

Sept. 27, 1932.

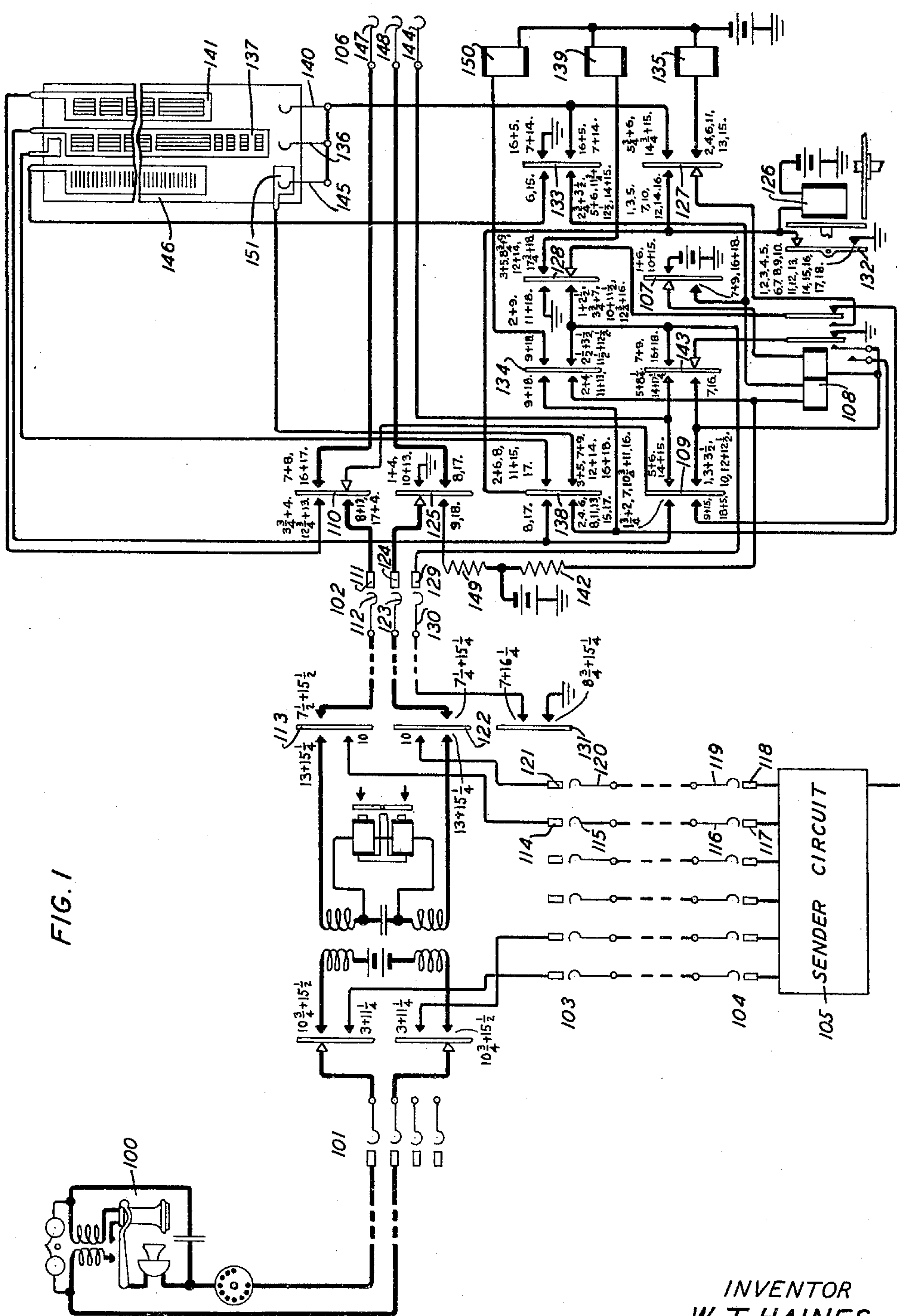
W. T. HAINES

1,879,741

TELEPHONE SYSTEM

Filed March 12, 1932

2 Sheets-Sheet 1



INVENTOR  
W. T. HAINES  
BY *ge 7016*

ATTORNEY



Sept. 27, 1932.

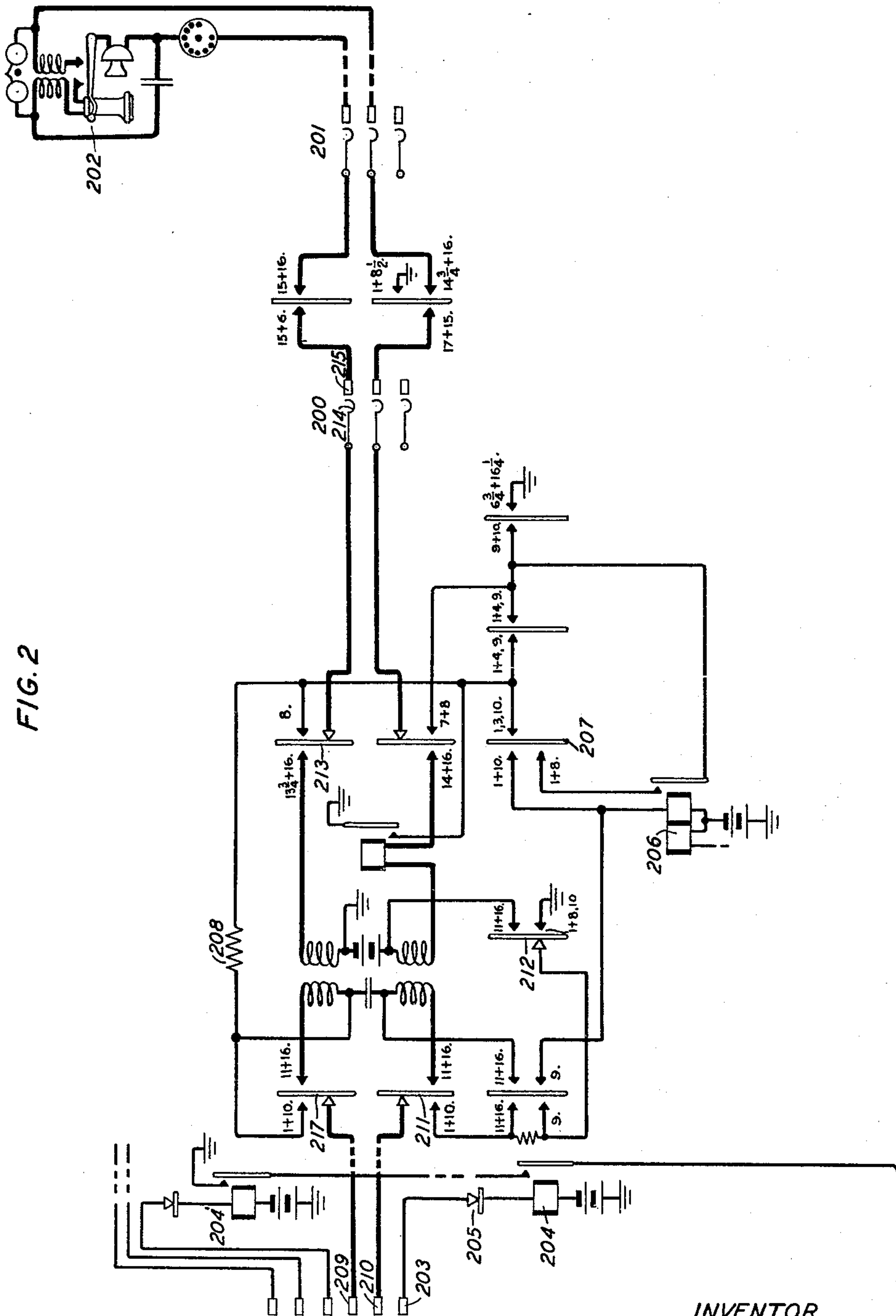
W. T. HAINES

1,879,741

TELEPHONE SYSTEM

Filed March 12, 1932

2 Sheets-Sheet 2



INVENTOR  
W. T. HAINES

BY

*John H. Haines*

ATTORNEY



## UNITED STATES PATENT OFFICE

WILLIAM T. HAINES, OF MOUNTAIN LAKES, NEW JERSEY, ASSIGNOR TO AMERICAN  
TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

## TELEPHONE SYSTEM

Application filed March 12, 1932. Serial No. 598,512.

This invention relates to telephone exchange systems and more particularly to systems of the character in which selector switches are employed for establishing connections.

In dial switching telephone exchange systems it is often desirable to provide each trunk of a group of trunks outgoing from a selector switch multiple-bank with a relay operable over the sleeve multiple. For example, it may be desirable to provide sleeve relays for the purpose of closing an all-trunks-busy circuit when all trunks of the outgoing group are busy. Such an all-trunks-busy circuit would be especially desirable for causing the automatic rerouting of a call through a tandem office to thereby obviate the necessity of requiring a calling subscriber to redial when all direct trunks to the desired office are busy.

The connection of a sleeve relay directly to the sleeve multiple of an outgoing trunk whereby the relay is operable directly over the sleeve multiple when the trunk is seized by a selector switch entails certain difficulties when a selector switch of a type is employed, which is provided with a test or control relay which releases to stop the hunting movement of the switch when an idle trunk is encountered. One well known type of switch such as is disclosed for example in Patent No. 1,601,058 granted September 28, 1926 to C. H. Berry is provided with a control relay which is operated over a local circuit to initiate trunk hunting and which is held operated over a holding winding and the test wiper of the switch so long as the test wiper encounters the test multiples of busy outgoing trunks. This relay controls the circuit of the clutch magnet which causes the switch wipers to be advanced in a trunk hunting movement. A busy trunk is marked by the connection of direct ground to the test or sleeve multiple appearing in the terminal bank of the switch and an idle trunk has its sleeve multiple on open circuit. When the terminals of a busy trunk are encountered the control relay is thus maintained operated over its holding winding but when the terminals of an idle trunk are encountered the

holding circuit is opened and as soon as the wipers are properly centered on the terminals of the idle trunk the control relay immediately releases to arrest the hunting movement of the switch.

It is necessary in this type of switch that the control relay be quick to release when an idle trunk is tested in order that the switch wipers shall not overrun and fail to stop on the terminals of a selected idle trunk. If, however, a sleeve relay should be added to an outgoing trunk, then, when the switch tests the multiple of such an outgoing trunk which is idle and therefore has no direct ground connected to its sleeve multiple, the holding circuit of the switch control relay would extend from battery through the holding winding of the control relay over the test wiper of the switch and trunk sleeve multiple through the winding of the trunk sleeve relay to battery, thus establishing a closed shunt circuit for the control relay. The control relay would release under this condition to arrest further hunting movement of the switch but this shunt circuit would tend to render the release of the control relay sluggish thereby causing overrun. It is, therefore, the object of the present invention to enable the use of a sleeve relay in an outgoing trunk without causing the establishment of a shunt of the holding winding of the control relay such as would cause the switch to overrun following the selection of the trunk when idle.

In accordance with the present invention this is accomplished by the interpolation of a rectifying device between the winding of the sleeve relay and the sleeve multiple terminal so poled that the shunting effect of the sleeve relay is removed when the trunk is idle but that after the trunk has been seized by the switch and direct ground is applied to the sleeve multiple of the trunk by the switch, current will flow through the winding of the sleeve relay to cause its operation. The rectifying device may be of any of the well known types which will allow current to flow therethrough in but one direction. As an example, a rectifier of the electrolytic, cop-



per oxide or vacuum tube type might be employed.

The manner in which the invention functions will be more clearly understood by reference to the following detailed description taken in connection with the accompanying drawings in which:

Figure 1 shows schematically a calling subscriber's line, a line finder, district selector switch, link circuit comprising a district trunk finder and sender selector, and sender and the complete circuit of an office selector; and

Fig. 2 shows schematically portions of the circuits of an incoming selector switch, a final selector switch and a called subscriber's line.

The line finder 101, district selector switch 102, and link circuit comprising district finder 103 and sender selector 104, and the sender indicated by the rectangle 105 of Fig. 1 may be of the type fully disclosed in the Patent No. 1,862,549, granted June 14, 1932 to A. Raymond and W. J. Scully. The incoming selector switch 200 and final selector switch 201 shown schematically in Fig. 2 may be of the type disclosed in detail in Patent No. 1,395,977, granted November 1, 1921, to F. A. Stearn and F. J. Scudder.

It will be assumed that the calling subscriber 100 desires to establish a connection with the line of subscriber 202 and to initiate the connection removes his receiver from the switchhook thereby causing the line finder 101 to select the terminals of the calling line and causing the connection of the line finder district selector trunk circuit with the sender 105 over the brushes of the trunk finder 103 and sender selector 104. Upon the association of the sender with the calling line, the calling subscriber receives the usual dial tone and then proceeds to dial the office and numerical designations of the called line 202. The digits dialed by the calling subscriber are then registered on the registers of the sender 105 and the sender then proceeds to set the district selector 102 and office selector 106 to extend the connection from the calling line to the trunk extending to the office in which the called line terminates in accordance with the office code registered in the sender. These operations are well known in the art and the detail circuits for accomplishing them being fully disclosed in the patent granted to Raymond and Scully above referred to, need not be described in detail herein except in connection with the operation of the office selector 106 which involves the features of the present invention.

When the district selector 102 has been positioned to seize an idle trunk terminating in the office selector 106, a fundamental control circuit is established from battery, upper contacts of cam 107, right winding of

control relay 108, lower right contact of cam 109, lower contacts of cam 110, terminal 111 and brush 112 of the district selector 102, right and lower left contacts of cam 113, terminal 114 and brush 115 of trunk finder 103, brush 116 and terminal 117 of sender selector 104, thence through the winding of the stepping relay (not shown) of sender 105, returning over terminal 118 and brush 119 of sender selector 104, brush 120 and terminal 121 of trunk finder 103, upper left and right contacts of cam 122, brush 123 and terminal 124 of district selector 102, to ground over the upper contacts of cam 125. Relay 108 operates and closes a circuit extending from battery through the winding of sequence switch magnet 126, left contacts of cam 127, outer front contact of relay 108, lower contacts of cam 128, sleeve terminal 129 and brush 130 of the district selector to ground at the contacts of cam 131 of the sequence switch of the district selector, for advancing sequence switch 126 into position 2 or 11 under the control of master cam 132. As the sequence switch enters either position 2 or 11 ground is connected directly to sleeve terminal 129 over the left contacts of cam 128, holding the office selector 106 busy to all other district selectors. This busy ground is effective in positions 2 to  $2\frac{1}{2}$  and  $3\frac{3}{4}$  to 7 or 11 to  $11\frac{1}{2}$  and  $12\frac{3}{4}$  to 16. In positions  $2\frac{1}{2}$  to  $3\frac{1}{2}$  or  $11\frac{1}{2}$  to  $12\frac{1}{2}$  the busy condition is produced by ground connected over the upper right and lower left contacts of cam 133, left winding of relay 108, lower contacts of cam 134 and thence to sleeve terminal 129. Relay 108 is now held operated from battery over the upper contacts of cam 107, right winding and inner contacts of relay 108, lower left contact of cam 109, lower contacts of cam 110, thence over the fundamental circuit to ground at the upper contacts of cam 125.

In position 2 or 11 the up drive magnet 135 is operated over the lower contacts of cam 127, outer front contact of relay 108, lower right and upper left contacts of cam 128 to ground for advancing the brush shaft of selector 106 in a brush selection movement. As the brush shaft moves upwardly a circuit is closed from ground over the right contacts of cam 133, brush 136, commutator segment 137, upper right contact of cam 109, lower contacts of cam 110, thence to the stepping relay of sender 105 for intermittently shunting the sender stepping relay until the sender is satisfied as to its office brush registration. Control relay 108 is held operated. When the sender is satisfied the fundamental circuit is opened thereat and as soon as the holding circuit of relay 108 extending from battery, upper contacts of cam 107, right winding and inner front contacts of relay 108, left contacts of cam 109, commutator segment 137, brush 136, to ground at the right



contacts of cam 133, is opened when brush 136 engages the next insulating portion of commutator segment 137, relay 108 releases opening the circuit of up drive magnet 135 and closing a circuit from battery, winding of magnet 126, lower left contact of cam 138, outer back contact of relay 108 to ground over the lower right and upper left contacts of cam 128 for causing the sequence switch to advance into position 3 or 12. When the sequence switch reaches position  $2\frac{1}{2}$  or  $11\frac{1}{2}$  the left winding of relay 108 is shunted from ground on the sleeve terminal 129, lower contacts of cam 134, left winding of relay 108, lower left and upper right contacts of cam 133.

When the sequence switch reaches position 3 or 12 the fundamental circuit is again closed through the right winding of relay 108 and relay 108 again operates closing the previously traced circuit for advancing the sequence switch into position 4 or 13 for group selection. With the sequence switch in position 4 or 13 relay 108 is locked to the fundamental circuit in the manner previously described and the circuit for the up drive magnet 135 is again closed. In positions 3 to 5 or 12 to 14 the trip magnet 139 is also operated over a circuit extending from battery, winding of magnet 139, to ground over the upper contacts of cam 128. As the brush shaft advances under the control of magnet 135 in its group selection movement, with trip magnet 139 operated the previously selected brush set is tripped during the initial portion of this movement and shunting impulses are transmitted over the fundamental circuit for intermittently shunting down the sender stepping relay. These impulses are applied from ground over the right contacts of cam 133, brush 140, commutator segment 141 and the left contacts of cam 110. Control relay 108, however, remains operated. When sufficient shunting impulses have been transmitted to satisfy the office group registration set up in the sender, the fundamental circuit is opened at the sender, and as soon as the holding circuit of relay 108 extending from battery, upper contacts of cam 107, right winding and inner front contacts of relay 108, lower left contact of cam 109, lower right and upper left contacts of cam 110, segment 141, brush 140 to ground at the right contacts of cam 133, is opened when brush 140 engages the next insulating portion of segment 141, relay 108 releases to open the circuit of up drive magnet 135 and to close the previously traced circuit for advancing the sequence switch into position 5 or 14.

With the sequence switch in position 5 or 14 a circuit is closed from ground over the upper right and lower left contacts of cam 133, left winding of relay 108 to battery through resistance 142 for operating relay 108. With relay 108 operated a circuit is es-

tablished from battery through the winding of magnet 126, left contacts of cam 127, outer front contact of relay 108, lower right and upper left contacts of cam 128, for advancing the sequence switch into position 6 or 15. When the sequence switch reaches position 6 or 15 if the first trunk of the group selected by the selector 106 is busy, relay 108 is held operated in a circuit extending from battery, over the upper contacts of cam 107, right winding and inner front contacts of relay 108, lower right and upper left contacts of cam 143, test brush 144, to ground on the test multiple of the busy trunk. As long as relay 108 is held operated by this busy condition, the circuit of up drive magnet 135 is established from battery through the winding of magnet 135, lower contacts of cam 127, outer front contact of relay 108, to ground over the lower right and upper left contacts of cam 128 and magnet 135 advances the brush shaft in a trunk hunting movement.

When an idle trunk circuit is found, for example the trunk circuit of Fig. 2, upon the sleeve terminal 203 of which no direct ground potential is connected by ground connected to the multiples thereof over the test brush 144, upper contacts of cam 143 to ground over the sleeve terminal 129 of another office selector, the self-inductance of the right winding of relay 108 will tend to cause current to flow battery through this winding over the path traced to brush 144 thence over terminal 203 towards battery through the winding of sleeve relay 204 of the incoming trunk circuit, but this tendency is nullified by the rectifying device 205 which is interposed between terminal 203 at the winding of relay 204, since the rectifying device 205 is so poled as to oppose the flow of current in this direction. Until the selector brushes are centered on the terminals of the selected idle trunk, relay 108 is held energized over a circuit extending from ground, upper left and lower right contacts of cam 128, the outer front contact of relay 108, the lower left and upper right contacts of cam 127, brush 145, commutator segment 146, the left contacts of cam 133, left winding of relay 108 to battery through resistance 142. When the brushes become centered and brush 145 engages an insulating portion of segment 146, relay 108 releases quickly opening the circuit of up drive magnet 135 and closing the previously traced circuit for advancing the sequence switch into position 7 or 16. It is to be noted that when the holding circuit through the left winding of relay 108 is opened at the time brush 145 engages the insulating portion of segment 146, the breaking of this circuit will tend to produce a potential by induction in the circuit through the right winding of relay 108 extending over brush 144, terminal 203 toward battery, through



the winding of sleeve relay 204, but due to the interposed rectifying device 205 which is so poled as to oppose this current flow, the effect of this induced potential is nullified.

5 Consequently, relay 108 releases quickly when the initial operating and the holding circuits of relay 108 are opened.

Until the sequence switch reaches position 7 or 16, ground is applied over the inner back  
10 contact of relay 108, lower right and upper left contacts of cam 143, brush 144, terminal 203, through the rectifying device 205 to battery through the winding of relay 204. The rectifier is so poled as to allow current to flow  
15 and relay 204 operates. The ground applied to the multiples of terminal 203 also marks the multiples as busy to other office selectors. When the sequence switch reaches position 7 or 16 ground is applied over the left contacts  
20 of cam 128 and the upper contacts of cam 143 to brush 144 and thence to battery through the winding of relay 204. A circuit is also reestablished for relay 108 extending from  
25 battery through resistance 142, left winding of relay 108, left contacts of cam 107, right winding of relay 108, lower left and upper right contacts of cam 143, left contacts of cam 128 to ground. Relay 108 operates and  
30 locks from battery through resistance 142, left winding of relay 108, left contacts of cam 107, right winding of relay 108, inner front contacts of relay 108, right contacts of cam 143 to ground at the left contacts of cam 128 and closes the previously traced cir-  
35 cuit for advancing the sequence switch into position 8 or 17. With the sequence switch in positions 8 to 9 or 17 to 18 relay 108 is maintained locked to ground at the district selector over brush 130, terminal 129, right  
40 contacts of cam 143, inner front contacts and right winding of relay 108, left contacts of cam 107, left winding of relay 108 to battery through resistance 142.

In position 8 or 17, the fundamental cir-  
45 cuit is extended from battery, right winding of control relay 206 of the incoming selector 200, upper contacts of cam 207, resistance 208, left contacts of cam 217, terminal 209, brush 147, upper right and lower left con-  
50 tacts of cam 110 thence to the sender 105 through the winding of the stepping relay thereof, returning over the upper left and lower right contacts of cam 125, brush 148, terminal 210, left contacts of cam 211 to  
55 ground over the lower contacts of cam 212. In the well known manner, sender 105 operates to control the incoming selector in its brush and group selection movements. The selector 200 then hunts for an idle final se-  
60 lector in the selected brush group advancing its sequence switch into the selection beyond position 8, in which position the tip conductor of the fundamental circuit is extended through resistance 208, the right con-  
65 tacts of cam 213, brush 214 and terminal 215

through the control relay (not shown) of the final selector 201. The sender then functions to set the final selector 201 in its brush, tens and units selection movements.

The manner in which the incoming and  
70 final selectors function to select the desired line 202 under the control of sender 105, to apply ringing current thereto and to finally cut through the talking circuit is fully set forth in Patent No. 1,359,977 hereinbefore  
75 referred to and a discussion thereof is not necessary to the understanding of the present invention.

When the sleeve relay 204 operates follow-  
80 ing the seizure of the outgoing end of the incoming selector trunk it may, as indicated, in cooperating with other sleeve relays 204' etc. of other trunks of the same group, close an all-trunks busy circuit when all trunks of the group are busy. This all-trunks busy cir-  
85 cuit may be employed for various purposes as, for example, to give the sender 105 a signal that the sender should reroute the connection over a trunk of another group extend-  
90 ing through a tandem point to reach the office in which the desired line terminates. This procedure would thereby obviate the necessity of requiring a calling subscriber to redial when all direct trunks to the desired of-  
95 fice are busy.

When the office selector 106 finds all of the  
100 trunks of a selected group busy at which time sequence switch 126 is in position 6 or 15, the selector shaft will advance the brushes to the top of the group where they will rest on the overflow terminals. As there is no ground on the sleeve of the overflow terminals relay 108  
105 will release and cause the sequence switch to advance to position 7 or 16. In this position relay 108 again operates in a circuit from battery through resistance 142, left winding of relay 108, left contacts of cam 107, right  
110 winding of relay 108, lower left and upper right contacts of cam 143, to ground at the left contacts of cam 128, locks in the circuit just traced through its windings in series, its inner front contacts, right contacts of cam 143, to ground at the district selector and  
115 closes the previously traced circuit for advancing the sequence switch into position 8 or 17. In position 8 or 17 a circuit is closed from ground over the right contacts of cam 133, brush 136, commutator segment 137, up-  
120 per left contact of cam 138 to battery through magnet 126 for advancing the sequence switch into position 9 or 18. When the sequence switch reaches position 9 or 18, battery through resistance 149 is connected over the left contacts of cam 125, the ring  
125 fundamental conductor, thence through the stepping relay and overflow relay of the sender 105, returning over the lower contacts of cam 110, lower left contact of cam 109, inner front contacts of relay 108, right con-  
130 tacts of cam 143, sleeve terminal 129, thence



to ground in the district selector. This circuit advances the sender and district selector to the overflow position district selector to become released in turn releasing the office selector 106. The sender having received the all-trunk-busy signal over the traced circuit closed by the trunk sleeve relays, such as 204, 204' etc., may then proceed to reroute the connection.

10 The manner in which the office selector is restored following the release of district selector 102 when the calling subscriber hangs up upon the termination of conversation or when the district selector advances to the overflow position, is as follows: When the  
15 district selector at cam 131 removes ground at cam 131 from the sleeve terminal 129, relay 108 releases and if sequence switch 126 has not advanced into position 9 or 18 due to an  
20 overflow condition a circuit is established from battery through the winding of magnet 126, lower left contact of cam 138, outer back contact of relay 108, lower right and upper left contacts of cam 128 to ground.  
25 With relay 108 released and the sequence switch in position 9 or 18, the circuit of down drive magnet 150 is established over the upper contacts of cam 134, outer back contact of relay 108 to ground at cam 128 and magnet  
30 150 operates to drive the brush shaft into normal position. When the brush shaft reaches normal position, a circuit is closed from ground over the right contacts of cam 133, brush 145, normal commutator segment  
35 151, lower right contact of cam 138, to battery through the winding of sequence switch magnet 126, thus advancing the sequence switch into normal position 1 or 10. The sequence upon reaching normal position opens the circuit of down drive magnet 150. Following  
40 the restoration of the office selector 106, the incoming selector 200 and final selector 201 are returned to normal in the well known manner.

45 What is claimed is:

1. In a telephone exchange system, a plurality of trunk circuits, a selector switch for extending a connection to any one of said trunk circuits, a test brush for said switch,  
50 means for advancing said test brush to test for idle trunk circuits, a sleeve relay for each trunk circuit, and a current rectifying device for connecting said relay to the test multiple of its trunk circuit.

55 2. In a telephone exchange system, a plurality of trunk circuits, a selector switch for extending a connection to any one of said trunk circuits, a test brush for said switch, means for advancing said test brush to test  
60 for idle trunk circuits, a sleeve relay for each trunk circuit having one terminal of its winding connected to battery, a current rectifying device for connecting the other terminal of said relay to the test multiple of said trunk circuit, and means in said switch for con-

necting ground over said brush to said test multiple, said rectifying device being poled to prevent current from said battery from flowing over said test multiple and brush but to allow current to flow from ground in said switch to said relay to operate said relay. 70

3. In a telephone exchange system, a plurality of trunk circuits, selector switches for extending a connection to any one of said trunk circuits, means in a selector switch  
75 which has made connection with one of said trunk circuits for applying busy ground potential to the test multiples thereof, a control relay and a test brush for each of said switches, means controlled by the relay of  
80 a switch for advancing the test brush to hunt for an idle trunk circuit, a sleeve relay for each trunk circuit having one terminal of its winding connected to battery, a current rectifying device for connecting the other terminal  
85 of said sleeve relay to test multiples of said trunk circuit, and a locking circuit for said control relay maintained as long as said test brush encounters grounded test multiples of busy trunk circuits, said rectifying  
90 device being poled to prevent current from said battery from flowing over said test multiples and brush through the locking circuit of said control relay but to allow current to flow from ground in said switch through said  
95 sleeve relay to operate said sleeve relay as soon as said hunting switch has selected said idle trunk circuit.

4. In a telephone exchange system, a plurality of trunk circuits, selector switches for  
100 extending a connection to any one of said trunk circuits, means in a selector switch which has made connection with one of said trunk circuits for applying busy ground potential to the test multiples thereof, a control  
105 relay and a test brush for each of said switches, means controlled by the relay of a switch for advancing its test brush to hunt for an idle trunk circuit, a sleeve relay for each trunk circuit having one terminal of its  
110 winding connected to battery, a current rectifying device for connecting the other terminal of said sleeve relay to the test multiples of said trunk circuit, and a locking circuit for said control relay maintained as  
115 long as said test brush encounters grounded test multiples of busy trunk circuits, said rectifying device being poled to prevent current from said battery from flowing over said test multiples and brush through the locking  
120 circuit of said control relay due to the self-inductance of said control relay when said test brush engages the multiples of an idle trunk circuit but to allow current to flow from ground in said switch through said sleeve  
125 relay to operate said sleeve relay as soon as said hunting switch has selected said idle trunk circuit.

5. In a telephone exchange system, a plurality of trunk circuits, selector switches for 130



extending a connection to any one of said trunk circuits, means in a selector switch which has made connection with one of said trunk circuits for applying busy ground potential to the test multiples thereof, a control relay and a test brush for each of said switches, means controlled by the relay of a switch for advancing its test brush to hunt for an idle trunk circuit, a locking circuit for said relay maintained as long as said test brush encounters grounded test multiples of busy trunk circuits, a sleeve relay for each trunk circuit having one terminal of its winding connected to battery, and means for nullifying the self-inductance of the locking circuit of said control relay when said locking circuit is opened at the time said test brush encounters the multiples of an idle trunk circuit to render said control relay quick to release, said means comprising a current rectifying device connected between the other terminal of the sleeve relay of the trunk circuit and the test multiples thereof which is so poled as to permit current to flow there- through only from ground applied to said test multiples from said switch.

6. In a telephone exchange system, a plurality of trunk circuits, selector switches for extending a connection to any one of said trunk circuits, means in a selector switch which has made connection with one of said trunk circuits for applying busy ground potential to the test multiples thereof, a control relay having two windings, a test brush and a control commutator for each of said switches, means controlled by the relay of a switch for advancing the test brush to hunt for an idle trunk circuit, a first locking circuit for said relay maintained through a first winding thereof as long as said test brush encounters grounded test multiples of busy trunk circuits, a second locking circuit maintained through a second winding of said relay under the control of said commutator until said test brush is fully centered upon the test multiple of said selected idle trunk circuit, a sleeve relay for each trunk circuit having one terminal of its winding connected to battery, and means for nullifying the effect of potential induced from said second winding of said control relay to the first winding thereof when said test brush is properly centered to render said control relay quick to release when said locking circuits are both opened, said means comprising a current rectifying device connected between the other terminal of the sleeve relay of the trunk circuit and the test multiples thereof which is so poled as to permit current to flow therethrough only from ground applied to said test multiples from said switch.

In testimony whereof, I have signed my name to this specification this 11th day of March, 1932.

WILLIAM T. HAINES.