

Sept 3, 1957

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2,805,368

STEP SWITCH WITH MEMORY CONTACTOR

Filed June 21, 1954

4 Sheets-Sheet 1

FIG. 1.

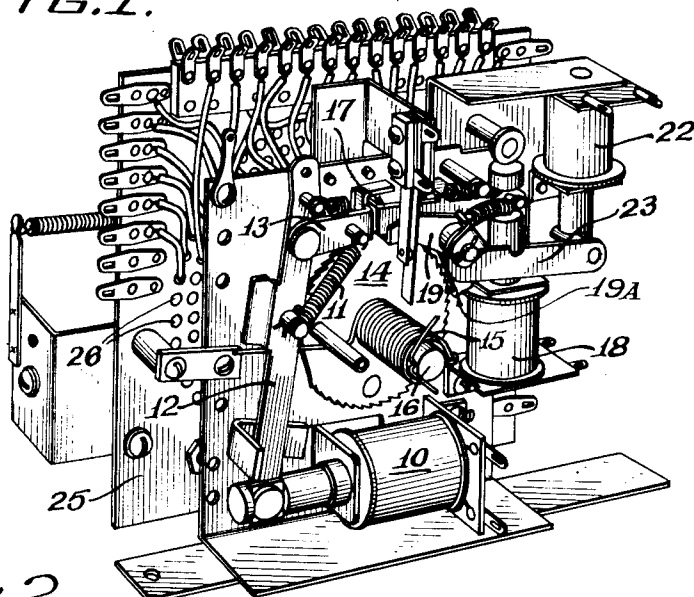
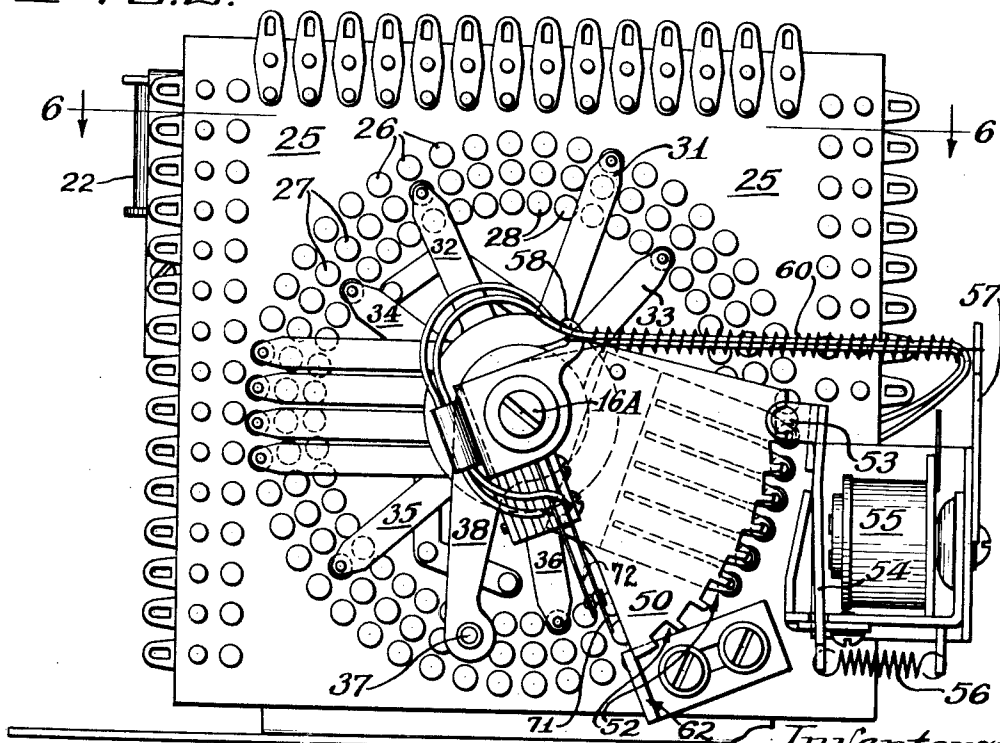


FIG. 2.



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4 Sheets-Sheet 2

FIG. 3.

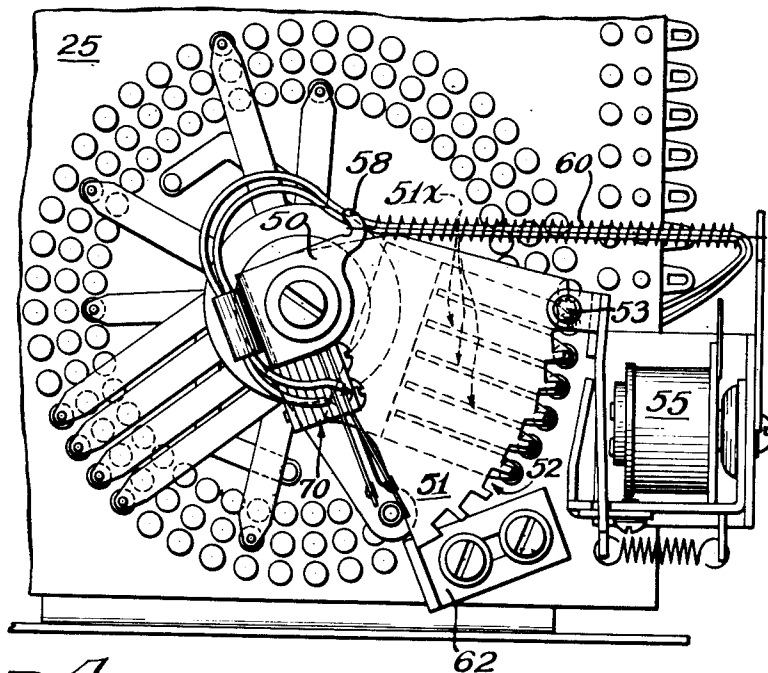
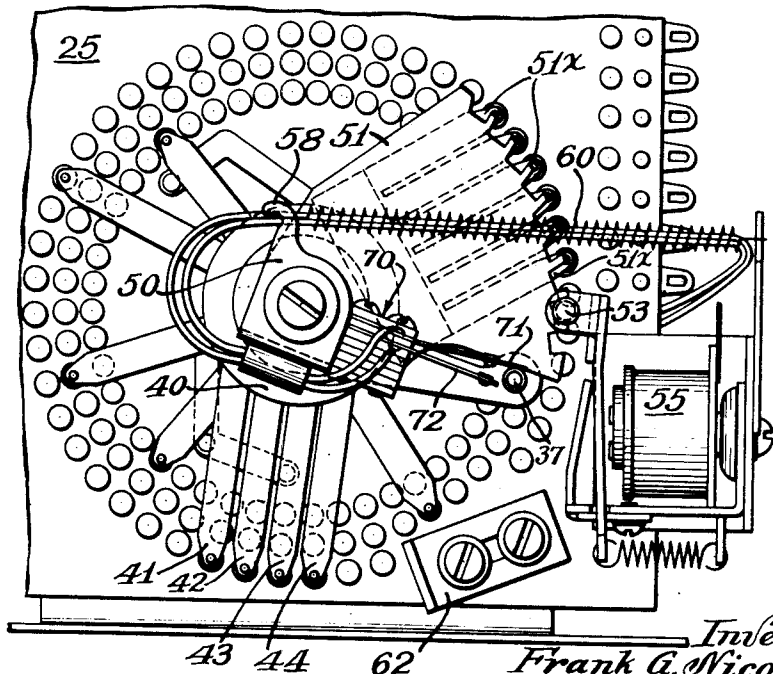


FIG. 4.



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4 Sheets-Sheet 3

FIG. 5.

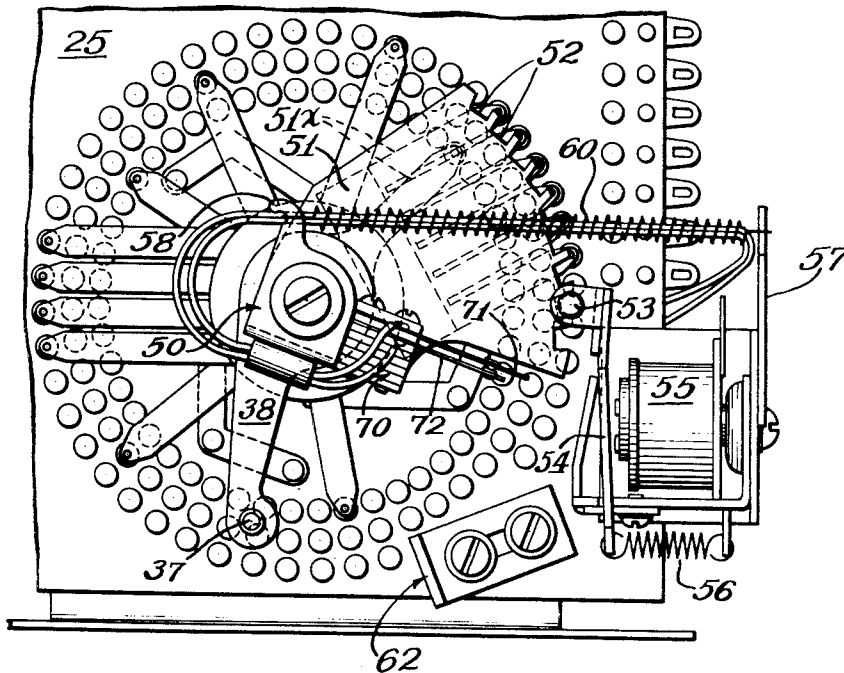


FIG. 6.

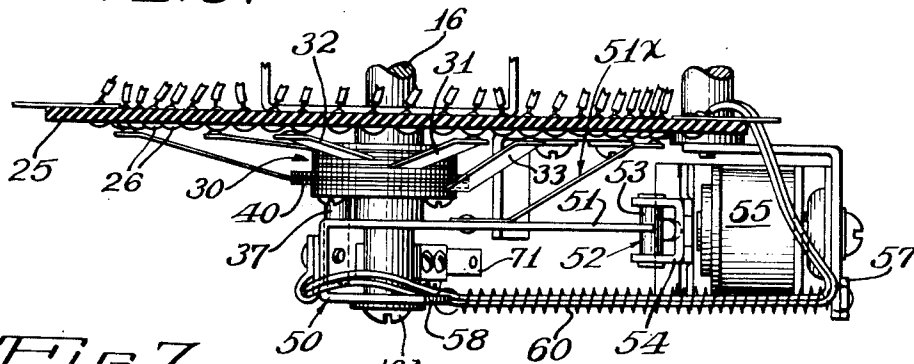
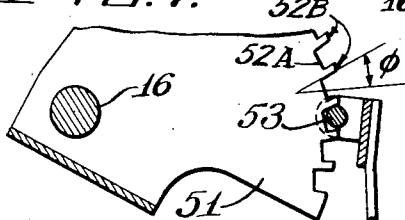


FIG. 7.



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2,805,368

STEP SWITCH WITH MEMORY CONTACTOR

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4 Sheets-Sheet 4

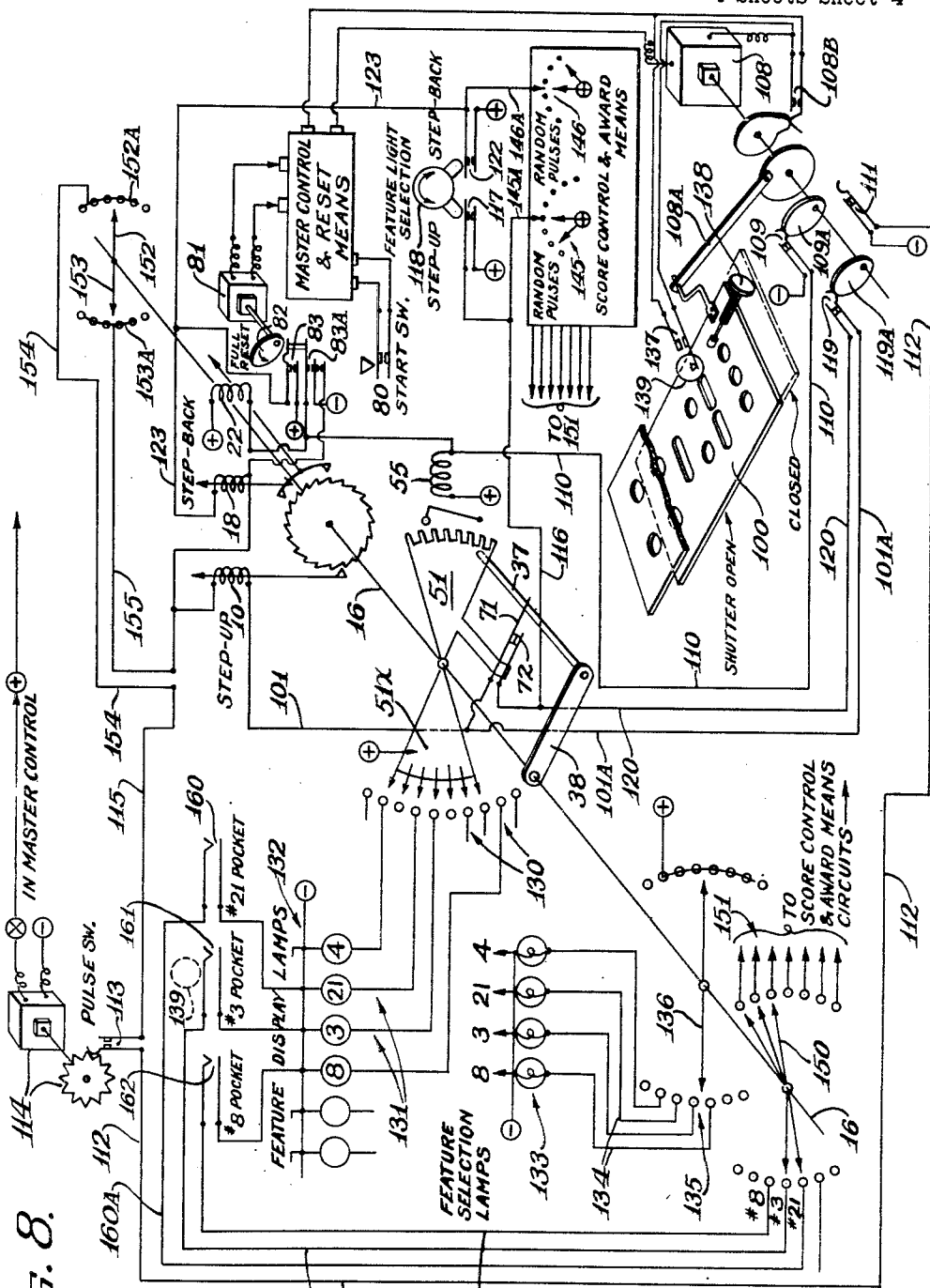


FIG. 8.

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1

2,805,368

## STEP SWITCH WITH MEMORY CONTACTOR

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Application June 21, 1954, Serial No. 437,904

8 Claims. (Cl. 317—155.5)

This invention pertains to step-by-step rotary switches of the type having electromagnetic ratchet means for moving switch wipers forward and backward in steps, or completely back to starting position in one full reset step, the principal object of the present disclosures being the provision of auxiliary step-switch means cooperable with a main stepping switch mechanism and serving as a form of memory switch to hold certain switching positions under certain conditions.

In U. S. Patent No. 2,668,261 there is described a form of stepping switch having a main step-up switch wiper system, and a supplemental follower switch wiper means which will assume certain positions, either forwardly or reversely, in relation to the main wiper system upon release of an indexing means.

The present step-switch is of analogous type but differs from the so-called follower and homing switch of the mentioned patent in construction and operation, especially in the fact that the auxiliary memory switch device which characterizes the present switch does not respond to the movements of the main stepping switch contactors until the latter have taken a predetermined number of steps from a starting position; and instead of there being a yielding driving connection between a main and auxiliary stepping mechanism so that when one is held the other may nevertheless be free to move, as is the case with the device of said patent, the present switch means disables the main stepping mechanism when the auxiliary switch means is immobilized in one direction.

Viewed from another aspect, it is a general object to provide a stepping switch having a partly dependent auxiliary memory switch device movable co-directionally therewith but which cannot be moved in a forward direction from its starting position until the main stepping switch shaft has been advanced a certain number of steps from its starting position; but which can be held at a memory position to which it has been advanced; and to provide supervisory control switch and circuit means for disabling the forward drive means for the main stepping switch at times when the auxiliary switch is held in a so-called memory position and the main switch means has been stepped up to a limit determined by the auxiliary switch means.

Additional objects and aspects of novelty and utility relate to details of the construction, operation, and circuits for the preferred embodiment described hereinafter in view of the annexed drawings in which:

Fig. 1 is a rear perspective view of the step switch looking at the principal drive mechanism;

Fig. 2 is a front elevation showing the main and auxiliary wipers;

Figs. 3, 4, and 5 show the wipers in various operating positions;

Fig. 6 is a horizontal sectional view along lines 6—6 of Fig. 2 looking down in plan upon some of the mechanism;

Fig. 7 is a fragmentary sectional detail of the ratchet index teeth and index dog for the auxiliary wiper section;

2

Fig. 8 is a circuit diagram.

Step switches are of many varieties, the present improvements being concerned mainly with the auxiliary supervisory contact means and the memory and control circuits therefor.

The preferred form of the device shown in Fig. 1 employs a conventional pawl and ratchet drive means for advancing the main switch wiper, said means consisting of a driving or advancing solenoid 10, spring 11, drive lever 12, and drive pawl 13 for stepping a ratchet disc or wheel 14 clockwise against the return effort of a coil spring 15 on the main shaft 16.

The gain of the ratchet wheel is held by holding pawl 17, releasable step-by-step by impulses to a step-back solenoid 18, rocking a lifting dog 19 to raise the pawl 17 while its tail 19A lowers into the ratchet teeth so that no more than one step back is taken. This is a form of escapement.

Full release of the ratchet wheel is achieved by simultaneous energization of step-back solenoid 18 and full-release solenoid 22, which raise the escapement dog tail 19A through lever 23 so that the ratchet is not held at all and will be returned counterclockwise by spring 15 to starting position.

Assembled with the stepping mechanism is an insulating plate 25 (Figs. 1 and 2) on which are circularly arranged sets of contacts 26, 27, 28 (Fig. 2) concentric with the main ratchet shaft 16.

Keyed to shaft 16 (as in Fig. 6) is an insulated hub assembly 30 carrying a plurality of Phosphor bronze or spring contact wiper fingers 31, 32, 33, 34, 35, 36 (Fig. 2), some of which are electrically interconnected so as to bridge contacts on opposite sides of the axis of the shaft, it being noted, for example, that contact wipers 31, 32, and 33, respectively, travel over the outermost, middle, and innermost rings of contacts, and that the remaining wiper 34 travels over the innermost ring, as does contact wiper 36, while wiper 35 travels over the middle ring. This arrangement is arbitrary in accordance with the required switching operation needed, and is of no concern here except as may be hereinafter especially pointed out.

As seen best in Fig. 4, there is a second insulated hub member 40 also fast on ratchet shaft 16, which carries a set of four interconnected contact fingers 41, 42, 43, 44, all riding on the outer ring of contact buttons; and these wipers are likewise an arbitrary provision for the particular switching application required.

Auxiliary supervisory wiper means, as depicted in Fig. 6, includes a special U-shaped bracket or stamping 50 floating and retained on shaft 16 by set screw 16A, and having an enlarged and radially projecting sector arm 51 with an arcuate edge in which are formed a series of especially shaped and pitched holding teeth 52 (Fig. 7).

On the underside of the sector 51 is a set of ganged wiper contacts 51X referred to hereinafter as the feature switch contacts or wipers.

The holding teeth 52 in the especially shaped sector 51 are engaged by a stop or index pin 53 in armature or index arm 54 of an indexing magnet 55 (Figs. 5 and 6), owing to action of the index-arm spring 56, the action being such that the auxiliary sector 51 cannot move unless the electromagnet 55 is energized to withdraw the stop pin 53.

Attention is directed to Fig. 7 and the special shape of the index teeth 52 there shown and characterized in that the teeth 52 are pitched at a slight angle to a true radius therethrough, as indicated for example by the angle  $\phi$  in Fig. 7; and the roots 52A of the teeth are substantially flat or linear instead of arcuate, and are non-tangent to the common arc touching all teeth bases.

Moreover, each tooth is slightly wider at its crown than at its root, as indicated at 52B.

The purpose of the special shape of the indexing teeth is to prevent any camming interaction between the pawl and ratchet teeth which would throw the index stop pin 53 back, or unseat it sufficiently to permit the taking of an extra or unwanted step in either direction; and, in this respect, the ratchet teeth are shaped to have an interlocking holding engagement with the pawl pin 53.

The auxiliary or supervisory sector 51 is normally urged in a clockwise direction by a long traction spring 60 (Figs. 5 and 6) anchored at one end on a projection 57 on the index coil frame, and hooked at its opposite end on a radial lug 58 on the shorter U-arm of the auxiliary sector bracket.

Carried on the auxiliary wiper arm 50 in the bight portion of the U-shaped stamping is a stack switch 70 (Fig. 4) having a pair of long, normally closed, spring contact fingers 71, 72, the former being the longer and its end projecting radially free to lie in the arcuate path of a follow-up pin 37 on a radial follow-up arm also keyed to the shaft 16 to turn in step with the main contact fingers 31—36, 41—44, toward or away from the free end of the stack switch contact 71, depending upon which direction the ratchet wheel is caused to move.

It is important to observe that the follow-up pin 37 (Fig. 6) is of a length, in its upward projection from the radial arm 38 on which it is mounted, to bear against the rearward edge of the sector member (as in Fig. 3), as well as to engage the stack switch finger 71, in order that the sector may be carried along with the main contact wiper assembly after the latter has been stepped or advanced a predetermined number of steps from its starting position.

The sector member 50—51 has its own normal or starting position, as determined by an adjustable stop-cleat 62 (Fig. 2), but in the latter view it will be noted that the follow-up pin 37 is displaced an appreciable angular distance from the sector and switch finger 71, so that the main wiper system, and hence radial follow-up arm 38 and pin 37 must advance a certain distance before engaging the sector and switch (as in Fig. 3) to cause the latter to advance also to a position such as shown in Fig. 4.

#### Operation

The fully reset starting position of all switch wipers is shown in Fig. 2. Such a condition would result, for example, from simultaneous energization of both reset coils, meaning the step-back or escapement coil 18 and the full reset coil 22, with the consequent full release (not shown) of both holding dogs 17, 19A (Fig. 1).

Each pulsing of the driving or stepping coil 10 will cause an advancing step of the ratchet wheel 14, and hence of the shaft 16 and all wiper contacts such as 31—36, 41—44, and the follow-up arm and pin 38, 37.

In the embodiment shown, the pin 37 must be advanced five steps from starting position before it will engage and open switch contact 71; and upon the sixth step the sector 50 will be engaged and advanced, provided the index pin 53 is withdrawn from the sector holding teeth.

It will be appreciated that the follow-up pin may be caused to retreat from the position of Fig. 3 to any intermediate position by operation of the step-back coil and dog means 18, 19; and in practice the wiper contact system may oscillate back and forth from starting to various advanced positions without ever engaging or operating the supervisory or follow-up switch means 71—72.

In accordance with one of many possible control-circuit arrangements, the supervisory follow-up switch is in the operating circuit for the stepping or ratchet-driving solenoid 10, so that as soon as the latter has been pulsed five times consecutively without step-back, supervisory switch contacts 71—72 are opened by follow-up pin 37 and the circuit for drive coil 10 is opened and no further advance of the main wiper system can be effected, in the absence of other special circuit connections for puls-

ing the drive coil free of such control by the supervisory cut-out and limit switch.

Fig. 8 depicts a circuit which is illustrative of the memory function of the novel stepping switch in conjunction with a ball-rolling game in which the player is given an opportunity at certain times to operate a selector switch to select a score number as an objective for further scoring.

The game apparatus chosen for illustration includes a desired form of ball-rolling board having a ball-holding and releasing shutter panel reciprocable in well-known manner therebelow to hold balls in score pockets or release balls therefrom, all under the ultimate control of a "Master Control and Reset Means" (so-designated in Fig. 8) now to be described.

It will be assumed a player begins a round of play by operating one or another form of start switch 80 connecting into the master control and reset means, which cycles the motor 81 in the well-known manner and rotates cam 82 to close a reset switch 83 and thereby energize two coils 18 and 22 to fully reset the stepping switch.

As a further incident of such a resetting operation or the starting of any game cycle by operation of start switch 80, a conventional ball-retaining and releasing shutter panel 100 will be moved by motor-driven crank means 108, 108A to an open position to release any previously scored or pocketed balls in the manner well-understood in the art.

Shutter 100 is left standing in the open position because motor 108 is stopped by the cam-switch control means at each 180° of displacement of the cycle of crank means 108A.

In the illustrative embodiment, motor 108 is started in its reset cycle by the master control means and is stopped, when the shutter is open, by shutter cam switch 108B which will be shunted however by a ball switch 137 when a certain ball is shot from its position thereon by the player.

While the shutter 100 stands open, a shutter cam switch 111 is left closed by cam 109A standing in the shutter-open position 180° away (where it closes switch 109) and as a result a pulsing circuit is completed for the step-up coil 10 via conductor 112, motor-actuated pulse-switch contacts 113, conductors 115, 154, through the master limit switch wipers 152, 153 and their contacts 152A and 153A, and conductor 155 to coil 10, and thence via conductor 101 to one contact 71 of the limit switch, the remaining contact 72 of which connects via conductor 116 to a selector step-up switch 117 operable under the control of the player at appropriate times, so that the pulsing switch means 113—114 can pulse and advance the step-up coil 10 as long as the player-controlled switch 117 is held closed, provided, of course, that certain other supervisory controls such as the index means 54—55 will permit.

Another incident to the open condition of the ball shutter is the energization of the index coil 55 via conductor 110 and shutter switch 109 closed at this time, the result of which is to free the auxiliary wiper sector 51 for advancing movement with the main wiper by urgency of the follower pin 37.

When the pin 37 engages the sector 51 and tends to push the latter ahead of it responsive to further advances of the main stepping shaft 16, limit switch contacts 71—72 are opened and this would ordinarily break the stepping circuit through the player's selector switch 117; however, since the shutter is standing open, shutter motor cam 119A closes the limit shunt switch 119 to short out the limit switch contacts 71—72 via conductors 101A and 123, so that the limit switch will not disable the step-up coil 10 when the follower pin 37 seeks to advance the sector 51 while the shutter 100 is open.

It may be observed also that the player may selectively cause the stepping switch to step back by closing the

switch 122, which will complete a pulsing circuit via conductor 123 to the escapement or step-back coil 18 for pulsing from conductor 115 as in the case of step-up action.

Should the auxiliary selector have been previously in an advanced condition with the index pawl withdrawn, the sector would of course follow the main shaft and switch wipers in step-back or retrograde action to the limit of its permitted travel; however, if the index pawl has returned to index condition, the sector 51 will be held thereby at its advanced position, and in this sense constitutes a circuit "memory" device for retaining or remembering a previously selected position, for purposes to appear.

In the example described, the auxiliary sector switch wipers 51X follow the sector 51 and close circuits through contacts 130 and conductors 131 to cause illumination of certain feature display lamps 132, each corresponding to desired score numbers, a few of which (e. g. 8, 3, 21, 4) are depicted, and which have a corresponding set of complementary feature selection lamps 133 connected via conductors 134 to step-switch contacts 135 included amongst those on the step-switch panel 25, as previously described.

At certain times in a game cycle, as determined by circuit means (not shown) controlled by the score control and award means, the player may manipulate the selector switch knob 118 clockwise or counter-clockwise to operate the switch means 117 or 122 and step the shaft 16 and appertaining wipers (excepting 51X) so as to cause one of the selection lamps 133 to be illuminated to match an illuminated one of the feature display lamps 132.

When such a selection or matching is accomplished, the player shoots one of the allotted balls by operation of the usual ball plunger 138, causing a certain ball 139, resting at this time on a ball control switch 137, to leave the latter and be propelled in play, with a consequent closure of ball switch 137 restarting the shutter motor 108 to complete its cycle and close the shutter 100 again (and before the propelled ball reaches the field), which will at once release the index coil 55, because of opening by shutter switch index contacts 109. As soon as this happens, the sector 51 and wipers 51X are locked up, and there will now be no further change in the feature display lamp illumination; but stepping of the shaft 16 and movement of wipers such as 136 may change the illumination of the selection lamps 133 under control of the player's selector switch means 117, 118, 122, as aforesaid.

It will be recalled that at the beginning of each game cycle the entire step switch is reset to starting position.

In order to add variety and interest, the step-up and step-back or escapement coils 10 and 18 are pulsed at random automatically from time to time by random pulse switch means 145, 146 (actuated by the "Score Control and Award Means") to pulse said coils via conductors 145A, 146A, with resultant changes in illumination of the feature display lamps 133, and corresponding changes in position of the various step-switch wipers (excepting the auxiliary sector wiper 51X) including particularly the wiper 150 and its position on score control contacts 151 which are connected (not shown) in the game to effect scoring circuits intended to correspond to the lamps 133, which are illuminated either by automatic random stepping, as aforesaid, or by the player's selector switch means.

The limit switch means 71—72, when effectively in the circuit and not shunted out by the shutter switch 119, will prevent injury to the step-up means where the index means prevents movement of the memory sector 51.

But when the shunt at shutter switch 119 is lifted, the step-up and step-back coils and circuits are still protected by wipers 152 and 153 working over the angular limits of their respective sets of contacts 152A, 153A in series with the pulse circuit conductor 115 via conductors 154, 155,

which in practice permit a total range of angular displacement of shaft 16 through about 90° of travel, corresponding to the safe or permitted range of movement of the shaft 16 and the instrumentalities driven thereby.

Thus, it appears that in the illustrative game circuit there is provided the usual electromagnetically-actuated step-up step-back, and resetting means for the main step-switch means including the main ratchet shaft 16, wipers such as 136, 150, 152, 153; along with circuit means including the reset switch means 81, 82, 83, 83A for resetting the main shaft and step switch means; together with circuit means which is both automatically and selectively operable for actuating the step-up and step-back circuit means for the coils 10 and 18, including the player-controlled selector switch means 117, 122 on the one hand, and the random pulse switch means 145, 146 operated automatically by the "Score Control and Award Means" on the other hand.

Moreover, the control-circuit also comprises a memory switch means including memory wiper 51X which can be actuated at certain times by the follower means 37, 38 when the index means 54, 55 is released, or can be held in a memory position if the latter is operated when the auxiliary memory member or sector 51 has been advanced.

The index circuit includes the switch means 109, operable at certain times (as by cam means 109A) to effect release of the index means 54, 55; as well as concurrently operated switch means 119 for shunting out the supervisory cut-out or limit switch means 71—72 at times when the index means is released or the stop pawl 54 withdrawn from the special teeth 52.

Accordingly, the main control means contemplates a stepping circuit for stepping the main step-switch means "up" or "back"; a resetting circuit for energizing both the escapement coil 18 and the full reset coil 22; and an index circuit with switch means operable concurrently for energizing the index coil 55 and releasing the index means, and also shunting or disabling the supervisory cut-out switch 71—72 so that whenever the index means is released and the auxiliary memory device 51 is free to be advanced, the step-up mechanism at least will be operative to cause advance stepping of the main step-switch shaft 16 to advance the follower drive means 37 far enough, i. e. through the necessary plural or predetermined number of steps (five in the embodiment shown) to urge the auxiliary member 51 ahead of it and away from its starting position to some advance position where it may be held by a restoration of the holding pawl 54 of the index means.

This holding of the auxiliary stepping member 51 and its associated memory switch means 51X, 130, etc., constitutes a memory function by holding the latter in some advanced position until it is either stepped back to another position, including its normal starting position, by action of the step-back ratchet means and its coil 18, or by a full reset in the manner described.

And more particularly, in the illustrative game embodiment the function of the memory switch means 51X, 130 is to hold the "Feature Display Lamp" connections after the ball 139 is projected from the switch 137 in the expectation that it will score on one of the matched selections "#3" or "#21" on which the memory switch contactor 51X stands in Fig. 8, and from which circuit connections are extended to corresponding ball scoring switches 160, 161, 162, these ball scoring switches in turn being respectively connected via conductors 160A, 161A, and 162A to contacts in the bank 151 for connection by the main step-switch wipers to the "Score Control and Award Means" for appropriate award action in the event the projected ball scores on one of the selected numbers.

For example, if it assumed that the ball 139 is now projected, it will be recalled that the ball switch 137 will be closed as this ball leaves and the shutter panel will at once complete its cycle and close. Now, if this ball should score upon or close the ball switch 161 a scoring circuit

connection would be extended to the "Score Control and Award Means" by wiper 150 and corresponding to the position of the memory switch wipers 51X via one of the conductors 131 to ball score switch contacts 161, now assumed to be closed by this ball 139, and thence via conductor 161A to the contact button "#3" on bank 151 to be connected by the wiper 150 to said "Score Control and Award Means" for appropriate scoring action by the latter, the corresponding display lamp #3 being one of the lamps illuminated at this time by the memory switch wipers 51X, along with the feature lamp #3 likewise illuminated according to the position of wiper 136 at this time.

We claim:

1. A stepping switch with memory device comprising a ratchet-driven shaft, electromagnetic stepping, resetting, and escapement mechanism respectively operable to step said shaft forward, backward, or reset the same relative to a starting position; stepping contact means moved by said shaft; an auxiliary member freely rotatable on said shaft; stop means defining a starting position for the auxiliary member; spring means normally urging said auxiliary member into said starting position; index teeth formed on said auxiliary member and an electromagnetically operable index pawl engaged normally in said teeth to immobilize the auxiliary member; a limit switch carried by the auxiliary member; and a follower member rotatable with the said shaft into engagement with said auxiliary member and an operable part of said switch to actuate the latter and urge the auxiliary member to move co-directionally with the shaft and follower member when said index means is released, said index means being operable to hold said auxiliary member in advanced positions away from the starting position thereof.

2. A stepping switch with memory device for game circuits comprising main stepping switch contact means and a ratchet shaft therefor; electromagnetically actuated step-up, step-back, and reset ratchet means for stepping the shaft accordingly; means determining a main starting position for said shaft; a stepping circuit for selectively actuating the step-up and step-back ratchet means; an auxiliary member and memory switch contactor carried thereby rotatable concentrically of said shaft; follower means rotatable with said shaft into driving engagement with said auxiliary member and said memory switch to actuate the latter and urge said member ahead; stop means determining a starting position for said auxiliary member located a plurality of steps in advance away from the main starting position; spring means urging said auxiliary member against said stop means to starting position; electromagnetically operated index means normally holding said auxiliary member against movement; and an index circuit connected with said index means for operation to release and hold said auxiliary member; together with shunt switch means connected with said limit switch and controlled by said index circuit for disabling said limit switch at times when said index means is in released condition.

3. A stepping switch with memory contact means comprising stationary contact means including a plurality of concentrically arranged contact banks; main contactor means mounted to rotate concentrically of said banks and engageable with contacts in certain of said concentric banks for movement over the latter back and forth relative to a main starting position; electromagnetically actuated step-up, step-back, and resetting means for accordingly moving said main contactor means; a memory member mounted to rotate concentrically of said contactor banks and main contactor means; memory contact means carried by said memory member to engage and travel over contacts in certain of said banks; a limit switch carried by said memory member; follower means movable with said main contactor means into engagement with said limit switch to actuate the latter and urge said memory device ahead; stop means for the memory member posi-

tioned a predetermined number of steps away from the starting position of the main contactor means in the direction of advance of the latter; spring means urging said memory member into engagement with said stop means as a starting position; index teeth on said memory member; electromagnetically releasable index means normally engageable with said teeth to immobilize the memory member; a resetting circuit for said resetting means; a stepping circuit connected with said electromagnetically actuated step-up and step-back means for selectively stepping-up and stepping-back said main contactor means in advance away from or back toward said main starting position; a supervisory circuit including said limit switch and connected with said stepping circuit to disable the latter when said limit switch is actuated by said follower means; and an index circuit including switch means connected with the electric magnetically releasable index means and said limit switch and operable to release the index means and disable said limit switch from effective operation by said follower means whereby to permit advance of the memory member by the follower means when the index means is released as aforesaid, said memory contact means being adapted to be held in advanced positions by said index means under control of said index circuit, and said limit switch being operated to disable said step-up means at times when the memory member is immobilized.

4. In a stepping switch of the type including a ratchet shaft spring-urged to a main starting position and switch wipers moved by said shaft, electromagnet step-up, step-back, and resetting ratchet means for moving said shaft accordingly, and circuit means for selectively actuating said ratchet means; improvements including a memory switch cooperable with said stepping switch and comprising, to wit: an auxiliary member freely rotatable on said ratchet shaft; stop means determining a secondary starting position for said auxiliary member located a plural number of steps in advance away from said main starting position; spring means urging said auxiliary member to engage said stop means for disposition in said secondary starting position; memory switch wiper means carried by said auxiliary member; a limit switch carried by said auxiliary member; a follower member rotatable with said ratchet shaft from said main starting position through said plural number of steps to engage said limit switch and said auxiliary member and urge the latter ahead of the follower member and concurrently operate the limit switch; index teeth on said auxiliary member; an index pawl normally spring-urged to engage in said teeth to immobilize the auxiliary member; electromagnetic index-release means for withdrawing said pawl to free the auxiliary member for movement by the follower means; and an index circuit including switch means connected with said electromagnetic release means, as well as switch means connected with said limit switch, and operable to actuate said index release means and shunt said limit switch so that the latter does not disable the stepping circuit at times when said index pawl is withdrawn by said index release means.

5. A memory switch and circuit comprising a stepping switch having a shaft, switch wipers moved thereby, step-up, step-back, and full reset mechanism for said shaft, a step-up coil, a step-back coil, and a reset coil respectively cooperable with said step-up, step-back, and full reset means; an auxiliary stepping member floating on said shaft and having index teeth; an index pawl spring-urged normally to engage in said teeth; and index coil energizable to release said pawl; a limit switch movable with said auxiliary member; a follow-up member movable by said shaft to engage said limit switch and auxiliary member to advance the latter if free from said index pawl and also to operate said limit switch; pulse switch means and selectively operable player-actuated switch means connected in an operating circuit including said limit switch to pulse said step-up and step-back coils selectively; a memory switch movable with said auxiliary member; score

switch means moved by said shaft, and a circuit for energizing said index coil to free said auxiliary member for movement by said follow-up member, and a shunting switch connected for operation to render said limit switch effective and ineffective to open and close said circuit to the step-up coil to safeguard the latter when said index pawl locks up said auxiliary member.

6. A stepping switch including a shaft, electromagnetic step-up, step-back, and reset mechanisms for moving said shaft, switch means movable by said shaft; an auxiliary member rotatably mounted on said shaft, spring means urging said member to a starting position; follower means rotated by said shaft to engage said auxiliary member and push the latter, if free to move, ahead of the follower; an index pawl movable into and out of holding engagement with said auxiliary member; limit switch means carried by said auxiliary member in position to be engaged and operated by said follower means; and an operating circuit for said electromagnetic step-up mechanism including said limit switch and connected to be disabled when said limit switch is actuated by said follower means; and circuit connections for energizing said index coil means to free said auxiliary member for movement in one direction by said follower means and in another direction by said spring means.

7. In a game circuit, stepping switch means including stepping mechanism and operating coils therefor for moving said stepping switch means forward, backward, and fully resetting the same to a normal starting position; and a memory device including a toothed sector member, index dog and releasing coil means therefor for locking the sector in certain positions; a limit switch moveable with the sector, a follow-up member moved advancingly toward the limit switch by said stepping mechanism concomitantly with stepping operations of the switch means and movable a predetermined plurality of steps forward from said starting position into a critical position of operative engagement with said limit switch; forward movement of said follow-up member beyond said critical posi-

tion tending to drive said sector member forward from a predetermined starting position substantially corresponding to said critical position; and a circuit for energizing said operating coils to effect said forward stepping action, at least; electrically released index means cooperable with said sector to hold the latter at any of a plurality of positions into which it may be moved; and a control circuit for energizing said release index and that particular one of said operating coils, at least, which effects said forward stepping movement, said circuit including said limit switch and a shunt switch therefor connected for operation to permit energization of said particular coil so long as said limit switch is not operated by said follower member, as well as under the condition where the limit switch is actuated by the follower member and said index means is released to permit movement of the sector.

8. In a stepping switch a stepping shaft and means for stepping same; a memory device freely rotatable concentrically of said shaft; a supervisory switch movable with said memory device; releasable index means cooperable with said memory device to hold the latter in any of a predetermined number of advanced angular positions relative to a normal position; follower means movable angularly with said shaft into and out of operative engagement with said supervisory switch and operable to actuate said switch and thereafter urge said memory device ahead by further advance; electrical means for actuating said stepping means and said index means; and control connections for said electrical means including said supervisory switch for preventing effective operation of said electrical means at times when said supervisory switch is actuated by said follower means and said memory device is held by said index means.

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