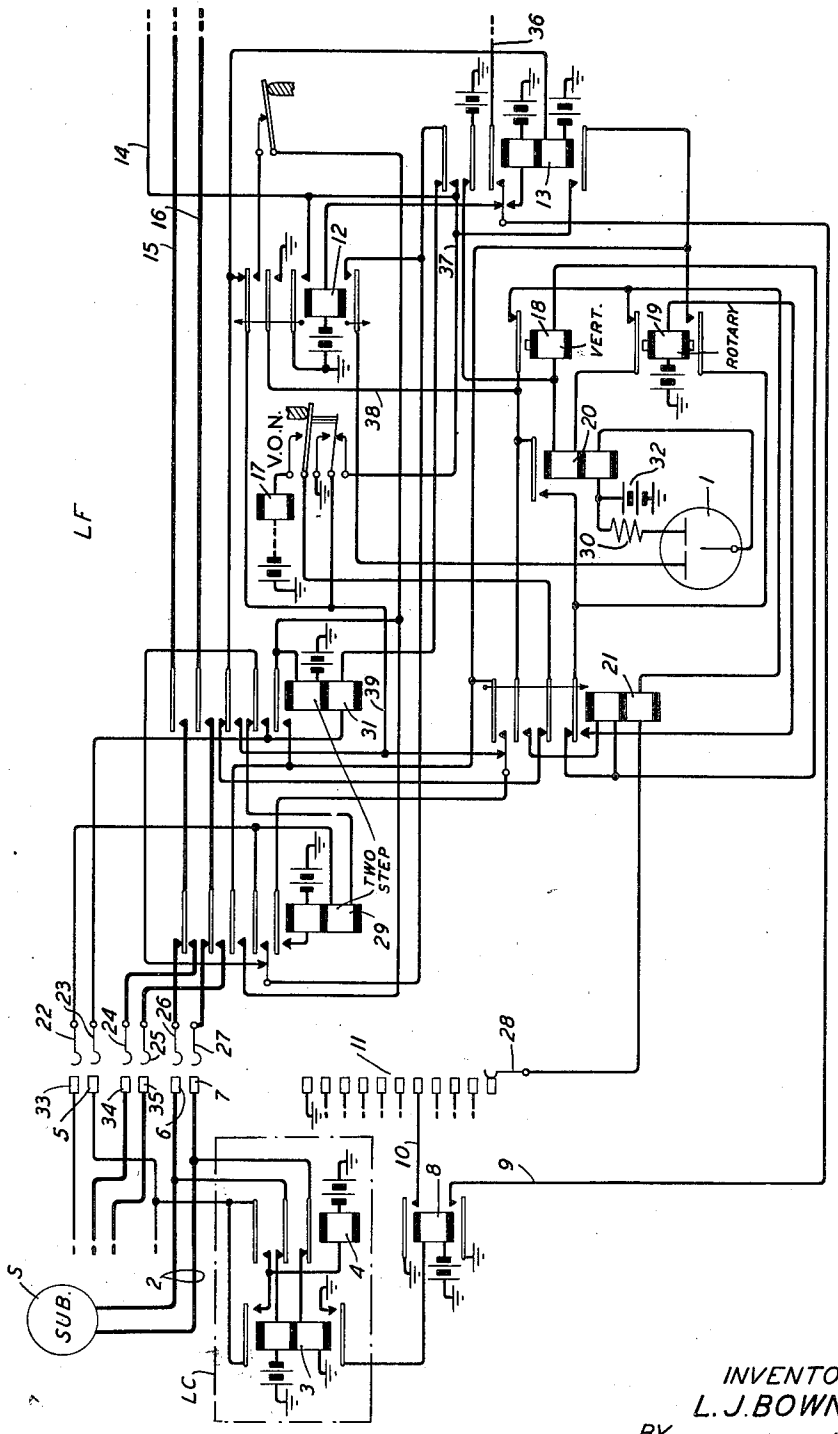
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SELECTIVE SWITCH

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SELECTIVE SWITCH

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This invention relates to selective switches and particularly to those employed in automatic and semi-automatic telephone systems.

The object of the invention is to improve the operation of these switches by enabling a more positive test to discriminate between the conditions existing on the circuits being tested.

In switches of the non-numerical or line-hunting type, such as the finder switch shown in the patent to Stokely No. 1,799,654 of April 7, 1931, it has been the practice to use a single relay for controlling the stepping action of the switch and also for testing the condition of the circuits over which the switch brushes pass. This relay and the hunting or rotary stepping magnet have their operating circuits each dependent on the other to thus cause the stepping movement of the switch by said magnet. Since the test terminal of the line for which the switch is hunting is identified by potential of one polarity, and since other lines may present potential of the opposite polarity, each time the switch encounters one of these latter lines, a short circuit is closed around the winding of said relay, which at this time is in its operated condition. This tends to delay the release of the relay and consequently to retard the hunting speed of the switch. To avoid this, the practice has been to stiffen the adjustment on the relay springs to insure that it will release promptly under these conditions. On the other hand when the desired line is reached said relay is required to remain energized, to thus stop the switch, in series with a considerable amount of resistance. Thus the said stepping and test relay must be capable of releasing and holding under two sets of opposing conditions.

According to a feature of this invention an improvement is secured in these switches by introducing a space-discharge tube in the circuit of said stepping and testing relay in such a way that the unlimited resistance of the tube prevents any flow of current through the winding of the relay while the switch is passing over unwanted lines. This eliminates any tendency to retard the releasing action of the relay, and it is, therefore, unnecessary to stiffen the adjustment of the springs. When, however, the desired line is reached, the potential encountered is of the proper polarity to cause the tube to discharge. Current now flows through the relay winding, and the relay, having a normal spring adjustment, is easily able to hold its armature attracted although there is resistance in circuit with its winding.

The foregoing and other features of the invention will be more readily understood from the following detailed description, which should be considered in conjunction with the accompanying drawing, and also from the appended claims.

Referring now to the drawing the single figure shows a line or trunk finder circuit LF, a calling subscriber's station S, and the calling subscriber's line circuit LC. Associated with the line or trunk finder LF over leads 14, 15 and 16, and individual to the line or trunk finder, is a trunk circuit, a repeater circuit, or a selector circuit (not shown) over which an originating call is extended towards the called subscriber's station. These circuits succeeding the finder are not shown, nor will a description of their operation be given, since the features of this invention are confined to the operation of the finder circuit LF in its selection of a calling line or trunk. The finder circuit LF is of the well-known Strowger type, but the invention may be applied to systems using other types of switches.

Associated with the circuits of the finder is a space-discharge tube 1. This tube is of the cold-cathode gas-filled discharge type which breaks down and becomes conducting when certain potential conditions are applied to its electrodes.

Assuming that the subscriber at station S originates a call, the removal of his receiver from the receiver hook causes line relay 3 to operate over an obvious circuit over line 2. In operating, line relay 3 connects battery, through the winding of the cut-off relay 4, to the sleeve conductor terminal 5 of the line finder terminals. The tip and ring conductors of line 2 are connected to finder terminals 6 and 7, respectively, and these terminals are associated with sleeve terminal 5 with respect to their position on the finder bank. Relay 3, in operating, closes an obvious circuit for operating group relay 8, which is common to all of the lines in the group with line 2. In operating, relay 8 connects ground to starting conductor 9 and also connects ground over conductor 10 to the commutator segment, of all finders having access to line 2, which corresponds to the level in which the terminals of line 2 are located. Conductor 10 is shown connected to the fourth segment of commutator 11, and line 2 is therefore assumed to be connected to terminals in the fourth level of the finder bank.

Assuming that the finder LF is idle, starting relay 12 operates in a circuit from battery through its winding, inner upper back contact of delay 13, over conductor 9, to ground over the lower front contact and armature of relay 8. In op-

erating, relay 12 connects ground over its inner upper armature and front contact to the associated trunk, repeater or selector circuit over sleeve conductor 14. Relay 12 also opens the circuit to the release magnet 17 over its outer upper back contact, and, in addition, closes the circuit from ground over its middle upper front contact and armature, armature and back contact of the vertical stepping magnet 18, back contact and armature of the rotary stepping magnet 19, upper winding of stepping relay 20, to battery over the middle upper back contact and armature of relay 13, causing stepping relay 20 to operate. The stepping relay 20, in operating, closes a circuit from ground over the middle upper front contact of relay 12, front contact of relay 20, inner upper back contact of relay 21, winding of the vertical stepping magnet 18, to battery over the middle upper back contact of relay 13. The vertical stepping magnet 18 operates and steps the shaft (not shown) and brushes 22 to 27 inclusive up to the first group of bank terminals. The vertical off-normal springs VON are actuated as soon as the shaft is moved out of its normal position, ground being thereby connected through the lower front contact of these springs to conductor 39. In operating, magnet 18 opens the circuit through the upper winding of the stepping relay 20. The commutator brush 28 is now in contact with the segment of the commutator 11 which corresponds to the group of lines which are connected to terminals in the first level of the multiple bank. Brush 28 is connected through the lower winding of relay 21, back contact of the rotary stepping magnet 19, upper winding of the stepping relay 20, to battery over the middle upper back contact of relay 13, but stepping relay 20 releases when magnet 18 operates since the lower winding of relay 21 and the upper winding of relay 20 are not energized until the brush 28 contacts the fourth commutator segment (to which ground was connected by the operation of group relay 8). In releasing, relay 20 opens the circuit through the vertical stepping magnet 18, which releases and in turn closes the operating circuit for relay 20 through the upper winding of that relay.

The vertical stepping magnet 18 and the stepping relay 20 alternately operate and release thereby elevating the line-finder shaft step by step until the commutator brush 28 contacts the commutator segment which corresponds to the level in which the terminals of the calling line are located (in this case the fourth segment). When brush 28 contacts the fourth segment, ground over the upper front contact of relay 8, fourth commutator segment and brush 28, is connected through the lower winding of relay 21, over the upper back contact of the rotary stepping magnet 19, through the upper winding of relay 20, to battery over the middle upper back contact of relay 13, causing relay 21 to operate and relay 20 to hold operated. Relay 21 locks in a circuit from battery over the middle upper back contact of relay 13, winding of vertical magnet 18, upper winding of relay 21, upper middle front contact of relay 21, to ground over the middle upper front contact of relay 12. The foregoing circuit is not effective in holding the vertical stepping magnet 18 and this magnet therefore releases. Relay 21, in operating, opens the operating circuit through the vertical stepping magnet 18 and closes a circuit from battery through the winding of the rotary stepping magnet 19, inner front contact of relay 21, front contact of relay 20, to ground over the middle upper front contact of relay 12. Vertical stepping magnet 18 releases and rotary stepping magnet 19 operates. In operating, magnet 19 opens the circuit through the upper winding of relay 20 and through the lower winding of relay 21 and advances the two sets of multiple brushes (22, 24, 26 and 23, 25 and 27, respectively) to contact the first two sets of terminals in the selected level of the line or trunk finder bank. Relay 21 is of the slow-to-operate type and provides an interval between the last vertical step and the first rotary step to insure that the brushes will not be vibrating when they enter the banks thereby eliminating the possibility of the snagging of these brushes.

As stated hereinbefore, the characteristics of tube 1 are such that when certain potential conditions are applied to its electrodes the tube breaks down or ionizes and its gaseous content becomes conducting. One cathode of tube 1 is connected through resistance 30, to the positive terminal of 48-volt battery 32. The second cathode of tube 1 is connected to brush 22 in a circuit which may be traced from the left cathode, lower front contact of relay 12, inner upper back contact of relay 29, inner upper back contact of relay 31, and through the lower winding of relay 29. This left cathode is also capable of being connected to brush 23 in a circuit over the lower front contact of relay 12, outer upper back contact of relay 13, and through the lower winding of relay 31. The anode of tube 1 is connected to the positive terminal of 48-volt battery 32 through the lower winding of relay 20.

Assuming that the calling line is not connected to either of the first two sets of bank terminals, the lines or trunks connected to these first sets of terminals are therefore either idle or busy and their associated sleeve-bank terminals (corresponding to sleeve terminals 5 and 33) present one of four conditions to the brushes 22 and 23 of the hunting finder LF. First, if connected to an idle line, no potential exists on the sleeve terminal, as, for example, no potential would be present on sleeve terminal 5 if line 2 were idle since relay 3 would not be operated to connect the battery through the winding of relay 4 to terminal 5. Second, if connected to a busy line, the sleeve bank terminal has ground connected to it after the selector, repeater or trunk circuit associated with the particular finder connected to that line has functioned. Third, if connected to a line which has just been selected by a finder and before the selector, repeater or trunk circuit associated with that particular finder has functioned to return the busy ground, as set forth in the second condition, the sleeve terminal has a potential of approximately 10 volts negative. Fourth, if connected to a busy line and message registration is taking place on that line, the sleeve terminal presents a positive potential of approximately 60 volts to the sleeve brush of the hunting line-finder.

When the operation of rotary magnet 19 advances the two sets of brushes to contact the first two sets of bank terminals as hereinbefore described, brushes 22 and 23, upon contacting the first sleeve terminals, encounter either no potential, ground potential, negative 10 volts or positive 60 volts, depending on the condition of the line connected to the first two sets of terminals as hereinbefore set forth. Since brushes 22 and 23 are connected to the left cathode of tube 1, over circuits previously traced, no potential, ground

potential, negative 10 volts or positive 60 volts is impressed on the left cathode of tube 1 this time. None of these potential conditions is, however, effective in causing tube 1 to ionize or break down, and the tube therefore remains in the non-conducting condition. As stated previously, rotary magnet 19, in operating, opens the circuit through the upper winding of relay 20 and through the lower winding of relay 21, releasing relay 20. In releasing, relay 20 opens the circuit through rotary magnet 19, and the release of magnet 19 again closes the circuit through the upper winding of relay 20. The stepping relay 20 and rotary magnet 19 are, therefore, alternately operated and released to advance the line or trunk finder brushes step by step until sleeve brush 22 or sleeve brush 23 makes contact with the sleeve terminal of that set of terminals to which the calling line is connected.

If and when brush 23 makes contact with the sleeve terminal of the calling line, a circuit is closed from the negative terminal of the 48-volt office battery, through the winding of cut-off relay 4, over the upper front contact of line relay 3, sleeve terminal 5, brush 23, lower winding of relay 31, outer upper back contact of relay 13, lower front contact of relay 12, to the left cathode of tube 1. With negative 48 volts on its left cathode, and positive 48 volts from battery 32 through resistance 30 on its right cathode, tube 1 ionizes and becomes conducting, thereby completing a circuit from the positive terminal of battery 32, through the lower winding of relay 20, anode of tube 1, left cathode of tube 1, lower front contact of relay 12, outer upper back contact of relay 13, lower winding of relay 31, brush 23, sleeve terminal 5, to the negative terminal of the office battery through the winding of cut-off relay 4. Cut-off relay 4 operates and relay 31 is energized sufficiently to close its inner front contact. The upper winding of relay 31 is thereby energized in a circuit from battery through its upper winding and locking contact, lower front contact of magnet 19, front contact of relay 20, to ground over the middle upper front contact of relay 12. Relay 31, which completely operates in the circuit through its upper winding, extends the connection through to the associated selector, repeater or trunk circuit over conductors 15 and 16. The tip circuit of the line may be traced over bank terminal 6, brush 26, outer back contact of relay 29, outer front contact of relay 31, and over conductor 15. The ring circuit may be traced over bank terminal 7, brush 27, next-to-outer back contact of relay 29, next-to-outer front contact of relay 31, and over conductor 16.

Assume that the calling line does not connect to bank terminals 5, 6 and 7, as shown, but is connected instead to bank terminals 33, 34 and 35. In this instance, if and when brushes 22, 24 and 25 contact terminals 33, 34 and 35, respectively, a circuit is closed from the negative terminal of the 48-volt office battery, through the winding of cut-off relay 4, over the sleeve bank terminal 33, brush 22, through the lower winding of relay 29, inner back contact of relay 31, back contact of make-before-break contacts of relay 29, lower make contact of relay 12, to the left cathode of tube 1. Since the potential difference between its cathodes is now sufficient to cause ionization, tube 1 breaks down and becomes conducting, thereby completing a circuit from the positive terminal of battery 32, through the lower winding of relay 20, anode and left cathode of tube 1, lower front contact of relay 12, to the negative terminal of the 48-volt office battery through the lower winding of relay 29 and the winding of cut-off relay 4 over a previously traced circuit. Cut-off relay 4 operates and relay 29 is energized sufficiently to close its inner front contact. The upper winding of relay 29 is thereby energized in a circuit from battery through its upper winding and locking contact, front contact of the make-before-break contacts of relay 21, lower front contact of magnet 19, front contact of relay 20, the ground over the middle upper front contact of relay 12. Relay 29, which completely operates in the circuit through its upper winding, closes a circuit for operating relay 31. This circuit may be traced from battery through the upper winding of relay 31, over the middle front contact of relay 29, lower front contact of magnet 19, front contact of relay 20, to ground over the middle upper front contact of relay 12. With relays 29 and 31 both operated, the connection from the calling line over terminals 34 and 35 and brushes 24 and 25, respectively, is extended to conductors 15 and 16 and thence to the associated selector, repeater or trunk circuit.

If brush 23 finds the calling line, the complete operation of relay 31 is effective to short-circuit its lower winding. If brush 22 finds the calling line, the complete operation of relay 29 is effective to short-circuit its lower winding. In either case the cut-off relay 4 is held operated over the particular sleeve terminal and brush, over either the next-to-inner front contact of relay 31 and back contact of the make-before-break contacts of relay 29, or over the next-to-inner make contact of relay 29, and over the lower front contact of relay 12, cathode-anode circuit of tube 1, and lower winding of relay 20 to the positive terminal of battery 32. The complete operation of relay 31 is, in either case, also effective to open the circuit through the lower winding of relay 29, and to close a circuit for operating relay 13. This operating circuit for relay 13 may be traced from battery through its lower winding, over the middle armature and front contact of relay 31, to ground over the lower armature and front contact of the VON springs. In operating, relay 13 closes a circuit from conductor 14, in parallel with ground over the inner upper front contact of relay 12, to brush 22 or brush 23 and to the left cathode of tube 1 over the lower front contact of relay 12. This ground holds the cut-off relay 4 operated, and also since the potential on the left cathode and also on the anode of tube 1 is positive, the tube is caused to deionize, thereby opening the circuit through the lower winding of relay 20, which releases. Relay 13, in operating, also closes an additional holding circuit for relay 31 from battery through the upper winding and inner front contact of relay 31, over the lower front contact of relay 13, to ground over the inner front contact of relay 12 over conductor 37. The operation of relay 13 also opens the circuit from battery over its middle upper armature and back contact through the winding of magnet 18 and the upper winding of relay 21. Relay 21, in releasing, disconnects the upper winding of relay 29, if operated, from the lower armature of relay 13 and connects this winding to ground over the lower armature and front contact of the VON springs.

In operating, relay 13 is also effective in closing a circuit from battery through its upper winding and inner upper front contact to the

starting conductor 9 and to extend this conductor over its inner upper armature, over conductor 36, to the next finder in the same group with finder LF. Relay 13 also opens the circuit from ground over conductor 9 to the winding of relay 12. Relay 12 is slow in releasing so that the ground over its inner upper front contact is not disconnected from conductor 37 until after ground has been returned to this conductor by the associated selector, repeater or trunk circuit (not shown) over conductor 14. Relay 12, in releasing, opens the circuit from ground to conductor 38, opens the circuit from ground over conductor 14, outer upper front contact of relay 13, lower front contact of relay 12 to the left cathode of tube 1, opens the circuit from ground to conductor 37, this conductor having previously become grounded over conductor 14, and, in addition, connects its upper back contact in parallel with the middle front contact of relay 31, thus rendering the circuit through the lower winding of relay 13 independent of the continued operation of relay 31.

The aforementioned operation of cut-off relay 4 opens the circuit through the windings of the subscriber's line relay 3. The release of relay 3 opens the circuit through the winding of the group relay 8 causing relay 8 to release unless a call has been originated by a subscriber on some other line in the same group with line 2.

When the calling line is extended over conductors 15 and 16, by the operation of relay 31 as hereinbefore described, the succeeding circuits function in response to impulses from the dial at station S, and the connection may be completed to the called station in a manner well known to the art.

Upon the termination of the conversation, disconnection at the calling end causes the circuits succeeding the line-finder LF to release and remove the ground from conductor 14. The removal of this holding ground from conductor 14 causes the release of relays 31 and 4 when the line is connected to terminals 5, 6 and 7, as illustrated. Should the line be connected to terminals 33, 34 and 35, the removal of ground from conductor 14 also causes the release of relays 31 and 4. In either case, the release of relay 31 closes a circuit from ground over the lower front contact and armature of the VON springs, over the upper back contact of relay 12, outer upper back contact of relay 31, middle back contact of relay 21, upper armature and front contact of the VON springs, to battery through the winding of the release magnet 17. In operating, magnet 17 causes the line-finder brushes to restore to normal at which time the VON springs are returned to their normal position thereby opening the circuit through the winding of the release magnet 17 and opening the ground from the upper winding of relay 29 and from the lower winding of relay 13. Relay 29 releases and relay 13 also releases unless the starting conductor 9 is grounded in which case relay 13 holds operated through its upper winding until the ground is disconnected by the release of the group relay 8.

While the invention has been shown in connection with a finder switch for subscribers' telephone lines, it is obviously applicable to switches of other types and for other uses.

What is claimed is:

1. In combination, a switch having a plurality of fixed circuit terminals and a movable contact for testing the condition of said terminals, means for placing potential of either polarity on said terminals, a stepping magnet for moving said contact over said terminals, a relay for controlling the stepping action of said magnet, a space-discharge device arranged to permit or prevent the flow of current between its electrodes according to the potential applied thereto, and means for including said device in circuit with said movable contact and said relay.

2. In combination, a switch having a contact bank and a test brush for engaging the contacts of said bank, means for placing a potential of either polarity on said contacts, a stepping magnet for advancing said test brush over the contacts of said bank, a relay for controlling the stepping action of said magnet, a gas-filled tube arranged to permit or prevent the flow of current between its electrodes according to the polarity of the potential applied thereto, and means for including said tube in circuit with said testing brush and said relay.

3. In a telephone system, a line-finder switch having a bank of fixed terminals, lines appearing in said terminals, a brush for engaging said terminals, means for placing a ground potential on said terminals to identify the lines as busy, means for placing a battery potential on said terminals for identifying the line as calling, a stepping magnet for advancing said brush from terminal to terminal, a relay for controlling the stepping action of said magnet, a space-discharge tube arranged as to permit or prevent the flow of current between its electrodes according to whether battery or ground potential is applied thereto, and means for including said tube in circuit with said brush and said relay.

4. In combnation, a switch having a plurality of fixed circuit terminals and a movable contact for testing the condition of said terminals, means for placing potential of either polarity on said terminals, a stepping magnet for moving said contact over said terminals, a discharge device having an input and two output electrodes, a circuit including one of said output electrodes, a second circuit including the other output electrode, means effective when said movable contact engages a terminal having thereon a potential of one polarity for causing an initial flow of current in said first circuit and the subsequent flow of current in said second circuit, said discharge device being unresponsive when said contact encounters a terminal of the other polarity, and a relay in said second circuit for controlling the action of said stepping magnet.

5. In combination, a switch having a plurality of fixed circuit terminals and a movable contact for testing the condition of said terminals, means for placing potential of polarity on said terminals, a stepping magnet for moving said contact over said terminals, a discharge device having an input and two output electrodes, a circuit including one of said output electrodes, a second circuit including the other output electrode, means effective when said movable contact engages a terminal having thereon a potential of one polarity for causing an initial flow of current in said first circuit and the subsequent flow of current in said second circuit, said discharge device being unresponsive when said contact encounters a terminal of another polarity, a relay having a winding controlled by said stepping magnet, and a second winding for said relay energized by current flowing in said second circuit for arresting the stepping action of said magnet.

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