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CONNECTER SWITCH CIRCUITS

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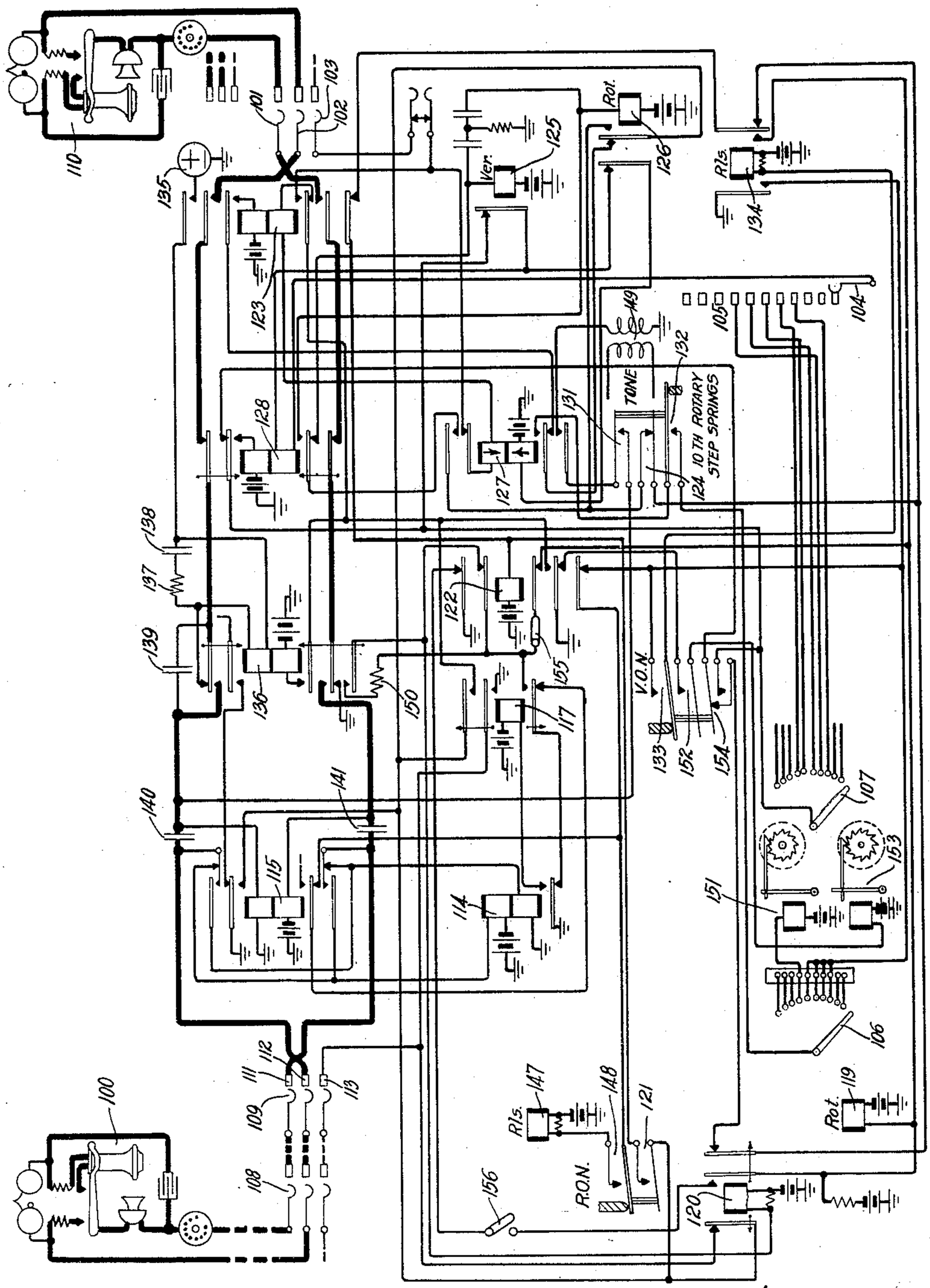

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CONNECTER-SWITCH CIRCUITS

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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 of 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. The invention is applied to a switch of the two motion type such as is employed in step-by-step dial switching systems. 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 then rotated to test for an idle trunk in the level. If all trunks of the level are busy, the switch is restored to normal, and the auxiliary switch is advanced one step to mark another level which the main 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 main switches to hunt over the levels in different orders so that the wear on the switches and the time necessary to find an idle trunk is reduced.

To enable the main switch to be more quickly arrested upon testing a trunk and finding it idle, a differentially wound test relay is provided which also serves as a stepping relay to control both the vertical and rotary stepping movements of the main switch. This relay, which energizes over one of its windings to cause the selector to step in its hunting movement, becomes differentially energized over its other winding and the test brush, whereby the relay cannot operate to cause the further rotary movement of the switch. Provision is also made for enabling the calling subscriber to release all switches ahead of the connecter, leaving the connecter to be released by the called subscriber if the calling subscriber restores his receiver to the switchhook first, by momentarily withdrawing the holding ground from the sleeve conductor extending from the connecter switch back to the preceding selector. In order that this holding ground shall be withdrawn for an interval only sufficient to initiate the release of preceding switches, and shall be again applied to prevent the connecter from again being seized by another selector, a relay is provided whose energizing and releasing characteristics are controlled by a resistance connected in series therewith. Provision is also made for reducing the hunting time of the connecter over large trunk groups comprising several bank levels, by extending the stepping circuit of the vertical magnet over a back contact of the release magnet, so that immediately upon the release of the connecter the vertical magnet is operative to again advance the connecter in its vertical level hunting movement. The brushes of the connecter are arrested in their hunting movement over a bank level, on the last set of terminals in the level rather than after they have rotated beyond the last set of terminals, and are then restored to normal. This overcomes the tendency of the brushes to snag on the last terminal set as they reenter the bank in their restoring movement.

The invention will be more clearly understood from a consideration of the following description taken in connection with the attached drawing in which the single figure shows a connecter switch embodying the invention.

The connecter switch indicated by brushes 101, 102 and 103 is of the type usually employed in step-by-step dial systems and has two motions, a vertical motion to select levels of bank terminals, and a rotary motion to select a terminal in a level. No attempt has been made to show the terminal bank since it is of well known construction. The connecter has, in addition to the usual 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 compris-

ing brushes 106 and 107 is a rotary switch having a definite normal position.

If the subscriber at substation 100 wishes to be connected with a subscriber whose substation, such as 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 private 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 for extending 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 innermost upper 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 dialing. Each release of relay 114 closes a circuit from ground over the back contact of relay 114, lower front contact of relay 117, jumper connection 155, innermost lower back contact of relay 122, winding of rotary magnet 119 of the auxiliary switch to battery. A circuit is also closed in parallel with the winding of magnet 119 which extends over the innermost upper back contact of relay 122 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 impulse of the digit, and closes a circuit from battery, through the winding of relay 122, off-normal contact 121 of the auxiliary switch, left back contact of relay 120, inner upper contact of relay 117 to ground. Relay 122 operates and locks over off-normal contact 121, the upper contact of relay 117 to ground at the lower front contact of relay 122. The operation of relay 122 prevents the dialing of a further digit from affecting the auxiliary switch. The rotary off-normal contacts 148 also close at this time to prepare a circuit for the release magnet 147 of the auxiliary switch.

A circuit is now closed for relay 127, from battery through the winding of relay 127, outer back contact of rotary magnet 126, back contact of vertical magnet 125, inner upper back contact of relay 128, normally closed vertical off-normal contacts 154, right back contact of relay 120, back contact of connecter release magnet 134, lowermost back contact of relay 123, off-normal contact 121, left back contact of relay 120 to ground at the inner upper front contact of relay 117. Relay 127 operates in this circuit, closing a circuit from battery through the winding of vertical magnet 125, innermost lower back contact of relay 128, upper front contact of relay 127, normally closed tenth rotary step springs 124 to ground at relay 117, as previously traced. Magnet 125 operates to elevate the connecter brush set 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 reoperates and takes another vertical step.

Following the third vertical step, brush 104 will make contact with the third segment of commutator 105 and a circuit will be completed from ground at the intermediate front contact of relay 117, left back contact of relay 120, off-normal contacts 121, lower back contact of relay 123, back contact of magnet 134, right back contact of relay 120, lower alternate off-normal contact 154, now closed, brush 107 and its third terminal, the third segment of commutator 105, brush 104, lower winding of relay 128, the outer back contact of rotary magnet 126, lower winding of relay 127 to battery.

Relay 127 is held operated. Relay 128 operates in this circuit and locks over its inner upper front contact, off-normal contacts 154, 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 previously described in connection with the operation of magnet 125. Each time that relay 127 releases following a rotary step, a circuit is prepared from ground at the lower 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 take ten steps testing each terminal in the level. At the tenth rotary step of the connecter, the tenth rotary step springs will be operated. Springs 124 are now opened to prevent the further operation of the rotary magnet 126. A circuit is also closed from ground at the lower front contact of relay 122, over the upper front contact of relay 117, inner back contact of rotary magnet 126, inner lower front contact of relay 127, contact 132, brush 106 and its third terminal, vertical off-normal contact 133, 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 134 operated, ground is removed from brush 107 and the circuit of relay 127 is held open. Upon the energization of magnet 134, a circuit is closed from battery through the winding of rotary magnet 119 of the auxiliary switch, front contact of release magnet 134, lower back contact of relay 123, off-normal contacts 121, left back contact of relay 120 to ground at the intermediate front contact of relay 117. Magnet 119 operates in this circuit, advancing the auxiliary switch one step and releases when the release magnet 134 releases. When the release magnet 134 retracts its armatures, the circuit of relay 127 is immediately reclosed and the vertical magnet 125 is operated to elevate the connecter brush shaft to the level marked by the next terminal of the auxiliary switch. This need not be the next level of the switch but may be as shown the seventh level or any other level included in the group serving the particular branch exchange. In the connecter switches having access to these trunks, the marking of the trunks will usually be arranged in various orders so that the orders of testing the levels will differ between switches.

It will be noted that the rotary step springs 132 closed when the brushes 101, 102, and 103 were resting on the tenth or last terminal set of the third bank level and that the switch shaft was restored to normal from this position. Since the brushes have therefore not been stepped-off of the last terminal set of the level there is no tendency for them to snag on their restoring movement as would be the case were the springs 132 closed in the eleventh rotary step position of the switch shaft when the brushes would be in a position beyond the last terminal set of the bank level.

Assuming that a trunk in level 7 is idle, battery connected to brush 103 over that trunk will complete the circuit above traced through windings of relays 123 and 127, operating relay 123 and releasing relay 127 since the current now flowing in its upper winding sets up a flux in opposition to the flux created by current flowing through the lower winding. Relay 123 locks in a circuit from battery through its upper winding, and upper front contact, innermost lower back contact of relay 127, inner back contact of magnet 126, upper front contact of relay 117 to ground at the front contact of relay 122. The operation of relay 123 disconnects ground from brush 107 and also from the locking circuit 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 intermediate lower 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 uppermost front contact, upper winding of relay 136, upper back contact of relay 136, upper back contact of relay 128, intermediate upper front contact of relay 123, brush 102 to the private branch exchange and back over brush 101, lower front contact of relay 123, lower back contact of relay 128, innermost lower back contact of relay 136 to ground. A ringing tone is transmitted to the calling subscriber through condensers 139 and 140. The ringing current signals the branch exchange, which answers, completing a direct current circuit in the well known manner. Relay 136 is not responsive to the ringing current but does operate in the direct current circuit closed at the branch exchange. Resistance 137 and condenser 138 are supplied to protect the upper contact of relay 136. Relay 136 locks in a circuit from battery through its lower winding and inner lower front contact to ground at the front contact of relay 122. When relay 136 operates, it connects the talking conductors from terminal 111, condenser 141, middle lower front contact of relay 136, lower back contact of relay 128, lower front contact of relay 123 to brush 101, and also from terminal 112, condenser 140, uppermost front contact of relay 136, uppermost back contact of relay 128, intermediate upper front contact of relay 123 to brush 102. Talking current is supplied to the branch exchange over a circuit from battery through the lower winding of relay 115, intermediate lower front contact of relay 136, lowermost back contact of relay 128, middle lower front contact of relay 123, brush 101 through the private branch exchange, back to brush 102, middle upper front contact of relay 123, upper back contact

of relay 128, 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 energizes but as its circuit includes resistance 150 its core does not become fully saturated so that when its circuit is opened upon the release of relay 117, it is not as slow in releasing as it normally is. Relay 120 does not release therefore for a short interval following the release of relay 117 and ground from the front contact of relay 115 is thereby 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 re-selection of the connecter before the called subscriber restores his receiver. 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 the winding of connecter release magnet 134, vertical off-normal contact 133, lower back contact of relay 122, 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 calling 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 called 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 middle lower 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 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 of release magnet 134 and the closure of the tenth rotary step springs does not release the connecter switch. The closure of contact 131 connects tone from coil 149 over the lower front contact of relay 127, to the ring conductor and thence through condenser 140 to the subscriber's substation informing him that no trunks to the branch exchange are available. This tone 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 when a call is attempted, a meter 151 may be connected to the terminal of the auxiliary switch corresponding to the last group of trunks to be tested, so that upon the closure of the tenth step springs, a circuit is completed from the meter over brush 106 and the tenth rotary step spring 132, front contact of relay 127, inner back contact of magnet 126, back contact of relay 120 to ground over the middle front contact 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. The modification of the circuit to render the operation of the auxiliary switch independent of the number of impulses of the first digit dialed into the connecter switch, may be made by opening strap 155 and closing strap 156. The circuit of magnet 119 of the auxiliary switch now extends over the right front contact of relay 120, strap 156 to ground over the uppermost back contact of relay 122. Therefore, when relay 120 operates in response to the first

impulse dialed into the connecter, rotary magnet 119 is operated and is held operated under the control of relay 120 until the dialing operation is completed. Therefore, irrespective of the digit employed, the rotary switch will make but one step after which the automatic operation will proceed substantially as hereinbefore described.

When the release magnet 134 operates after all of the trunks of a level have been found busy, and the switch starts to restore, a circuit is closed from ground over the middle contact of relay 117, left back contact of relay 120, off-normal contact 121, lower back contact of relay 123, right front contact of magnet 134, winding of magnet 119 to battery. Magnet 119 thereupon operates advancing the auxiliary switch one step. When the switch is completely restored, release magnet 134 is deenergized, opening the circuit of magnet 119. After the last level in the group has been tested, no circuit is closed for magnet 134 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 therefore be very easily accomplished by supplying the two straps 155 and 156.

What is claimed is:

1. In a telephone system, a selector switch, a magnet for advancing said switch in a hunting movement, a double wound test relay in said switch, a circuit for said magnet controlled by said relay, an energizing circuit for said relay extending through one of its windings, a test brush for said switch, and a circuit extending from said test brush through the second winding of said relay, the windings of said relay being arranged in opposition whereby when said test brush engages the terminal of an idle line the energization of said relay is prevented to arrest the further advance of said switch.

2. In a telephone system, a selector switch, a magnet for advancing said switch in a hunting movement, a double wound test relay, a circuit for energizing said relay over one of its windings and under the control of said magnet, a circuit for said magnet closed upon the energization of said relay whereby said relay and magnet reciprocally operate to cause the advance of said switch, and a test brush for said switch connected in circuit with the other winding of said relay, the windings of said relay being arranged in opposition whereby when said test brush engages the terminal of an idle line the energization of said relay is prevented to arrest the further advance of said switch.

3. In a telephone system, a selector switch having one motion to select a group of lines, and a second motion to select an idle line of a group, a magnet for controlling said first motion, a second magnet for controlling said second motion, a double wound test relay, a circuit for energizing said relay over one of its windings and under the control of either one of said magnets, circuits for said magnets closed upon the energization of said relay whereby said relay and magnets operate reciprocally first to cause said switch to be moved to select a group of lines, and then to be moved to hunt for an idle line in a group, and a test brush for said switch connected in circuit with the other winding of said relay, the windings of said relay being arranged in opposition whereby when said first brush engages the terminal of an idle line the energization of said relay is prevented to arrest the further hunting movement of said switch.

4. In a telephone system, a calling line, a called line, a train of switches for extending a connection from said calling line to said called line, a line relay and first and second slow-releasing relays controlled by said calling subscriber to govern the setting of the last switch of the train, said first slow relay being operable over a front contact of said line relay and said second slow relay being operable over a back contact of said line relay and a front contact of said first slow relay, a holding circuit extending from the last switch of the train to the preceding switches, a first ground connection for said holding circuit controlled by said first slow relay, a second ground connection for said holding circuit controlled over a back contact of said second slow relay, a resistance for insertion in series with said second slow relay to render it quicker to release, and circuit connections whereby when said calling subscriber restores his receiver before said called subscriber, said line relay releases followed in succession by the operation of said second slow relay to open said second ground connection, by the release of said first slow relay to open said first ground connection, thereby causing the release of preceding switches, and by the release of said second slow relay to again apply said second ground connection to thereby render said line switch unselectable.

5. In a telephone system, a calling line, a called line, a train of switches for extending a connection from said calling line to said called line, a line relay and first and second slow-releasing relays controlled by said calling subscriber to govern the setting of the last switch of the train, said first slow relay being operable over a front contact of said line relay and said second slow relay being operable over a back contact of said line relay and a front contact of said first slow relay, a holding circuit extending from the last switch of the train to the preceding

switches, a first ground connection for said holding circuit controlled by said first slow relay, a second ground connection for said holding circuit controlled over a back contact of said second slow relay, means controlled by the response of the called subscriber to render said second slow relay quicker to release, and circuit connections whereby when said calling subscriber restores his receiver before said called subscriber said line relay releases followed in succession by the operation of said second slow relay to open said second ground connection, by the release of said first slow relay to open said first ground connection, thereby causing the release of preceding switches, and by the release of said second slow relay to again apply said second ground connection to thereby render said line switch unselectable.

6. 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, a magnet for restoring said switch if all the lines in said group are busy and means controlled over a back contact of said magnet upon the complete release of said switch to then cause said switch to automatically select another of said groups and to hunt for an idle line in such other group.

7. In a telephone system, a selector switch, a group of lines terminating therein, means for advancing the brushes of said switch in a hunting movement over the terminals of said lines, and means for automatically releasing said switch from the terminals of the last line of the group in response to a non-selectable condition of said last line.

8. In a telephone system, a selector switch, a group of lines terminating therein, means for advancing the brushes of said switch in a hunting movement over the terminals of said lines, shaft contacts closed when said brushes engage the terminals of the last line of the group, and means for releasing said switch from the terminals of the last line upon the closure of said contacts in response to a non-selectable condition of said last line.

9. In a telephone system, a selector switch, a group of lines terminating therein, means for advancing the brushes of said switch in a hunting movement over the terminals of said lines, means for arresting said brushes on the terminals of the last line of said group, and means for thereupon releasing said switch in response to a non-selectable condition of said last line.

10. In a telephone system, a selector switch, a group of lines terminating therein, means for advancing the brushes of said switch in a hunting movement over the terminals of said lines, means for arresting said brushes on the terminals of the last line of said group, shaft contacts closed when said brushes engage the terminals of the last line of the group, and means for releasing said switch from the terminals of the last line upon the closure of said contacts if said last line is in a non-selectable condition.

11. In a telephone system, a selector switch, a group of lines terminating therein, means for advancing the brushes of said switch in a hunting movement over the terminals of said lines, means for releasing said switch, and shaft contacts operated when said brushes engage the terminals of the last line of the group to arrest the further advance of said switch and to cause the operation of said releasing means if said last line is in a non-selectable condition.

In witness whereof, I hereunto subscribe my name this 12 day of August A. D., 1927.

HENRY HOVLAND.

DISCLAIMER

1,747,169.—*Henry Hovland*, Huntington, N. Y. Connecter-Switch Circuits. Patent dated February 18, 1930. Disclaimer filed July 2, 1931, by the assignee, *Bell Telephone Laboratories, Incorporated.*

Hereby enters this disclaimer to the said claim of said Letters Patent which is in the following words to wit:

"4. In a telephone system, a calling line, a called line, a train of switches for extending a connection from said calling line to said called line, a line relay and first and second slow releasing relays controlled by said calling subscriber to govern the setting of the last switch of the train, said first slow relay being operable over a front contact of said line relay and said second slow relay being operable over a back contact of said line relay and a front contact of said first slow relay, a holding circuit extending from the last switch of the train to the preceding switches, a first ground connection for said holding circuit controlled by said first slow relay, a second ground connection for said holding circuit controlled over a back contact of said second slow relay, a resistance for insertion in series with said second slow relay to render it quicker to release, and circuit connections whereby when said calling subscriber restores his receiver before said called subscriber, said line relay releases followed in succession by the operation of said second slow relay to open said second ground connection, by the release of said first slow relay to open said first ground connection, thereby causing the release of preceding switches, and by the release of said second slow relay to again apply said second ground connection to thereby render said line switch unselectable."

(*Official Gazette July 21, 1931.*)