April 27, 1937. G. W. SPRENGER ET AL 2,078,781

TIME SWITCH

Filed Feb. 5, 1936 2 Sheets-Sheet 1

Fig. 1.

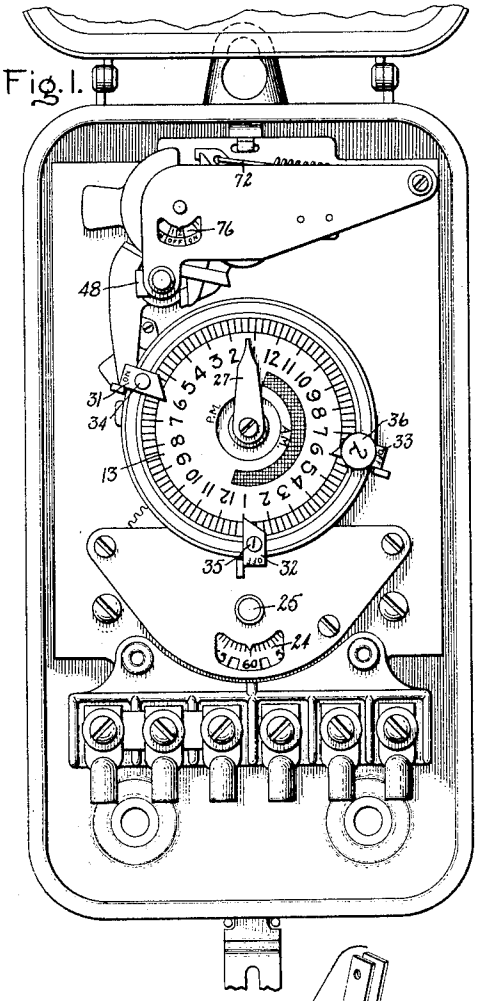

Fig. 2.

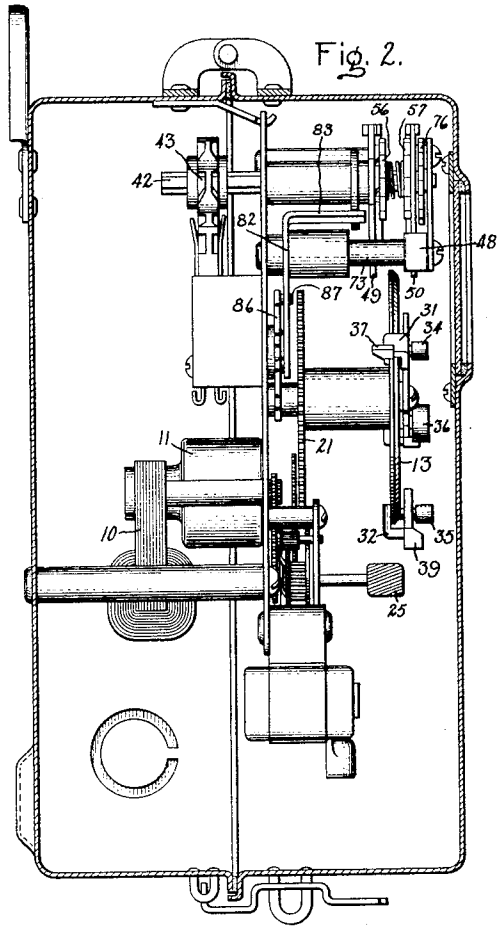

Fig. 4.

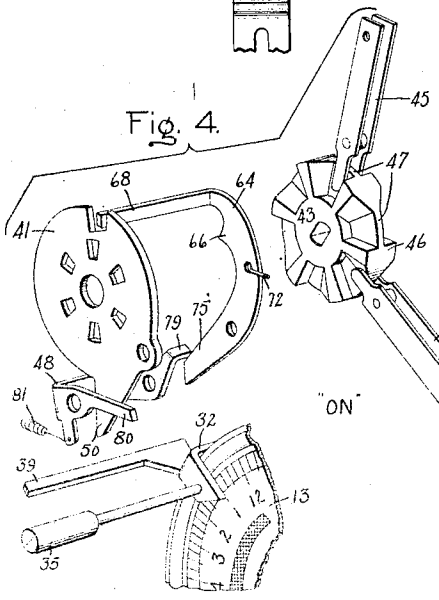

Fig. 5.

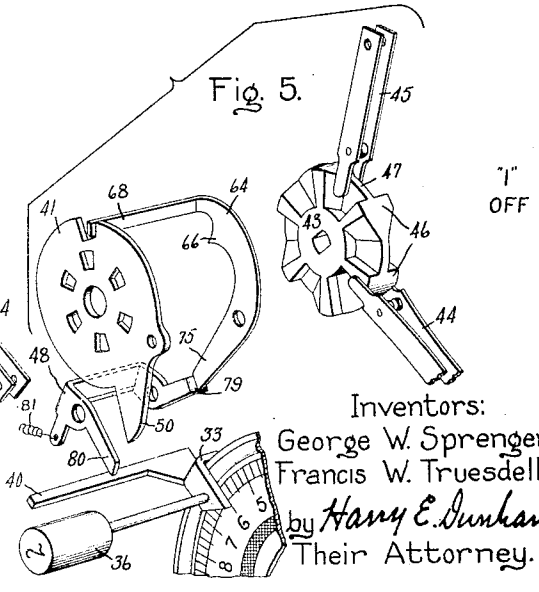

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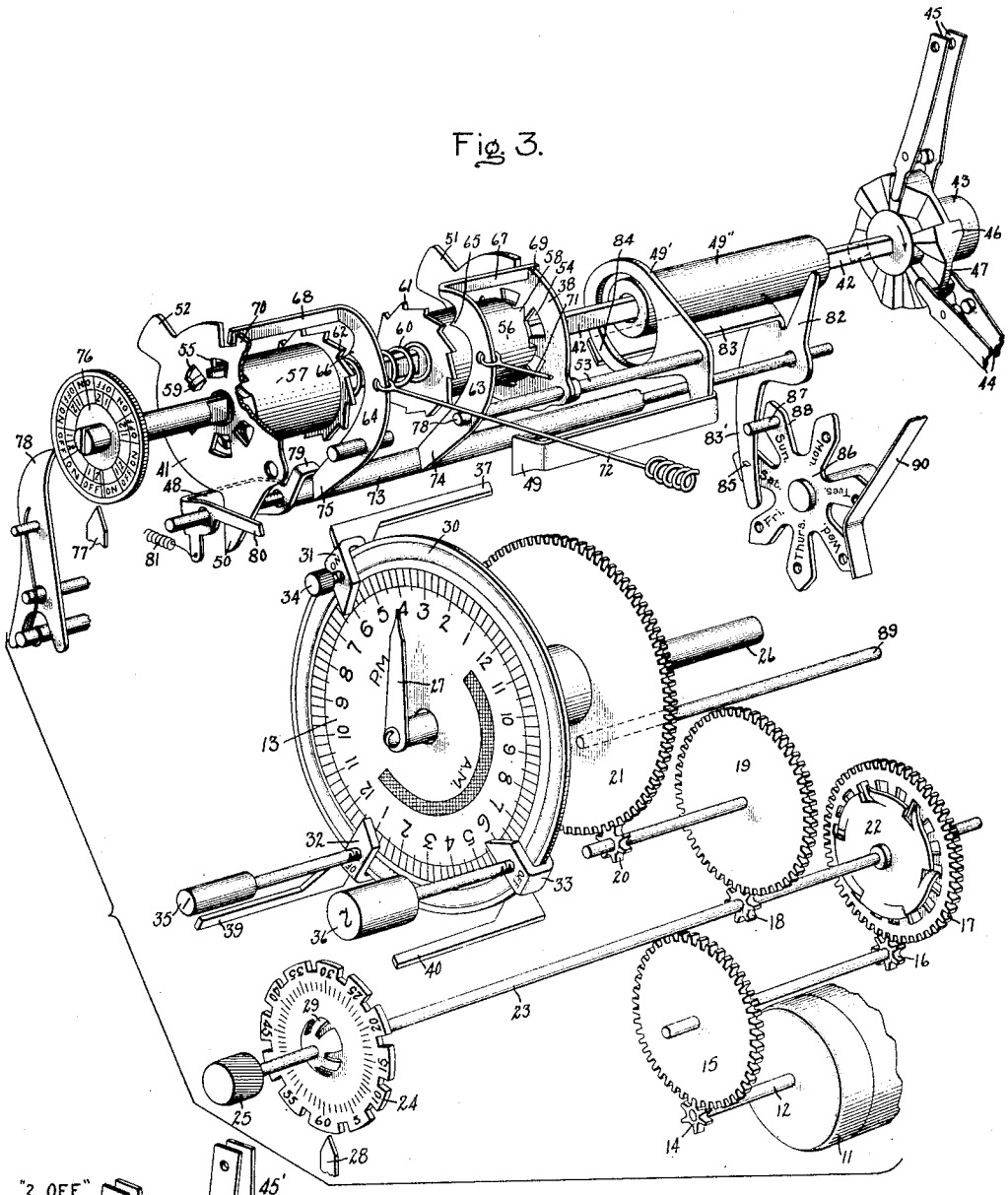
Fig. 3.



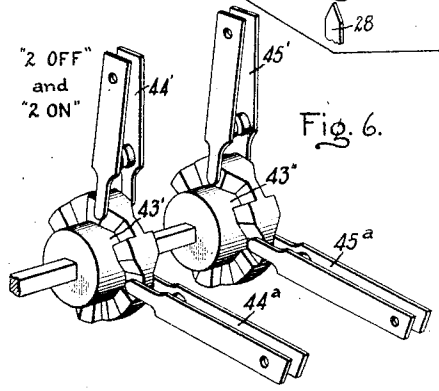


Fig. 6.

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UNITED STATES PATENT OFFICE

2,078,781

TIME SWITCH

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Application February 5, 1936, Serial No. 62,446

12 Claims. (Cl. 200—38)

Our invention relates to time switches and concerns particularly improvements in switch-operating mechanism.

It is an object of our invention to provide a two-circuit feature for a time switch whereby two different circuits may be turned off at different times although turned on simultaneously, or turned on at different times and turned off simultaneously.

Another object of our invention is to provide an arrangement for accurately producing intermediate positions in an indexing system of the type disclosed in the copending application of Donald G. Cameron and George W. Sprenger, filed September 18, 1935, Serial No. 41,090, and assigned to the same assignee as the present invention.

Still another object of our invention is to provide an improved omitting device for time switches.

Other and further objects and advantages will become apparent as the description proceeds.

The invention will be understood more readily from the following detailed description when considered in connection with the accompanying drawings and the features of the invention which are believed to be novel and patentable will be pointed out in the claims appended hereto. In the drawings, Figs. 1 and 2 are front and side views respectively of a time switch showing one embodiment of our invention; Fig. 3 is an extended (axially distorted) perspective view of the apparatus of Figs. 1 and 2; Figs. 4 and 5 are exploded fragmentary perspective views of the apparatus in different operating positions; and Fig. 6 is an exploded fragmentary perspective view of another embodiment of the invention.

Like the switch disclosed in the previously mentioned copending application, Serial No. 41,090, the switch illustrated in the drawings of the present application has contact blades operated by one or more rotary cams, advanced by an indexing mechanism, controlled by fingers on a timing unit. The present switch differs, however, in that any two pairs of contact blades for opening or closing their circuits at different times are mounted with somewhat different angular relationships to the rotary cam, and means are provided for stopping short the rotary motion of the cam during the circuit opening operation in order that the circuits controlled by the two pairs of blades may be opened at different times although these circuits may be closed at the same time. Another distinction is in the form of omitting devices for preventing operation of the switch on certain days of the week or month.

The timing of the switch is effected and all the operating energy therefor is supplied by a suitable timing motor which is preferably a self-starting synchronous motor where regulated frequency alternating-current supply is available. The synchronous motor is best shown in Fig. 2 at 10. This is a high-speed self-starting motor driving unit of the type described in Warren Patent No. 1,495,936, May 27, 1924, and includes a casing 11, enclosing the rotor of the motor in the reduced portion of the casing and a suitable reduction gear train in the enlarged portion of the casing to reduce the speed of the motor from the usual 3,600 revolutions per minute to usually one revolution per minute at the terminal shaft 12 shown extending from the casing 11 in Fig. 3.

The timing motor unit drives the time-switch dial 13 at one revolution in twenty-four hours in a clockwise direction through a gear train including gears 14, 15, 16, 17, 18, 19, 20, and 21. Between the gears 17 and 18 of this gear train is a one-way driving clutch consisting of a toothed disk 22 fastened on the shaft 23 with the gear 18 and co-operating with notched openings in the face of the gear 17. The gear reduction is such that the shaft 23 normally rotates at one revolution per hour, and this shaft is provided with disk 24 having its periphery graduated in minutes and with a thumb piece 25 by means of which the dial 13 may be turned in the normal direction of rotation manually to set the same accurately with respect to the time of the day.

The dial 13 and the gear 21 are fastened to the same hub and are not relatively adjustable. They rotate on a stationary shaft 26 which has a stationary time-indicating pointer 27 secured thereto in front of the dial 13. The pointer 27 co-operates with twenty-four hour A. M. and P. M. graduation marks on the dial 13 and the rotary minute dial 24 co-operates with a stationary pointer 28 so that the time in hours and minutes is given by these two dials. Furthermore, the minute dial 24 is secured to the shaft 23 by friction washers, one of which is shown at 29.

The hour dial 13 may be made up of a thin disk having a stiffening ridge 30 near its periphery, serving as a convenient means for adjustably securing switch-operating riders 31, 32, and 33 on the hour dial. The rider 31 is an "on" rider, the rider 32 a "circuit 1 off" rider and the rider 33 a "circuit 2 off" rider. The "on" and "off" riders are similar and interchangeable, having branches threaded to permit removing a screw 34, 35, or 36 and reversing the rider. The "2 off" rider 33, however, carries a large headed screw 36, whereas the riders 31 and 32 carry small headed screws 34 and 35, respectively.

The arrangement of the driving unit, dial, and riders is more fully explained in the said copending application S. N. 41,090. The purpose of the difference in size between the heads of

the screws 35 and 33 in the apparatus illustrated in the present application will be explained hereinafter.

The "on" rider 31 has a laterally extending finger 37 for operating a cocking member 38 of a switch operating and detent mechanism and the "off" riders 32 and 33 have laterally extending fingers 39 and 40, respectively, for operating a cocking member 41. The switch operating and detent mechanism is assembled about and largely supported by a flat-sided rotary shaft 42 and includes mechanism for rotating the shaft 42 a step at a time when one of the cocking members 38 or 41 is released by one of the fingers 37, 39, or 40. The shaft 42 carries one or more contact-operating insulating cams 43 about which are radially arranged two or more pairs of contact blades 44 and 45.

The pair of contact blades 44 controls one electrical circuit identified as "No. 1 circuit" and the pair of contact blades 45 controls a second circuit identified as "No. 2 circuit". The cam 43 is mounted to rotate with the shaft 42 but is axially slidable thereon. Since the cam 43 has six thick or bulging portions 46 and six thin or receding portions 47 riding between the tips of the contact blades, it is adapted to produce two operations per cycle (one "on" and one "off" or vice versa) in two 30 degree motions as explained in the aforesaid copending application S. N. 41,090. In order to be operated simultaneously, the blades 44 and 45 would be mounted 60 degrees apart or a multiple thereof. However, in the present apparatus the two circuits are to be turned off at separate times, and in order to produce two "off" operations in each cycle of two 30 degree motions, the 30 degree step from "on" to "off" is split into two sections, which may be approximately 15 degrees each. The mechanism is arranged for the "on" finger 37 to produce 30 degrees rotation of the shaft 42, whereas the "off" fingers 39 and 40 each produces approximately 15 degrees rotation. The switch blades 44 and 45 are not mounted a multiple of 60 degrees apart (or in the same relative angular position on two different cams like the cam 43) but somewhat less in order that only the blades 44 will be spread during the first 15 degrees rotation of the cam 43. The blades 45 will be spread during the next 15 degrees rotation, while the tips of the blades 44 remain on a thick portion of the cam 43 and the blades 44 remain spread. As shown in Fig. 3 at the "2 off" position both blades 44 and 45 are spread keeping open both their respective circuits, the latter part of a thick portion of the cam 43 being between the tips of the blades 44 while the first part of another thick portion of the cam is between the tips of the blades 45.

With cam 43 advanced 30 degrees to the "on" position, as illustrated in Fig. 4, the tips of both blades 44 and 45 are on the thin portions 47 of the cam 43 and both circuits are closed. With the cam 43 advanced a further 15 degrees, to the "1 off" position, as illustrated in Fig. 5, a thick portion 46 of the cam 43 has spread the tips of blades 44 to open circuit 1, while a thin portion 47 is still between the tips of the blades 45 leaving circuit 2 closed. Then with the cam advanced 15 degrees more, the "2 off" position illustrated in Fig. 3 is repeated. Thus to produce successive cycles of operation with, first, two circuits closed, second, one opened and then, third, both circuits opened the cam is rotated during each cycle in successive stages, moving first 30 degrees, second 15 degrees, and then third 15 degrees.

The mechanism for producing this rotation accurately will presently be explained. However, it will be understood that our invention is not limited to the precise arrangement illustrated and described but also includes making all the stages 15 degrees apart so as to close the circuits separately as well as opening them separately, or includes moving either or both of the blades 44 and 45 30 degrees from the position shown in the drawing in order that the corresponding circuit will be closed instead of opened and vice versa at the particular angular position of the shaft 42 and cam 43. The specific reference to 15 degrees, 30 degrees, and 60 degrees is to be understood as being merely relative and not as limiting our invention to these absolute values or to the use of cams divided into six similar parts.

In the apparatus described by way of illustration, the angular steps are 30 degrees and, in the arrangement of Figs. 3, 4, and 5, the pairs of blades 44 and 45 are spaced approximately 15 degrees less than 120 degrees apart or sufficiently less than 60 degrees to cause the contacts to open on separate half steps of the cam-advancing motion. In other words, the pairs of switch blades 44 and 45 are spaced a fraction less than two whole steps and they might be spaced a fraction less than any even whole number of steps. Regarding zero also as an even whole number, the switch blades might be spaced a fraction of a step less than zero, that is, with the blades 45' a fraction of a step ahead of instead of behind the blades 44', if two different cams 43' and 43'' are employed as shown in Fig. 6. Fig. 6 illustrates also an arrangement with pairs of switch blades 44*a* and 45*a* spaced 90 degrees or an odd whole number of steps from the blades 44' and 45', respectively. It will be evident that the blades 44*a* will be closed when the blades 44' are open and vice versa. Likewise, the blades 45*a* will be closed when the blades 45' are open and vice versa. The blades 44*a* and 45*a*, used with the apparatus of Figs. 1, 2, and 3, therefore, illustrate an arrangement with which two circuits may be opened simultaneously but closed at different times.

The part of the switch operating and detent mechanism for producing the 30 degree rotation from "off" to "on" may be like that described in the aforesaid copending application S. N. 41,090. The part of the mechanism for producing the two 15 degree relations from "on" to "1 off" and "2 off" is also like that for producing the 30 degree rotation from "on" to "off" in application S. N. 41,090, except for the addition of a "short stop" member 48 for stopping the trigger 41 after 15 degrees and splitting the "off" operation into steps "1 off" and "2 off". The triggers 38 and 41 are loosely mounted upon the shaft 42 and include, respectively, downwardly projecting tips or noses 49 and 50, adapted to be engaged by the finger 37 and the fingers 39 and 40, and arms 51 and 52 for operating the switch manually when desired.

The tip 49 of the trigger 38 may be integral therewith as in the case of the trigger 41, but is shown retractile to provide an omitting feature which will later be described. The tip 49 normally co-operates with finger 37 as if the tip 49 were fixed rigidly upon the main portion of the trigger 38, because the retractile tip 49 is pivoted upon a pin 53 carried by the main portion of the trigger

38 and has an arm 49' which normally drops down on a bushing 49'' carried by the shaft 42 so that the retractile tip 49 cannot rotate further about the pivot pin 53 and the finger 37 pressing against the tip 49 rotates the trigger or cocking member 38.

The triggers 38 and 41 are provided with circularly arranged groups of slots 54 and 55, and ratchet members 56 and 57 are provided having axially extending groups of ratchet teeth 58 and 59 adapted to engage the groups of slots 54 and 55 respectively. The ratchet members 56 and 57 are axially slidable upon the shaft 42 but the shaft 42 and the ratchet members 56 and 57 are constrained to rotate together. A compression spring 60 is provided to hold the ratchet members 56 and 57 against the triggers 38 and 41.

The embodiment of the invention illustrated is designed for rotation of the contact-operating cam 43 in the direction of the arrow in Fig. 3; i. e., in a clockwise rotation when viewed from the front of the apparatus, which will be referred to as the forward direction of rotation. The ratchet teeth 58 and 59 are so arranged that the triggers 38 and 41 can produce only forward rotation of the ratchets and the shaft 42. The ratchet members 56 and 57 are provided also with radially extending groups of ratchet teeth 61 and 62, forming a second ratchet system on each of the ratchet members 56 and 57. A pair of detent pawls 63 and 64 are pivotally mounted upon the triggers 38 and 41, respectively. These detent pawls have detents 65 and 66 adapted to engage the ratchet teeth 61 and 62 to prevent overtravel.

The detent pawls 63 and 64 carry spurs 67 and 68 normally abutting ears 69 and 70 formed in the triggers 38 and 41, and tension springs (only one of which is shown) attached to the detent pawls 63 and 64 by wires 71 and 72 are provided, which tend to rotate the detent pawls 63 and 64 and the triggers 38 and 41 in a forward direction. However, a stationary post or stop 73 is provided and the detent pawls 63 and 64 are provided with tails 74 and 75 which limit forward rotation under the force of the springs on the wires 71 and 72. The tails 74 and 75 are so shaped that they abut the post 73 while there is still clearance between the tips 49 and 50 of the triggers 38 and 41 and the post 73. The radial distance from the center of the shaft 42 to the pivot points of the detent pawls 63 and 64 is less than the radial distance from the shaft 42 to the post 73 so that forced rotation of the triggers 38 and 41 beyond the points where the tails 74 and 75 abut the post 73 produces backward rotation of the detent pawls 63 and 64 relative to the triggers 38 and 41, thus flexing the springs on wires 71 and 72. The arrangement, therefore, tends to oppose rotation of the triggers 38 and 41 in either direction from the points at which the tails 74 and 75 abut the post 73.

A semaphore 76, rigidly mounted on the shaft 42 and a co-operating pointer 77 co-operating with suitable indices on the semaphore 76 are provided to indicate the switch positions. For the type of switch operation herein disclosed by way of example the semaphore 76 is divided into sectors marked alternately with the words "on" and "off", and the "off" sectors are, in turn, divided into smaller sectors marked with the numerals "1" and "2". The semaphore 76 may also be formed as a ratchet wheel to co-operate with a spring pressed detent 78 to act as a check ratchet, preventing backward rotation of the shaft 42 and the parts carried thereon.

The times at which the switch blades 44 and 45 are closed and opened depend upon the positions on the dial 13 of the "on" rider 31 and the "off" riders 32 and 33. Let it be assumed that the time switch is used for automatically controlling the electric lights in the public areas of an apartment house, that the principal hall and lobby lighting is to be extinguished after the usual retiring hours of the occupants of the building but that the safety hall lights and fire-escape lights are required by law to burn the entire night. Accordingly, the "on" rider 31 is set at 6 P. M., e. g., to turn on all the lights, the "off 1" rider 32 is set at 1 A. M., e. g., to turn off circuit 1 controlling the principal hall and lobby lights and the "off 2" rider 33 is set at about 6 a. m., e. g., to turn off circuit 2 controlling the safety hall lights and fire-escape lights.

The motor 11 effects the timing of the switch by driving the dial 13 at the proper uniform speed, and supplies the energy for opening and closing the switch blades by stressing the springs on the wires 71 and 72 and cocking the trigger and ratchet mechanisms. In Figs. 1, 2, and 3 the apparatus is shown in the "2 off" position with both pairs of switch blades 44 and 45 open. When the finger 37 of the "on" rider 31 engages the tip 49 of the trigger 38, it gradually rotates the trigger 38 in a backward direction (with respect to the desired forward direction of rotation of the contact operating cam 43) against the force of the spring (not shown) attached to the wire 71. After the trigger 38 has been rotated sufficiently, the ratchet teeth 58 drop into the slots 54 but the finger 37 continues to rotate the trigger 38 backwards through a predetermined "excess angle" when the finger 37 rides off the tip 49 and releases or trips the trigger 38. The spring on the wire 71 thereupon snaps the trigger 38 in a forward direction and the trigger 38 acquires considerable momentum while retracing the "excess angle" just mentioned. The edges of the slots 54, serving as detents, then engage the ratchet teeth 58 and rotate the ratchets, the shaft 42, and the cam 43 through an angle equal to the angular distance between thick and thin portions 46 and 47 of the cam 43. The cam 43 accordingly is moved from the "2 off" position shown in Fig. 3 to the "on" position shown in Fig. 4 wherein both switch blades 44 and 45 are closed.

After the cam 43 has been rotated the requisite angle, the tail 74 of the detent pawl 63 strikes the post 73 while the trigger 38 still retains some of its momentum. This momentum is utilized to rotate the detent pawl 63 backward around the pivot pin 53 and to drive the detent 65 in before the adjacent ratchet tooth of the group of radial ratchet teeth 61 on the ratchet member 56. The forces acting on the detent pawl 63 at the pivot point 70 and at the post 73 as a result of the momentum of the trigger 38 form a couple or torque which rotates the detent pawl 63 backward. In this way, overtravel of the contact operating cam 43 is prevented and the angular position of the shaft 42 is precisely indexed. The spring on the wire 71 draws the detent 65 away from the ratchet teeth 61 as soon as the parts have come to rest and leaves the mechanism free for a subsequent operation.

In a manner similar to that just described, the finger 39 of the "1 off" rider 32 at the proper time engages the tip 50 of the trigger 41, and the parts associated therewith would be actuated to rotate

the cam another 30 degrees to the position of Fig. 3 with both switch blades 44 and 45 closed, were it not for the short stop member 48. However, in the apparatus here illustrated, as distinguished from that illustrated in application S. N. 41,090, the short stop member 48 comes into play to stop the action after the shaft 42 has rotated approximately 15 degrees to the "1 off" position of Fig. 5. As previously explained, in the "1 off" position, the switch blades 44 are open but the switch blades 45 are still closed.

The short stop member 48 is pivoted loosely on the post 73 and straddles the trigger 41. It has a transverse projection 79 adapted to drop in between the post 73 and the tail 75 of the detent pawl 64, and an arm 80 adapted to engage the large head 36 of the clamping screw of the "2 off" rider 33. There is also a biasing spring 81 which tends to rotate the short stop member 48 in the direction which has been arbitrarily defined as the forward direction.

Returning now to the time when the "1 off" finger 39 engages the tip 50 of the trigger 41, the trigger 41 is rotated backward by the finger 39 and backs the tail 75 of the detent pawl 64 away from the post 73. The transverse projection 79 of the spring biased short stop member 48 is permitted to drop down as soon as the tail 75 has been backed away far enough. Then when the finger 39 rides off the trigger tip 50, the trigger 41 rotates forward under the force of the spring 72. However, the tail 75 soon strikes the transverse projection 79 as shown in Fig. 5 and the rotation of the switch operating cam is stopped after 15 degrees, instead of after 30 degrees rotation.

When the "2 off" finger 40 engages the tip 50 of the trigger 41, the trigger 41 is again cocked or rotated backward against the force of the spring 72 and when the finger 40 releases the trigger, the trigger rotates forward and picks up the ratchet member 57 at the angular position where it previously stopped. The ratchet member 57 as well as the shaft 42 and the cam 43 are thus rotated another 15 degrees, the remainder of the 30 degrees rotation which the "off" trigger 41 and the associate mechanism is capable of producing. This time, also, the short stop member 48 tended to drop down in the position with the transverse projection 79 blocking the tail 75, however, owing to the large size of the screw head 36 and the length of the arm 80 the arm 80 and the transverse projection 79 were held up and the tail 75 was permitted to continue traveling until it struck the post 73, bringing the switch-operating mechanism to the "2 off" position of Fig. 3.

It will be understood that the relative sizes and positions of the parts are such that the end of the arm 80 clears the small diameter screw head 35 but cannot clear the larger diameter screw head 36. Consequently, the use of the large diameter screw head 36 makes the short stop member 48 ineffective, whereas the use of the small diameter screw head 35 permits the short stop feature to come into effect.

Since the arrangement is such that the fingers rotate the triggers only approximately 30 degrees plus a slight "excess angle" previously referred to, and the slots in the triggers are spaced at 60 degrees with approximately 30-degree solid sections between slots, after a trigger has rotated a ratchet mechanism 30 degrees it cannot pick up the ratchet teeth again to rotate it further unless the other trigger has first imparted 30 degrees rotation to the parts carried by the shaft 42. Consequently, if the time switch is initially placed in service with the correct time of day setting but with the cam 43 in the wrong position to correspond to the time of day and the setting of the riders, either trigger will merely be energized and released by the fingers without picking up its corresponding ratchet member until the time of day is reached when the switch operating cam 43 should be advanced to another position.

Another feature of the apparatus illustrated in the present application is the omitting device, for use when the time switch controls certain electrical circuits such as the lighting circuit of a factory building which is not occupied on certain evenings of the week or month, such as Sundays. The omitting device is used to prevent the circuit or circuits from being turned "on" on such a day.

As already explained the "on" trigger 38 has a retractile tip 49. Mechanism is provided to keep the tip 49 retracted; that is, drawn upward, on the day that the closing of the circuits is to be omitted. With the tip 49 retracted, it is not engaged by the "on" finger 37 and no switch closing operation can take place on that day. It has already been explained that the retractile tip 49 is pivotally attached to the trigger 38 on a pin 53, and that the arm 49' and the bushing 49'' limit the rotation of the tip 49 with respect to the main position of the trigger 38 and cause the two to rotate as one when engaged by the "on" finger 49.

For the purpose of retracting the tip 49 there is a push-lever 82 having a transverse projection 83 adapted to press on the arm 49'. The arm 49' may be forked or have a portion extending entirely around the bushing 49'' so that there is a portion 84 which the transverse projection 83 can strike. The push-lever 82 also has a tail 85' carrying a diamond-shaped index 85. There is a seven-pointed star wheel 86 with seven teeth corresponding to the seven days of the week marked thereon. Each tooth has a tapped hole adapted to receive an omitting screw such as the screw 87 which is shown secured in the "Sunday" tooth 88. The omitting screws 87 are adapted to strike the tail 85' of the push lever 82 for raising the arm 49' and retracting the trigger tip 49. For advancing the star wheel 86 there is a driving pin 89 on the back of the gear 21 at such a position that the driving pin 89 engages the star wheel 86 during the night, at about midnight, for example, and advances it one tooth position. To prevent overtravel of the star wheel 86 and to fix its position resiliently there is a strip spring 90 with a blunt tip fitting between the star wheel teeth.

When the time switch is placed in service, omitting screws 87 are placed in the teeth corresponding to the days on which switch operation is to be omitted and the star wheel is manually rotated to the position in which the index 85 is opposite the name of the day of the week which it happens to be when the adjustment is made. Suppose, for example, this is done on Saturday and switch operation is to be omitted on Sundays. Fig. 3 represents the resultant setting of the mechanism. During the night, the driving pin 89 will strike one of the teeth of the star wheel 86 and advance it to the position in which the omitting screw 87 pushes the tail 85' of the push-lever 82 to the left. The transverse projection 83 consequently raises the member 84 and retracts the tip 49 of the "on" trigger 38. The next evening, Sunday evening, the trigger 38

is not engaged by the "on" finger 37 and the switch blades 44 and 45 are not closed. Sunday night the star wheel 86 is again rotated one point and the push lever is permitted to return to its original nonomitting position.

In accordance with the provisions of the patent statutes, we have described the principle of operation of our invention together with the apparatus which we now consider to represent the best embodiment thereof, but we desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

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

1. In a cam operated switch, a pair of relatively movable contact blades, a second pair of relatively movable contact blades, rotary cam means in operative relation with said blades, said cam means having alternately bulging and receding portions for changing the setting of said contact blades from closed to open and vice versa, and means for rotating said cam a half step at a time, each half step representing one-half the angular distance between adjacent bulging and receding portions of said cam means, said pairs of blades being angularly spaced a whole number of steps less a fraction, whereby rotation of said cam means a whole step changes the setting of both pairs of contact blades, but rotation of said cam a half step changes the setting of only one pair of contact blades.

2. In a cam operated switch, a pair of relatively movable contact blades, a second pair of relatively movable contact blades, rotary cam means in operative relation with said blades, said cam means having alternately bulging and receding portions for changing the setting of said contact blades from closed to open and vice versa, and means for rotating said cam either a step or a half step at a time, each half step representing one-half the angular distance between adjacent bulging and receding portions of said cam means, said pairs of blades being angularly spaced a whole number of steps less a fraction, whereby rotation of said cam means a whole step changes the setting of both pairs of contact blades, but rotation of said cam a half step changes the setting of only one pair of contact blades.

3. A two-circuit switch for closing two circuits together and opening them at different times, said switch comprising a pair of relatively movable contact blades for controlling one circuit, a second pair of relatively movable contact blades for controlling a second circuit, rotary cam means in operative relation with said blades, said cam means having alternately bulging and receding portions for changing the setting of said contact blades from closed to open and vice versa, and means for rotating said cam means in repeated cycles each comprising a whole step, a half-step and a second half-step, each step representing the angular distance between bulging and receding portions of said cam means, said pairs of blades being angularly spaced an even whole number of steps less a fraction, the blades being so positioned in relation to the rotation producing means and the dimensions of said bulging and receding portions with respect to the fractional deviations from whole-step spacing of said blade pairs being such that, at the conclusion of each of said cycles of operations, both blades are opened, whereby the next one-step rotation closes both pairs of blades, the succeeding half-step rotation opens one pair of blades and the final half-step rotation opens also the second pair of blades.

4. A switch comprising in combination, a pair of relatively movable contact blades, a rotary cam in operative relation with said blades, a ratchet member with which said cam is constrained to rotate, said ratchet member carrying two sets of teeth forming two ratchets, a pivotally mounted trigger having an ear thereon and including a detent adapted to co-operate with one of said ratchets to produce rotation of said ratchet and said blade-operating cam in a forward direction, a stop, a detent pawl pivotally mounted on said trigger, having a spur engaging said trigger ear when said detent pawl is rotated in a forward direction, means attached to said detent pawl tending to produce forward rotation thereof and of said trigger, said detent pawl having a tail adapted to engage said stop to limit forward rotation of said detent pawl and having a detent adapted to cooperate with said second ratchet to prevent overtravel thereof when the momentum of said trigger draws its ear away from the spur of said detent pawl, movable means adapted to be interposed between said stop and said tail to decrease the limit of forward rotation of said detent pawl and thereby reduce the angle of rotation of said trigger, said ratchet member and said cam, and means for deflecting said trigger against the force of said forward rotation producing means and abruptly releasing said trigger.

5. A switch comprising in combination relatively movable contact blades, a rotary cam in operative relation with said blades, a ratchet with which said cam is constrained to rotate, pivotally mounted trigger means including a detent adapted to co-operate with said ratchet to produce rotation of said ratchet and said blade-operating cam in a forward direction, means attached to said trigger means to produce forward rotation thereof, a stop, said trigger means including a tail adapted to engage said stop to limit forward rotation of said trigger means, movable means adapted to be interposed between said stop and said tail to decrease the limit of forward rotation of said trigger means and thereby reduce the angle of rotation communicated to said ratchet and said cam, and means for deflecting said trigger means against the force of said forward rotation producing means and for releasing said trigger means.

6. Mechanism for producing stepwise rotation comprising in combination a ratchet member carried by a shaft to be rotated stepwise, said ratchet member carrying two sets of teeth forming two ratchets, a pivotally mounted trigger having an ear thereon and including a detent adapted to co-operate with one of said ratchets to produce rotation of said ratchet and said blade-operating cam in a forward direction, a stop, a detent pawl pivotally mounted on said trigger, having a spur engaging said trigger ear when said detent pawl is rotated in a forward direction, means attached to said detent pawl to produce forward rotation thereof and of said trigger, said detent pawl having a tail adapted to engage said stop to limit forward rotation of said detent pawl and having a detent adapted to co-operate with said second ratchet to prevent overtravel thereof when the momentum of said trigger draws its ear away from the spur of said detent pawl, movable means adapted to be interposed between said stop and said tail to decrease the limit of forward rotation of said detent pawl and thereby reduce the angle of rotation of said trigger and said ratchet member, and means for deflecting said

trigger against the force of said forward rotation and abruptly releasing said trigger.

7. Mechanism for producing stepwise rotation comprising in combination a ratchet carried by a shaft to be rotated stepwise, pivotally mounted trigger means including a detent adapted to co-operate with said ratchet to produce rotation of said ratchet in a forward direction, means attached to said trigger means to produce forward rotation thereof, a stop, said trigger means including a tail adapted to engage said stop and limit forward rotation of said trigger means, movable means adapted to be interposed between said stop and said tail to decrease the limit of forward rotation of said trigger means and thereby reduce the angle of rotation communicated to said ratchet, and means for deflecting said trigger means against the force of said forward rotation-producing means and for releasing said trigger means.

8. Mechanism for producing stepwise rotation comprising in combination a ratchet carried by a shaft to be rotated stepwise, pivotally mounted trigger means including a detent adapted to co-operate with said ratchet to produce rotation thereof in a forward direction, means attached to said trigger means to produce forward rotation thereof, a stop, said trigger means including a tail adapted to engage said stop to limit forward rotation of said trigger means, a short stop member adapted to be interposed between said stop and said tail to decrease the limit of forward rotation of said trigger means and thereby reduce the angle of rotation communicated to said ratchet, means for alternately moving said short stop member into interposed position and preventing it from being so moved when said tail is drawn away from said stop, and means for deflecting said trigger means against the force of said forward rotation-producing means and for releasing said trigger means.

9. Mechanism for producing stepwise rotation comprising in combination a rotary dial carrying trigger-operating fingers and a short-stop-member-engaging projection associated with one of said fingers, a rotatably mounted ratchet carried by a shaft to be rotated stepwise, pivotally mounted trigger means adapted to be engaged by said fingers and including a detent adapted to co-operate with said ratchet to produce rotation thereof in a forward direction, means attached to said trigger means to produce forward rotation thereof, a stop, said trigger means including a tail adapted to engage said stop to limit forward rotation of said trigger means, a short-stop member adapted to be interposed between said stop and said tail to decrease the limit of forward rotation of said trigger means and thereby reduce the angle of rotation communicated to said ratchet, said short-stop member being biased to said interposed position, said fingers being adapted to deflect said trigger means against the force of said forward rotation producing means and to ride off and release said trigger means, said short-stop member including an arm engageable by said dial projection, said projection holding said short-stop member out of its interposed position when said projection engages said arm.

10. Mechanism for rotating a shaft stepwise in repeated cycles each consisting of a whole, then a half-step and finally a second half-step, said mechanism comprising in combination a rotary dial carrying three trigger operating fingers and a short-stop-member-engaging projection associated with one of said fingers, said fingers being at different angular positions on said dial, the first of them being offset from the other two in a direction parallel to the axis of said dial, and the third being associated with said short-stop-member-engaging projection, a pair of rotatably mounted ratchets with which a shaft to be driven stepwise is constrained to rotate, pivotally mounted trigger means adapted to be engaged by the first of said fingers and including a detent adapted to co-operate with the first of said ratchets to produce rotation thereof in a forward direction, second pivotally mounted trigger means adapted to be engaged by either the second or third of said fingers and including a detent adapted to co-operate with the second of said ratchets to produce forward rotation thereof, a stop, each of said trigger means including a tail adapted to engage said stop to limit forward rotation of said trigger means, and a short-stop member adapted to be interposed between said stop and the tail of said second trigger means to decrease the limit of forward rotation of said second trigger means and thereby reduce the angle of rotation communicated to said second ratchet, said short-stop member being biased to said interposed position, said fingers being adapted to deflect said trigger means against the force of said forward rotation producing means and to ride off and release said trigger means, said short-stop member including an arm engageable by said projection on said dial for causing said projection to hold said short-stop member out of its interposed position.

11. An omitting device for a shaft-advancing mechanism having a resiliently biased trigger adapted to rotate the shaft in steps and a rotating rider adapted to engage the end of said trigger periodically and cock the trigger, said omitting device comprising a star wheel adapted to be rotated in steps and having a pin thereon at an angular position corresponding to an operation to be omitted, and means deflected by said pin in one angular position of said star wheel for retracting the end of the trigger out of engagement with the rider.

12. A shaft-advancing mechanism comprising in combination a spring biased trigger adapted to engage and advance said shaft when said trigger is rotating yielding to its bias, said trigger having a retractile tip, a rotary dial carrying a finger adapted to engage said tip and cock said trigger by rotating it backward in opposition to its bias, thereafter riding off said tip to release said trigger and produce forward rotation of said shaft through a predetermined angle, a star wheel carrying an omitting pin at an angular position corresponding to an operation to be omitted, a driving pin carried by said dial adapted to engage and rotate said star wheel one step whenever said driving pin is carried past said star wheel, and a push lever adapted to be engaged by said omitting pin and moved to an omitting position when said star wheel is in a predetermined angular position, said push lever having an arm adapted to retract the tip of said trigger and prevent its engagement by said finger when said push lever is in the omitting position.

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