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TELEPHONE SYSTEM

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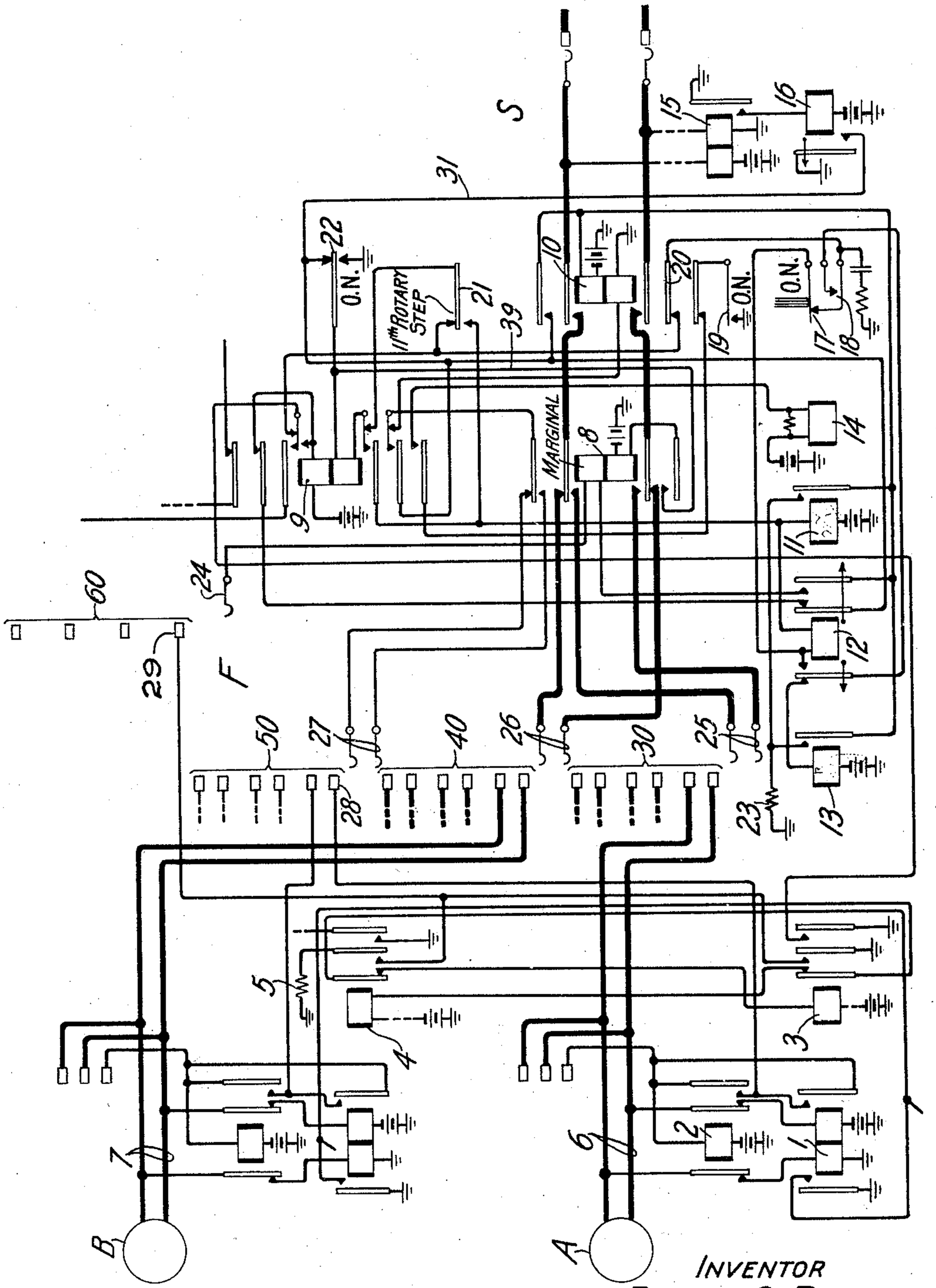

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TELEPHONE SYSTEM

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This invention relates to telephone systems and more particularly to improvements in the construction and operation of automatic switches.

According to a feature of the invention an automatic switch, having a plurality of brush sets, which engage simultaneously respective groups of terminals, is arranged to make a preliminary movement to position the brush sets with respect to the groups and to selectively render effective a desired set.

Another feature of the invention is an automatic switch having a stepping magnet the operating circuit of which is repeatedly opened and closed at the normally closed contacts of an interrupter relay.

To consider a specific and practical application of the invention, a line finding switch is equipped with two sets of brushes arranged on a single shaft having a vertical movement to position the brush sets, each opposite successive levels of contacts. At the end of the vertical movement the brush sets stand each opposite a level of contacts, one of which levels contains the contacts desired. By means of an advance test the desired level is determined and the brush set cooperating with that level is rendered electrically effective, to the exclusion of the other set of brushes, before the switch initiates its rotary or contact selecting movement. Thereupon the shaft rotates both sets of brushes over their respective contact levels, but only the selected set is effective to test the individual contacts to locate the desired one.

During the automatic stepping movement of the switch the circuit of the stepping magnet is interrupted by the back contacts of an interrupter relay, which in turn is controlled by contacts on the magnet. By leading the stepping circuit through a back contact of the interrupter relay the danger of overstepping is reduced in the event of a momentary release of said relay, since the magnet is considerably slower to operate on its energizing stroke than on its deenergizing stroke.

The drawing discloses a line finding switch embodying the features of this invention, and also illustrates in diagrammatic manner a first selector switch.

The line finder F is of the step-by-step type and has a capacity for 200 lines. These lines are divided into two groups of 100 lines each. The first group of 100, including the line 6, is assigned to the bank 30 in the finder switch. The bank 30 comprises 10 levels, each level having 10 sets of tip and ring contacts. The brushes 25 cooperate with the bank 30. The other group of 100 lines, including the line 7, is assigned to the bank 40 of the finder switch which is identical with the bank 30. The brushes 26 mounted on the same shaft with the brushes 25 cooperate with the bank 40. The test conductors for the entire group of 200 lines are assigned to a separate bank 50 in the switch. The bank 50 comprises 10 levels of contacts. Each level consists of a lower row of 10 contacts and an upper row of 10 contacts. The lower row of 10 contacts represents the 10 lines in the first 100 group, whereas the upper row of the same level represents the corresponding 10 lines in the second group of 100. The test brushes 27 attached to the shaft of the switch cooperate with the contacts in the bank 50.

The switch is further equipped with a vertical commutator 60 having ten segments, each segment representing a level of ten contacts in the bank 30 and the corresponding level in the bank 40. The brush 24 attached to the switch shaft engages the commutator 60.

The switch has a vertical movement for the purpose of selecting a group of 20 lines, 10 of which appear in the bank 30 and the other 10 of which appear in the bank 40. This movement is determined by the commutator 60. The switch then rotates, passing the brushes 25, 26 and 27 over the terminals in the selected levels to search for the particular line that is calling.

In order to limit the hunting operation to 10 lines during the secondary movement of the switch the circuits are arranged to determine at the end of the primary movement which bank contains the calling line and to render the corresponding test brush effective to the exclusion of the other test brush. This test is made by a marginal relay 8 which is connected to the commutator brush 24. Each segment of the commutator 60 is connected to

a front contact of a group relay 3 in the lower group of 10 lines and to a front contact of a group relay 4 in the corresponding upper group of 10 lines. The armatures of the group relays 3 are connected directly to ground whereas the armatures of the relays 4 lead to ground through a resistance 5. In this manner the relay 8 is enabled to distinguish between a calling line appearing in the bank 30 and a line appearing in the bank 40.

Describing the operation in detail, assume that the subscriber at substation A initiates a call. The line relay 1 is operated in an obvious circuit leading through the contacts of the cut-off relay 2 and including the line 6. Relay 1 places a battery potential upon the sleeve contact 28 in a circuit from battery through the winding of cut-off relay 2 and the right contact of relay 1. Relay 1 also operates the group test relay 3 in a circuit from ground through the left contact of relay 1 and the inner contact of group relay 4. Relay 3 at its inner contact opens the operating contact of relay 4 to prevent the simultaneous initiation of a call in the corresponding subgroup of the upper bank. Relay 3 at its middle contact completes a circuit for applying ground potential to the commutator segment 29.

Relay 3 also closes the start circuit for initiating the vertical stepping operation of the switch. This circuit leads from ground through the outer contact of relay 3, normal contact of relay 9, contact 20 of relay 10, off normal contact 17, winding of relay 12, winding of the vertical stepping magnet 11 to battery. Relay 12 which is slow-to-release operates and remains operated during the vertical movement to hold open the circuit of the rotary magnet 13. The magnet 11 operates to advance the brushes 25, 26 and 27 to the first level of contacts in the banks. The magnet 11 in operating also completes a circuit from ground, through resistance 23, contact of said magnet, upper winding of the interrupter relay 10 to battery. The relay 10 is so constructed that when its upper winding is energized in series with the resistance 23 the armature 20 is attracted to open its contact, but the energization is not sufficient to change the position of any of the remaining armatures of the relay. Relay 10 in opening its armature 20 breaks the energizing circuit of the magnet 11 permitting said magnet to release. The magnet on releasing opens the circuit of relay 10 which in turn releases, reclosing the circuit of the magnet 11 which advances the switch another step and so on. After the first vertical step the stepping circuit for the magnet 11 is shifted by the off-normal contacts 17 and 18 and now leads over the armature 20 of relay 10, closed contacts 18, left front contact and winding of relay 12 to the winding of the vertical magnet.

In the present instance, however, the calling line 6 is shown as appearing in the first level in the bank 30. Accordingly, the switch on taking the first step advances the commutator brush 24 onto the segment 29. The instant the brush 24 engages segment 29 a circuit is completed from battery, through the upper winding of relay 10, outer right contact of relay 12, upper winding of the test relay 8, brush 24, contact 29 to ground directly through the contact of the group relay 3. This circuit maintains the relay 10 in its operated condition so that when the magnet 11 releases at the end of the first step its energizing circuit is not reclosed at the armature 20 of said relay. Thus, the switch stops opposite the first level of contacts in the switch bank.

Since the test circuit above traced leads directly to ground, the marginal relay 8 operates and locks through its lower winding and contact, conductor 39, to ground at the off-normal contact 22, closed as soon as the shaft leaves its normal position. The relay 8 completes the talking conductors to the lower set of brushes 25 and also selects the lower test brush 27 to the exclusion of the upper test brush.

After an interval the slow relay 12 releases causing the release of relay 10. The rotary stepping magnet 13 is now energized in a circuit from battery, through its winding, back contact of relay 12, contacts 18, armature 20 and thence to ground as above traced over the start circuit. The magnet 13 energizes to advance the brushes 25, 26 and 27 each onto the first set of terminals in the corresponding banks. The magnet 13 also closes a circuit through the resistance 23, armature and contact of said magnet, upper winding of relay 10 to battery. Relay 10 attracts its armature 20 to open the circuit of the magnet 13, which in turn releases to cause the release of relay 10. Relay 10 recloses the circuit of magnet 13 which takes another step. In this way the brushes are driven from position to position searching for the calling line 6.

As soon as the calling line is reached, a test circuit is completed from battery on the terminal 28, lower test brush 27, upper front contact of relay 8, normal contact of relay 9, lower winding of relay 10 to ground. Due to the closure of this circuit relay 10 holds its armature 20 attracted to prevent a reclosure of the stepping circuit and also receives sufficient energization to attract its other armatures. The cut-off relay 2 operates in series with relay 10, causing the release of the line relay 1 which in turn opens the operating circuit of the group relay 3. The cut-off relay 2 in operating closes a locking circuit for itself from battery through its winding, outer right contact to the terminal 28.

The instant the relay 10 operates it extends the tip and ring conductors of the calling line through to the windings of the relay 15 at the selector switch S. Relay 15 operates the relay 16 in an obvious circuit and the latter relay applies ground potential to the holding conductor 31 to hold the finder F in its operated position. Relay 10 locks to the conductor 31 in a circuit from battery through its upper winding and upper contact.

When ground appears on the conductor 31, the advance relay 9 is operated in a circuit from battery through its upper winding and middle upper contact, inner right contact of relay 12 to said conductor 31. The relay 9 in operating closes a locking circuit for itself traceable from ground through the off-normal contact 22, lower winding and front contact of said relay, winding of the magnet 11 to battery. Relay 9 is so constructed that the locking circuit is closed before it opens its energizing circuit. Due to the resistance of relay 9 the magnet 11 does not operate in series therewith. Relay 9 opens the circuit through the lower winding of relay 10 and closes a substitute holding path for the relay 2 to the sleeve conductor 31.

When it is desired to release the connection the calling subscriber replaces his receiver on the switch-hook causing the release of relay 15 which in turn releases relay 16. The removal of ground from conductor 31 causes the release of relay 10. Relay 10 in releasing operates the release magnet 14 in a circuit from battery, through the winding of said magnet, lower contact of relay 9, lower contact of relay 10 to ground at the off-normal contact 19. Magnet 14 releases the finder switch F to its normal position. When the brushes reach normal the off-normal contact 22 is shifted to its normal position opening the holding circuit of relays 8 and 9. Relay 9 thereupon releases, completing the start circuit and making it possible to start the finder F in operation to search for other calling lines.

If a call is initiated in the upper group of 100 lines, as for instance on the line 7, the group relay 4 is operated. Relay 4 applies ground potential to the segment 29 of the commutator through a resistance 5. Due to the resistance 5 the marginal relay 8 fails to operate at the time the brush 24 reaches the segment 29 and accordingly the upper set of brushes 26 is rendered effective to extend the calling line and the upper test brush 27 is included in the test circuit.

It will be recalled that the stepping circuits for the vertical magnet 11 and the rotary magnet 13 lead through the armature 20 and back contact of interrupter relay 10. At the instant the switch brush reaches the desired contact, relay 10 is held in its energized condition to prevent any further operation of the stepping magnet. In the event of a momentary release of the relay 10, due to one cause or another, the momentary closure of the stepping circuit is not sufficient to give the magnet a full operation. This is true due to the fact that the magnet is more sluggish on its energizing stroke than on its releasing stroke.

What is claimed is:

1. The combination in an automatic switch of a bank comprising groups of contacts, a plurality of sets of brushes, means for advancing said brushes in a primary movement to select said contact groups, a test circuit for controlling said primary movement, means 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 contacts of the selected groups.

2. The combination in an automatic switch of a contact bank comprising a plurality of groups, a plurality of brush sets, means for advancing said brush sets in a primary movement to selectively position each set in operative relation to a group of contacts, a test circuit for controlling said primary movement and effective at the end of the primary movement to select one of said brush sets, and means to advance said sets simultaneously, each into engagement with the contacts of the selected groups.

3. In an automatic switch, a contact bank comprising a plurality of levels of contacts, a number of sets of brushes, means for driving said brushes in a primary movement, testing means for selectively stopping said switch in operative relation with respect to said levels of contacts, means effective at the end of the primary movement to select a desired one of said sets of brushes, and means for driving said brush sets in a secondary movement into engagement with the contacts of the selected levels.

4. In an automatic switch, a bank comprising groups of contacts, a plurality of sets of brushes, means for driving said brushes in a primary movement to select said contact groups, a test circuit for stopping the switch, a marginal relay in said test circuit for selecting a desired set of brushes, and means for driving said brush sets in a secondary movement into engagement with the contacts of the selected groups.

5. The combination in an automatic switch of a bank comprising groups of contacts, a plurality of sets of brushes, a separate test brush for each of said sets, means for advancing said brush sets simultaneously in a primary movement to select said groups of contacts, a test circuit for stopping the primary movement, means effective after the primary movement for selecting one of said brush sets, and means for advancing said sets of brushes in a secondary movement into en-

gagement with the contacts of the selected groups.

6. The combination in an automatic switch of a stepping magnet for operating said switch, an interrupting relay, a testing circuit including said relay, a circuit for said magnet leading through a contact of said relay, and a circuit for successively operating and releasing said relay.

7. The combination in an automatic switch of a stepping magnet for operating said switch, an interrupting relay, a testing circuit including said relay, a circuit for said magnet leading through a contact of said relay, and a circuit for said relay leading through a contact of said magnet.

8. The combination in a line finder of a bank comprising groups of contacts, a plurality of brush sets, means for automatically advancing said brush sets in a primary movement to select said contact groups, a test circuit for controlling said primary movement, a relay in said circuit for selecting a set of brushes at the end of said movement, and means for advancing said brush sets in a secondary movement into engagement with the contacts of the selected groups.

9. The combination in an automatic switch of a bank comprising groups of contacts, a plurality of sets of brushes, a stepping magnet for advancing said brush sets in a primary movement to select said contact groups, a test circuit for controlling said primary movement and for selecting a set of brushes, a second stepping magnet for advancing said brush sets in a secondary movement into engagement with the contacts of the selected groups, an interrupting relay, circuits for said stepping magnets leading through a back contact of said interrupting relay, and circuits for said interrupting relay leading through contacts of said stepping magnets.

10. The combination in an automatic switch of means including a stepping magnet for operating said switch, an interrupting relay, a circuit for operating said magnet leading through a back contact of said interrupting relay, a circuit for operating said interrupting relay leading through a contact of said stepping magnet, and a holding circuit for said interrupting relay effective to prevent further operation of said stepping magnet.

11. The combination in an automatic switch of a bank comprising groups of contacts, a plurality of brush sets, means including a stepping magnet for advancing said brush sets in a primary movement to select said contact groups, means including a second stepping magnet to advance said brush sets in a secondary movement into engagement with the contacts of the selected groups, an interrupting relay, a circuit for operating said first stepping magnet leading through a back contact of said interrupting relay, a circuit for operating said interrupting relay leading through a contact of said stepping magnet, a holding circuit for said interrupting relay effective to stop said primary movement, means in said holding circuit effective to select one of said brush sets, a circuit for operating said second stepping magnet leading through a back contact of said interrupting relay, a circuit for operating said interrupting relay leading through a contact of said second stepping magnet, and a holding circuit for said interrupting relay effective to stop said secondary movement.

12. The combination in an automatic switch of a bank comprising groups of contacts, a plurality of brush sets, means including a stepping magnet for advancing said brush sets simultaneously in a primary movement to select said groups of contacts, a test brush, an interrupting relay, a marginal relay, means including said test brush, said interrupting relay and said marginal relay effective to stop said primary movement and to select one of said brush sets, and means for driving said brush sets into engagement with the contacts in said selected groups.

13. The combination in an automatic switch of a bank comprising groups of contacts, a plurality of brush sets, an individual test brush for each set, means for advancing said brush sets in a primary movement to select said groups of contacts, means for selecting one of said brush sets, means including a stepping magnet for advancing said brush sets in a secondary movement into engagement with the contacts in said selected groups, an interrupting relay, a circuit for operating said stepping magnet leading through a back contact of said interrupting relay, a circuit for operating said interrupting relay leading through a contact of said stepping magnet, and a circuit including said interrupting relay and one of said individual test brushes for stopping said secondary movement.

In witness whereof, I hereunto subscribe my name this 13th day of April, A. D. 1927.

ROBERT C. PAINE.