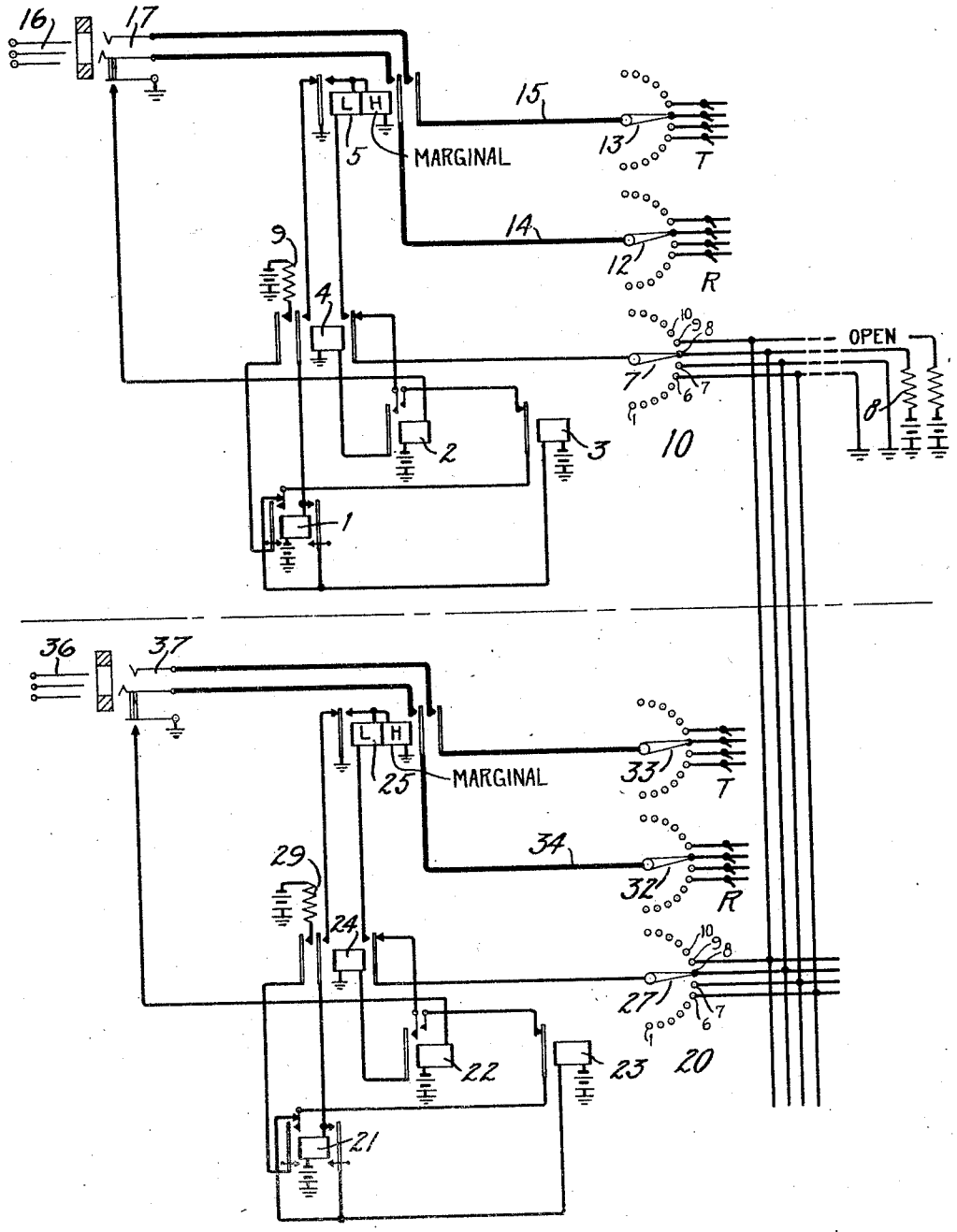
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TRUNK TESTING CIRCUITS FOR SELECTOR SWITCHES

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TRUNK-TESTING CIRCUITS FOR SELECTOR SWITCHES.

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This invention relates to telephone exchange systems, and more particularly to a trunk hunting circuit for use in such telephone systems.

Trunks or lines extending from a telephone office to various destinations are ordinarily placed in groups according to their destination in order that they may be readily selected by an operator or automatic apparatus. When automatic apparatus is used for selecting trunks, it is the usual practice to connect the trunk conductors in multiple to several groups of stationary terminals and employ a plurality of switch brushes to hunt over the stationary terminals for trunks, to a particular destination, that are idle.

It is important that selector switches operate as rapidly as possible during trunk hunting in order to make the time required for finding an idle trunk as short as possible. It is difficult to provide a test which will stop a rapidly moving switch positively and certainly on the first idle trunk reached and at the same time prevent two switches which may test the same trunk simultaneously from becoming associated with said idle trunk. This is especially true of switches of the self interrupting type in which the brushes are advanced by the return stroke of the magnet armature.

Where a number of such switches are hunting over the same multiples at the same time, it will very often occur that a plurality of brushes are arrested upon the same idle trunk, thus associating the conductors of several incoming lines with the single outgoing line. It is highly desirable that only one incoming line be associated with an outgoing trunk or line, since double connections cause serious delays in making telephone connections and require more apparatus than would otherwise be necessary if it were impossible for more than one incoming line to connect to one outgoing trunk or line.

It is an object of this invention to provide a testing means which will permit trunk hunting at high speed and at the same time prevent double conections without the use of apparatus of more than ordinary sensitiveness for speed of operation.

A feature of this invention resides in the provision of means in each of a plurality of hunting circuits to establish an auxiliary driving circuit, effective when the hunting brushes of more than one switch select terminals associated with the same idle trunk or line to prevent the connection of a plurality of incoming lines to a single outgoing trunk or line.

A further feature of this invention resides in the provision of means to prevent the selection of a trunk or line which has a defective test circuit connected to the test terminal of a hunting switch.

This and other features of the invention will be apparent from the following description, taken in connection with the accompanying drawing which illustrates the tip and ring conductors of a group of trunks or lines and the test terminals associated with such trunks connected to stationary contacts of switches. Brushes associated with these switches are rotated under the control of a combination of apparatus to locate idle trunks. Two hunting switches and two control apparatus combinations have been shown. There may, however, be any number in a trunk group and there may be a plurality of such trunk groups in an office.

Switches of the self-interrupting step-by-step type have been disclosed but the invention is equally applicable to any type of switch which advances automatically to find an idle line or trunk.

A plug and jack have been shown for the association of the incoming line with the hunting circuit. This, however, may be any type of apparatus and the hunting apparatus may be selected by automatic apparatus such as a selector.

Detail description.

Let it be assumed that an incoming line connected to plug 16 is to be connected to a trunk extending to a particular office served by switch 10. An operator inserts the plug 16 into jack 17 which closes the lower contact of the jack and establishes a circuit to operate relay 2. The operation of relay 2 associates the switch driving magnet 3 with brush 7. Assuming that brush 7 is resting on terminal No. 6 which is a busy trunk characterized by ground potential, a circuit is established to energize the winding of magnet 3 from grounded battery through said winding, left normal contact of relay 1, con-

tact of magnet 3, contact of relay 2, right contact of relay 4, brush 7 and its associated contact to ground. The magnet 3 is energized over the circuit traced, to propel brushes 7, 12, and 13 to the next successive terminal No. 7. This terminal is also assumed to be connected to a busy line which again energizes magnet 3 through its self-interrupting contact. The switch brushes are thus propelled to terminal No. 8 which is connected to an idle trunk, as indicated by battery potential, through resistance 8.

Relay 4 is now energized from grounded battery through the winding of magnet 3, left contact of relay 1, contact of magnet 3, contact of relay 2, to ground through the winding of relay 4. The resistance of relay 4 in the circuit traced, does not allow the magnet 3 to again operate. It will be noted that the operating circuit for relay 4 was established upon the operation of relay 2, but a shunt circuit is also established to prevent the operation of relay 4 during the time that brush 7 is associated with busy terminals so that relay 4 cannot operate until brush 7 is associated with a terminal connected to an idle trunk with the test terminal connected to battery or connected to a trunk with a faulty test terminal, such as an open conductor, between the battery and the test terminal.

The operation of relay 4 establishes a circuit to energize the windings of marginal relay 5 from ground through its right and left windings, right contact of relay 4, brush 7, resistance 8 to grounded battery. Relay 5 operates and establishes a locking circuit for itself from ground, through its left contact and left winding. The operation of relay 5 further associates the incoming line with the outgoing trunk through the right outer and inner contacts of relay 5 and brushes 12 and 13 and their associated terminals. The incoming line is thus associated with the idle outgoing trunk, and relay 5 remains operated until the conversation has ceased and the trunk is released. The test terminal is made busy by its connection to ground through the low resistance left winding of relay 5.

Let it be assumed that terminal 8 is a busy terminal, the same as terminals Nos. 6 and 7, and that brushes 7, 12, and 13 have been propelled to terminal No. 9 by the operation of magnet 3, as previously described. When brush 7 arrived at terminal No. 9, since the conductor associated with this terminal is open, there is no ground to shunt relay 4 which operates as previously described over a circuit through the winding of magnet 3 to battery. The operation of relay 4 connects the windings of relay 5 to terminal No. 9 through brush 7; but since the conductor connected to terminal No. 9 is open, there is no battery potential to operate relay 5. It therefore remains in a released condition.

With relay 5 in its normal released condition and relay 4 operated, a circuit is established to operate relay 1 from ground through the left back contact of relay 5, left inner contact of relay 4 to battery through the winding of relay 1. It will be noted that relay 1 is slow to operate in order that sufficient time may be allowed for the operation of relay 5 if a circuit is established for its operation.

A circuit is now established to energize switch magnet 3 from ground, through the left back contact of relay 5, left inner contact of relay 4, right contact of relay 1, to battery through the winding of magnet 3. The operation of relay 1 further establishes a circuit to maintain relay 4 energized until magnet 3 has opened its contact. This circuit may be traced from grounded battery, through resistance 9, left outer contact of relay 4, left contact of relay 1, contact of magnet 3, contact of relay 2 to ground through the winding of relay 4.

Upon the operation of magnet 3, the holding circuit for relay 4 is opened to cause its release. The release of relay 4 opens the energizing circuit for magnet 3 and relay 1 to cause their release. The release of magnet 3 propels the brushes 7, 12, and 13 to the next terminals which may be associated with a busy or idle trunk. It will be noted that when the switch brush 7 is advanced to terminal No. 10, the apparatus of the hunting circuit is in the same condition as it was when brush 7 started to hunt for an idle line. Therefore, if the tenth terminal is associated with a busy line, a circuit is established to energize magnet 3 to advance the brushes to the next succeeding terminals. In this manner, the brushes are advanced until an idle trunk is selected and the incoming line connected to brushes 12 and 13 by the operation of relay 5.

Let it be assumed that brushes 7 and 27 are positioned upon the trunk associated with terminal No. 6 of each switch, and that plugs 16 and 36 are simultaneously inserted into jacks 17 and 37. Let it further be assumed that magnet 3 and magnet 23 are simultaneously energized in the manner previously described to rotate the brushes of the switches 10 and 20 in search of an idle trunk and that brushes 7 and 27 arrive at terminal No. 8 at the same time. Since battery potential through resistance 8 is connected to terminal No. 8, there will not be a shunt to prevent the operation of relays 4 and 24 over a circuit as previously traced to grounded battery through the windings of magnets 3 and 23.

The operation of relays 4 and 24 establishes circuits through the windings of relays 5 and 25 in multiple extending from ground through the windings of relay 5, right contact of relay 4, brush 7, and associated terminal and ground through the windings of

relay 25, right contact of relay 24, brush 27, and associated terminal to the common point connected to the resistance 8 and grounded battery. Since the relays 5 and 25 are in multiple there is insufficient current flow to operate either relay and thus they remain in their normal non-operated condition.

With relay 5 normal and relay 4 operated, a circuit is established to energize relay 1 in the same manner as previously described; and further, with relay 25 normal and relay 24 operated, a circuit is established to operate relay 21. The operation of relay 1 establishes a circuit to energize magnet 3. The operation of magnet 3 opens the holding circuit for relay 4 which releases magnet 3 and relay 1 for the advancement of brushes 7, 12, and 13 to the next succeeding terminal in the manner previously described. The operation of relay 21 establishes an energizing circuit for magnet 23 in the same manner as described for magnet 3. The operation of magnet 23 opens the holding circuit for relay 24 to cause its release in the same manner as described for relay 4. The release of relay 24 opens the energizing circuit for magnet 23 to cause its release for the advancement of brushes 27, 32, and 33 of switch 20 in the manner described for the brushes of switch 10.

The hunting circuits for switches 10 and 20 are now actuated to rotate the associated brushes to each select separate idle trunks. It is well understood in the art that switches of the character used in automatic telephone circuits are such that a slight difference in the inductance of windings or operating circuits of any kind, would cause a slight difference in the time of stepping the brushes from terminal to terminal. For this reason, the brushes of two switches, such as 10 and 20, will not be propelled far before they are out of step with each other, which will allow one to select an idle terminal before the other switch arrives at that terminal.

Let it be assumed for the following description that two or more switches are arrested upon the multiple of the same idle trunk, but that the brushes of one of these switches arrive at this multiple slightly before the others. Under such a condition, relay 4 is operated before the relays, corresponding to relay 4, in the other circuits are associated with the same terminal, and thus a circuit is established for relay 5 before it is placed in multiple with the relays, corresponding to 5, of the other circuits. If relay 5 has time to operate so that the locking circuit is established through its left winding to battery through resistance 8, there will be sufficient current to hold relay 5 in an operated position, even though it were placed in multiple with other relays, corresponding to 5, upon the operation of relays corresponding to 4, in the other circuits. In this manner, the one hunting circuit seizes the idle trunk.

In the remaining circuits that have associated their hunting brush, corresponding to brush 7, with the idle trunk, the relays, corresponding to relays 5 or 25, remain in an unoperated position, since these relays are placed in multiple and do not receive sufficient current through their windings to cause their operation. In the hunting circuits that have the unoperated relays, circuits are established to energize relays, corresponding to 21, and to energize the switch magnets, corresponding to 23, which open the holding circuit for the relays, corresponding to relay 24, which further cause the release of the magnets, to advance the brushes of such switches in search of idle trunk circuits beyond the one with which switch 10 is associated.

What is claimed is:

1. In a telephone exchange system, in combination, a plurality of switches, lines, a primary driving circuit for each switch, a primary test circuit to control said primary driving circuit for the selection of an idle line, a secondary driving circuit for each switch and a secondary test circuit to control said secondary driving circuit when more than one of said switches has selected the same idle line.

2. In an electrical control system, hunting circuits comprising a plurality of switches with movable brushes and fixed terminals, brush driving circuits, means to disestablish said driving circuits when said brushes become associated with an idle terminal, means to establish second brush driving circuits when more than one brush is simultaneously associated with the same idle terminal, and means to restore to use said first driving circuits.

3. In an electrical control system, hunting circuits comprising a plurality of switches with movable brushes and fixed terminals, brush driving circuits, means to disestablish said driving circuits when said brushes become associated with an idle terminal, means to establish second brush driving circuits when more than one brush is simultaneously associated with the same idle terminal, and means controlled by said second driving circuits to restore to use said first driving circuits.

4. In a telephone exchange system, hunting circuits comprising a plurality of switches with movable brushes and fixed terminals, brush driving circuits, means for disestablishing said driving circuits when said brushes become associated with an idle terminal to arrest the movement of said brushes, and means to establish a second driving circuit for the movement of said arrested brushes if more than one brush is arrested upon the same idle terminal.

5. In a telephone exchange system, in combination, incoming lines, outgoing trunks, a plurality of switches with movable brushes

and fixed terminals for associating said incoming lines with said outgoing trunks, brush driving circuits, means for disestablishing said driving circuits, when said brushes become associated with an idle terminal, to arrest the movement of said brushes, means to prevent the connection of incoming lines to an outgoing trunk if the brushes of more than one switch are arrested upon the same idle terminal, and means to establish a second driving circuit for the movement of said arrested brushes.

6. In a telephone exchange system, in combination, incoming lines, outgoing trunks, a plurality of switches with movable brushes and fixed terminals for associating said incoming lines with said outgoing trunks, brush driving circuits, means for disestablishing said driving circuits, when said brushes become associated with an idle terminal to arrest the movement of said brushes, means to establish a connection from one incoming line to an outgoing trunk if the brushes of more than one switch are arrested upon the same idle terminal, and means to establish a second driving circuit for the movement of arrested brushes other than the one associated with the connected line.

7. In a telephone system, in combination, a switch, lines, a primary driving circuit, a primary test circuit to control said primary driving circuit for the selection of an idle line, a secondary driving circuit and a secondary test circuit to control said secondary driving circuit if the idle line selected is faulty.

8. In an electrical control system, hunting circuits comprising a plurality of switches with movable brushes and fixed terminals, brush driving circuits, means to disestablish said driving circuits when said brushes become associated with an idle terminal or with a terminal which is in an unstandard condition, auxiliary driving circuits and automatically operable means to actuate said auxiliary driving circuits to move said brushes off said unstandard terminal and to reestablish said first driving circuit.

9. In a telephone exchange system, a plurality of sets of stationary terminals associated with electrical apparatus, one of each set being a test terminal, a movable brush, test terminals characterized as busy, test terminals characterized as idle, test terminals connected to a faulty conductor or apparatus, means to move said brush over said stationary terminals to select idle terminals, means to arrest the movement of said brush upon an idle terminal, means to arrest the movement of said brush upon a terminal connected to a faulty conductor or apparatus and means automatically operable thereupon to restart the movement of said brush in search of an idle terminal.

10. In a telephone system, lines, fixed test terminals for said lines, a switch having a brush adapted to engage said terminals, driving means for said switch, a driving circuit for said means, a test circuit responsive to one condition of line to disable said driving circuit, a second test circuit made responsive to other conditions of said line upon the operation of said first test circuit, and means controlled by said second test circuit for reestablishing said driving circuit.

11. In a telephone system, lines, fixed test terminals for said lines, a switch having a brush adapted to engage said terminals, driving means for said switch, a test circuit responsive to one condition of line to disable said driving means, a second test circuit made responsive to other conditions of said line upon the operation of said first test circuit, and means controlled by said second test circuit for establishing connections to said line.

12. In a telephone system, lines, fixed test terminals for said lines, a switch having a brush adapted to engage said terminals, driving means for said switch, a driving circuit for said means, a test circuit responsive to one condition of line to disable said driving circuit, a second test circuit made responsive to other conditions of said line upon the operation of said first test circuit, and means controlled by said second test circuit for reestablishing said first test circuit and said driving circuit.

13. In a telephone system, fixed terminals associated with electrical circuits, switches having brushes adapted to engage said terminals, driving means for said switches, a driving circuit in each switch for said means, a testing circuit for each switch including means operable in response to tests of certain conditions associated with said terminals for disabling said driving circuits, another testing circuit for each switch including means for making a secondary test of said certain conditions, and means controlled by said secondary testing means for reestablishing any of said driving circuits dependent upon the action of each of said secondary testing means.

14. In a telephone system, fixed test terminals, a switch having a brush adapted to engage said terminals, driving means for said switch, a driving circuit for said switch including means for testing the condition of terminals associated with said brush, means responsive to certain conditions tested for disabling said driving circuit, means for making a supplementary test of said disabling condition, and means under the control of said secondary testing means for rendering said driving circuit again effective.

15. In a telephone system, fixed test terminals, a switch having a brush adapted to engage said terminals, driving means for said switch, a driving circuit for said switch in-

cluding means for testing the condition of terminals associated with said brush, means responsive to certain tests to disable said driving means, a secondary means for testing terminals associated with said brush, and means under the control of said secondary testing means for establishing an auxiliary driving circuit for said driving means.

16. In a telephone system, fixed test terminals, a switch having a brush adapted to engage said terminals, driving means for said switch, a normal driving circuit for said switch including means for testing the condition of terminals associated with said brush, means responsive to certain tests to disable said driving means, a secondary means for testing terminals associated with said brush, means under the control of said secondary testing means for establishing an auxiliary driving circuit for said driving means, and means for rendering said normal driving circuit again effective in response to the action ensuing from the establishment of said auxiliary driving circuit.

17. In a telephone system, fixed terminals associated with electrical circuits, switches, each having a brush adapted to engage said terminals, driving means for each switch, a driving circuit for each of said driving means including means for testing the condition of terminals associated with each brush, means responsive to certain tests to simultaneously disable a plurality of said driving circuits, secondary means for testing terminals associated with said brushes, and means under the control of each secondary testing means for rendering any of said driving circuits again effective.

18. In a telephone system, lines, fixed test terminals for said lines, switches having brushes adapted to engage said terminals, driving means for said switches, test circuits responsive to any of a plurality of conditions of said lines to disable said driving means, other test circuits made responsive to one of said conditions of said lines, and means controlled by said second test circuit for rendering said driving means again effective.

19. In a telephone system, lines, fixed test terminals for said lines, a switch having a brush adapted to engage said terminals, driving means for said switch, a primary test circuit for energizing said driving means, a secondary test circuit responsive to one condition of a line encountered to disable said driving circuit, a tertiary test circuit made responsive to a particular condition of said line, and means controlled by said tertiary test circuit for rendering said primary test circuit again effective.

20. In a telephone system, banks of fixed terminals associated with electrical circuits, a plurality of switches with movable brushes, brush driving circuits, means for disabling said driving circuits responsive to the association of said brushes with certain of said electrical circuits, and second brush driving circuits independent of said first driving circuits automatically established for disconnecting any of said brushes from one of said certain circuits when the brushes of more than one switch have been associated with the same circuit.

21. In a telephone system, lines, fixed test terminals for said lines, a switch having a brush adapted to engage said terminals, driving means for said switch, a test circuit responsive to one condition of a line to disable said driving means, a second test circuit made responsive to other conditions of said line, and means controlled by said second test circuit for either establishing connections to said line or rendering said driving means again effective depending upon the condition of said line.

22. In a telephone system, in combination incoming lines, outgoing lines, a switch for interconnecting an incoming and an outgoing line, driving means for said switch, a primary test circuit including means operable upon the test of any outgoing line for disabling said driving means, thus positioning the switch for the interconnection of an incoming line to a particular outgoing line, and a secondary test circuit, established by the operation of said primary testing means, including means for controlling either the connection of said incoming line to said particular outgoing line or for rendering said driving means again effective, the alternative being dependent upon different conditions established at said particular outgoing line.

In witness whereof, I hereunto subscribe my name this 31st day of March A. D., 1925.

EDWARD E. HINRICHSEN.