Aug. 20, 1940. D. G. CAMERON 2,212,387

TIME SWITCH

Original Filed Dec. 30, 1937

Fig. 2.

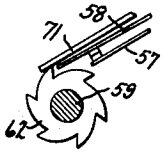


Fig. 3.

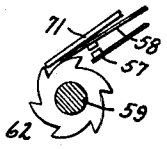
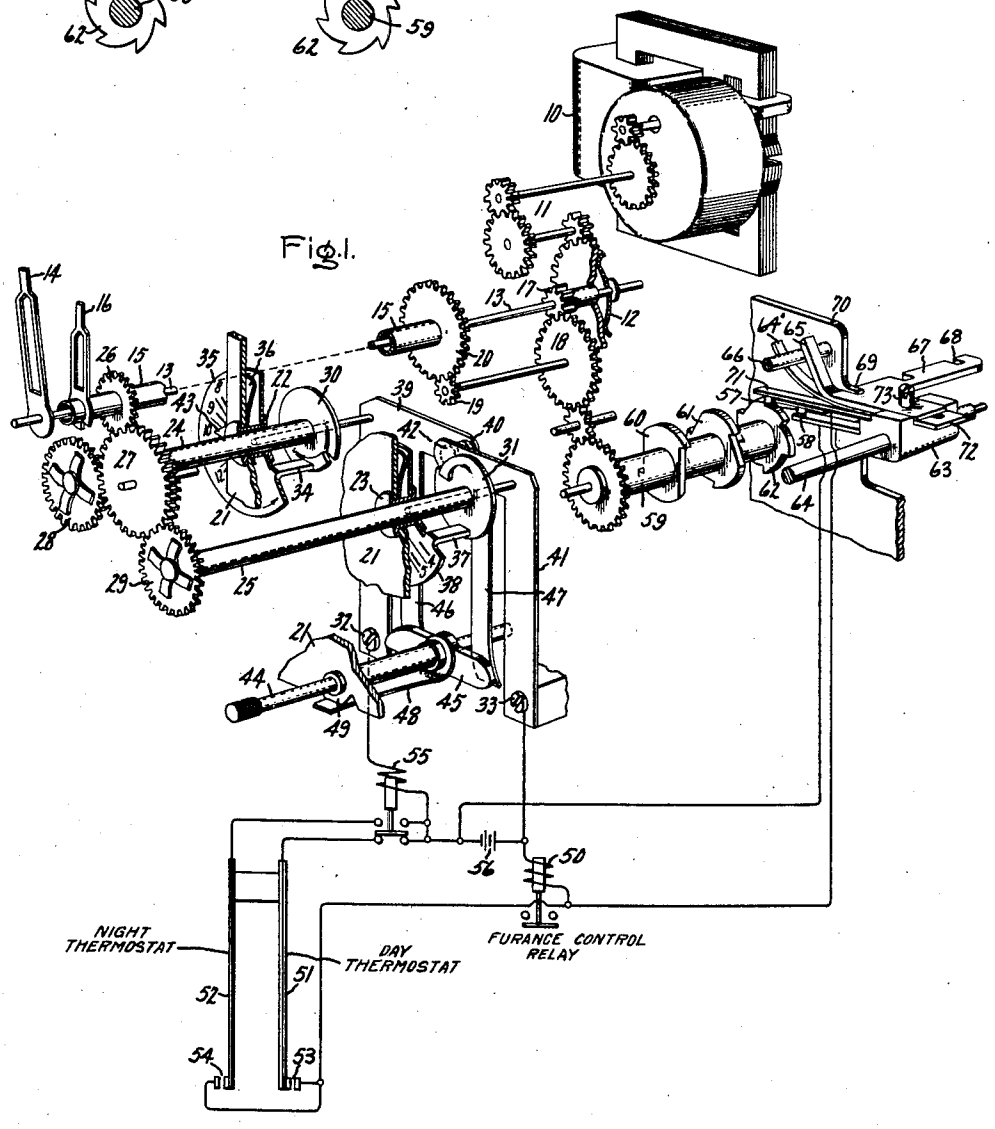


Fig. 1.



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TIME SWITCH

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Original application December 30, 1937, Serial No. 182,539. Divided and this application November 30, 1939, Serial No. 306,978

7 Claims. (Cl. 200—30)

My invention relates to time switches and although not limited thereto is particularly designed for use in systems of automatic control for domestic heating apparatus.

In the form shown the time switch employs two sets of time controlled contacts. One set is employed to open and close a circuit at predetermined adjustable times in a given period of time such as a 24 hour period and may thus be used to shift control from day to night thermostat and vice versa. This switch is of simple construction and operation. The lines of the circuit controlled may be connected directly to the switch contact blades and manual means is provided to move these blades to permanently open or to permanently closed position to suspend automatic control. The other set of time controlled contacts is arranged to close a circuit for a short interval of time periodically. The number of times that this switch is closed during a 24 hour period may be adjusted and also the duration of closure may be adjusted in a novel manner This set of contacts may thus be used to momentarily start up the furnace at intervals and prevent a coal fire from going out entirely in case furnace operation is not otherwise called for.

This application is a division of my application, S. N. 182,539, filed December 30, 1937 and assigned to the same assignee as the present application. My prior application contains claims classifiable in class 200, subclass 39. The present application contains claims classifiable in class 200, subclass 27. Another divisional application filed concurrently herewith contains claims classifiable in class 161, subclass 1.5.

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 drawing in which Fig. 1 represents a perspective, somewhat exploded view of my improved switch and one possible way of connecting it with a furnace control system. Figs. 2 and 3 represent different positions of the cam-operated switch shown at right in Fig. 1.

Referring to Fig. 1, the time switch is driven by a synchronous motor indicated at 10. The motor is connected through a speed-reducing gear train 11 and a friction clutch 12 to a shaft 13 so as to drive said shaft at one revolution per hour in a clockwise direction. A minute hand 14 of a clock is mounted on the front end of this shaft. Concentric with shaft 13 is a hollow hour hand shaft 15 on which is mounted the hour hand 16, and this shaft 15 is driven from shaft 13 in a clockwise direction one revolution in twelve hours through the usual back gears 17, 18, 19 and 20. Shafts 13 and 15 have been broken away over the main time switch mechanism to more clearly expose the latter. The clock hands will cooperate with the usual clock dial (not shown) to indicate time.

The main time switch has its operating mechanism supported by a clock plate 21 which has been mostly broken away in the drawing. Extending through this plate are bearings 22 and 23 for rotatively supporting cam shafts 24 and 25. These cam shafts are driven from the hour hand shaft 15 in a clockwise direction, one revolution in 24 hours, through gears 26, 27, 28 and 29. Gears 28 and 29 are secured to shafts 24 and 25 respectively. Also secured to shafts 24 and 25 are cam disks 30 and 31, having spiral side cam surfaces. The cam 30 cooperates with a cam-follower 34, projecting to the rear from a dial disk 35. Dial disk 35 is rotatively mounted on the bearing housing 22 but is normally held against rotation by a friction spring 36 which is compressed between disk 35 and plate 21.

Cam 31 cooperates in a similar manner with a cam-follower 37 projecting to the rear of an adjustable dial plate 38. Shafts 24 and 25 may slide endwise in their bearings as well as rotate therein.

Cam shaft 24 together with cam plate 30 is at all times urged axially towards the front with the cam plate against cam-follower finger 34 by a spring 39, which spring is also a resilient switch contact. This spring switch member has its lower end rigidly supported. Also, its lower end constitutes the terminal to which the external circuit wire may be connected. A reduced rear end portion of shaft 24 rests against the spring contact member 39 near its upper end adjacent contact 40 so that, as shaft 24 is moved endwise to the rear or to the front by cam 30, contact 40 is likewise moved back and forth.

Shaft 25 likewise has reduced rear extension against which a spring switch contact member 41 presses. Member 41 has its upper end extending in overlapping relation and in front of contact 40 and is provided with a cooperating contact 42 on its rear face. The lower end of contact member 41 is likewise rigidly supported in a support insulating member 41 from 39 and constitutes the other line terminal 33 of the switch. The slope of the cam surfaces are such as to produce a slow, substantially uniform rearward movement of shafts 24 and 25, as these shafts are rotated

once in a given 24 hour time period except when the cam followers 34 and 37 ride over the step in the cams, at which time there is a quick forward movement of the shafts. The gear 27 is purposely made wide enough to mesh with gears 28 and 29 at all times, regardless of the endwise position of the shafts 24 and 25.

The quick forward movement of shaft 24 is made use of to close switch contact 40 onto contact 42 to close the switch, and the quick forward movement of shaft 25 is made use of to move contact 42 away from contact 40 to open the switch. Dial plate 35 has time graduations over part of its periphery in order that it may be set with respect to a fixed index or pointer 43 to indicate the time when cam-follower 34 will drop over the step in cam 30 to close the switch. In the example given the switch is intended to close in the evening between, say 8 p. m. and midnight, and the graduations on dial 35 will thus read from 8–12 and the indication opposite pointer 43 will designate the time as given by the clock hands when the switch will close. The opening and closing adjustments are independent of each other.

The switch is intended to open in the morning, say between 4 a. m. and 8 a. m. and dial 38 will have the approximate part of its periphery graduated accordingly and otherwise arranged to be set so that the switch will open at a time designated on such dial. The shape of the cam surfaces and the spacing of contacts 40 and 42 are such that within the time setting range indicated, the switch will remain closed at night and will remain open during the day. That is, the device may be set to close the switch as early as 8 p. m. in the evening and have it remain closed until as late as 8 a. m. in the morning and remain open until 8 p. m. again, or, it may be set to be closed between 12 midnight and 4 a. m. and remain open the remainder of the 24 hour period, etc. When open, the contacts remain at about the same spacing although both contacts are gradually moved to the rear during the open and closed periods. The setting range may be extended somewhat beyond the limits indicated above but generally, for the purpose for which the switch is intended, the range given will suffice.

Associated with the switch is a manually rotatable shaft 44 having an insulated cross bar 45 at its rear end. This device is to lock the switch in either the closed or open position or to permit automatic operation as desired.

The insulated cross bar 45 cooperates with fingers 46 and 47 which are integral with and extend downward from joints on the upper portions of switch members 39 and 41 which are nearer the contacts than the joints where the automatic control operates on these contact members. These fingers are bent away from the cross bar adjacent thereto so as to form cam surfaces and to permit of a cam action when the shaft 44 and cross bar 45 are turned by hand. In the horizontal intermediate or neutral position of the cross bar shown, it does not interfere with the automatic opening and closing of the switch at contacts 40 and 42. If the cross bar be turned to the left so that its right end is raised and its left end lowered through an angle of about 45 degrees, finger 47 will be forced to the rear, forcing contact bar 41 to the rear away from the end of shaft 25 to close the switch in all positions of cam 30. On the other hand, if bar 45 be turned about 45 degrees clockwise from the position shown, finger 46 contacts bar 45 and contact 40 will be forced to the rear away from contact 42 and the switch will remain open in all positions of cam 31. A flat, resilient finger 48 is secured to and turns with cross bar 45 and shaft 44. The free end of this finger bears against one of the three squared surfaces at 49 cut in the plate 21 and serves as a resilient lock to hold shaft 44 and cross bar 45 in any one of the three positions mentioned until turned to some other position by hand.

It is thus seen that I have devised a simple switch having few parts but one which accomplishes the several purposes described in a reliable manner.

I will now explain how the switch mechanism thus far described may be used in a furnace control system. At 50 I have shown a relay which may be termed a furnace control relay. For instance, it may be assumed that when this relay is energized, it sets into operation a stoker motor and a draft fan to increase the heat given out by a furnace. The relay is under the control of day and night thermostats 51 and 52. It may be assumed that thermostat 51 is set so as to close its contact at 53 when the temperature drops below 70 degrees F. and to open its contact when the temperature rises to 71 degrees F. It may further be assumed that the night thermostat 52 is set so as to close its contacts at 54 when the temperature drops below 64 degrees F., and to open its contacts when the temperature rises to 65 degrees F. The time switch already described controls a transfer relay 55 which serves to transfer the control of the furnace relay 50 from the day thermostat 51 to the night thermostat 52 at some time in the evening, depending on the setting of dial 35, and back again to the day thermostat 51 at some time in the morning, depending on the setting of dial 38. To this end, relay 55 is energized from a source 56, when switch contacts 40—42 are closed. This connects furnace control relay 50 with the night thermostat 52 through the upper contacts of relay 55 and source 56. Thus, during the night time, whenever thermostat 52 calls for heat, relay 50 will be energized. During the day time, when switch contacts 40—42 are open, relay 55 is deenergized and the furnace control relay 50 is under control of the day thermostat 51 through the lower set of contacts of relay 55.

Now, it sometimes happens when the temperature is mild, particularly when the furnace is operating on the night thermostat, that no heat is called for by the thermostat for long periods of time. This may cause a coal furnace fire to go out or to so nearly go out as to fail to respond with any degree of desirability to a subsequent closing of the thermostat. To prevent this, the switch mechanism shown at the upper right in Fig. 1 is utilized. Its function is to assure that the furnace relay 50 will be energized for a short period of time periodically, so as to prevent the furnace fire going out under conditions where it might otherwise do so, but without producing any great amount of actual heating. To this end I have provided a pair of contacts 57 and 58 operated by the timer motor 10 to momentarily energize furnace control relay 50 for a few minutes every several hours, the duration of closure of the contacts and the interval between closure times both being adjustable to correspond with the several different kinds of conditions likely to be met with in practice.

This switch mechanism includes a cam shaft

59 driven from gear 18 and some intermediate gears so as to operate at a rate of one revolution in three hours, for example. The cam shaft has on it several cam members, three in this instance, designated 60, 61 and 62.

These cam members operate counterclockwise. Member 60 has two steps, member 61 three steps and member 62 six steps. The steps of individual cams in each cam member are equally spaced. The contact supporting block 63 may be slid along its supporting post 64 parallel with cam shaft 59 so as to cause the contact mechanism to be operated by any one of the three cam members that may be selected. The individual cams on all of the cam members are the same, that is the maximum and minimum radii of the steps are equal in all cases. Hence, if the contact mechanism is opposite cam member 62, it will be operated every half hour, if opposite cam member 61, it will be operated every hour, and if opposite cam member 60, it will be operated every hour and a half, but the individual operations will be similar in all cases. It is seen then that by moving the contact block 63 and the parts carried thereby along post 64, the time interval between contact operations may be varied over a suitable range.

The contact mechanism is held in proper position by post 64 and by the fingers 64' and 65 extending from the upper part of the block and embracing a post 66. Finger 64' is resilient and allows slight rotation of the block 63 on post 64 during operation of the contact mechanism. It also permits the block to be rotated clockwise from the position shown in order that it may be moved endwise. The upper metal part 67 of which finger 65 is a part, is provided with three notches 68 in its forward edge. These notches are spaced apart the distance of the cam members on cam shaft 59 and serve to lock the contact block in its three operative positions with respect to the three cam members. This locking is done by causing the appropriate notch to slip over a projection 69 in the plate 70. As represented in the drawing the block 63 and its contact mechanism is positioned in operative relation with cam 62 and hence the contact device will be operated every half hour. To adjust for operation every hour the contact block and the parts carried thereby are rotated slightly about post 64 in a clockwise direction until the notch in plate 67 which is engaged with the locking projection 69 is free of said projection. Then the contact block is slid along post 64 towards the front until the middle notch in plate 67 is in line with plate 70 and its locking extension 69. Then the contact block is allowed to rotate counterclockwise on post 64 under the light tension of spring 64' until the block is locked from further endwise movement by engagement of projection 69 in the middle notch of plate 67. The contact finger is then aligned with cam 61 and operation of the contact device will occur once per hour.

The contact finger arrangement is designed so that the relation between the time during which the contacts are closed and the time during which they are open during a complete cam operating cycle may be varied over a wide range in a simple manner. The lower contact finger 57 is of metal and is relatively stiff and is sufficiently short that it never engages the rotary operating cam. This finger 57 has a contact button on its upper free end opposite a cooperating contact button on the lower side of contact finger 58. Contact finger 58 is also of metal, is relatively flexible and is long enough to engage with and at times to be moved by the operating cam. Contact fingers 57 and 58 have their right hand ends secured in the insulating block 63 and insulated from each other therein. The wires leading to the external circuit controlled by this contact device are connected to contact fingers 57 and 58 as indicated in Fig. 1. Above contact finger 58 is another finger 71 extending from block 63 out over the operating cam. Finger 71 is preferably of insulating material and is relatively stiff and its free end extends beyond the free end of contact finger 58 by an adjustable amount. In the structure shown cam-follower 71 is an extension of a fiber strip 72 seen projecting to the rear of block 63 from beneath plate 67. Strip 72 is slotted to accommodate a screw 73. When the screw is loosened the strip 72 may be adjusted to cause its end finger 71 to extend a greater or less amount beyond the end of contact finger 57. It is this adjustment which determines the relative length of "time on" and "time off" of the contact device. The resilient finger 64' which engages with the under side of post 66 is suitably secured to the block 63 between plate 67 and insulating strip 72. The block 63 is free to turn on post 64 and in the operation of the contact device by the cam member there is a slight back and forth rotational movement of block 63 on post 64 as a pivot, such rocking movement however is insufficient to raise plate 67 so as to disengage a notch 68 therein from projection 69. The extent of this rotational movement corresponds substantially to the amount by which insulating finger 71 is raised and lowered by engagement with the high and low parts of the cam. Thus, Fig. 2 shows the finger 71 in approximately its highest position and Fig. 3 shows this finger in approximately its lowest position.

The rocking movement of the contact block 63 and the parts carried thereby is thus largely controlled by the relatively slow rise of finger 71 by rotation of cam 62 and the sudden drop of finger 71 over the step in the cam. As pointed out above, insulating finger 71 and the short lower contact finger 57 are relatively stiff and hence both move up and down together with the rocking movement of block 63. The intermediate contact finger 58 is relatively flexible and is normally biased, as shown in Figs. 1 and 2, to close its contact on the contact of finger 57. However, when the finger 71 drops off of the step in the cam and contact finger 57 is lowered, the flexible contact finger 58 is prevented from following finger 57 downward by reason of it striking the cam surface as shown in Fig. 3, and hence the contacts open. Thus it is seen that when the insulating contact finger 71 rests directly on the cam the contacts are closed (Figs. 1 and 2) and when contact finger 58 rests on the cam the contacts are open (Fig. 3).

It is further evident that when finger 58 drops off the step in the cam the contacts close with a quick action and when insulating finger 71 drops off the step in the cam, the contacts open with a quick action. The contacts thus open and close quickly and without hesitation which is desirable.

Now it will be seen that the time during which the contacts are closed during an operating cycle is the period between the dropping of fingers 58 and 71 over the same step in the cam. Also the time during which the contacts are open is the period between the dropping of finger 71 over one

step in the cam and the dropping of finger 58 over the next approaching step in the cam. If we make fingers 71 and 58 exactly the same length so that they drop over the same step together the contacts will remain open continuously. Hence, we can reduce the "on" period by any desired amount down to zero by decreasing the difference between the effective lengths of fingers 71 and 58. In the present embodiment this adjustment is accomplished by making the effective length of insulating finger 71 adjustable. In Figs. 2 and 3, for example, we may reduce the length of the "on" period and increase the length of the "off" period by reducing the effective length of finger 71.

It is thus seen that by means of the cam and contact mechanism described we may materially vary the length of the operating cycle by selection of the desired cam 60, 61 or 62 and we may vary the relative duration of "on" and "off" periods during an operating cycle by adjusting the effective length of finger 71.

Let us assume that this mechanism is adjusted for an operating cycle of once per hour and that the "on" period is adjusted for a duration of one minute. This assures that regardless of the operation of the day and night thermostats 51 and 52, the furnace control relay 51 will be energized at least one minute every hour, and this will avoid the inconvenience of having the furnace go out entirely in case no heat is called for by the thermostats, but without producing any apreciable amount of heating. It may often happen that the circuit of relay 50 will be closed at contacts 57 and 58 at a time when the relay 50 is already energized by one of the thermostats. This will do no harm since the connection made by contacts 57 and 58 is merely a parallel connection to the one closed by the connected thermostat.

The manual control 44 of switch contacts 40 and 42 is desirable in the application described. For example, when the family retires later than usual in the evening, turning switch 44 to "off" position assures that the temperature will be maintained by the day thermostat until switch 44 is again turned to neutral position. When the family is to be away from home during the day time, switch 44 may be turned to "on" position, which will then assure the maintenance of a temperature according to the setting of the night thermostat until such time as switch 44 is again turned to neutral position. Such use of switch 44 does not disturb the setting of dials 35 and 36 or of the thermostats or the function of the contacts 57 and 58.

It is thus seen that I have provided a relatively simple, yet convenient and reliable time switch for taking care of all of the time functions met with in furnace control. Although the switch is particularly suited for furnace control applications, I do not wish to limit my invention to this particular use.

All of the adjustments heretofore described are made independently of each other. For example, adjustment of cam finger 34 in no way alters the result of adjusting the number of cycles of operation of contacts 57 and 58 in a given 24 hour time period or the relation between the on and off period of contacts 57 and 58 during their cycle of operation. By making the ratio between the 24 hour time period and the time cycles of operation of contacts 57 and 58 during such period an integer, the sequence of operation of all contacts will remain the same in subsequent 24-hour periods for any given adjustment. This is not important in the application described but will be important in some process applications where a given program or sequence of operation is to be repeated on a device such as relay switch 50 under the joint control of both sets of synchronized contact mechanisms.

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

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

1. In a time switch a rotary stepped cam, a contact mechanism operated by said cam, said contact mechanism comprising a supporting block pivoted for rotation on an axis parallel to the axis of rotation of said cam and supporting a relatively stiff lower contact member extending toward but not reaching said cam; a relatively flexible intermediate contact member extending toward and reaching said cam and a relatively stiff upper cam follower member extending towards and supported by said cam, said contact members having coopearting contacts between them normally biased to a closed position, the upper cam follower member extending beyond the intermediate contact member by an adjustable amount, the arrangement being such that as the cam is rotated and the cam follower is raised and lowered thereby, the supporting block is oscillated about its pivot to raise and lower the lower contact member substantially in accordance with the rise and fall of the cam follower, and the intermediate contact member rises and falls with respect to the lower contact member to break and make contact therewith, such contact being made when the intermediate contact member drops over a step in the cam and being broken when the cam follower drops over the same step in the cam.

2. In a time switch a contact mechanism comprising a rotary cam having a step therein, a contact block mounted for rotation about an axis parallel to the axis of rotation of the cam, a relatively stiff cam follower extending from said block and supported by the periphery of the cam so as to be raised and lowered thereby to oscillate the block about its axis of rotation when the cam is rotated, a relatively flexible contact member extending from said block and resting on the cam beneath the cam follower, a relatively stiff contact member extending from said block beneath the relatively flexible contact member towards said cam but terminating short of the cam, cooperating contacts on said contact members normally biased to a closed position and means for adjusting the relative length of the cam follower and flexible contact member such that the cam follower projects beyond the flexible contact member to an adjustable extent where they contact with the cam, the arrangement being such as to open and close the cooperating contacts when the cam is rotated to lower and raise the cam follower respectively, the relation between the time the contacts are closed and opened during such operating cycle depending upon the difference in the lengths of the cam follower and flexible contact member.

3. In a time switch, a cam shaft having a plurality of spaced cams each with a different number of similar steps therein, a rod parallel to the cam shaft, a contact block slidable along and rotatable about said rod, contact and cam follower fingers extending from said block to be operated by any one of said cams depending upon the position of said block along said rod, locking means for retaining the block and its cam contacting fingers in operative relation with the selected operating cam, said contact mechanism being arranged to change the relative positions of the contact fingers and the rotary position of said block on said rod as the mechanism is operated by a cam, a pair of contacts carried by said fingers which are opened and closed by such operation and means for adjusting the relative length of certain of said fingers to vary the time of closure of said contacts during each such operation.

4. In a time controlled device, a cam, a movable support, a pair of control members extending therefrom, one of said control members being positioned between the second one and said cam, means urging said support to move in a direction to engage said control members with said cam, said members being normally engaged with each other while on a lobe of said cam and thereby assuming one control position and being disengaged from each other while the second one is on said lobe and the first one is past said lobe, said members being proportioned for the first one to pass said lobe before the second one during rotation of said cam.

5. In a time controlled device, a cam, a movable support, a pair of control members extending therefrom, means urging said support to move in a direction to engage said control members with said cam, said control members being normally engaged with each other with one of them superposed on the other one while they are on the lobe of said cam and being disengaged from each other while one of them is on said lobe and the other one is relatively past the lobe, said members being proportioned to pass said lobe at different time periods, and a third member carried by said support, said third member and the one of said two control members which underlies the other one making contact with each other during the time between successive passage of said control members past said lobe.

6. In a device of the class described, a plurality of cams, a switch to be actuated thereby, said switch comprising a support, an actuating arm extending therefrom and coacting with one of said cams, a switch arm extending therefrom, coacting with said cam and normally retained engaged with said actuating arm by a lobe thereon, said lobe being movable past said switch arm, whereupon prior to said lobe moving past said actuating arms, said switch arm disengages said actuating arm, said support being movable to a position where said arms coact with another of said cams, a contact arm carried by said support, and switch contacts carried by said contact arm and said switch arm and operable by said actuating and switch arms to assume one position when the switch arm is engaged with the actuating arm and another position when it is disengaged therefrom.

7. In a device of the class described, a cam, a switch to be actuated thereby, said switch comprising a support, an actuating arm extending therefrom and coacting with said cam, a switch arm extending therefrom coacting with said cam and normally retained engaged with said actuating arm by a lobe thereon, said lobe being movable past said switch arm whereupon prior to said lobe moving past said actuating arm, said switch arm disengages said actuating arm, a contact arm carried by said support, switch contacts carried by said contact arm and said switch arm and operable by said actuating and switch arms to assume one position when the switch arm is engaged with the actuating arm and another position when it is disengaged therefrom, and means for changing the relative positions of said arms to vary the time period between movement of the cam successively past the arms.

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