June 6, 1950

G. W. SPRENGER

2,510,666

PROCESS TIMER

Filed Dec. 21, 1948

2 Sheets-Sheet 1

Fig. 1.

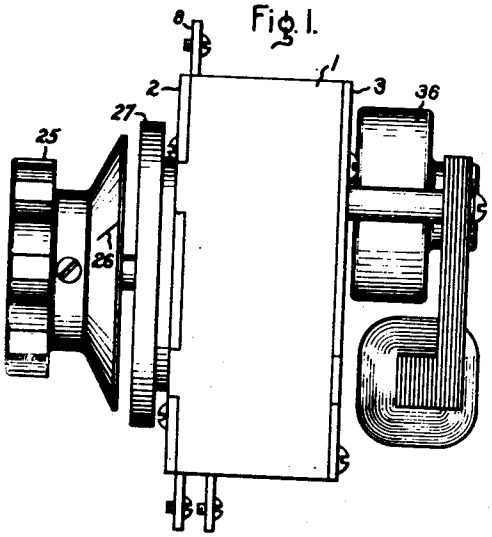


Fig. 2.

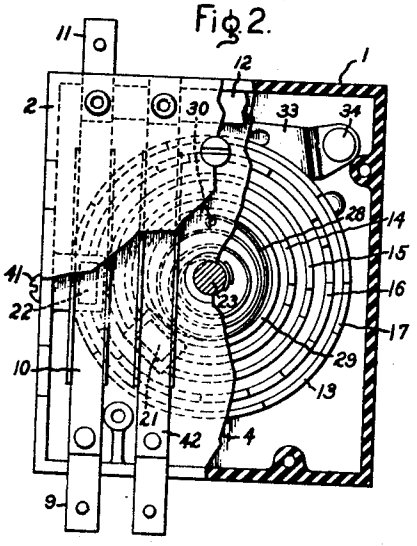


Fig. 3.

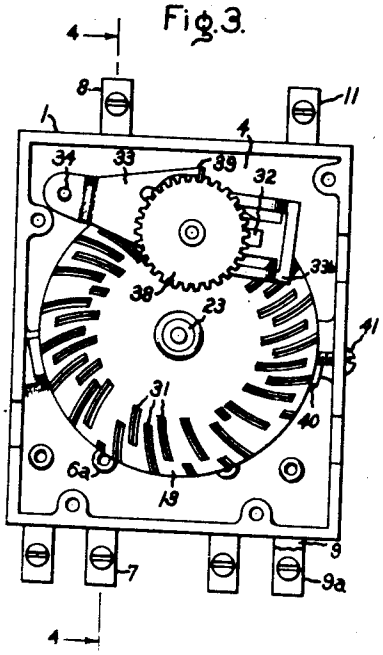


Fig. 4.

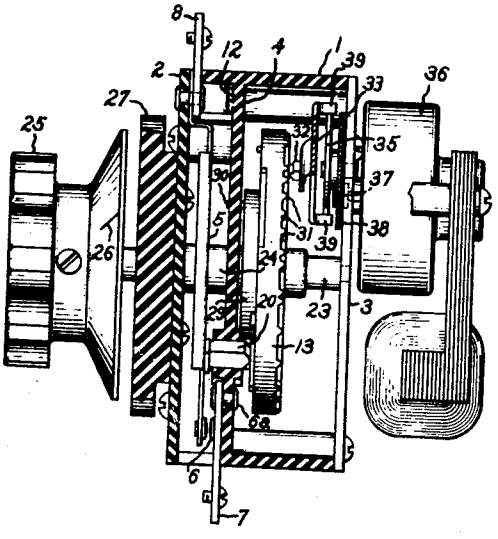


Fig. 5.

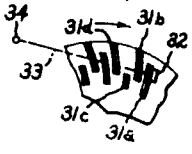


Fig. 6.

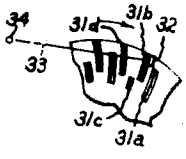
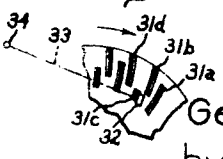


Fig. 7.



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Fig. 8.

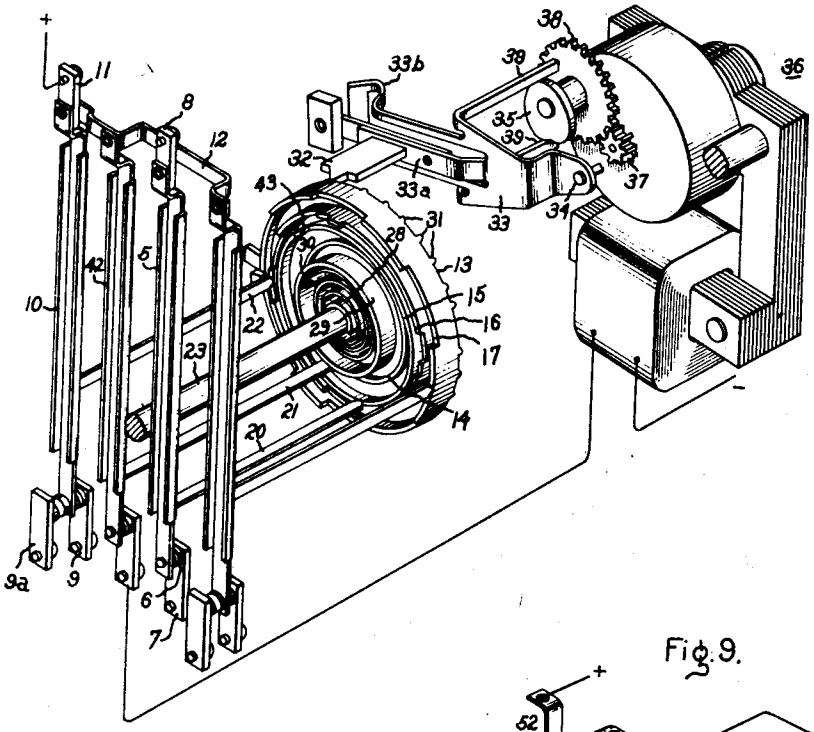
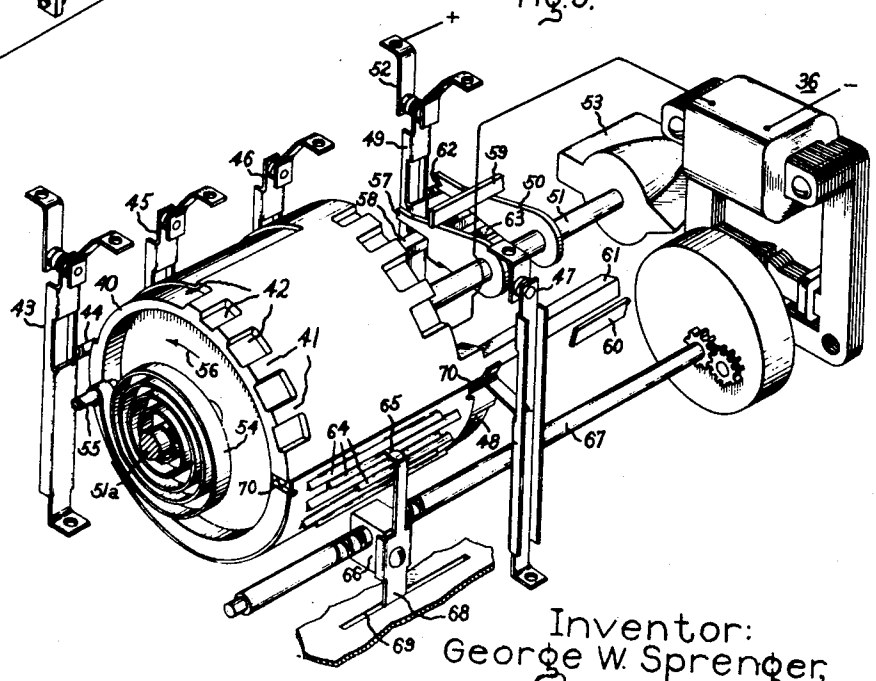


Fig. 9.



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UNITED STATES PATENT OFFICE

2,510,666

PROCESS TIMER

George W. Sprenger, Lynn, Mass., assignor to General Electric Company, a corporation of New York

Application December 21, 1948, Serial No. 66,536

6 Claims. (Cl. 161—1)

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My invention relates to process timers of the type for opening and closing switches in a desired sequence, and its object is to provide a small, low-cost, reliable timer which may be adapted for a wide variety of switching programs embodying a spring driven escapement mechanism controlled by a timer motor. The features of my invention which are believed to be novel and patentable will be pointed out in the claims appended hereto. For a better understanding of my invention, reference is made in the following description to the accompanying drawings in which Fig. 1 represents a side view of a preferred form of my process timer, employing a disk form of program selecting escapement mechanism. Fig. 2 is a front view of the timer of Fig. 1 with the spring winding and setting knob removed and with the front and forward wall sections partially broken away. Fig. 3 is a rear view of the timer of Figs. 1 and 2 with a rear cover and timer motor removed. Fig. 4 is a side sectional view taken on line 4—4 of Fig. 3 but with the rear cover and timer motor in place. Figs. 5, 6, and 7 represent detail views of escapement parts of the device of the preceding figures with the escapement in progressively different positions. Fig. 8 is a perspective exploded view of the operating mechanism of this timer. Fig. 9 represents a perspective view of the essential parts of a process timer employing an escapement principle as in Figs. 1 to 7, but with the escapement lugs and switch operating cams arranged on the periphery of a drum instead of on the side of a disk.

Referring now to Figs. 1 to 4, 1 represents a cubical-shaped housing box of the proportions shown and of a height of the order of three inches, preferably made out of insulating material and having front and rear removable covers 2 and 3 which may be of transparent insulating material, such as transparent plastic, for convenience in observing the position of certain parts of the internal mechanism. A supporting wall or partition 4 (see Fig. 4), also of insulating material, parallel with the front and rear covers divides the casing into front and rear compartments. The front compartment contains a series of switches having stationary and movable contacts. In the example given, there are four switches. Each switch has a flexible moving contactor, such as the contactor 5 seen in Figs. 4 and 8, and one or more stationary contacts, such as the back contact 6 cooperating with the contact end of resilient contactor 5 as seen in Figs. 4 and 8. In the example given, the back stationary

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contacts, such as 6, are riveted to the partition 4 as by rivet 6a and may have terminals brought out as at 7. The movable contactors, in the example given, are secured to the front wall 2 at their stationary ends and may have terminals brought out as the terminal 8 for contactor 5. The switches may have both back and front stationary contacts with the movable contactor moving between them. Thus, 9, Figs. 2 and 8, is a terminal for a back stationary contact secured to partition 4; and 9a, Figs. 3 and 8, is a terminal for a front stationary contact secured to front wall 2 for a flexible switch contactor 10, the terminal of which is brought out at 11. Such front contact with its terminal 9 is secured to the front wall 2 of the casing. Each contact of the several switches does not necessarily have an external terminal, but certain contacts may be connected together by internal cross-connections, such as represented by the crossbar 12 seen in Figs. 2, 4 and 8. The number, arrangement and connections for such switches may be varied in different process timers to meet the needs of different processes and are not important to the present invention.

In the rear compartment there is a metallic rotary disk 13 which has on its front surface a series of circular cam tracks at different radia, designated 14, 15, 16, 17 in Figs. 2 and 8, there being one cam track for each movable switch contactor 5, 10, etc. Each cam track has an axially extending cam surface cut in its cam track as best shown in Fig. 8. The cammed surface of each cam track cooperates with a pusher, such as the pusher at 20, Figs. 2, 4, and 8. These pushers are small, short bars of insulating material which are freely slidable endwise through openings in the partition 4 and constitute the operating connection between a cam and its movable switch contactor. Thus pusher 20 is the operating connection between the cams in the cam track 15 and the flexible contact member 5 and, as shown in Fig. 4, has been pushed to the left by a raised portion of its cam track against contactor 5 and opened the contacts between contactor 5 and stationary contact 6. As this raised cam portion rotates and presents a lower surface against the pusher, the resiliency of contactor 5 will push 20 towards the rear or to the right in Fig. 4 and close such contacts. At 21 and 22 in Figs. 2 and 8 are indicated other pushers for cam tracks 14 and 16, respectively. These pushers are of a rectangular cross section so they cannot turn in the openings therefor in partition 4, and have an overhanging lip at their front ends

to limit their movement to the rear or to the right in Figs. 4 and 8 and the corresponding movement of their movable contactors. Where these pushers pass through the partition 4, the partition is made sufficiently thick to provide good sliding support and resist side thrust. The several pushers are located radially from the axis of rotation of disk 13 the same distance as their corresponding cam tracks and laterally across the width of the casing 1 to be in line with their corresponding movable contactors. Each cam track and its corresponding pusher and contactor operate without interference from the others. The nature and sequence of the switching operations to be performed will depend upon the nature of the cam surfaces cut in each cam track and their relation to each other, and will vary to suit the requirements and are not a limiting feature of my invention. While four sets of switches and their operating mechanisms have been illustrated, this may be decreased or increased by omitting or adding parts similar to those already described.

The disk 13 is fixed to a shaft 23 which extends through the casing and has a main bearing through a bushing 24 extending between front cover 2 and partition 4 and a support bearing in the rear cover 3. At the front end of shaft 23 is a knob 25. This knob has a radial index 26 marked on its skirt to indicate on a scale plate 27 the rotary position of the shaft 13 in terms of the switching program to be performed. Thus if the timer is to be used for controlling the different switching operations of an automatic washing machine, the positions of the switch for start, wash, rinse, dry, etc., may be marked on scale plate 27 and indicated by the index 26. The knob 25 is also used to set the cam disk 13 to any desired rotary position and to wind a spiral spring 28 which is contained in a hollow drum section 29 of the disk 13. This spring 28 has its inner end secured to shaft 23 and its outer end fixed to a pin 30 fixed in partition 4. Rotating shaft 23 counterclockwise in Fig. 3 and clockwise in Fig. 8 winds spring 28 and thus builds up a force for rotating disk 13 in the reverse direction in the subsequent automatic operation of the process timer.

On the rear face of disk 13 is a series of slightly spiral-shaped nearly radial escapement lugs 31, best shown in Figs. 3, 5, 6, and 7. Such lugs have a variety of different radial lengths and are located at a variety of radial distances from the axis of rotation, but all are contained within given inner and outer circles defining their inner and outer limits. These lugs cooperate with an escapement pawl 32 mounted on an arm 33 pivoted at 34, best shown in Figs. 3 and 8, and diagrammatically illustrated in different positions in Figs. 5, 6, and 7. The pawl 32 is reciprocated toward and away from the axis of rotation of disk 13 between an outer limit represented in Fig. 6 and an inner limit represented in Fig. 7 by a cam 35 rotated by a timer motor 36. The tip of pawl 32 when engaged with the raised front surface of an adjacent lug 31 normally prevents the disk 13 from turning clockwise in Figs. 3, 5, 6, 7 (counterclockwise Fig. 8) against the tension of spring 28, except as permitted by the pawl moving radially off the end of a lug thereby permitting disk 13 to turn a short distance until caught and stopped by the pawl engaging the next lug. Thus, in Fig. 5, pawl 32 engages a lug 31*a*. When the pawl is moved outwardly, it will move off the outer end of lug 31*a* at which time

the disk 13 will rotate clockwise and be stopped by the pawl engaging lug 31*b* as shown in Fig. 6. The pawl will then move inwardly sliding along the surface of lug 31*b* until it moves off the inner end of such lug at which time the disk will rotate forward another step and be stopped by the pawl engaging lug 31*c* as shown in Fig. 7. The next advance will occur when pawl 32 moves outwardly off the end of lug 31*c* and engages lug 31*d*. Lug 31*d* will not be released until pawl 32 has moved outwardly to the limit of its travel and back again to the inner end of lug 31*d*. Thus the disk 13 with its cams is advanced in steps in a time sequence determined by the length and arrangement of the escapement lugs 31 on such disk, and the rate of reciprocation of arm 33. It is apparent that this form of escapement is subject to a wide range of operating periods by the selection and arrangement of the lugs. In case it is desired that the distance of advance of disk 13 be varied, this can be done by varying the peripheral spacing of the lugs or omitting one or more of them. The particular arrangement and length of lugs are not a limiting factor of the invention.

The spiral shape of the substantially radial lugs shown preferably conforms to or is parallel to the arc of travel of the pawl about pivot point 34 so that the disk 13 remains absolutely stationary between forward advancing steps. The motor 36 illustrated is of the self-starting synchronous type. It is secured to the back wall of the casing, and the back wall has an opening to permit insertion of the terminal gear 37 of the motor into mesh with a gear 38 inside the casing, which gear 38 drives the cam 35. The cam is straddled by a pair of fingers 39 bent out of the arm 33 to serve as a cam follower.

In setting the disk 13 by means of the knob 25 and the winding of spring 28, it is desirable that the escapement be designed to permit this without damage. To this end the pawl 32 is mounted on a somewhat resilient weighted central tongue portion 33*a* of arm 33, and the shape of the lugs 31 is somewhat triangular with sloping faces so that the disk may be forcibly turned in either direction by hand through knob 25, with the pawl 32 riding over the lugs 31 without damage. The face of the escapement lugs can be made perpendicular to the face of disk 13 instead of sloping such as to permit manual setting only in the spring winding direction where that is desired. A third stirrup-shaped resilient portion 33*b* of arm 33 is shaped to rest and slide lightly against the inside wall of back cover 3 to provide sufficient pressure on the pawl 32 to assure that it remains in contact with the escapement surface of disk 13 and performs its escapement function with reliability during automatic operation. The holding force of the escapement must exceed the turning force of the spring 28 but yields to a greater manual turning force. The weight shown at the outer end of the pawl tongue 33*a* in Fig. 8 gives these parts sufficient inertia to absorb the momentum of the cam 13 to assure reliable operation.

The timer illustrated and described is intended to perform a selected switching program and then automatically cease functioning, and to this end the disk 13 is provided with a stop lug 40 adapted to engage with a stop such as screw 41 (see Fig. 3) at the limit of its program travel. In the rotary position of disk 13 shown in Fig. 3 the disk 13 has been turned in the direction to wind spring 28 to the limit permitted and such position corre-

sponds to the beginning of the switching program provided for. The motor 36 is preferably so wired through the switching provided in the timer that such setting of disk 13 and the winding of the spring 28 energize the motor, and it remains energized until the timer has completed its operating cycle and stop lug 40 is approaching stop 41 from the opposite side after nearly a complete revolution of disk 13. This is provided for by the inner cam track 14, switch pusher 21, and switch contactor 42. Cam track 14 has only one short raised cam lobe 43 in such position that it opens the contacts controlled by contactor 42 only when stop lug 40 is close to or against stop 41 at the end of an automatic operation. As indicated by the wiring in Fig. 8, motor 36 is energized through contactor 42 when closed. Hence, the timing motor will be energized continuously when the disk is positioned at the start or at any part of its operating cycle, and is deenergized only when the operating cycle has been completed or when the disk has been turned by hand to such off position.

There may be a peripheral space on the escapement side of disk 13 where the escapement lugs are omitted at the end of the automatic operating cycle when the switching program desired has been completed. When such space is reached in the operating cycle, the disk will immediately complete its turn to the off position by spring 28. The spring 28 should have some initial tension when in the off position.

At the beginning of a process timing operation when the disk 13 is set to the rotary position shown in Fig. 3 and the timing motor started, the exact radial position of the escapement pawl 32 and its initial direction of movement might be uncertain. Thus, in Fig. 5, if lug 31*a* represents the first or beginning holding lug of the series of lugs at the start of a program, it may happen that the pawl 32 will be in any one of the radial positions represented in Figs. 5, 6, and 7 when the disk is reset to start position. Thus it may be caught by the pawl in either the rotary position shown in Fig. 5 or in the rotary position shown in Fig. 6. Also the initial movement of the pawl as represented in Fig. 5 may be inward or outward. Because of this it may be desirable to make the second lug, such as 31*b*, the first active switching program lug and use lug 31*a* simply as a lug properly to synchronize pawl 32 with the disk 13 in case it needs synchronizing at the beginning of a program operation. Fig. 6 would then represent the relative positions of disk 13 and pawl 32 for the first active switching operation of the program other than the energization of the timing motor. And if this positioning of the parts is not obtained immediately upon resetting to the start position but pawl 32 is in a position to engage lug 31*a* instead of 31*b*, the correct process starting position of the parts will occur in not more than one complete revolution of cam 35, when the pawl 32 moves off the outer end of synchronizing lug 31*a*. Thus the apparatus needs no especial synchronizing attention at the start of a switching program other than turning knob 25 to start position and releasing it, and if any synchronization is needed it occurs automatically.

Where the timer is to be used continuously so as to repeat one operating cycle after another without attention, the automatic control of the timer motor and the stop feature 40—41 may be omitted and the spring 28 arranged to be wound continuously.

In Fig. 9, I have represented a process timer which employs the same operating principles previously described but which is of modified construction. The combined cam and escapement disk 13 of Figs. 1 to 8 is replaced by a drum 40 having a switch operating cam surface sector covering about 165 degrees of the periphery shown uppermost in Fig. 9, and an escapement lug surface sector covering most of the remaining part of the periphery partially shown at the lower right in Fig. 9. Thus, a raised cam surface is shown at 41 and a depressed cam surface is shown at 42 for operating a resilient member contactor 43 having a cam follower extension 44 bearing against such cam surface so as to operate contactor 43 when the drum 40 is rotated in accordance with the contour of the cam track against which the cam follower 44 bears. There are four such contactors 43, 45, 46 and 47 having cam followers bearing against different axially spaced cam row surfaces of drum 40, the first three contactors mentioned being shown to the left of the drum and contactor 47 being shown at the right and having a cam track 48 on an end portion of the drum to the right of the escapement lug section.

A fifth contactor 49 is also provided and it is operated between its two positions by an arm 50 free to rotate on shaft 51. The contactor 49 is included in the circuit of the timer motor 36, and this circuit is closed when contactor 49 engages its back stationary contact 52. An arrangement to be described is provided for automatically closing the motor circuit at the beginning of an automatic switching program and opening such circuit at the end of such program, and also for manually opening the motor circuit to stop the switching program at any point during such program should that be desired.

Fifty-three (53) represents the setting and spring winding knob and is secured to shaft 51. The drum 40 is not connected directly with shaft 51, and the shaft 51*a* shown at the left of the drum is a separate shaft on which drum 40 is secured in axial alignment with shaft 51. Fifty-four (54) represents the spring for turning the drum 40 during an automatic operating cycle. This spring has its inner end secured to shaft 51*a* and its outer end secured to a stationary pin 55. The spring 54 is wound and drum 40 turned in the direction of arrow 56 to program starting position by turning knob 53 and shaft 51 in such direction through an arm 57 secured to shaft 51 and a finger 58 extending axially from the periphery of drum 40 and engaged by arm 57. Fifty-nine (59) and 60 are stops which limit the rotary movement of arm 57 and define the limits of rotary movement of the apparatus. Arm 57 rests against the underside of stop 59 as shown when the apparatus is in the off position at the end of a switching program before reset to start position. Arm 57 rests against the underside of stop 60 when the device is set to the start position of a switching program. It will be apparent that when shaft 51 is thus turned from the off to the start position in the direction of arrow 56, drum 40 will be turned accordingly and the spring 54 will be wound. When the drum 40 is thus turned manually from off to start position, a finger 61 extending axially to the right from the periphery of the drum rotates around and engages the top of arm 50 near its outer end and rotates it a short distance until the cam follower of switch contactor 49 engages in the V-shaped notch at 62 in the free end of arm 50. This is the limit of move-

ment of finger 61 in this direction. This operation moves contactor 49 to the left against stationary contact 52 and closes the power circuit to the motor and preferably also to the remaining circuits controlled by the other contactors. The V-shaped notch at 62 holds contactor 49 in such closed position until the arm 50 is again forcibly moved from this position.

The arm 50 will be raised from the position last described to the position shown in Fig. 9 either when the drum 40 rotating in the direction opposite to arrow 56 reaches the end of its automatic time cycle at which time arm 58 comes against the underside of arm 50 near its end and raises it to the position shown and opens the switch contacts 47—52, or such switching off operation may be made regardless of the rotary position of drum 40 by manually rotating knob 53, shaft 51, and arm 57 to the position shown against stop 59. This is by reason of the fact that arm 57 has a finger 63 extending to the right therefrom in position to engage the underside of arm 50 and move it to the position shown when arm 57 is rotated from beneath against stop 59. Hence the switching program performed automatically by drum 40 may be stopped in any desired rotary position of such drum but if not so stopped, it will continue to the end thereof when the drum will have arrived at the off position and opened the power circuits.

The escapement mechanism employed in Fig. 9 comprises a lugged surface 64 and an escapement pawl 65 which is reciprocated back and forth axially of the drum by a groove and pin mechanism indicated at 66 driven from the timer motor 36 through shaft 67. Thus the shaft 67 has two grooves cut therein, the two grooves being spiraled in opposite directions and made continuous with each other at their ends. The pawl member has a carriage through which the shaft extends and in such carriage there is a rotatable pin having an end thereof which enters the groove. The follower end of such pin which enters the groove has an elongated curved shape so as to enable it to follow one spiral groove to its end and return in the other spiral groove such that as the shaft is rotated in a given direction the pawl 65 with its carrier is reciprocated back and forth at a constant rate between limits corresponding to the operating length of the lugged surface 65. A resilient tail 68 of the lug enters into a slot 69 in a stationary guide resiliently to retain the pawl 65 in operative position against the lugged surface 64, but allowing the pawl to slip over the lugs when the drum is turned with sufficient force manually. The double spiral groove and pin arrangement per se is not new and the details of such a device may be found in Fig. 4 of United States Patent No. 2,177,479—October 24, 1939, assigned to the same assignee as the present invention. The drum 40 is preferably molded or machined from insulating material since the switch contactors ride directly thereon. The lugged surface may be cut therein, but it is preferable that the lugs be made of a longer wearing metallic material, and hence, I make the lugged surface from sheet metal and secure it to the drum surface as by several bent-over retaining members engaging in openings therefor cut into the drum as indicated at 70.

It will be understood that when the drum 40 is turned manually in the direction of arrow 56 to wind up spring 54, the pawl 65 will slip over the lugs in 64 engaged thereby, but that the retaining force of such pawl with the lugs is sufficient

to prevent such slipping over against the force of the wound-up spring, and hence, the drum will be rotated by the spring in the reverse direction in steps only as permitted by the escapement as the pawl is moved to the end of the lugs one after the other. The timing and switching program may be varied by providing lugs of various lengths and by the nature of the drum cam surface and the number and connections of the contactors as mentioned in connection with the previously described design. With either modification a long and varied switching program is provided for by a relatively simple, reliable, and low-cost mechanism. The switching operations are performed quickly and positively notwithstanding the fact that switching programs of long time duration are possible. For instance, the time required for the pawl 65 to travel the length of the longest lug may be made anything from a few seconds up to several days. However, when the drum steps forward from one lug to the next, a switching operation is performed substantially instantaneously.

Except as otherwise mentioned, the functioning of the two modifications described is similar.

It will be evident to those skilled in the art that the program of escapement teeth may be laid out on a flat surface which is moved along a straight line; however, the rotary arrangements described are to be preferred because in general the rotary modifications can be built smaller and more compactly.

What I claim as new and desired to secure by Letters Patent of the United States is:

1. A timing controller comprising a rotary member for performing desired operations in a timed sequence, motor means for urging said members to rotate in a given direction and an escapement mechanism for controlling such rotation comprising a series of elongated teeth on an exposed surface of said rotary member and extending generally transversely of the direction of rotary movement of such surface, a pawl engaging said surface and adapted to hold the rotary member from rotation when in engagement with one of said teeth, and a timing motor for moving said pawl transversely back and forth on such exposed surface in a path parallel to the adjacent elongated tooth thereon such that the rotary member is held from rotation in all transverse pawl and tooth engaging positions of said pawl, said pawl having a range of movement on said surface coextensive with and which extends beyond the length of the elongated teeth thereon at least at one end of each tooth such that the pawl may be moved off an end of each tooth to allow the rotary member to advance, adjacent teeth also having a staggered end relation as least at one end such that when the rotary member is released by movement of the pawl off the end of a tooth it advances and is stopped by reason of the engagement of the pawl with a next adjacent tooth.

2. A timing controller comprising a movable member for performing desired operations in a timed sequence, means whereby said member is urged to move in a given direction, and an escapement mechanism for controlling such movement comprising a series of elongated teeth on an exposed surface of said member and extending generally transversely of the direction of movement of said surface, a pawl engaging said surface and adapted to hold the member from movement when in engagement with one of said teeth, and a timing motor for moving said pawl trans-

versely back and forth on said surface in a path parallel to the adjacent elongated tooth thereon such that the member is held against movement in all transverse positions of said pawl when in engagement with one of said teeth, said pawl having a range of movement on said surface which is coextensive with and which extends beyond the length of the elongated teeth thereon at least at one end of each tooth such that the pawl may be moved off an end of each tooth to allow the member to advance, adjacent teeth also having a staggered end relation at least at one end such that when the member is released by movement of the pawl off the end of a tooth it advances and is stopped by reason of the engagement of the pawl with a next adjacent tooth.

3. A timing controller comprising a rotary member, a spring for urging said member to rotate in one direction, a position indicating knob for rotating said member in the opposite direction to wind said spring, said member having a plurality of cams, a plurality of switching members operated by said cams when the member is rotated, and an escapement mechanism for controlling the time and extent of rotation of said member comprising a series of elongated teeth on an exposed surface of said member extending transversely of the direction of movement of such surface, a pawl engaging said surface and adapted to hold the member against rotation by said spring when in engagement with one of said teeth, and a timing motor for moving said pawl transversely back and forth on said surface in a path parallel to the adjacent elongated tooth thereon, the transverse length of said teeth being varied and their alignment in the direction of movement being staggered to suit the timing cycle desired and said pawl having a range of movement coextensive with and which extends beyond the length of each tooth at least at one end whereby in operating over the timing range of the controller the pawl moves along the length of each tooth at least once, the shape of said teeth and pawl being such and the pawl mounting being such as to permit of the pawl riding over the teeth when the controller is rotated manually in a direction to wind said spring.

4. A switch controlling timer comprising a circular disk-shaped member mounted for rotation on its central axis, a spring for biasing said member to rotate in one direction, a plurality of cams at different radii on one end surface of said member, switching means operated by said cams when the member is rotated, an escapement mechanism for controlling intermittent rotation of said member by said spring comprising a plurality of substantially radially disposed elongated teeth on the other end surface of said member, a pawl engaging said toothed surface so as to prevent spring biased rotation of said member when the pawl is in engagement with a tooth thereon, a pivoted lever on which said pawl is mounted, and a time operated cam for oscillating said lever such that the pawl moves back and forth in a fixed path on said toothed surface parallel to the substantially radially disposed elongated adjacent tooth thereon, the range of travel of said pawl being sufficient to move over the length of all of said teeth and beyond at least one end of each tooth, adjacent teeth having their ends staggered at least on one end such that when the pawl moves off the end of a tooth, the member is rotated by said spring and is stopped by engagement of said pawl with a next adjacent tooth, said rotary

member having a control range of operation of nearly a complete revolution, a stop for confining the rotation of said member to substantially its operating range, and manual means for rotating said member in a direction to wind said spring, the shape of the teeth and the mounting of the pawl of said escapement being designed to allow the pawl to ride over the top of the teeth during such spring winding rotary movement of said member.

5. A switch controlling timer comprising a rotatively mounted drum, said drum having a plurality of cams on a sector portion of its surface, said cams being in a plurality of peripheral rows, switching means cooperating with each cam row so as to be operated by the cam or cams in its corresponding row when the drum is rotated, a spring for rotating said drum between start and finish positions in one direction, and an escapement for permitting intermittent rotation of said drum by said spring, said escapement comprising a plurality of elongated teeth extending parallel with the axis of said drum and spaced apart peripherally about another sector portion of the surface of said drum, a pawl resting on such toothed surface of said drum so as to engage with the teeth thereon to prevent spring biased rotation of the drum, a timing motor driven mechanism for reciprocating said pawl back and forth on said drum parallel to the elongated teeth thereon in a fixed path such that the pawl can slide along any tooth in engagement therewith to hold the drum stationary and off at least one end of each tooth to allow the drum to advance, the ends of adjacent teeth being staggered at least at one end such that when the drum is released for advancement by the pawl riding off the end of a tooth, it advances and is stopped by engagement of the pawl with a next adjacent tooth, manual means for turning said drum to start position to wind said spring, said escapement being designed to permit such spring winding rotation by reason of the pawl riding over the teeth thereof, stops for limiting the rotation of said drum to its normal range of operation between start and finish positions less than a complete revolution, a lost-motion connection between said manual means and drum whereby the manual means may be turned between start and finish operating limits independently of the drum, a line switch closed in response to the rotation of said drum to its start position, and means for opening said line switch either in response to the return of the drum to its finish position or the return of said manual means to its finish position independently of the drum.

6. A time controller comprising a rotary member adapted to rotate between start and finish positions to perform a series of control operations, means for urging such member to so rotate and an escapement for permitting such rotation in a timed intermittent series of steps, said escapement comprising a multiple-toothed surface part on said rotary member and a pawl part resting against such surface and cooperating with the teeth thereon, said teeth being elongated transversely to the direction of travel of such surface with their lengths and alignment relation being variously selected in accordance with the desired time duration between intermittent stepping operations, an electric timing motor and mechanism driven thereby for reciprocating said pawl back and forth in a fixed path parallel to the adjacent elongated tooth so as to slide

along such tooth with the rotary member stationary and off at least one end of such tooth to permit the rotary member to advance and to be stopped by engagement of the pawl with the next adjacent tooth and such operation being repeated for each tooth, manual means for moving said rotary member from finish to start position, said pawl riding over the teeth on the rotary member as necessary for such manual setting of the rotary member to start position, and an energizing switch for said timing motor which is closed when the rotary member is set to start position and is opened automatically upon the rotary member reaching its finish position.

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No references cited.