

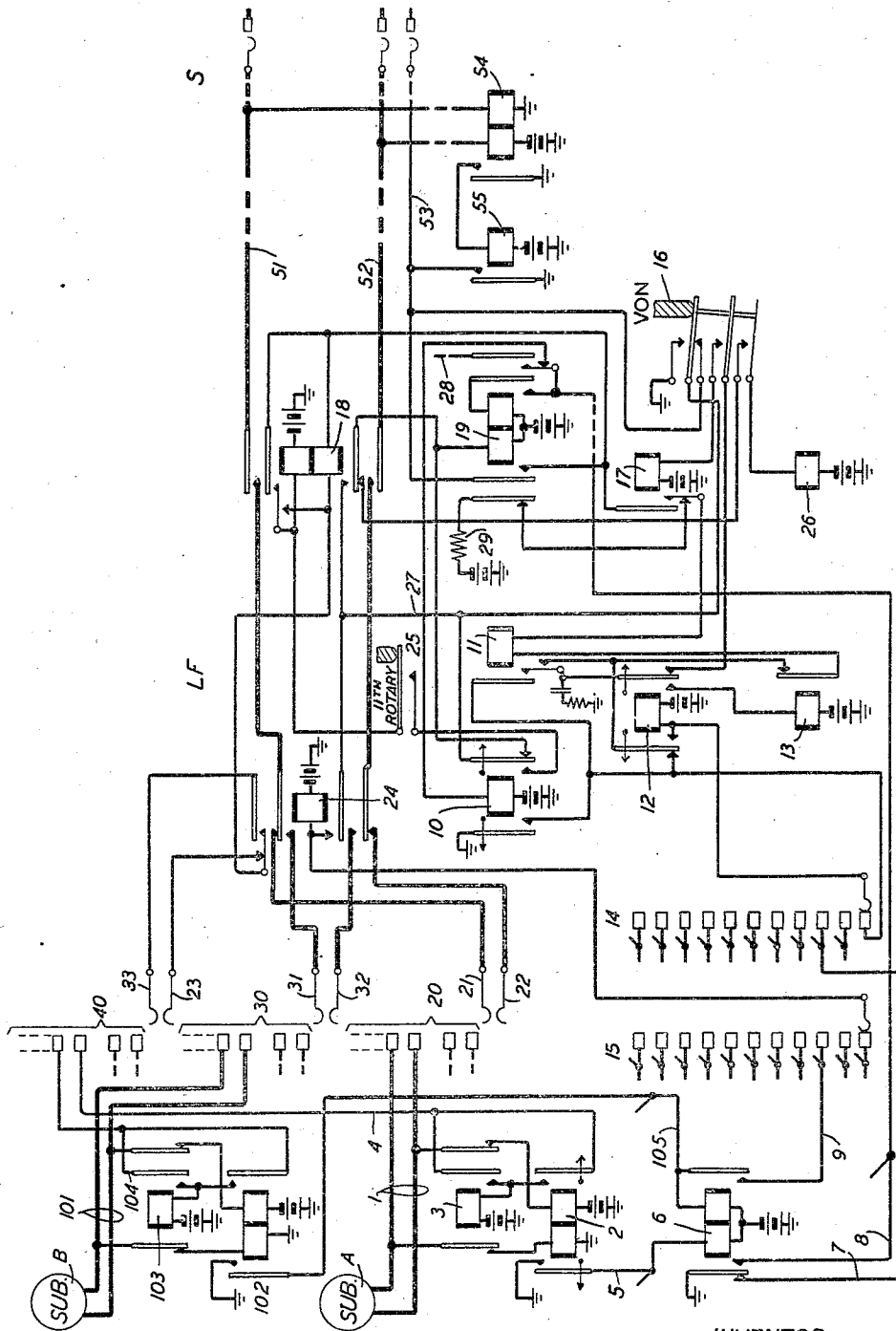
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TELEPHONE EXCHANGE SYSTEM

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TELEPHONE EXCHANGE SYSTEM

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This invention relates to telephone systems and more particularly to systems in which automatic switches are provided for establishing connections.

The object of this invention is to improve the construction of line-finder switches and to render their operation more positive and reliable.

In telephone systems now in use two-motion step-by-step automatic switches having two sets of brushes are employed as line-finders for extending calling lines to idle first selectors. The lines terminating in the banks of such a line-finder are divided into groups, one group for each level. Each group is divided into two sub-groups, the lines in one sub-group being accessible to the one set of brushes and the lines in the other sub-group being accessible to the other set of brushes. Upon the origination of a call over one of the lines, both sets of brushes are advanced in a primary movement to the level in which the terminals of the calling line are located; thereafter the brushes are advanced in a secondary movement into engagement with the terminals of the calling line. It is necessary that the set of brushes through which connection with the calling line is established be rendered effective to the exclusion of the other set of brushes. In order that the action of the finder be more positive when the terminals of the calling line are reached it is desirable that brush selection be completed prior to the secondary movement of the switch.

According to this invention, a two-motion line-finder switch having two sets of brushes is also provided with two commutators, one for use in selecting the group of terminals in which the terminals of the calling line are located, and the other for indicating the sub-group and for rendering the set of brushes having access thereto effective to the exclusion of the other set of brushes.

Another feature of this invention is a line-finder switch having two sets of brushes and

two commutators, one for use in selecting the group of terminals in which the terminals of the calling line are located and the other for cooperating with a group relay, which is common to the two sub-groups in the calling level, to make brush selection as soon as the level of the calling line is reached.

The invention is illustrated in a system using step-by-step line-finder switches each having a capacity of 200 lines; but the invention is applicable to any finder switch equipped with two sets of brushes and banks. In such a system the subscribers' lines are divided into groups of 200 lines, the lines of each group being connected to terminals in the banks of a corresponding group of line-finder switches. One set of brushes of each line-finder switch has access to the terminals of one half of the lines of a group, and another set of brushes has access to the terminals of the other half of the group. Each line is provided with the usual line and cut-off relays, and a start relay (also known as a group relay) is provided for every 20 lines to which both sets of brushes have access on one level. Upon origination of a call at any station the operation of the corresponding line and start relay causes an idle line-finder switch to hunt for the terminals of the calling line. Since only one of the two sets of brushes of each switch have access to the terminals of a particular line, each line-finder is arranged to transfer its line conductors from one set of brushes to the other, depending upon in which of the two sub-groups the terminals of the calling line are located.

The drawing discloses a line-finder switch embodying the features of this invention and also illustrates in diagrammatic manner a first selector switch with which the line-finder is permanently associated.

Referring to the drawing, A and B represent subscribers' stations connected, by the lines 1 and 101, respectively, to terminals in

the banks of a group of line-finder switches, of which one only is shown. This line-finder LF has two sets of brushes, mounted on one shaft and designated 21, 22 and 23 and 31, 32 and 33, respectively. The brushes 21 and 22 have access to the terminal bank 20, the brushes 31 and 32 have access to the bank 30, and the brushes 23 and 33 have access to the bank 40. Each bank has 100 sets of terminals arranged in ten levels, ten pairs of terminals per level. The two terminals of each pair are separated vertically the same amount as the corresponding pair of brushes; so that both brushes of a pair make contact simultaneously with both terminals of a set in any position. A brush-switching relay 24 controls the connections from the two sets of brushes so that only the brushes 21, 22 and 23 are operatively effective when relay 24 is normal, and only the brushes 31, 32 and 33 are operatively effective when relay 24 is operated. A vertical magnet 13 is provided for advancing the shaft and brushes one step at a time in a vertical direction; and a rotary magnet 17 is provided for rotating the shaft and brushes one step at a time over the terminals in any selected level. A release magnet 26 is provided for releasing the shaft so that the brushes may be returned to their normal position.

The conductors of 100 lines, including the line 1, are connected to the terminals in bank 20; and the conductors of another 100 lines including the line 101, are connected to the terminals in bank 30. The associated test or sleeve conductors of these lines are connected to the correspondingly located terminals in the bank 40. Thus line 1 is shown connected to terminals in the second level of bank 20, line 101 is shown connected to terminals in the second level of the bank 30, the sleeve conductor 4 of line 1 is connected to the lower terminal of the pair which is located in the corresponding position of the second level of bank 40, and the sleeve conductor 104 of line 101 is connected to the upper terminal of this pair in bank 40. The start (group) relay 6 is associated with all of the lines connected to the second level of both banks 20 and 30; and it is operated whenever the origination of a call over any of these lines causes the operation of the corresponding line relay. The operation of relay 6, or of any of the other start (group) relays associated with lines connected to banks 20 or 30, connects ground to start conductor 8 which leads successively through all the busy line-finders of the associated group to the start relay of the first idle finder.

The switch LF also includes two commutators 14 and 15, each of which has one segment with which the corresponding commutator brush is normally in contact and ten off-normal segments, one for each level of

the terminal banks. The brushes are attached to the shaft so that they make contact successively with each of the off-normal commutator segments during the vertical movement of the switch. Ground is normally connected to each of the ten off-normal segments of commutator 14, but the operation of any one of the ten start relays disconnects the ground from the corresponding segment so as to stop the vertical movement of the switch when the multiple brushes have been raised to the level in which the terminals of the calling line are located. Commutator 15 is used to control the operation of brush-switching relay 24, the segments of this commutator being normally connected neither to battery nor to ground. Whenever a call is originated over a line connected to terminals of bank 30, the operation of the start (group) relay connects ground to the corresponding off-normal segment of commutator 15 so as to operate relay 24 when the multiple brushes have been raised to the calling level. The rotary magnet 17 is then effective to rotate the brushes successively from one set of terminals to the next until the terminals of the calling line are reached.

To describe the operation in detail assume that the subscriber at station A initiates a call. When the receiver is removed from the receiver hook at station A the line relay 2 operates in an obvious circuit. Relay 2 closes a circuit for operating group relay 6 and the winding of cut-off relay 3 is connected through the right-hand front contact of relay 2, over conductor 4, to the sleeve terminal of the line 1 in bank 40. Relay 6 disconnects ground from conductor 7, so as to mark the second commutator segment of all of the line-finders having access to the line 1, and connects ground to start conductor 8. Assuming the line-finder LF to be the first idle finder in the group, the ground on conductor 8 is extended through the outer right-hand back contact of relay 19 to the winding of relay 10. Relay 10 operates thereby closing a circuit for energizing relays 11 and 12. The circuit for operating relay 12 may be traced from battery through its winding, through the brush and normal segment of commutator 14, to ground at the left-hand front contact of relay 10. The circuit for energizing relay 11 may be traced from battery through resistance 29, the left-hand back contact of relay 19, through the normally closed contacts of rotary magnet 17, winding of relay 11, back contact of the vertical magnet 13, and through the left-hand back contact of relay 12, to ground at the left-hand front contact of relay 10. When relay 12 operates the circuit for operating relay 11 is traced through the left-hand front contact of relay 12 (instead of through its back contact) and thence through the brush and normal segment of commutator 14, to ground

at the the left-hand front contact of relay 10. Relay 11 is locked operated through its front contacts, independent of relay 12 and independent of the commutator 14; and relay 12 is locked operated through its left-hand front contact and the front contacts of relay 11, to the ground at the left-hand front contact of relay 10.

With both relays 11 and 12 operated, a circuit is closed for operating the vertical magnet 13; this circuit is traced from battery through its winding, the right-hand front contact of relay 12, and the outer left-hand front contact of relay 11, to ground at relay 10. The operation of vertical magnet 13 raises the shaft and all multiple and commutator brushes up to the first level, and opens the circuit through the winding of relay 11. When relay 11 releases, it opens the circuit through the winding of magnet 13, thereby causing the release of magnet 13. If the terminals of the calling line were located in the first level of the terminal bank, relay 12 would release as soon as its locking circuit is opened by the release of relay 11, the operating circuit for relay 12 having been opened when the brush of commutator 14 was advanced from its normal position. But in the case here under consideration the terminals of the calling line are not located in the first level, and relay 12 is held operated through the brush and first segment of commutator 14, to ground at the back contact of the group relay associated with the lines which do connect to terminals in the first level. Relay 11 is then reoperated through the left-hand front contact of relay 12, to ground on the first off-normal segment of commutator 14. When relay 11 reoperates, a circuit is again closed for energizing the vertical magnet 13; and the reoperation of magnet 13 steps the shaft and brushes up to the second level. With magnet 13 operated, relay 11 again releases, thereby opening the circuit through the winding of magnet 13 and again opening the locking circuit of relay 12. Since the ground normally connected to the second segment of commutator 14 has been disconnected therefrom by the operation of relay 6, relay 12 releases to prevent the further operation of magnet 13. The calling line being connected to bank 30, to which brushes 21 and 22 have access, it is not necessary to operate the brush switching relay 24; and since relay 6 was operated through its left-hand winding, no ground is connected to conductor 9 to cause the operation of relay 24.

As soon as the shaft was moved upward from its normal position, the vertical off-normal springs 16 were operated to connect ground to conductor 27 and to prepare for the operation of the rotary magnet 17. The release of relay 12, after the brushes have been advanced to the calling level, again closes a

circuit for operating relay 11; and the reoperation of relay 11 closes a circuit, for operating the rotary magnet 17, from battery through its winding, the middle front contact of the vertical off-normal springs 16, the right-hand back contact of relay 12, and through the front contacts of relay 11 to ground at relay 10. Magnet 17 advances the multiple brushes to the first set of terminals in the selected level, opens the circuit for operating relay 11, and connects the winding of relay 11 through the front contacts of magnet 17, the lower winding of relay 18, and through the outer upper back contact of relay 24 to the test brush 23. If the calling line is connected to the first set of terminals, set of terminals in the selected level, relay 11 is extended through brush 23, over the sleeve conductor of the calling line, through the front contact of the operated line relay, and through the winding of the cut-off relay to battery, thereby holding relay 11 operated to prevent the further advance of the brushes. If the calling line is connected to some other set of terminals in the selected level, relay 11 is not held operated and the release of relay 11 causes the release of magnet 17. When magnet 17 releases, relay 11 reoperates; and the reoperation of relay 11 causes the reoperation of magnet 17. Relay 11 and magnet 17 are in this manner alternately operated and released until the test brush 23 reaches the sleeve terminal to which conductor 4 is connected, at which time relay 11 is held operated in series with the winding of cut-off relay 3. The cut-off relay 3 operates and relay 18 is sufficiently energized by the current through its lower winding to close a locking circuit from battery through its upper winding and middle upper front contact, through the front contact of magnet 17, the winding of relay 11, the back contact of magnet 13, and through the front contacts of relay 11, to ground at the left-hand front contact of relay 10. Relay 18 is now completely operated to extend the connections from line 1 through brushes 21 and 22, the outer back contacts of relay 24, and the outer front contacts of relay 18, over conductors 51 and 52, to the windings of the line relay 54 of the associated selector S. Relay 18 also closes a circuit for operating relay 19, from battery through the left-hand winding of relay 19 and the inner lower front contact of relay 18, to the off-normal ground on conductor 27.

When the line relay 54 of selector S operates in the circuit over the calling line, it closes a circuit for operating relay 55. Relay 55 connects ground over the sleeve conductor 53, through the inner left-hand front contact of relay 19, the middle and inner upper front contacts of relay 18, and the outer upper back contact of relay 24 to sleeve brush 23, thereby holding cut-off relay 3 operated until the connection is released by the

calling subscriber. The ground on conductor 53 is also extended through the left-hand front contact of relay 19 and the middle upper front contact of relay 18 to hold relay 18 operated until the connection is released, the lower winding of relay 18 being short-circuited by its own inner and middle upper front contacts.

With the holding ground connected to conductor 53, the winding of relay 11 is short-circuited to cause the release of relay 11; and the release of relay 11 opens the circuit through magnet 17. Relay 11 cannot reoperate since the circuit for operating this relay is held open at the left-hand back contact of relay 19. Relay 19 is held operated as long as the off-normal ground is connected to conductor 27. With relay 19 operated, the starting conductor 8 is disconnected from the winding of relay 10 and extended through the outer right-hand front contact of relay 19, over conductor 28 to the next line-finder in the group. Relay 10 releases and relay 19 is now held operated independently of relay 18 by the circuit from battery through the left-hand winding of relay 19, through the back contact of relay 10, to the off-normal ground on conductor 27.

When operated, the cut-off relay 3 locks through its own front contact independently of line relay 2, and disconnects the conductors of line 1 from the winding of line relay 2. Relay 2 releases thus disconnecting the ground at its left-hand front contact from conductor 5. Group relay 6 releases unless the origination of a call over one of the other lines associated with this relay has caused ground to be connected to conductor 5. When relay 6 releases, it reconnects ground over conductor 7 to the second off-normal segment of commutator 14 and disconnects the ground at its left-hand front contact from start conductor 8.

No further operation takes place in the line finder circuit until the connection is released by the calling subscriber at which time the selector switches and connector switch through which the connection is completed to a called line are restored to normal and the holding ground is disconnected from the sleeve conductor 53. The cut-off relay 3 releases when the holding ground is disconnected from conductor 53 so that another call may be initiated or an incoming call received at station A. Relay 18 also releases when the holding ground is disconnected from conductor 53, thereby closing a circuit for operating the release magnet 26; this circuit is traced from battery through its winding, lower front contact of the VON springs 16, lower back contact of relay 18, and through the back contact of relay 10 to ground on conductor 27. When the shaft and brushes reach their normal position, the ground at the VON springs 16 is disconnected from conductor 27

thereby releasing release magnet 26 and opening the circuit through the left-hand winding of relay 19. Relay 19 releases unless it is held operated by a circuit through its right-hand winding and front contact over start conductor 8 to ground at the start (group) relay of some other line which has originated a call. As soon as the start conductor 8 is no longer connected to ground, relay 19 releases thereby reconnecting start conductor 8 through its right-hand back contact to the winding of relay 10 in readiness for the next call.

When a call is originated at station B, line relay 102 operates to cause the operation of group relay 6 and to connect the winding of cut-off relay 103 over conductor 104 to the sleeve terminal of this line in bank 40. Group relay 6 now disconnects ground from the second off-normal segment of commutator 14, connects ground to start conductor 8 and also extends the ground at the left-hand front contact of line relay 102, through the right-hand front contact of relay 6, over conductor 9 to the second off-normal segment of commutator 15. The operation of the line-finder LF in searching for the calling line is now the same as that described when a call is originated at station A, except that the switching relay 24 is operated as soon as the brushes have been advanced to the second level. The circuit for operating relay 24 is traced from battery through its winding, brush and second off-normal segment of commutator 15, and through the right-hand front contact of relay 6 to ground at the left-hand front contact of relay 102. The switching relay 24 locks through its inner lower front contact over conductor 27 to the off-normal ground at the VON springs 16. With relay 24 operated, brushes 31, 32 and 33 are rendered operatively effective to the exclusion of brushes 21, 22 and 23. Relay 24 holds until the connection is released and the off-normal ground is disconnected from conductor 27.

In case the shaft and brushes are stepped around to the tenth set of terminals in any level without finding the calling line, an additional step is taken thereby closing the contacts of the "11th rotary step" springs 25. Relay 18 is thereby operated through its upper winding even though the calling line has not been found. The operation of relay 18 closes the circuit for operating relay 19 thereby extending the starting conductor 8 to the next line-finder in the group. Relay 10 is thus released and, when relay 10 releases, relay 18 releases. With relay 18 released the circuit for operating the release magnet 26 is closed and the switch is returned to normal in the usual manner.

What is claimed is:

1. The combination in an automatic switch of a bank comprising groups of terminals, a plurality of sets of brushes, means including a commutator for advancing said brushes in

a primary movement to select one of said terminal groups, means including a second commutator and effective at the end of the primary movement to select one of said brush sets, and means for advancing said brush sets in a secondary movement into engagement with the terminals of the selected group.

2. In combination, an automatic switch having two sets of brushes and terminal banks, a relay for switching from one set of brushes to the other, groups of terminals in each bank so arranged that both sets of brushes simultaneously engage the terminals of a pair of said groups, a start relay for each of said pairs of groups, means effective in consequence of the operation of any one of said start relays for advancing said brushes in a primary movement, a circuit opened when said brushes reach the pair of groups corresponding to the operated one of said start relays to stop the primary movement, another circuit controlled in part by said one of said start relays and effective as soon as said brushes reach the corresponding pair of said groups for operating said switching relay, and means for advancing said brushes in a secondary movement into engagement with the terminals in said corresponding pair of groups to select one of the sets of terminals.

3. In a telephone system, an automatic switch having two sets of brushes and terminal banks, a relay for switching from one set of brushes to the other, groups of lines each divided into two subgroups, the lines of one subgroup being accessible to one of said sets of brushes and the lines of the other subgroup being accessible to the other of said sets of brushes, group relays one for each of said groups of lines, means including one of said group relays effective upon the origination of a call over one of the lines of the associated group for marking this group, means including a magnet for advancing both sets of brushes, a circuit closed when said brushes reach said marked group to stop the advance of said brushes, and a circuit closed when said brushes reach said marked group for operating said switching relay.

4. In combination, a two-motion automatic switch having two sets of brushes and terminal banks, a relay for switching from one set of brushes to the other, groups of lines each group comprising two subgroups, the lines of one subgroup being connected to terminals in one of said banks and the lines of the other subgroup being connected to the correspondingly located terminals in the other of said banks, group relays one for each of said groups of lines, means effective upon the operation of one of said group relays for advancing the brushes in a primary movement to select the corresponding subgroup, a circuit opened when said brushes reach said corresponding subgroup to stop the primary movement, a second circuit effective as soon as

the brushes reach said corresponding subgroup to operate said switching relay, and means for advancing said brush sets into engagement with the terminals of the selected group.

5. In a telephone system, a two-motion line-finder switch having two sets of brushes, groups of terminals in the bank of said switch, each group divided into two sub-groups, relays one for each of said groups of terminals, subscribers' lines connected to the terminals of said bank, means including one of said group relays and effective upon the origination of a call over one of said lines for starting the operation of said switch, means including a commutator for advancing the brushes of said switch in a primary movement to the group which includes the terminals of the calling line, means for advancing said brushes in a secondary movement into contact with the terminals of said selected group and means including said group relay and a second commutator for determining which set of brushes is to be effective during said secondary movement.

6. In a telephone system, a finder switch comprising two sets of terminal banks and corresponding sets of brushes, groups of lines connected to the terminals in said banks so that one of said sets of brushes has access to half the lines in each group and the other of said sets of brushes has access to the other half of said lines in each group, a relay for switching from one set of brushes to the other, group relays one for each of said groups of lines, means effective upon the operation of any one of said group relays for advancing the brushes in a primary movement, a circuit opened when the brushes reach the group corresponding to said one of the group relays to stop the primary movement, a circuit closed when said brushes reach said corresponding group for operating said switching relay, and means for advancing said brushes in a secondary movement to select one of the sets of terminals in said corresponding group.

7. In a telephone system, a two-motion finder switch comprising two sets of terminal banks and corresponding sets of brushes, groups of lines connected to the terminals in said banks so that one set of brushes has access to half of the lines in each group and the other of said brushes has access to the other half of said lines in each group, a relay for switching from one set of brushes to the other, group relays one for each of said groups of lines, two commutators having segments corresponding to each of said groups, means effective upon the origination of a call over any one of said lines for operating the corresponding one of said group relays to mark the corresponding segment of one of said commutators, means for advancing said brushes in a primary movement to said marked group, means including the corresponding

segment of the other of said commutators effective if said one of said group relays is operated in consequence of the origination of a call over a line to which one of said sets of brushes has access and ineffective if said one of said group relays is operated in consequence of the origination of a call over a line to which the other of said sets of brushes has access for operating said brush switching relay, and means for advancing said brushes in a secondary movement to select the set of terminals to which the calling line is connected.

In witness whereof, I hereunto subscribe
my name this 30th day of September, 1930.
RAY L. STOKELY.