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H. M. BASCOM

CONNECTER SWITCH CIRCUIT

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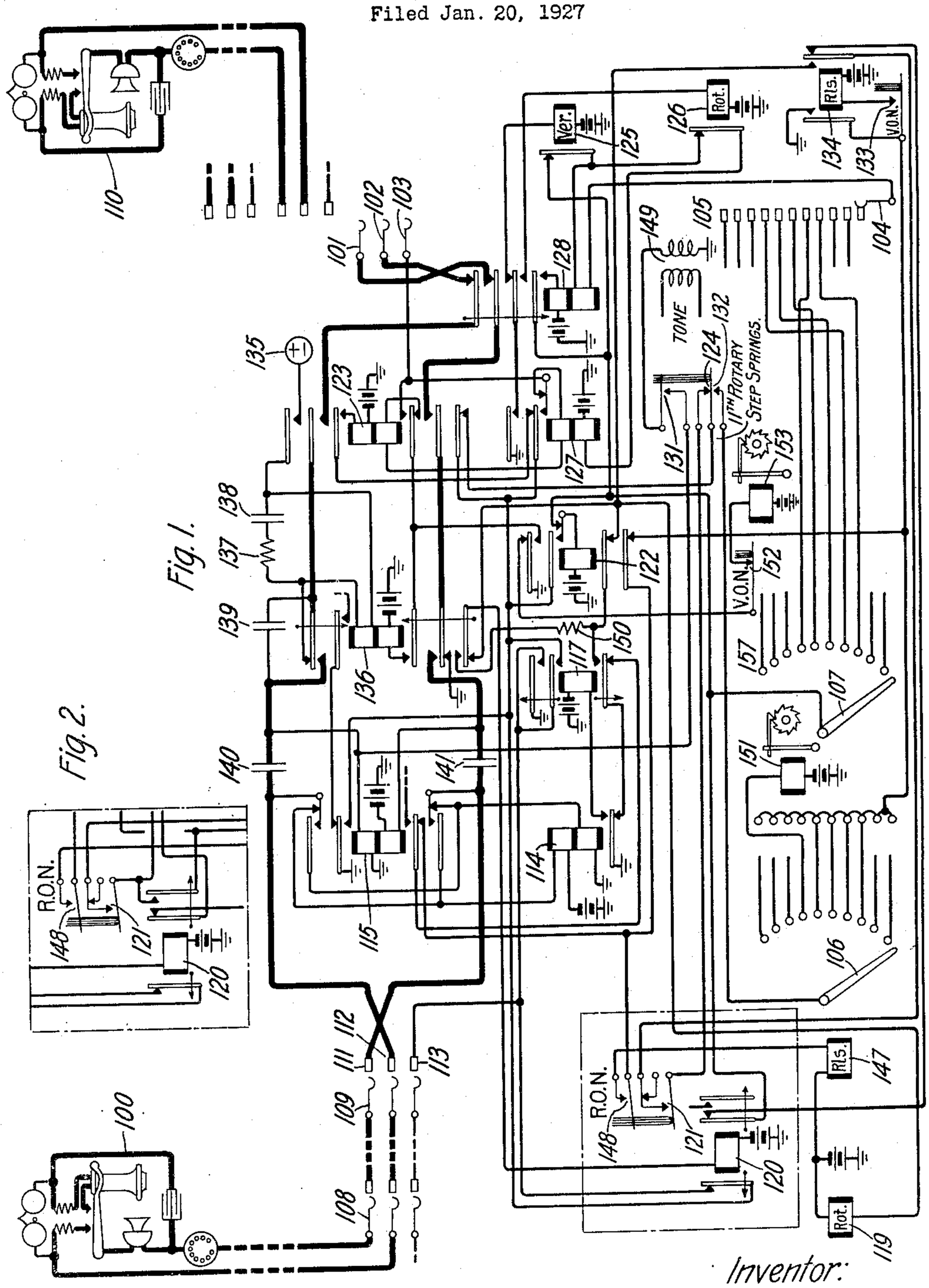

Fig. 1.

Fig. 2.

Inventor:
Henry M. Bascom.
by
Attorney.

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HENRY M. BASCOM, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

CONNECTER-SWITCH CIRCUIT.

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This invention relates to telephone exchange systems employing automatic switches and has for its object the provision of an improved arrangement for selecting one of a plurality of lines serving a private branch exchange.

In accordance with the present invention the lines leading to a private branch exchange are arranged in groups and means is provided for marking the group which is first to be tested by a particular selector switch for the purpose of finding an idle trunk. If all the trunks of the group prove to be busy, the selector is restored to normal and is then made to select another group and to test the trunks in that group.

In the present disclosure the invention is applied to a switch of the two-motion type such as is employed in the step-by-step machine switching system but need not be restricted to such a system. An auxiliary switch or register is provided which responds to dial impulses to mark a level of the main switch. The main switch is then operated to select the marked level and is rotated to test for an idle trunk in the level. If all trunks of the group are busy the switch is restored to normal. The auxiliary switch advances one step to mark another level which the switch will then select and test.

According to this arrangement a number of groups of trunks may be assigned to serve a particular branch exchange. The cross connections to the auxiliary switch permit the different connecter switches to hunt over the groups in different orders so that the wear on the switches and the time necessary to find an idle trunk is reduced. It is also an improvement over the arrangements where a group is made busy by a series or chain circuit through the trunks of the group or through the connecters used in making the trunks busy. In the latter case two switches may both find a group in which only a single trunk is idle and the finding of that trunk by one switch will make the other give an "all trunks busy" signal while there might still be idle trunks in other groups. In the system of the present invention this would merely cause the selector to complete its rotary operation, restore and select another group for test.

The invention will be more clearly understood from a consideration of the following description in connection with the attached drawing in which Figure 1 shows a connecter switch embodying the invention and Fig. 2 shows a modification for use where only one branch exchange is served by the connecter.

The connecter switch indicated by brushes 101, 102 and 103 is of the type usually employed in step-by-step machine switching systems and has two motions, a vertical motion and a rotary motion. No attempt has been made to show the terminal bank since it is well-known in the art. The connecter has in addition to the brushes 101, 102 and 103 an auxiliary brush 104 which makes contact with a segment of commutator 105 at each level to which the brush set is raised. The auxiliary switch comprising brushes 106 and 107 is a rotary switch having a definite normal position which steps upon the energization of its stepping magnet 119.

If the subscriber at substation 100 wishes to be connected with a subscriber whose substation, such as substation 110, is located in a private branch exchange, he will remove the receiver from the switchhook and will operate his dial to transmit impulses corresponding to the number of the branch exchange. The dialing of the earlier digits of the number will bring about the establishment in the well-known manner of a connection to the terminals 111, 112 and 113 extending to a connecter switch especially adapted for completing connections to branch exchanges. The switches 108 and 109 indicate the necessary train of switches to extend the connection to this point.

As soon as switch 109 comes to rest a circuit is completed from battery, through the upper winding of relay 114, upper normal contact of relay 115, terminal 112, over the ring conductor extending through the train of switches, through subscriber's substation 100, back over the tip conductor through the train of switches, to terminal 111, lower normal contact of relay 115, lower winding of relay 114 to ground. Relay 114 operates in turn operating relay 117. Relay 117 connects ground over its uppermost front contact to terminal 113 to hold the train of switches.

When the subscriber now dials the next to the last digit of the wanted number, relay 114 releases at each interruption of its circuit. Relay 117 is slow to release and maintains its armatures attracted throughout di-

aling. Each release of relay 114 closes a circuit from ground over the back contact of relay 114, lower front contact of relay 117, inner lower back contact of relay 122, winding of operating magnet 119 of the register switch to battery. A circuit is also closed in parallel with the winding of magnet 119 which extends over the lowermost back contact of relay 136 to the winding of relay 120 and battery. At the first impulse relay 120 operates, opening a circuit to brush 107 which will be traced hereinafter and, being slow to release holds this circuit open until the digit has been completely dialed. Magnet 119 advances the auxiliary switch one step for each impulse. Assuming that the digit dialed is 3, brush 107 will come to rest on its third terminal.

Relay 120 releases following the last pulse of the digit and closes a circuit from battery through the winding and normal contact of relay 122, right back contact of relay 120, back contact of connecter release magnet 134, contact 121 of the register switch which is now closed since the switch has been moved off normal, contact 124 of the connecter switch which has not been operated, lowermost back contact of relay 123, upper front contacts of relay 117 to ground. Relay 122 operates and locks over its inner upper front contact and the upper front contacts of relay 117 to ground. The operation of relay 122 prevents the dialing of the last digit from affecting the register switch. A branch of the operating circuit of relay 122 extends from ground as traced to the back of relay 120 and thence to brush 107 and its third terminal. Another branch extends from ground at the back contact of relay 120, over the back contacts of vertical magnet 125 and rotary magnet 126 to the lower winding of relay 127 and battery. Relay 127 operates in this circuit closing a circuit from battery through the winding of vertical magnet 125, lowermost back contact of relay 128, uppermost front contact of relay 127 to ground. Magnet 125 operates to elevate the brush shaft of the connecter one step and to open the circuit of relay 127. Relay 127 opens the circuit of magnet 125. When magnet 125 releases relay 127 is reoperated after which magnet 125 operates and the switch takes another vertical step.

Following the third vertical step, brush 104 will make contact with the third segment of commutator 105 to which ground was connected as previously traced. A circuit is now completed from ground on the commutator segment over brush 104, through the lower winding of relay 128, back contact of rotary magnet 126, lower winding of relay 127 to battery. Relay 127 is held operated and relay 128 operates in this circuit. Relay 128 locks over its inner upper front contact, back contact of relay 120 to ground as previously traced. Relay 128 is slow to operate in order to delay the first rotary step until the brushes have come to rest after the vertical movement. The operation of relay 128 transfers the circuit closed by relay 127 from the vertical magnet 125 to the rotary magnet 126. When relay 128 completely operates magnet 126 operates opening the circuit of relay 127. Magnet 126 and relay 127 operate and release in the manner described for magnet 125. Each time that relay 127 releases following a rotary step a circuit is prepared from ground at the uppermost front contact of relay 122, inner lower back contact and lower winding of relay 123, upper winding and upper normal contact of relay 127 to sleeve brush 103. Busy trunks are characterized by ground connected to their terminals and idle trunks by battery.

Assuming that none of the trunks in the third level are idle, the above traced circuit will not be completed and the connecter switch will make ten steps testing each step in the level after which it will make an eleventh step. At the eleventh rotary step of the connecter the eleventh rotary step springs will be operated. A circuit is thereupon closed from ground over the upper front contacts of relay 117, lower back contact of relay 123, contact 132, brush 106 and its third terminal, vertical off normal contact 133 to the winding of connecter release magnet 134 and battery. Release magnet 134 closes a circuit for itself over contact 133 to ground at its left front contact to insure its continued energization until the switch reaches its normal position. With release magnet 133 operated ground is removed from brush 107 and the circuit of relay 127 is held open. As soon as the switch starts to restore, contact 124 is reclosed and a circuit is completed from ground at the front contacts of relay 117, lowermost contact of relay 123, contact 124, contact 121, front contact of magnet 134, winding of magnet 119 to battery. Magnet 119 operates in this circuit advancing the auxiliary switch one step and releases when the release magnet 134 releases. When release magnet 134 retracts its armature the circuit of relay 127 is reclosed and the vertical magnet 125 is operated to elevate the connecter to the level marked by the next terminal of the register switch. This need not be the next level of the switch but may be, as shown, the seventh level or any other included in the group serving this particular branch exchange. In the connecter switches having access to these trunks, the marking of the levels will usually be arranged in various orders so that the order of testing the levels will differ between switches.

Assuming that a trunk in level 7 is idle,

battery connected to brush 103 over that trunk will complete the circuit above traced, operating relay 123 and releasing relay 127 since the current flowing in its upper winding opposes that through the lower winding. Relay 123 locks in a circuit from battery through its upper winding and inner front contact, upper back contact of relay 127, upper front contacts of relay 117 to ground. The operation of relay 123 disconnects ground from brush 107 and also from the locking circu't of relay 128 and the circuit through the lower winding of relay 127. It also opens the circuit through the upper winding of relay 127 so that relay 127 is not permitted to reoperate. In addition it closes a circuit from ground over the uppermost front contact of relay 122, inner lower front contact of relay 123 to brush 103 to hold the called trunk busy. It may be noted at this time that relay 123 is sufficiently marginal not to operate when two switches test a trunk simultaneously.

Relay 123 in operating connects ringing current from source 135, over its upper front contact, upper winding of relay 136, inner upper back contact of relay 136, middle upper front contact of relay 133, uppermost back contact of relay 128, brush 102 to the private branch exchange and back to brush 101, middle upper back contact of relay 128, lowermost front contact of relay 123 to ground at the lower back contact of relay 136. A ringing tone is transmitted back to the calling subscriber through condensers 139 and 140. The ringing current signals the operator at the branch exchange who answers completing a direct current circuit in the well-known manner. Relay 136 is not responsive to the ringing current due in part to the parallel circuit through resistance 137 and condenser 138 but does operate in the direct current circuit closed by the operator. Relay 136 locks in a circuit from battery, through its lower winding and inner lower front contact to ground at the outer upper front contact of relay 122. When relay 136 operates it connects the talking conductors from terminal 112, condenser 140, upper front contact of relay 136, middle upper front contact of relay 123, uppermost back contact of relay 128 to brush 102, and also from brush 111, condenser 141, intermediate lower front contact of relay 136, lowermost front contact of relay 123, middle upper back contact of relay 128 to brush 101. Talking current is supplied to the called subscriber over a circuit from battery, through the lower winding of relay 115, lower intermediate front contact of relay 136, lowermost front contact of relay 123, middle upper back contact of relay 128, brush 101, through the substation at the private branch exchange back to brsuh 102, uppermost back contact of relay 128, upper front contact of relay 123, middle upper front contact of relay 136, upper winding of relay 115 to ground. Relay 115 operates in this circuit connecting ground over the back contact of relay 120 to terminal 113. It also reverses the connection of the windings of relay 114 to the incoming tip and ring conductors for supervisory purposes.

When the calling subscriber restores his receiver to the switchhook relay 114 is released in turn, releasing relay 117. The release of relay 117 opens the ground connection from its front contact to terminal 113. Since relay 117 is slow to release, a circuit will be closed for a short interval from ground, over the back contact of relay 114, front contact of relay 117 through resistance 150, lowermost front contact of relay 136, which is held operated under the control of the called subscriber, to the winding of relay 120 and battery. Relay 120 is also slow to release, therefore, for a short interval following the release of relay 117, ground from the front contact of relay 115 is also removed from terminal 113 to permit the release of the train of switches used in building up the connection to the connecter. As soon as relay 120 releases ground is again connected to terminal 113 from relay 115 to prevent the reselection of the connecter before the called subscriber releases the outgoing end thereof. Ground from the inner upper front contact of relay 115 holds relays 122, 123 and 136 operated under the control of the called subscriber.

If the called subscriber is the first to hang up, relay 115 releases but relays 122, 123 and 136 are held operated under the control of relay 117 and the restoration of the receiver by the calling subscriber completely releases the connecter. When both relays 117 and 115 have been released, relays 122, 123 and 136 also release. With relays 115 and 117 both released, a circuit is closed from battery through winding of connecter release magnet 134, vertical off-normal contact 133, lower back contact of relay 122, inner lower back contact of relay 115, back contacts of relays 117 and 114 to ground. The operation of magnet 134 restores the connecter switch to normal. A branch of this circuit extends from battery through the winding of auxiliary switch release magnet 147, off-normal contact 148 to the back contact of relay 115 and thence to ground. The operation of magnet 147 restores the register switch to normal.

For the purpose of restoring a connecter to normal when either the called or the calling subscriber fails to hang up within a reasonable length of time, two supervisory circuits are provided. The circuit for supervising the release by the called subscriber extends from ground over the back contacts of relays 114 and 117, inner lower

front contact of relay 115 to a supervisory circuit (not shown). The circuit for timing the release by the calling subscriber extends from ground over the inner upper back contact of relay 115 and the front contact of relay 136 to the supervisory circuit. A peg count of the number of times that the connecter is taken for use is made by means of a circuit extending from battery through meter 153, vertical off-normal contact 152 to ground at the uppermost back contact of relay 122.

If all of the trunks in the seventh level had been busy, the connecter would have been restored and then directed to level 6. Similarly the other levels would have been tested in turn if no idle trunks were available in any of them. According to the cross-connecting arrangement shown in the drawing, level 4 is the last one to be tested with brush 107 engaging its seventh terminal. The terminal of brush 106 is therefore not connected to the circuit for release magnet 134 and the closure of the eleventh rotary step springs does not release the connecter switch. The closure of contact 131 connects tone from coil 149 to the ring conductor and thence through condenser 140 to the subscriber's substation informing him that no trunks are available to the branch exchange. This circuit is also closed momentarily at the closure of spring 131 which takes place after the testing of each level but the immediate release of the switch and opening of contact 131 prevents the tone from causing any confusion. The circuit now remains closed until the calling subscriber restores his receiver and releases the connecter.

In order to record the number of times that all of the trunks leading to a particular branch exchange are busy and a call is attempted, meter 151 may be connected to the terminal corresponding to the last group of trunks to be tested, so that upon the closure of the eleventh step springs, a circuit is completed through the meter over bursh 106 and eleventh rotary step spring 132, back contact of relay 123 to ground over the upper front contacts of relay 117.

It will be apparent that if a particular branch exchange requires the services of the entire number of trunks outgoing from a connecter switch, the auxiliary switch must be advanced only one step in order to start the automatic hunting operation. A modification of the circuit to render the operation of the register switch independent of the number of impulses of the first digit dialed into the connecter switch is shown in Fig. 2. With Fig. 2 substituted for the dotted rectangle at the lower left corner of Fig. 1, the circuit of magnet 119 of the auxiliary switch extends over the right front contact of relay 120, contact 124, lowermost back contact of relay 123 to ground over the uppermost contacts of relay 117. Therefore when relay 120 operates in response to the first impulse, rotary magnet 119 is operated and is held operated under the control of relay 120 until the entire number of impulses has been received. Therefore, irrespective of the digit employed, the rotary switch will make only one step, after which the automatic operation will proceed substantially as described for Fig. 1.

In this modification, however, when release magnet 134 operates after all the trunks of a level have been found busy and the switch starts to restore, a circuit is closed from ground over the upper contacts of relay 117, outer lower back contact of relay 123, contact 124, contact 121, right front contact of release magnet 134, lowermost back contact of relay 136, to the winding of relay 120 and battery. Relay 120 operates and extends a branch of its circuit from contact 124, over the right front contact of relay 120 to the winding of magnet 119 and battery. Magnet 119 thereupon operates advancing the auxiliary switch one step. When the switch is completely restored, release magnet 134 is denergized, opening the circuit of relay 120 and in turn releasing magnet 119. After the last level in the group has been tested no circuit is closed for relay 120 so that magnet 119 is not operated and a busy tone is transmitted to the calling subscriber as previously described.

The alteration of the connecter circuit from one serving several private branch exchanges to one serving only one private branch exchange may be very easily accomplished by supplying a relay 120 having the proper armatures and contacts. In that case it becomes necessary only to transfer one connection and to make one additional connection.

What is claimed is:

1. In a telephone system, a plurality of groups of lines, a selector switch, means for operating said switch to select one of a plurality of said groups, means for then moving said switch to hunt for an idle line in said group, means for completely restoring said switch if all lines in said group are busy, and means to then cause said switch to automatically select another of said groups and to hunt for an idle line in such other group.

2. In a telephone system, a plurality of groups of lines, a selector switch, means for marking one of said groups, means for operating said switch to select said group, means for then moving said switch to hunt for an idle line in said group, means for restoring said switch if all the lines on the said group are busy and means to then mark another group and to cause said switch to automatically select said group and to hunt for an idle line in such other group.

3. In a telephone system, a plurality of groups of lines, a selector switch, a register for said switch responsive to dial pulses for marking a group of lines for selection, means for operating said switch to select the marked group of lines and for hunting for an idle line in said group, means operative if all lines in said group are busy to advance said register to mark another group of lines for selection, means then effective to reoperate said switch to select the group of lines then marked for selection and to hunt for an idle line in such group.

4. In a telephone system, a plurality of groups of lines, a selector switch, an auxiliary switch, means to operate said auxiliary switch in response to dial impulses to mark a group of lines for selection, means for operating said selector switch to select the marked group of lines and to hunt for an idle line in said group, means operative if all lines in said group are busy to advance said auxiliary switch to mark another group of lines for selection, means then effective to reoperate said selector switch to select the group of lines thus marked for selection and to hunt for an idle line in such group.

5. In a telephone system, a plurality of groups of lines, a selector switch, an auxiliary contact on said switch individual to each group of lines, a register for said switch responsive to dial pulses for marking one of said auxiliary contacts, means for operating said switch to select the marked contact and to test for an idle line in the corresponding group, means operative if all lines in said group are busy to advance said register to mark another group contact, means then effective to reoperate said switch to select the contact then marked and to hunt for an idle line in the corresponding group.

In testimony whereof I have signed my name to this specification this 19th day of January, 1927.

HENRY M. BASCOM.