June 10, 1930. R. E. COLLIS 1,762,763

TELEPHONE SYSTEM

Filed Aug. 8, 1928 2 Sheets-Sheet 1

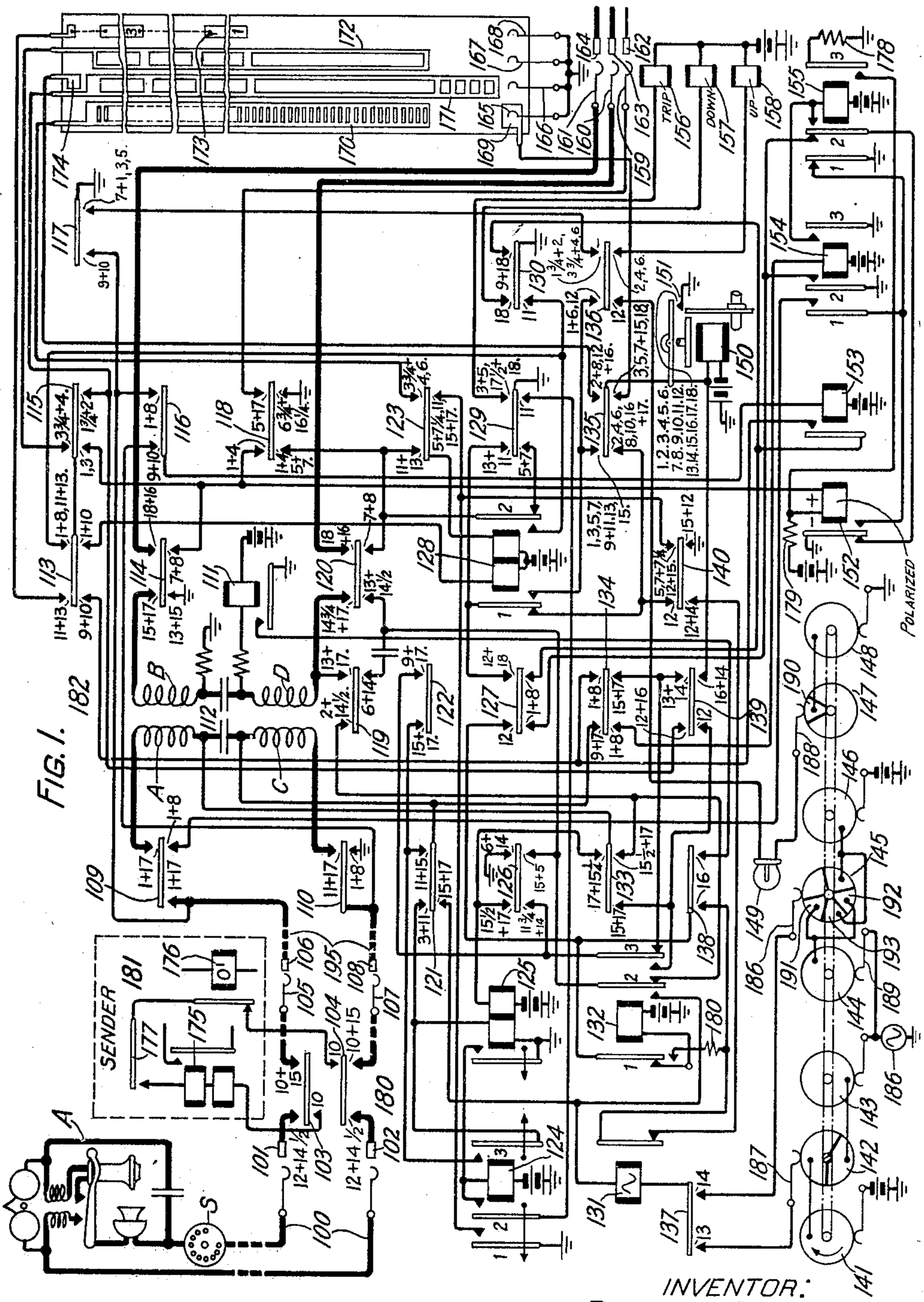

FIG. 1.

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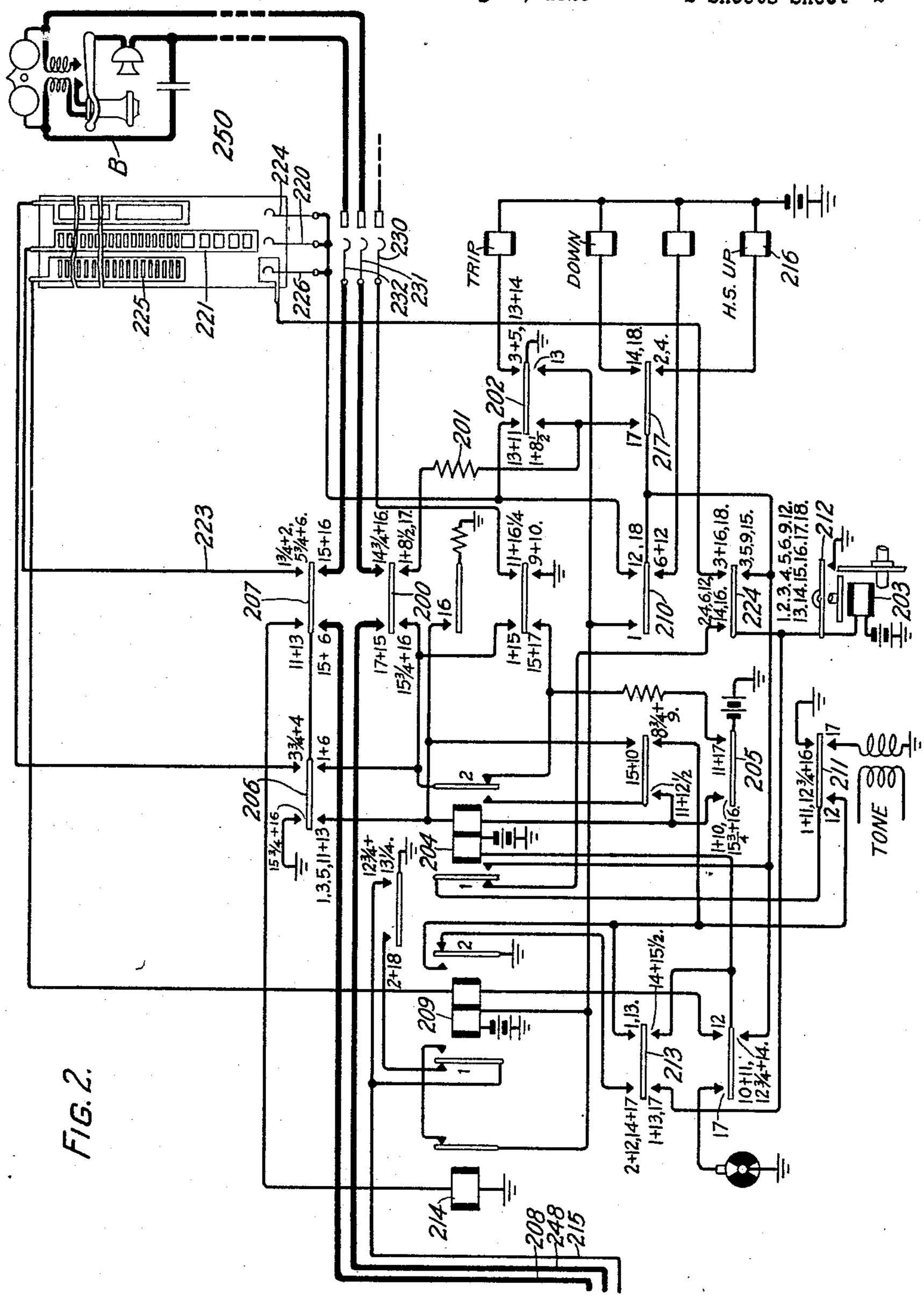

FIG. 2.

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Patented June 10, 1930

1,762,763

UNITED STATES PATENT OFFICE

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TELEPHONE SYSTEM

Application filed August 8, 1928. Serial No. 298,143.

This invention relates to telephone exchange systems and more particularly to an exchange system in which impulse controlled switches are arranged for connection to impulsing devices over cables which store and discharge sufficient energy to interfere with rapid operation of the switching apparatus and has for its object the operation of such switches in a manner to disregard reactionary cable energy.

In some telephone exchange areas a large number of switch controlling impulse circuits are established over cable conductors. Numerous circuit arrangements are known in which the switch controlling apparatus is at all times directly connected in series with the impulse circuit. In such circuit arrangements this apparatus must be designed and adjusted to operate satisfactorily over cables of various lengths. With all factors equal the capacity of a cable for storing energy is proportional to its length. The effect of cable energy is to retard the release of the apparatus in the pulsing circuit, thus making uncertain the control of the switch driving mechanism. It is highly desirable to establish pulsing circuits over very long cables and yet be able to obtain satisfactory margins for the operation of apparatus associated therewith.

In accordance with the present invention switching apparatus connected with an impulse controlling device nullifies the effect of the first of a series of impulses, responds to the remaining impulses in a series, and subsequently uses the effect of the nullified impulse independent of the impulse controlling device for the final setting of the switch brushes.

A specific embodiment of this invention comprises a selector switch of the reverted impulse type associated with a sending device which has been set for the control of said switch. A number of counting relays in the sending device equal to the number of impulses to be transmitted are arranged for controlling the extent of movement of the selector switch. A circuit is established over cable conductors for controlling the movement of the selector switch under the operative control of the counting relays. Certain apparatus of the switch is operated upon the establishment of this circuit and preceding the selective movement of the switch this apparatus causes the operation of the first counting relay. As soon as the first counting relay has been operated and the switching apparatus has accordingly been adjusted, the selective switch is set in motion to respond to the remainder of the impulses in accordance with the setting of the counting relays. At the termination of a series of impulses the impulsing circuit is opened. At this time apparatus that was operated, when the first impulse was nullified, is effective as the last pulse of a series of impulses for positioning the switch. This apparatus controls the switch driving mechanism and since it is independent of any reflection from cable energy the release of this apparatus may be controlled within close limits.

The invention will now be described in connection with the accompanying drawings which disclose one specific embodiment of the invention. In the drawings Fig. 1 shows the line of a calling subscriber, a diagrammatic illustration of a subscriber's individual line switch, a district selector, and an office sender, also the circuits of the incoming selector switch disclosing the present invention and Fig. 2 shows the circuits of a final selector switch and the line of the called subscriber.

Inasmuch as the manner in which a connection is extended from the calling subscriber's line to the incoming selector switch is not essential to an understanding of this invention, the circuits of the subscriber's line switch, district selector switch, and office sender have been disclosed only diagrammatically. For a full disclosure of these circuits and the manner in which they function reference may be had to Patent No. 1,395,977 issued to F. A. Stearn and F. J. Scudder, November 1, 1921.

The circuits of the incoming selector switch shown in Fig. 1 and the final selector switch shown in Fig. 2 are substantially of the same type as disclosed in the aforesaid patent being modified, however, for the purposes of this invention.

The manner in which this system is organized will be best presented in connection with the detailed description of its operation.

It will be assumed that the calling subscriber at station A desires to establish a connection with the line of subscriber B which line is located at a distant office of the exchange. To initiate the call the calling subscriber removes the receiver from the switchhook whereupon the individual line switch 100 functions in the well known manner to extend a connection from the calling line to terminals 101 and 102 of the district selector switch illustrated at 180. The calling subscriber then operates his impulse dial S in accordance with the designation of the desired line to set the registers (not shown) of the office sender 181. Following the setting of the registers the sender functions in the well known manner in accordance with the office code which has been set up on the code registers of the sender. In response to the operation of the sender the brushes 105 and 107 of the district selector switch are associated with an idle interoffice trunk extending to the particular office of the exchange in which the line of the desired subscriber terminates.

Upon the extension of the connection to an interoffice trunk, the sequence switch of the district selector advances into position 10 and a fundamental circuit is established extending between the office sender 181 and the incoming selector 182. This fundamental circuit includes the cable conductors of trunk 195 and may be traced from battery, through the winding of relay 153, right upper contact of cam 116, terminal 106, brush 105, right upper and left lower contacts of cam 103, winding of stepping relay 175, contact of sequence switch cam 177, normal contact of the 0′ counting relay, right upper and lower contacts of cam 104, brush 107, terminal 108, to ground through the lower contact of cam 110. The sender stepping relay 175 and relay 153 operate in the circuit traced. The sender stepping relay prepares a circuit in the well known manner for the operation of counting relays of the sender..

The operation of relay 153 initiates the operation of the incoming selector circuit 182. A circuit is established from the contact of relay 153 for energizing relay 154 which circuit may be traced from battery, through the winding of relay 154, lower left and upper right contacts of cam 134, contact of relay 153, lower contacts of cam 127, normal contact 2 of relay 155, to ground through the normal contact of relay 152. Relay 154 establishes a locking circuit for itself from ground, through its contact 2, lower contacts of cam 127, contact of relay 153, right upper and left lower contacts of cam 134 to battery through the winding of relay 154.

It will be noted that the operation of relay 154 establishes an obvious operating circuit for relay 155. However, after the operation of relay 154 and previous to the operation of relay 155, a ground pulse is transmitted to the sender for the initial release of the stepping relay 175. This circuit may be traced from ground, through the normal contact 1 of relay 155, contact 1 of relay 154, lower contacts of cam 109, terminal 106, brush 105, right upper and left lower contacts of cam 103 to the winding of the stepping relay 175. The ground thus associated with the fundamental circuit shunts the winding of stepping relay 175 to cause its release but maintains relay 153 operated. Upon the operation of relay 155 the shunt ground associated with the fundamental is opened causing the reoperation of the stepping relay 175. The release and reoperation of the stepping relay 175 causes the operation of a first set of counting relays in the sender and prepares a circuit for the operation of a second set of counting relays in the well known manner. The operation of relay 155 establishes an operating circuit for relay 128 which may be traced from ground, through resistance 178, contact 3 of relay 155, winding of relay 152, left lower contact of cam 115, left lower contact of cam 113 to battery through the left winding of relay 128. The current flow through the winding of polarized relay 152 is in the wrong direction to cause its operation. The operation of relay 128 establishes a locking circuit for itself from battery, through its left winding, right lower and upper contacts of cam 113, contact 2 of relay 128, left lower and upper contacts of cam 118, winding of relay 152, contact 3 of relay 155, resistance 178 to ground. The operation of relay 128 further establishes a circuit for moving the sequence switch from position 1 to position 2 which circuit may be traced from battery, through the winding of magnet 150, left upper contact of cam 135, contact 1 of relay 128, to ground at the left upper contact of cam 129.

When the sequence switch has reached position 2 a circuit is established for the up-drive magnet which may be traced from battery, through the winding of up-drive magnet 158, right lower and left upper contacts of cam 136, contact 1 of relay 128, to ground through the left upper contact of cam 129. The brushes 165, 166, 167 and 168 are thus driven upwardly bringing brush 166 into contact with commutator 171. When brush 166 touches commutator 171 a circuit is established for relay 152 which may be traced from ground, through brush 166 and commutator 171, right lower contact of cam 115, right upper contact of cam 113, contact 2 of relay 128, left lower and upper contacts of cam 118, winding of relay 152 to battery through resistance 179. The current flow in the cir-

cuit traced is in the direction to cause the operation of relay 152 which operation associates a shunt ground with the fundamental circuit to again cause the release of the sender stepping relay. This circuit may be traced from ground, through the contact of relay 152, contact 1 of relay 154, lower contacts of cam 109 and thence to the winding of stepping relay 175 as previously traced. A second set of counting relays is thus operated. The brush 166 continues in its upward movement until it is associated with an insulated portion of commutator 171 which opens the circuit for relay 152 causing its release. The release of relay 152 removes the shunt from stepping relay 175 permitting it to again operate over the fundamental circuit to battery through relay 153. Each conducting portion of commutator 171 associated with brush 166 causes the operation of relay 152 for establishing this shunt and each insulated portion at commutator 171 opens the operating circuit for relay 152. The brush 166 continues in its upward movement over the conducting and non-conducting segments of commutator 171 until the end set of counting relays of the sender are operated. The number of segments over which brush 166 passes depends upon the register setting in the sender which register setting controls the number of counting relays to be operated.

The operation of the 0′ counting relay opens the fundamental circuit and thus opens the energizing circuit for relay 153. If at this time relay 152 is operated, a secondary operating circuit remains established for relay 153 from the shunt ground associated with the fundamental circuit through the contact of relay 152. Relay 153 may, however, remain energized temporarily from energy stored in the cable conductors after the release of relay 152. The releasing moment of relay 153 is therefore indefinite within certain limits. Since the locking circuit for relay 128 is maintained through contact 3 of relay 155 the up-drive magnet is maintained energized and brush 166 continues in its upward movement. During the time that the brushes are moving upward over the next insulating segment of commutator 171 the release of relay 153 takes place which opens the locking circuit for relay 154 causing the release of the latter relay. Relay 155 remains locked over a circuit from battery through its winding and contact 2 to ground through the normal contact of relay 152 if relay 154 releases before the next operation of relay 152. When brush 166 reaches the next conducting segment of commutator 171 a circuit is again established for operating relay 152 as previously traced. The operation of relay 152 opens the locking circuit for relay 155 which releases. When brush 166 reaches an insulated portion of commutator 171 the circuit for relay 152 is opened which causes its release. The switch shaft carrying the brushes 165 to 168 and 169 to 171 has thus been advanced one terminal position after the fundamental circuit associated with the sender has been opened. This advance of the brush members was made independent of the action of relay 153 in the incoming selector and stepping relay 175 in the sender. The disconnection of the up-drive magnet from its energizing circuit is thus placed under the control of relays in the incoming selector which are not in any way connected with the cable. Relay 155 released quickly upon the last operation of relay 152. Relay 128 remains temporarily energized under the control of brush 166 which circuit may be traced from ground, through brush 166, a conducting segment of commutator 171, right lower contact of cam 115, right lower contact of cam 113, left winding of relay 128 to battery. When brush 166 reaches a non-conducting segment of commutator 171 this circuit is immediately opened to cause the release of relay 128. The release of relay 128 opens the circuit for the up-drive magnet which arrests the upward movement of the switch shaft and the switch brushes. The brushes are thus immediately brought to rest in the position in which they were located at the time that the circuit for relay 128 was opened.

The release of relay 128 also establishes a circuit for rotating the sequence switch from position 2 to position 3. This circuit may be traced through the sequence switch magnet 150, left lower contact of cam 135, normal contact 1 of relay 128, to ground through the left upper contact of cam 129. The operation of the O′ counting relay in the sender rotates the sender sequence switch one position to cause the release of the counting relays which again establishes a circuit for rotating the sequence switch into a position for controlling group selection in the incoming selector circuit. The fundamental circuit is again established for this selection as it was for brush selection.

In sequence switch positions 3 to 5 a circuit is established for energizing trip magnet 156 for associating a particular set of brushes with a particular group of terminals. This circuit may be traced from battery through the winding of magnet 156 to ground at the left upper contact of cam 129.

Relays 153 and 175 are operated as soon as this fundamental circuit is established. The fundamental circuit is identical with that previously traced for brush selection. The operation of relay 153 establishes an operating circuit for relay 154 as previously traced to ground at the normal contact of relay 152. Preceding the operation of relay 155 a ground shunt is associated with the fundamental circuit for initiating the operation of the first

pair of counting relays for which the sender is set for group selection. This ground shunt may be traced from contact 1 of relay 155, through contact 1 of relay 154, lower contacts of cam 109 where it is connected to the fundamental circuit for causing the release of stepping relay 175. The operation of relay 154 establishes an obvious circuit for the operation of relay 155 for opening the ground shunt circuit. A set of counting relays in the sender is thus operated. The operation of relay 155 further establishes a circuit for relay 128 which may be traced from ground, through resistance 178, contact 3 of relay 155, winding of relay 152, left lower contact of cam 115, right lower contact of cam 113 to battery through the left winding of relay 128. Relay 152 does not operate in the circuit traced since it is polarized and the flow of current is in the wrong direction for its operation. Relay 155 establishes a locking circuit through its contact 2 to ground through the normal contact of relay 152. Relay 154 establishes a locking circuit as previously traced through the contact of relay 153. Relay 128 establishes a locking circuit for itself which may be traced from battery, through its left winding, right lower and upper contacts of cam 113, contact 2 of relay 128, left lower and upper contacts of cam 118, winding of relay 152 to ground through contact 3 of relay 155 and resistance 178. The operation of relay 128 further establishes a circuit for rotating the sequence switch from position 3 to position 4. This circuit may be traced from battery through the winding of sequence switch magnet 150, left upper contact of cam 135, contact 1 of relay 128, to ground through the left upper contact of cam 129.

In sequence switch position 4 a circuit is established for the up-drive magnet 158 which may be traced from battery, through its winding, right lower and left upper contacts of cam 136, contact 1 of relay 128, to ground through the left upper contact of cam 129. The brushes 159 to 161 and 165 to 168 are thus driven upward for group selection. When brush 167 touches commutator 172 a circuit is established for the operation of relay 152. This circuit may be traced from ground, through brush 167, commutator 172, left upper contact of cam 115, right upper contact of cam 113, contact 2 of relay 128, left lower and upper contacts of cam 118, winding of relay 152, resistance 179 to battery. The current flow through the winding of relay 152 is in a direction to cause its operation which operation establishes a shunt circuit for the stepping relay 175. This circuit may be traced from ground through the contact of relay 152, contact 1 of relay 154, lower contacts of cam 109 shunting the fundamental circuit for eliminating the current flow from the winding of the stepping relay 175. The operation of a second set of counting relays in the sender is thus accomplished. Brush 167 continues in its upward movement and reaches an insulated segment of commutator 172. The circuit for relay 152 is thus opened which causes the release of this relay and the removal of the shunt ground from the fundamental circuit permitting the stepping relay 175 to again operate.

The number of counting relays to be operated is dependent upon the setting of the sender register for incoming group selection. The operation of counting relays thus continues upon each association of brush 167 with conducting and insulated segments of commutator 172 until the counting relay O′ operates to disestablish the fundamental circuit. Relay 153 is released upon the operation of the O′ counting relay and the release of relay 152 as previously described for brush selection. Upon the release of relay 153 the locking circuit for relay 154 is opened which causes the release of relay 154. Relay 155, however, remains locked in position to ground at the normal contact of relay 152.

Since relay 128 is locked through the contact of relay 155 the up-drive magnet 158 continues to be energized for moving the switch shaft and brushes upward during the release of relay 153. Relay 152 is again operated when brush 167 reaches the next conducting segment of commutator 172 thus opening the locking circuit for relay 155 to cause its release. The release of relay 155 opens the original holding circuit for relay 128. However, since relay 128 is maintained operated over a circuit to brush 167 it does not release until this brush reaches an insulated segment of commutator 172. This energizing circuit for relay 128 is in multiple with the operating circuit for relay 152 through the right lower contact of cam 113 and upper contact of cam 115. When brush 167 reaches this insulated segment of commutator 172, relays 128 and 152 are released. The release of relay 128 opens at its contact 1, the energizing circuit for the up-drive magnet. The switch shaft and brushes are thus arrested in their upward movement and the brushes 159 to 161 are associated with the first set of terminals of a particular group as controlled by the counting relays of the sender. The release of relay 128 establishes a circuit for rotating the sequence switch into position 5. A circuit may be traced from battery, through the winding of magnet 150, left lower contact of cam 135, normal contact 1 of relay 128, to ground through the left upper contact of cam 129. In sequence switch position 5 relay 128 is operated from battery, through its right winding, right lower contact of cam 123, to ground through the right upper and lower contacts of cam 140. A circuit is thus established to rotate the sequence switch from position 5 to position 6. This circuit may be traced from battery, through

the magnet winding 150, left upper contact of cam 135, contact 1 of relay 128, to ground through the left upper contact of cam 129.

It will be noted that the operating circuit for relay 128 is opened at the right upper contact of cam 140 as soon as the sequence switch leaves position 5. A test circuit is, however, established which maintains relay 128 operated if the first set of terminals in the group is busy. Assuming that terminal 162 is characterized by busy ground a circuit may be traced over brush 159, right upper and left lower contacts of cam 118, contact 2 of relay 128, right upper and lower contacts of cam 113, left winding of relay 128 to battery. If relay 128 is maintained operated a circuit is established for the up-drive magnet which may be traced from battery, through the winding of magnet 158, right lower and left upper contacts of cam 136, contact 1 of relay 128 to ground through the left upper contact of cam 129. Relay 128 is thus maintained energized and the up-drive magnet 158 is maintained energized until a terminal such as 162 is found that is not characterized by a busy ground which indicates that the final selector associated therewith is idle. When an idle terminal 162 is found relay 128 does not release until brushes 159 to 161 are centered directly opposite terminals 162 to 164. A circuit for relay 128 is maintained through its right winding, right upper contact of cam 123, conducting segments of commutator 170 to ground through brush 165. The brushes 159 to 161 are properly centered when brush 165 is engaged with an insulated segment of commutator 170. At this time the energizing circuit for relay 128 is opened to cause its release which opens the energizing circuit for up-drive magnet 158. Brushes 159 to 161 are thus caused to be associated with terminals 162 to 164 associated with an idle final selector circuit.

The release of relay 128 establishes a circuit for moving the sequence switch from position 6 to position 7. This circuit may be traced from battery, through the winding of magnet 150, left lower contact of cam 135, normal contact 1 of relay 128 to ground through the left upper contact of cam 129. In position 7 of the sequence switch a circuit is again established to operate relay 128 from battery, through its right winding, lower contact of cam 123, right upper and lower contacts of cam 140 to ground. The operation of relay 128 establishes a circuit for rotating the sequence switch from position 7 to position 8. The circuit may be traced from battery, through the winding of magnet 150, left upper contact of cam 135, contact 1 of relay 128 to ground through the left upper contact of cam 129. A locking circuit is established for relay 128 to the final selector circuit which may be traced from battery, through the left winding of relay 128, right lower and upper contacts of cam 113, contact 2 of relay 128, right lower and upper contacts of cam 120, brush 160, terminal 163, conductor 248, left upper and right lower contacts of cam 200, resistance 201 to ground through the left lower contact of cam 202.

The incoming selector is now in position 8 in which position circuits are established for the control of the final selector, Fig. 2, for selection of the line B. The sender 181 has advanced for the control of the final selector and reestablished the fundamental circuit. This fundamental circuit is extended only to the incoming selector and terminated at battery through the winding of relay 153 and ground at cam 110, the same as for the operation of the incoming selector switch. The control of the final selector is therefore accomplished over a separate circuit extending between the incoming selector and the final selector as follows. The relays 152, 153, 154 and 155 are used for controlling the final selector in the manner described for the control of the incoming selector. The operation of relay 153 establishes a circuit for relay 154 which may be traced from battery, through its winding, left lower and right upper contacts of cam 134, contact of relay 153, lower contacts of cam 127, normal contact 2 of relay 155 to ground through the normal contact of relay 152. The operation of relay 154 associates a shunt ground with the fundamental circuit, the same as previously described, for the first release of the sender stepping relay 175. Relay 155 is operated as before through the obvious circuit established by the operation of relay 154. The operation of relay 155 opens the circuit for associating the shunt ground with the fundamental circuit which causes the release of the stepping relay 175. The operation of the first set of counting relays for the final selector switch brush selection is accomplished in the same manner as it was for the incoming selector selections. Relay 154 is locked under the control of relay 153 and relay 155 is locked to the contact of relay 152 as previously traced for other selections. Upon the operation of relay 155 a circuit is established for the operation of relay 204 in the final selector. This circuit may be traced from ground, through resistance 178, contact 3 of relay 155, winding of relay 152, right lower and upper contacts of cam 114, brush 161, terminal 164, conductor 208, left lower contact of cam 207, left lower contact of cam 206, right winding of relay 204 to battery through cam 205. The operation of relay 204 establishes a circuit for relay 209 from battery, through the left winding of relay 209, left upper contact of cam 210, contact 1 of relay 204 to ground through the upper contact of cam 211. Relay 209 establishes a locking circuit for itself which may be traced from battery, through its left winding, normal con-

tact of relay 214, contact 1 of relay 209, conductor 215, terminal 162, brush 159 to ground through the right upper and lower contacts of cam 118. Sequence switch magnet 203 is now energized to rotate the sequence switch from position 1 to position 2. This energizing circuit may be traced from battery, through the winding of magnet 203, left lower and right upper contacts of cam 213 to ground through contact 2 of relay 209. In position 2 of the sequence switch a circuit is established for energizing the up-drive magnet 216 from battery, through its winding, lower contact of cam 217, contact 1 of relay 204 to ground through the upper contact of cam 211. The switch shaft is now driven upward in the well known manner carrying brushes 230, 231, 232, 220, 224 and 226 upwardly for brush selection. The brush 220 thus engages the first conducting segment of commutator 221 and a circuit is established to energize relay 152. This circuit may be traced from ground, through the left upper contact of cam 202, brush 220, commutator 221, right upper and lower left contacts of cam 207, conductor 208, terminal 164, brush 161, right upper and lower contacts of cam 114, winding of relay 152, resistance 179 to battery. The current flow in the circuit traced is in the proper direction to energize relay 152. A shunt ground is thus associated with the fundamental circuit which may be traced from ground, through the contact of relay 152, contact 1 of relay 154, lower contacts of cam 109 to one leg of the fundamental circuit. The stepping relay 175 is thus released to cause the operation of the second set of counting relays. Let it be assumed that the second brush is desired in the final selector switch and that the second set of counting relays operated included the O′ counting relay. The fundamental circuit is thus opened which opens the original energizing circuit for relay 153. When brush 220 reaches an insulated segment the circuit for relay 152 is opened to cause its release which removes the shunt ground holding relay 153. The up-drive magnet 216 in the final selector continues to be energized in order that the second conducting portion of commutator 221 may be reached for tripping the second brush. When brush 220 reaches the second conducting segment of commutator 221, relay 152 is again operated. Since the fundamental circuit has been opened the shunt ground which may be placed thereon by the operation of relay 152 is not effective. The last operation of relay 152 is only to open the locking circuit for relay 155. Sufficient time elapses between the opening of the energizing circuit for relay 153 and the subsequent operation and release of relay 152 for the release of relays 153 and 154 regardless of the capacity which may be present in a long cable. Relay 152 is released when brush 220 reaches the second insulated segment of commutator 221. Previous to this relay 155 will have released. The release of relay 155 opens the energizing circuit for relay 204 which causes the release of the latter relay opening the circuit for the up-drive magnet and arresting the upward movement of the switch shaft. A circuit for advancing the final selector sequence switch from position 2 to position 3 is now established from battery, through the winding of magnet 203, left upper contact of cam 224, normal contact 1 of relay 204, to ground through the upper contact of cam 211.

The opening of the fundamental circuit by the O′ counting relay advances the sender sequence switch into position for final group or tens selection which reestablishes the fundamental circuit. Relay 153 is again operated which operates relay 154 for transmitting the first shunt pulse to the sender which operates the first set of counting relays for final tens selection. Relay 155 is again operated for establishing a circuit through the winding of relay 152 and right winding of relay 204 which reoperates relay 204. A circuit for sequence switch magnet 203 is thus established for moving the sequence switch from position 3 to position 4. This circuit may be traced from battery, through the winding of magnet 203, lower contact of cam 224, contact 1 of relay 204 to ground through the upper contact of cam 211. In position 4 of the sequence switch the up-drive magnet 216 is again energized from battery, through its winding, lower contact of cam 217, contact 1 of relay 204, to ground through the upper contact of cam 211. The final selector switch is controlled for tens selection in the manner previously described for its group selection movement. Inasmuch as the functions of a final selector switch are well known its operation will not be described in detail herein.

Following the group selection or tens selection movement of the final selector the sequence switch magnet 203 is energized in the well known manner to rotate the sequence switch cams into position 6 in which position the final units selection movement of the switch shaft is controlled. This operation of the final selector switch and the subsequent functioning of the switch for testing the called line proceeds in the well known manner and is controlled by the operation of the relays in the incoming selector 182 as described for final brush selection.

Following the units selection, the final selector sequence switch is advanced beyond position 8 whereupon the previously traced holding circuit for relay 128 is opened at the contact of cams 200 and 202. The release of relay 128 establishes a circuit for advancing the incoming selector sequence switch out of position 8. This circuit may be traced from battery, through the winding of magnet 150, left lower contact of cam 135, normal contact

1 of relay 128 to ground through the left upper contact of cam 129.

In position 9 relay 153 is again connected to the sender over the opposite conductor of the trunk to which it was formerly connected in order to reverse the direction of current flow in the sender circuit. This circuit may be traced from battery, through the winding of relay 153, left upper contact of cam 116, terminal 108, brush 107, right lower and upper contacts of cam 104, contact of the 0′ counting relay, contact of cam 177, winding of stepping relay 175 and the overflow relay (not shown), left lower and right upper contacts of cam 103, brush 105, terminal 106 to ground through the left lower contact of cam 117. The sender is thus operated to advance its apparatus for controlling the district and incoming selector as fully set forth in the aforementioned Patent No. 1,395,977 to F. A. Stearn and F. J. Scudder. The operation of relay 153 establishes a circuit for operating relay 128 which may be traced from battery, through the left winding of relay 128, lower contacts of cam 113, contact of relay 153 to ground through the right upper contact of cam 130. The operation of relay 128 establishes a circuit for the sequence switch magnet to rotate the sequence switch into position 11. This circuit may be traced from battery, through the winding of magnet 150, left upper contact of cam 135, contact 1 of relay 128 to ground through the left upper contact of cam 129. When the sequence switch advances out of position 10 the circuit for relay 153 is opened at cam 116 which causes its release. The release of relay 153 opens the energizing circuit for relay 128 which causes the release of the latter relay for arresting the movement of the sequence switch in position 11.

In sequence switch position 11 trunk closure is established by the operation of the district selector switch 180 in response to the movement of apparatus in the sender in the manner set forth in the foregoing patent 1,395,977. A circuit is thus established for operating relay 125 from battery, through the right winding of this relay, upper contact of cam 133, winding A of coil 112, right upper and left lower contact of cam 109, terminal 106, brush 105, right upper contact of cam 103 and through a contact in the district (not shown), right lower contact of cam 104, brush 107, terminal 108, upper contact of cam 110, winding C of coil 112, left upper contact of cam 121, left winding of relay 125 to ground. The operation of relay 125 establishes an obvious circuit for the operation of relay 124. The latter relay establishes a locking circuit for itself through its contact 2 to ground through the right lower contact of cam 129 and also establishes a circuit for the operation of relay 128. This circuit may be traced from ground through contact 1 of relay 124, lower contact of cam 123, right winding of relay 128 to battery. The operation of relay 128 advances the sequence switch to position 12. The circuit for advancing the sequence switch may be traced from battery, through the magnet winding 150, left upper contact of cam 135, contact 1 of relay 128 to ground through the left upper contact of cam 129.

The incoming selector circuit 182 is arranged for four-party semi-selective ringing. A series of interrupters are shown in the lower left part of Fig. 1 for associating the interrupted ringing current with the stations of the different parties. Two of the subscriber's stations are actuated from a current source connected through an interrupter with a single ringing segment. These stations are known as the one ring parties. The alternate subscribers' stations are actuated from a current source connected through an interrupter having two ringing segments. These stations are known as the two ring parties. The final selector switches, Fig. 2, are divided into groups for association with different party lines. The 0 and 2 groups are associated with subscribers' stations requiring only one ring. Groups 1 and 3 are associated with subscribers' stations requiring two rings. Commutator 173 is accordingly arranged to connect the proper ringing interrupter to the station requiring two rings.

If the final selector switch associated with the incombing selector is in group 0 or 2, relay 128 is released in sequence switch position 12. A circuit is thus established to operate the pick-up relay 132 from battery, through its winding and contact 1, upper contacts of sequence switch cam 127, normal contact 1 of relay 128 to ground through the left upper and right lower contacts of cam 140. Relay 132 establishes a locking circuit for itself through its winding and contact 1, resistance 185, normal contact of relay 131 to ground through the lower contacts of cam 140. The operation of relay 132 further establishes a circuit for rotating the sequence switch to position 13. This circuit may be traced from battery, through the winding of magnet 150, lower contacts of cam 139, contact 3 of relay 132, left lower and right upper contacts of cam 126 to ground. In position 13 ringing current source 186 is connected through interrupters 143 and 142 to brush 187, thence through the left lower contact of cam 137, winding of relay 131, contact 2 of relay 132, left lower and right upper contacts of cam 120, brush 160, terminal 163 and thence over the final selector talking conductors and the ringing magnet of station B returning by the alternate conductor of the final selector to terminal 164, brush 161 to ground through the right upper and left lower contacts of cam 114. The ringing current is intermittently applied to the sub-

scriber's station B by the constant rotation of interrupter 142, one portion of which is connected to the alternating current source 186 and the other portion being connected to silent period battery. When the subscriber at station B removes the receiver from the switchhook a low impedance circuit is established for the operation of tripping relay 131. This occurs either when brush 187 is connected to the ringing source or to the silent period battery. The operation of relay 131 opens the holding circuit for relay 132 which releases to open the circuit established for connecting the ringing current source to the subscriber's station.

Let it now be assumed that the incoming selector sequence switch is standing in position 12 and that a final selector switch in group 1 has been selected. It will be remembered that relay 128 was operated in position 11 and that the operation of this relay advanced the sequence switch into position 12. A locking circuit is now established for relay 128 from ground, through brush 168, commutator 173 in group 1, upper contacts of cam 113, contact 2 of relay 128, left upper contact of cam 123, right winding of relay 128 to battery. This relay will remain locked until the sequence switch passes out of position 13. With relay 128 operated a circuit is established for the pick-up relay 132 which may be traced from battery, through its winding and contact 1, upper contacts of cam 127, contact 1 of relay 128, left upper and lower contacts of cam 136, pick-up lamp 149, brush 188, pick-up segment 190 of commutator 147 to ground through commutator 148. The pick-up segment 190 is so arranged with respect to ringing current segments 191 and 192 that the ringing current is connected to the subscriber's station at a point on commutator 145 which will insure the proper sequence of rings at station B. The operation of relay 132 establishes a circuit for rotating the sequence switch from position 12 to position 13 which may be traced from battery, through the winding of magnet 150, lower contacts of cam 139, contact 3 of relay 132 to ground through the left lower and right upper contacts of cam 126. This circuit is opened in position 12 at cam 139 and a circuit is established at cam 129 to rotate the sequence switch into position 14. This circuit may be traced from battery, through the winding of magnet 150, left upper contact of cam 135, contact 1 of relay 128 to ground through the left upper contact of cam 129. In sequence switch position 14 the ringing current source 186 is connected through commutators 144 and 145, brush 186, right lower contact of cam 137, winding of relay 131, thence through the subscriber's station B, returning to ground at cam 114 as previously traced. The constantly rotating commutator 145 connects segments 191 and 193 in sequence to the subscriber's station B thus intermittently sounding two rings at the subscriber's station. The remaining segments of interrupter 145 are connected to silent period battery. When the receiver is removed from the switchhook at subscriber's station B relay 131 operates to release the pick-up relay 132 as previously described. The release of relay 132 establishes a circuit for rotating the sequence switch from position 14 to position 15. This circuit may be traced from battery, through the winding of magnet 150, right upper and lower contacts of cam 139, normal contact 3 of relay 132, through the left lower and right upper contacts of cam 126. In sequence switch position 15 relay 128 is again operated from battery, through its right winding, lower contact of cam 123 to ground through contact 1 of relay 124. The operation of relay 128 establishes a circuit for rotating the sequence switch from position 15 to talking position 16. This circuit may be traced from battery, through the magnet winding 150, left upper contact of cam 135, contact 1 of relay 128 to ground through the left upper contact of cam 129. The subscribers at stations A and B are now connected together for telephone conversation.

Following the termination of the conversation between the calling and the called subscribers the subscribers restore their receivers to the switchhooks whereupon in response to the restoration of the calling party's hook, the line switch 100 and district selector switch 180 become restored in the well known manner. Upon the restoration of switch 180 the circuit of relay 125 is opened which releases and opens the circuit of relay 124. Relay 124 upon deenergizing opens the circuit for relay 128 causing the release of the latter relay. The release of relay 128 establishes a circuit to rotate the sequence switch from position 16 to position 18. This circuit may be traced from battery, through the winding of magnet 150, left lower contact of cam 135, normal contact 1 of relay 128 to ground through the left upper contact of cam 129. In sequence switch position 18 the down drive magnet 157 is energized from battery, through its winding to ground through the left upper contact of cam 130. The switch shaft is thus driven downward until brush 165 engages commutator segment 169 which establishes a circuit for rotating the sequence switch from position 18 to position 1. This circuit may be traced from ground, through brush 165, commutator 169, right lower contact of cam 135, winding of magnet 150 to battery.

At the time that the incoming selector sequence switch rotated from position 17 to 18 the circuit for maintaining relay 209 energized is opened at the contact of cam 118. The release of relay 209 establishes circuits for restoring the final selector switch to normal in the well known manner and also es-

tablishes a circuit through its contact 1 for maintaining terminal 162 busy to other selectors until the switch has restored to its normal position.

What is claimed is:

1. In a switch controlling system, an impulse controlled switch, means for absorbing the first controlling impulse, and means for adding the effect of said impulse after the following impulses have ceased.

2. In a switch controlling system, an impulse controlled switch, an impulse circuit, an electromagnetic device in said switch operable over said circuit, and means including said electromagnetic device to nullify the effect of certain impulses in series of impulses and to subsequently add such effect.

3. In a switch controlling system, an impulse controlled switch, an impulsing circuit, means for transmitting a series of impulses over said circuit, an electromagnetic device operable over said impulsing circuit, means including said device for nullifying the effect of an impulse, means for opening said circuit to permit the release of said device and means for adding the effect of said nullified impulse for continuing the movement of said switch subsequent to the opening of said circuit.

4. In a switch controlling system, an impulse controlled switch, an impulsing circuit, a device for controlling the number of impulses in series transmitted over said circuit, an electromagnetic device operable over said impulsing circuit for controlling said switch, means for operating said switch responsive to part of the impulses in a series transmitted over said impulsing circuit, means for opening said circuit to permit the release of said electromagnetic device, and means for subsequently positioning said switch in accordance with the setting of said impulse controlling device.

5. In a switch controlling system, an impulse controlled switch, an impulsing circuit, a device for controlling the number of impulses in series transmitted over said circuit for positioning said switch, means for operating said switch responsive to part of the impulses in a series transmitted over said circuit, means for opening said circuit and means operable subsequent to said opening for positioning said switch in accordance with the setting of said impulse controlling device.

6. In a switch controlling system, a switch, an impulse sender for directing the positioning of said switch, a circuit connecting said switch with said sender for the transmission of impulses, means to nullfy the effect of certain impulses transmitted over said circuit, means to open said circuit and means to subsequently add the effect of said nullified impulses for positioning said switch as directed by said sender.

7. In a switch controlling system, a switch, a sender for controlling the transmission of impulses for directing the positioning of said switch, a circuit extending from said sender to said switch, an electromagnetic device operable over said circuit for controlling the positioning of said switch, means including said device to cause said switch to be non-responsive to certain impulses and responsive to other impulses controlled by said sender, means to open said circuit for releasing said device, and means during the open period of said circuit for substituting impulses for positioning said switch as directed by said sender.

8. In a switch controlling system, a switch having a positionable brush member, means responsive to impulses for moving said brush member a number of positions, a device operable in progressive steps for controlling the arresting position of said brushes, means operable preceding the movement of said brush member to cause said device to operate for its first step, and means operable subsequent to the last step of said device for causing said brush member to move to the next position beyond that controlled by said device.

9. In a switch controlling system, a switch, a sender, a circuit selectable by apparatus associated with said sender extending over cable conductors to said switch, an electromagnetic device operable over said circuit under the control of said sender for controlling the movement of said switch, means including said device for nullifying the effect of an impulse transmitted under the control of said sender for positioning said switch, means in said sender operable subsequent to the nullification of said impulse for opening said circuit to release said device, and means in said switch operable subsequent to the opening of said circuit for making effective said nullified impulse.

10. In a switch controlling system in which the switch is operable over conductors extending through a long cable, a sender for controlling said switch, an electromagnetic device operable over said conductors for controlling the movement of said switch, means for nullifying the effect of the first impulse of a series, and means operable subsequent to the transmission of the last impulse of a series for permitting the release of said device during the final positioning of said switch responsive to the addition of the effect of said nullified impulse.

11. In a switch controlling system a train of impulse controlled switches, means for transmitting series of impulses for positioning said train of switches, means in one switch of said train to nullify the effect of an impulse in the series for positioning any switch of said train and means to subsequently add such effect.

12. In a switch controlling system a train

of impulse controlled switches, means for transmitting series of impulses for positioning said train of switches, means in one switch of said train to nullify the effect of the first impulse in each impulse series for positioning any switch of said train and means to subsequently add such effect for positioning said switches in accordance with the impulse series transmitted.

13. In a switch controlling system a train of impulse controlled switches, means for transmitting series of impulses for positioning said train of switches, means in one switch to reduce the number of effective impulses in a series for the particular operation of any switch in said train and means to subsequently restore the effect of the full number of impulses of the series for further operation of the particular switch then being controlled.

14. In a switch controlling system, a train of impulse controlled switches, means for transmitting series of impulses for positioning said train of switches, means in one switch to nullify the effect of an impulse transmitted to any switch in said train, means for causing said switch to respond to the remaining impulses of said series and to subsequently add the effect of the nullified impulse for positioning said switch in accordance with the series of impulses transmitted.

15. In a switch controlling system, means for producing impulses, a switch controllable by said impulses, means therein to nullify the effect of an impulse, and means to subsequently add such effect.

16. In a switch controlling system, means for producing a series of impulses, a switch controllable by said impulses, means therein to nullify the effect of the first impulse in said series, and means to add such effect at the end of said series.

17. In a switch controlling system, means for producing series of impulses, a switch controllable by said impulses, means therein to reduce the number of effective impulses in a series for a particular operation of said switch, and means to subsequently restore the effect of the full number of impulses of the series for further operation of said switch.

18. In a switch controlling system, means for producing impulses, a switch controllable by said impulses, means for absorbing the first controlling impulse, and means for adding the effect of said impulse after impulses succeeding the first have ceased.

In witness whereof, I hereunto subscribe my name this 6th day of August, 1928.

RAYMOND E. COLLIS.