June 20, 1944. W. H. T. HOLDEN 2,351,967

SELECTOR SWITCH

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FIG. 1

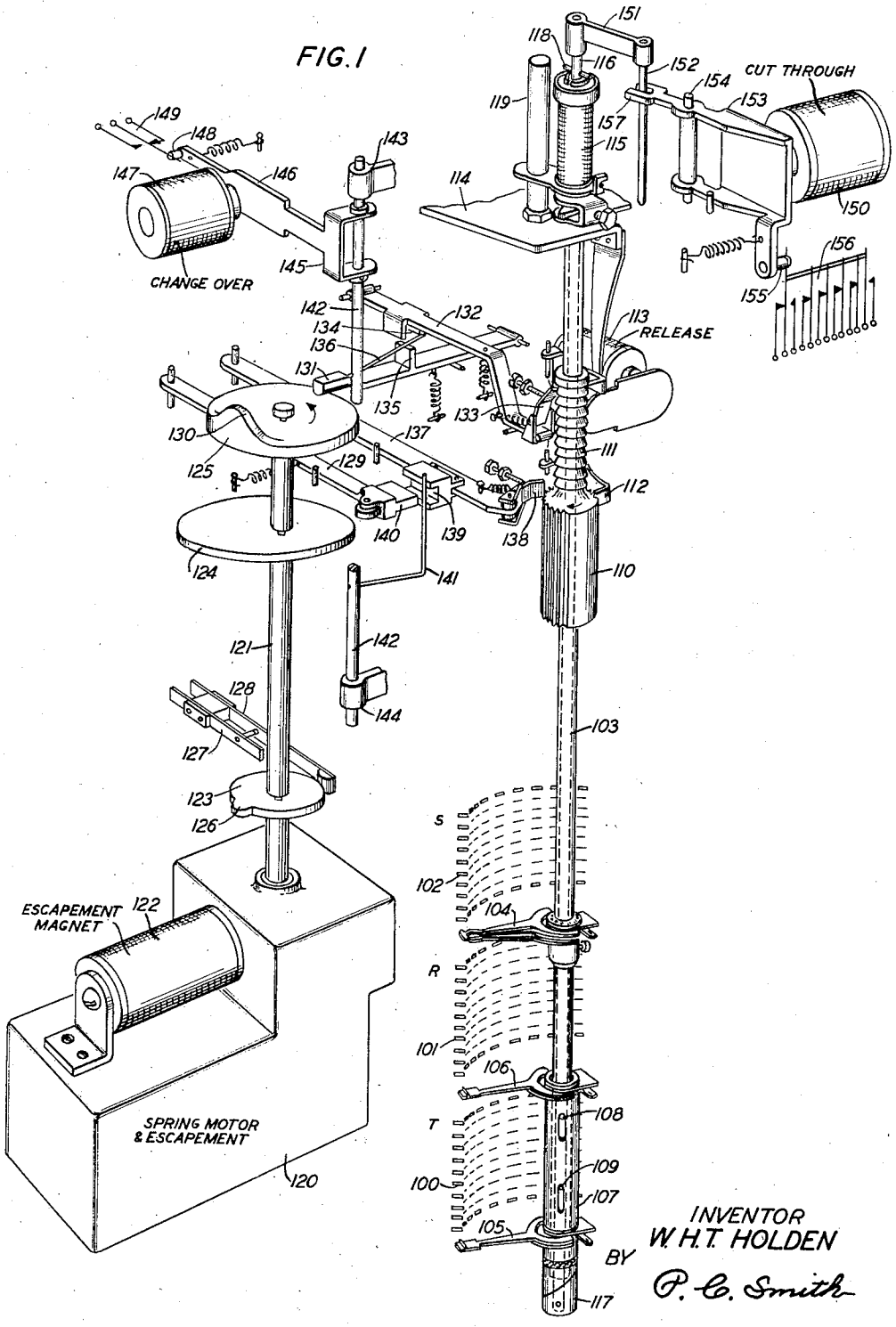

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FIG. 2

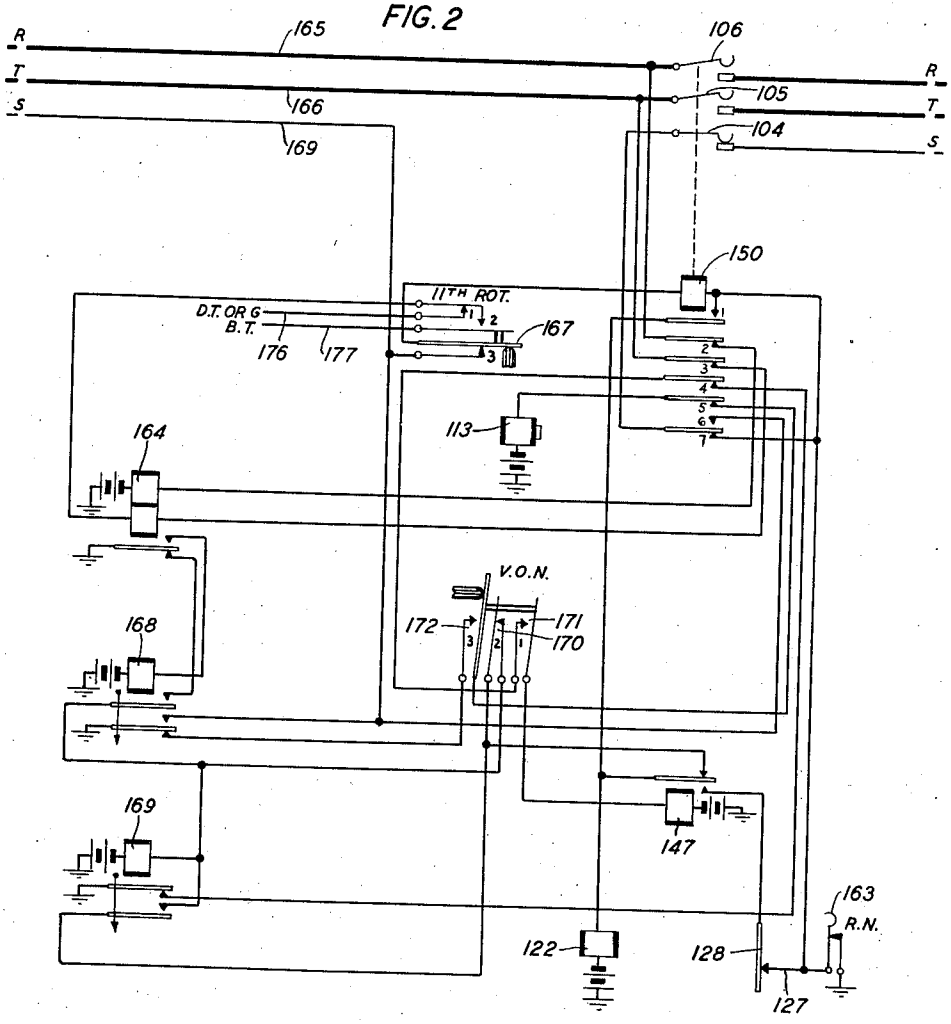
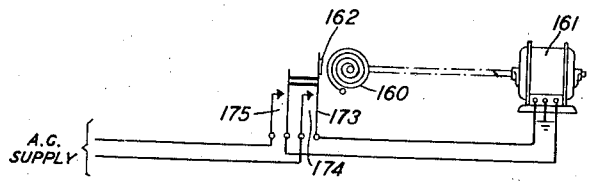


FIG. 3



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UNITED STATES PATENT OFFICE

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SELECTOR SWITCH

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Application June 18, 1943, Serial No. 491,274

5 Claims. (Cl. 179—27.52)

This invention relates to telephone systems and more particularly to an improved form of automatic switching apparatus for use in automatic or semiautomatic telephone systems.

In step-by-step telephone systems employing two-motion automatic switching apparatus, it has been customary to employ two operating magnets and brush sets all of which wipe over the terminal banks.

The use of a constantly acting power source with a digit impulse controlled escapement for such a two-motion switch has been proposed heretofore.

In accordance with the present invention a power driven shaft is provided controlled by an escapement mechanism. This power driven shaft carries two cams which serve to operate the horizontal and vertical stepping mechanisms. Each of these mechanisms comprises two sections, and a change-over mechanism is provided which interposes a finger between the sections of one or the other stepping mechanism in accordance with the direction in which the switch is to be moved.

Further, in order that noble metal may be used for the contacts in the talking circuit, the tip and ring brushes are arranged so that they may be positioned with relation to the desired bank terminals and a camming device is provided to move the brushes vertically into contact with the associated bank terminals.

These and other features of the invention will be more readily understood from a consideration of the following description in connection with the accompanying drawings in which:

Fig. 1 shows a perspective view of the essential parts of the switch structure;

Fig. 2 shows a circuit arrangement for operating the switch; and

Fig. 3 shows the spring winding circuit.

Referring first to Fig. 1, the switch itself resembles a standard step-by-step, two-motion switch in that it comprises sets of arcuate bank terminals, a brush rod centered with relation to the bank terminals and vertical and horizontal ratchet elements for controlling the corresponding motions of the brush rod. In general, no attempt has been made to show the mounting means for the various parts of this switch since any convenient means may be used and its disclosure would only serve to confuse the drawings.

The contact terminals are arranged in three separate banks 100, 101 and 102, each containing the terminals of one of the three trunk conductors terminating in the switch. Centered with respect to banks 100 to 102 is brush shaft 103. The double sleeve brush 104 is mounted directly on brush shaft 103. The single tip and ring brushes 105 and 106 are mounted on a sleeve 107 which surrounds brush shaft 103. Pins 108 and 109 on shaft 103 enter slots in sleeve 107 so that the tip and ring brushes 105 and 106 are raised and rotated in the same manner as sleeve brush 104. However, the brushes are so positioned on the shaft and sleeve that when they are raised to a particular level and then rotated, sleeve brush 104 wipes over the terminals in that level, while the tip and ring brushes 105 and 106 move around below the terminals of the corresponding level. It is to be noted that brushes 106 and 105 are provided with relay type contact elements, preferably made of noble metal. The corresponding bank terminals are similarly provided with noble metal contact elements. Near the upper end of the brush shaft 103 are located the rotary ratchet cylinder 110, and the vertical ratchet element 111. Double dog 112 engages the teeth of the two ratchet elements to hold the shaft 103 in position and is controlled by release magnet 113. The upper end of shaft 103 passes through plate 114 and restoring spring 115 to the top of which it is fastened. On plate 114 is mounted rod 119 for guiding the upper end of shaft 103. A cam drive rod 116 extends through brush shaft 103 and at its lower end is fixed to cam 117. Pin 118 resting on spring 115 prevents rod 116 from moving longitudinally with respect to shaft 103. The lower end of sleeve 107 has a cammed surface which conforms to the configuration of cam 117 when both rod 116 and sleeve 107 are normal.

The power for driving the switch comprises a spring, like a clock spring, which is rewound by a miniature motor whenever the tension drops below a value sufficient to carry the switch through a cycle. This spring and motor have been indicated at 120. The spring acts on drive shaft 121 and the rotation of the shaft is controlled by an escapement magnet 122. Any desired form of motor wound spring and escapement may be employed but one possible form is disclosed in the copending application of C. N. Hickman, Serial No. 475,330, filed February 10, 1943.

Drive shaft 121 carries three discs 123, 124 and 125. Disc 123 is provided with a cam 126 which, once during each revolution, opens the normally closed contact between springs 127 and 128. Disc 124 is mounted eccentrically so that once during each revolution it moves bar 129, forming part of the rotary stepping mechanism. Disc 125 has

a vertical camming surface 130 which acts on arm 131 forming part of the vertical stepping mechanism. Therefore at each revolution of drive rod 121 both the horizontal and vertical stepping mechanisms are acted upon by their respective cams.

Each stepping mechanism comprises two bars, one carrying the stepping pawl and the other acted on by the driving cam. On one bar is mounted a recessed member and on the other a correspondingly positioned projection, and when the stepping mechanism is ineffective the projection enters the recess without transmitting the motion of one bar to the other. When the mechanism is to be effective a finger is interposed between the projection and the recess and the movement of the one bar under the control of the driving cam is transmitted to the second bar and thence to the stepping pawl and the switch.

Specifically, the vertical stepping mechanism comprises bar 131 which is acted on by cam 130 and bar 132 which operates the vertical pawl 133. Two projections on bar 132 are bent downward to form recess 134 while a vertical projection 135 is formed on bar 131 and both bars are so mounted that projection 135 is in position to enter recess 134 when bar 131 moves. Similarly the horizontal stepping mechanism comprises the bar 129 which is acted on by the disc 124 and bar 137 which operates the rotary pawl 138. Mounted in any suitable manner on bar 137 is a member having a recess 139 while projection 140 is formed on bar 129. Bars 129 and 137 are so arranged that projection 140 is in position to enter recess 139 when bar 129 is moved.

In order to transmit the motion of the moving bar to the pawl carrying bar, fingers 136 and 141 are provided. These fingers are attached to rod 142 which is pivotally mounted on suitable supports 143 and 144. A part of rod 142 is broken away to show the apparatus behind it. Attached to the upper end of rod 142 is a bracket 145 formed integrally with the armature 146 associated with the magnet coil 147. At the other end of the armature is a stud 148 which controls a set of relay type contacts 149. When the coil 147 is deenergized, rod 142 occupies the position shown and finger 136 extends across the recess 134. Therefore, when bar 131 is raised by cam 130, projection 135 does not enter recess 134, but acts through finger 136 to raise bar 132 and raise brush shaft 103 by means of pawl 133.

When the magnet coil 147 is energized the rod 142 is rotated, moving finger 136 beyond recess 134 and moving finger 141 into position between projection 140 and recess 139. When cam 124 is rotated, acting on bar 129, the motion is transmitted to bar 137 which rotates brush shaft 103 by means of pawl 138.

In order to bring brushes 105 and 106 into contact with the terminals adjacent to which they have been positioned by the action of the stepping mechanisms, means is provided to rotate rod 116 and thereby cam 117. Clamped to the top of rod 116 is a link 151 which carries rod 152. The armature 153 associated with magnet coil 150 is pivoted on pin 154 and terminates in a fork 157 which embraces rod 152. When the magnet coil 150 is energized, attracting armature 153, fork 157 moves rod 152 laterally, thereby creating a rotary motion of rod 116, in turn rotating cam 117. Since sleeve 107, carrying brushes 105 and 106, is held against rotation by pins 108 and 109, but may move vertically due to the slots in which pins 108 and 109 are engaged, the rotation of cam 117 raises sleeve 107 and creates a relay type closure between brushes 105 and 106 and their corresponding contacts. The armature 153 associated with coil 150 also carries a stud 155 which acts on a set of relay type contacts 156.

In Fig. 2 is shown a suitable circuit arrangement for controlling the switch structure of Fig. 1. This circuit includes rotary normal contact 163, vertical off-normal contacts 170, 171, 172, and eleventh rotary step contacts 167 which have not been shown in Fig. 1 since they are well-known parts of a standard step-by-step selector switch.

The circuit for the motor 161 which winds the driving spring 160 is shown in Fig. 3. Spring 160 unwinds in operating the switch and lug 162 on spring 173 is so positioned that the spring 160 will exert pressure thereon after it has completed the driving of a switch through a predetermined number of steps. The pressure of spring 160 on lug 162 closes contacts 174 and 175, completing a circuit connecting the motor 161 to the alternating current supply whereby the spring is rewound, ready for the next seizure of the switch. As the spring tightens, pressure is removed from lug 162 and contacts 174 and 175 reopen to in turn open the circuit of motor 161. Spring 160 should be so designed as to be capable of operating the switch through several cycles without rewinding in case of a temporary power failure. Spring 173 and lug 162 should be so positioned that normally the spring will be rewound after each call requiring an average number of steps of the selector.

When the selector is seized, line relay 164 operates in a circuit from battery through the upper winding of relay 164, contact 2 of magnet 150, ring conductor 165 and thence over the calling substation to tip conductor 166, contact 3 of magnet 150, lower winding of relay 164, over normal contact 1 of the eleventh rotary step springs 167 to conductor 176. If the selector being described is a first selector, coupled with a line finder, conductor 176 will lead to ground through a source of dial tone, while if the selector is serving as a subsequent selector, conductor 176 will be grounded directly.

Line relay 164 operates in the above-traced circuit and closes an obvious circuit for slow-to-release relay 168. Relay 168 operates and connects ground to conductor 169 to mark the selector busy and to hold any preceding selectors.

When the dial at the calling substation is operated, relay 164 releases at each interruption of the line circuit, closing a circuit from ground, back contact of relay 164, inner front contact of relay 168 to the winding of relay 169 and battery, and in parallel therewith over contact 170 of the vertical off-normal springs, back contact of magnet 147 to battery through the winding of escape magnet 122. Relay 169 operates and at its front contact closes a substitute for contact 170 which opens as soon as the brush shaft moves off normal. Escape magnet 122 releases the drive shaft 121 which makes about three-fourths of a revolution when it is arrested. During this movement the vertical stepping mechanism is operated and the brush shaft lifted one step. When the dial recloses and relay 164 reoperates, the escape magnet 122 releases and the drive shaft 121 advances to normal. Relay 169 is slow to release and remains operated, holding the circuit of the escape magnet 122 closed be-

tween dial pulses. The following pulses cause the selector to advance one step for each pulse.

At the end of the digit, relay 164 remains operated and relay 169 is permitted to release closing a circuit from ground at its back cantact, contact 4 of magnet 150, contact 171, through the winding of change-over magnet 147 to battery. Change-over magnet 147 operates, disabling the vertical stepping mechanism and rendering the rotary stepping mechanism operative as described in connection with Fig. 1. Magnet 147 also closes a circuit from battery through the winding of escape magnet 122, front contact of magnet 147, contacts 128 and 127, controlled by the drive shaft in response to the operation of magnet 122, to ground at the rotary normal spring 163.

Magnet 122 operates in this circuit releasing the drive shaft which, as before, makes three-quarters of a revolution during which the brush shaft is rotated on step, and the contacts 127 and 128 are opened to release magnet 122 and to permit the drive shaft to complete its revolution back to normal.

After one rotary step by the brush shaft, rotary normal contact 163 is opened and sleeve brush 104 is in contact with the sleeve terminal of the first outgoing trunk. The circuit of magnet 122 now extends from contacts 127 and 128, through the winding of magnet 150, contact 3 of eleventh rotary step spring 167 to ground at the front contact of relay 168. In shunt of the winding of magnet 150 a branch circuit extends over contact 7 of magnet 150 to sleeve brush 104. If the first trunk is busy, ground will be connected to the associated sleeve terminal, magnet 150 will be shunted and magnet 122 will reoperate to cause brush 104 to be advanced to the sleeve terminal of the next trunk.

When an idle trunk is found the shunt around the winding of cut-through magnet 150 is opened and that magnet operates in series with magnet 122. Magnet 122 cannot operate through the winding of magnet 150 and the brush shaft remains in position with the sleeve brush 104 engaging the sleeve terminal of the idle trunk.

Cut-through magnet 150, in the manner described in connection with Fig. 1 now presses tip and ring brushes 105 and 106 against the corresponding tip and ring bank terminals, extending the calling line to the next selector. At its contacts 2 and 3, magnet 150 disconnects line relay 164 from the conductors 165 and 166, and relay 164 releases, opening the circuit of relay 168. At its contact 7 magnet 150 disconnects brush 104 from the circuit of magnet 122 and at contact 6 connects brush 104 to the incoming sleeve conductor 169 and to ground at the front contact of relay 168. Relay 168, being slow to release, holds ground on conductor 169 and brush 104 until after ground is supplied thereto from the next selector. At contact 5 magnet 150 opens the circuit of release magnet 113. At contact 4 magnet 150 opens the circuit of change-over magnet 147 which restores.

At contact 1 magnet 150 closes a holding circuit for itself from battery through the winding of escape magnet 122, contact 1 and winding of magnet 150, contact 3 of eleventh rotary step spring 167, contact 6 of magnet 150 to ground over brush 104. The talking circuit and switch are therefore held under the control of magnet 150.

When the conversation is terminated, the release of the connector removes ground from brush 104, releasing magnet 150. Magnet 150 closes a circuit from battery through the winding of release magnet 113, contact 5 of magnet 150, vertical off-normal contact 172 to ground at the back contact of relay 168. Magnet 113 withdraws the double dog from the ratchet elements and the brush shaft rotates to normal under the control of spring 115 and then returns to normal in the vertical direction under the force of gravity. When the vertical off-normal springs are restored, the circuit of release magnet 113 is opened and the double dog holds the brush shaft in its normal position.

If all trunks of a level are busy, the switch continues to rotate until the eleventh rotary step contacts 167 are operated. At contact 2 spring 167 connects busy tone from conductor 177 to the lower winding of line relay 164 and the tip conductor 166 to inform the calling subscriber that the call could not be completed. At contact 3, spring 167 disconnects ground from the windings of magnets 150 and 122 to prevent the operation of magnet 150 when brush 104 steps off the last busy terminal. When the subscriber restores his receiver relay 164 releases, opening the circuit of relay 168. Relay 168 releases slowly, and, when it closes its back contact, operates release magnet 113 to restore the selector to normal.

It will be apparent from the foregoing that the novel switch operating means of applicant's invention may be substituted for a conventional switch with a minimum of change in the operating circuits.

What is claimed is:

1. A two-motion step-by-step switch comprising a brush carrying shaft, a vertical ratchet mechanism for imparting vertical movement to said shaft, a rotary ratchet mechanism for imparting horizontal movement to said shaft, a power driven rotatable cam shaft having a first and a second cam mounted thereon, a vertical selecting finger positionable between said first cam and said vertical ratchet mechanism for imparting the movement of said cam shaft to said vertical ratchet, a rotary selecting finger positionable between said second cam and said rotary ratchet mechanism for imparting the movement of said cam shaft to said rotary ratchet, an escapement device for causing said cam shaft to make one revolution with each operation of said escapement device, and means for controlling the positioning of said vertical and rotary selecting fingers.

2. A two-motion step-by-step switch comprising a brush carrying shaft, a vertical ratchet mechanism for imparting vertical movement to said shaft, a rotary ratchet mechanism for imparting horizontal movement to said shaft, a power driven rotatable cam shaft having a first and a second cam mounted thereon, a vertical selecting finger normally positioned between said first cam and said vertical ratchet mechanism for imparting the movement of said cam shaft to said vertical ratchet mechanism, a rotary selecting finger positionable between said second cam and said rotary ratchet mechanism for imparting the movement of said cam shaft to said rotary ratchet mechanism, an escapement device for causing said cam shaft to make one revolution with each operation of said escapement device, and means for simultaneously removing said vertical selecting finger and moving said rotary selecting finger into position between said second cam and said rotary ratchet mechanism.

3. A two-motion step-by-step switch comprising a brush carrying shaft, a vertical ratchet bar for imparting vertical movement to said shaft, a rotary ratchet bar for imparting horizontal movement to said shaft, a recessed member on each of said ratchet bars, a power driven rotatable cam shaft having a first and a second cam mounted thereon, a first and second cam bar acted on by said cams, each cam bar having a projection thereon, said ratchet bars and said cam bars being so arranged that the projections on said cam bars may enter the recesses of said ratchet bars at each rotation of said cam shaft without imparting motion to said ratchet bars, a vertical selecting finger positionable between the projection on said first cam bar and the recess of said vertical ratchet bar for imparting the movement of said cam shaft to said vertical ratchet bar, a rotary selecting finger positionable between the projection on said second cam bar and the recess of said rotary ratchet bar for imparting the movement of said cam shaft to said rotary ratchet bar, an escapement device for causing the cam shaft to make one revolution with each operation of said escapement device, and means for controlling the positions of said vertical and rotary selecting fingers.

4. A two-motion step-by-step switch comprising an arcuate bank of terminals divided into three sections, a brush shaft, means for imparting vertical and rotary movement to said shaft, a first brush mounted directly on said brush shaft in position to wipe over the terminals of one of said bank sections, a pair of brushes mounted on a sleeve surrounding said brush shaft, means for holding said sleeve to said brush shaft so that the brushes carried by said sleeve move in accordance with the movement of said brush shaft, said pair of brushes moving out of engagement with the other two sections of said contact banks, a rod passing through said brush shaft, and means under the control of said rod to move said pair of brushes into engagement with the corresponding terminals.

5. A two-motion step-by-step switch comprising an arcuate bank of terminals divided into three sections, a brush shaft, means for imparting vertical and rotary movement to said shaft, a first brush mounted directly on said brush shaft in position to wipe over the terminals of one of said bank sections, a pair of brushes mounted on a sleeve surrounding said brush shaft, means for holding said sleeve to said brush shaft so that the brushes carried by said sleeve move in accordance with the movement of said brush shaft, said pair of brushes moving out of engagement with the other two sections of said contact banks, a rod passing through said brush shaft, a cam fixed to said rod and a camming surface on said sleeve, and means to rotate said rod to move said pair of brushes into engagement with the corresponding terminals.

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