subscriber's line, a plurality of trunk circuits each terminating in a switch, means for extending said calling subscriber's line to one of said trunk circuits, common controlling means for said trunk circuits, means for associating the selected one of said trunk circuits with said controlling means, a shaft common to the switches in which said trunks terminate, means under the control of said controlling means for operating said shaft to engage the switch in which the selected trunk terminates and to position said switch, and means to release said shaft from said switch and to restore said shaft to its normal position.

8. In a telephone exchange system, a calling subscriber's line, a plurality of trunk circuits each terminating in a switch, means for extending said line to one of said trunk circuits, common controlling means for said trunks, a common shaft for the switches in which said trunks terminate, means for operating said controlling means and said shaft in one manner in response to the extension of said line to said trunk, and means for differently operating said controlling means and said shaft in response to the release of said trunk.

9. In a telephone exchange system, a subscriber's line, a plurality of trunk circuits each terminating in a switch, a common shaft for said switches, means for extending said subscriber's line to one of said trunk circuits, and a pair of sequence switches common to said plurality of trunks for controlling the association of said shaft with the switch in which said trunk terminates and the positioning of the switch by said shaft.

10. In a telephone exchange system, a group of switches, a common shaft, means to automatically associate any one of said switches with said common shaft, means for operating said shaft to position said switch, means for restoring said common shaft, said means all being capable of repeated operation so long as any of said group of switches remain in an idle condition, and means for causing the association of said shaft with each operated switch, and the operation of said shaft to restore each switch as it becomes ready for restoration.

11. In a telephone exchange system, calling subscribers' lines, a plurality of trunk circuits each of which terminates in a switch, outgoing trunks accessible to said switches, an operating mechanism common to said switches for causing their operation and restoration, means operative upon the operation of one of said switches to select an outgoing trunk to render said selected trunk busy and means under the control of a calling subscriber for controlling the release of the operated switch, said means being effective to render the selected outgoing trunk again selectable prior to the restoration of said switch.

12. In a telephone exchange system, calling subscribers' lines, a plurality of trunk circuits each of which terminates in a switch, means for extending one of said calling subscribers' lines to one of said trunk circuits,

common controlling means for said trunk circuits, means for associating the selected one of said trunk circuits with said controlling means, a shaft common to the switches in which said trunks terminate, means under the control of said controlling means for operating said shaft to engage the switch in which the selected trunk terminates, outgoing trunks, means to operate said switch to select an idle outgoing trunk, means to render said outgoing trunk non-selectable to other switches as soon as said switch selects said trunk, means to release said common shaft to the use of the other switches in the group, means operated in response to the release of the connection by the calling subscriber to cause said common shaft to be again associated with the selected trunk switch to restore said switch and means responsive to the release of the connection to render said outgoing trunk again selectable to other switches prior to the restoration of said first switch.

13. In a telephone exchange system, calling subscribers' lines, a plurality of trunk circuits each of which terminates in a switch, means for extending one of said calling subscribers' lines to one of said trunk circuits, common controlling means for said trunk circuits, means for associating the selected one of said trunk circuits with said controlling means, a shaft common to the switches in which said trunks terminate, means under the control of said controlling means for operating said shaft to engage the switch in which the selected trunk terminates, groups of outgoing trunks accessible to said switch, means to operate said switch to select an idle trunk in one of said groups, a set of overflow terminals common to all of said groups of trunks, means operated which none of the trunks in a group are idle to position said switch on said set of overflow terminals, means to hold said switch on said set of overflow terminals as long as said calling subscriber's line is extended to said switch, means to restore said common shaft, and means responsive to the release of the trunks terminating in said switch by said calling subscriber to again associate said shaft with said switch to restore said switch.

14. In a telephone exchange system, calling subscribers' lines, a plurality of trunk circuits each of which terminates in a switch, means for extending one of said calling subscribers' lines to one of said trunk circuits, common controlling means for said trunk circuits, means for associating the selected one of said trunk circuits with said controlling means, a shaft common to the switches in which said trunks terminate, means under the control of said controlling means for operating said shaft to engage the switch in which the selected trunk terminates, groups of outgoing trunks accessible to said switch, means to operate said switch to select an idle trunk in one of said groups, a set of overflow terminals individual to each group of trunks, means operated when none of the trunks in a group are idle to position said switch on said set of overflow terminals, a set of overflow terminals common to all of the groups of trunks accessible to said switch, means operated when said switch engages an individual set of overflow terminals to operate said switch to engage said common set of overflow terminals, means to hold said switch on said common set of overflow terminals as long as said calling subscriber's line is extended to said switch, means to restore said common shaft and means responsive to the release of the trunk terminating in said switch by said calling subscriber's line to again associate said shaft with said switch to restore said switch.

In testimony whereof, I have signed my name to this specification this 10th day of December, 1923.

WILLIAM G. BLAUVELT.