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E. K. HOWELL
TIME DELAY SWITCHES
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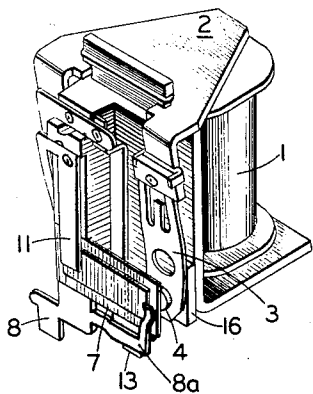


Fig. 1

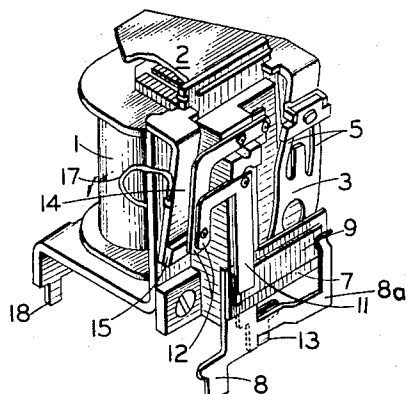


Fig. 2

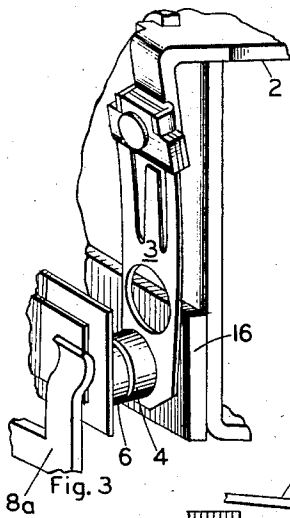


Fig. 3

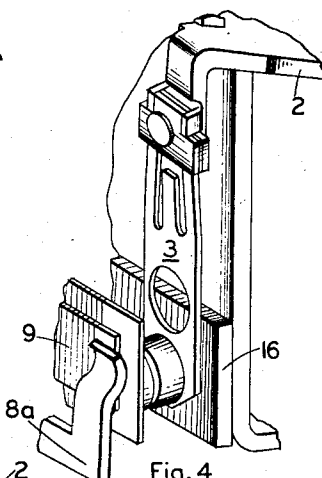


Fig. 4

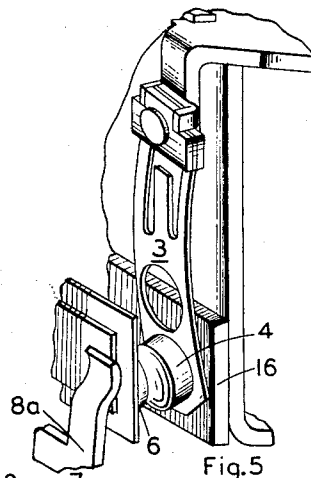


Fig. 5

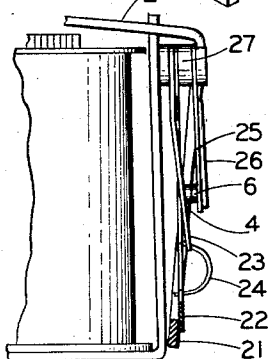


Fig. 6

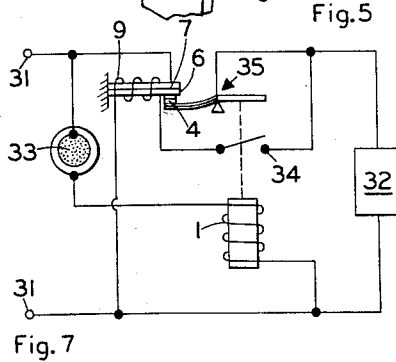


Fig. 7

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TIME DELAY SWITCHES

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5 Claims. (Cl. 200—88)

This invention pertains to circuit makers and breakers and more particularly to an improved snap action switch incorporating a time delay.

The present invention is particularly useful in connection with automatically controlled street lighting circuits wherein it is desirable to incorporate a time delay in de-energization of the lamp circuit in order to prevent transient conditions from extinguishing current in the lighting circuit. One particular application for which the present invention is intended is in a photoelectrically controlled circuit for street lighting wherein a photocell operates a relay directly. During the daytime the relay will be energized by current from the photocell and at night deenergized. A time delay is required to prevent mal-functioning during the night due to headlights and flashes of lightning which may operate the relay. The device described herein permits the relay to operate momentarily without interrupting the lamp load current. Without such delay a flash of light would cause momentary interruption of the load current, and in a mercury lamp circuit this would extinguish the light, requiring approximately 10 minutes cooling time thereafter to start. Such a period of unexpected darkness would in most instances constitute a serious traffic hazard.

It is an object of this invention to provide an improved snap action switch incorporating a time delay on actuation thereof and having an instantaneous response to reverse actuation.

Another object of the invention is to provide an improved snap action switch operated only by a sustained positive actuation but which is insensitive to transient actuation.

By way of a brief summary of but a single aspect of this invention, I provide an electrical relay with a snap action switch having a pair of contacts. One of the contacts is arranged to be moved between actuated and non-actuated positions by a snap action overcenter mechanism controlled in part by the armature of the relay. The snap-actuated contact is normally biased into electrical engagement with another electrical contact suspended by a bimetal cantilever, and the overcenter mechanism, which in a preferred embodiment includes a dished pre-stressed cantilever attached to the armature or actuating arm of the relay, is so arranged that actuating movement of the armature is insufficient of itself to bring the overcenter mechanism to a condition past the critical limit at which snap actuation would occur. Instead, movement of the armature to an actuated position merely arms the overcenter mechanism so that it may be driven past the critical limit by an additional force. The additional force for accomplishing this purpose is supplied by increasing the temperature of the bimetal cantilever which is so constructed that an increase in temperature will force the contact on the bimetal to press against the snap-actuated contact until the critical limit of the overcenter mechanism is reached. To supply the energy to accomplish this purpose, there is provided an electrical heater attached to the bimetal cantilever and energized by an additional pair of normally open contacts which are closed by actuation of the relay armature. Thus, when the relay is actuated, the overcenter mechanism is cocked or armed and electrical energization of the bimetal heater may take place. When the

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bimetal has been heated sufficiently to drive the snap-actuated contact to a position where the critical limit of the overcenter mechanism is passed, the contacts will open instantaneously.

In a preferred circuit arrangement I place the bimetal heater and its normally open energizing contacts in series circuit with the snap actuated contacts. By this means, as soon as the snap-actuated contacts open, the heater circuit is also opened permitting the bimetal to cool and reposition itself once again for time delay operation. A stop member is positioned to limit the movement of the snap-actuated contact to a position just past its critical overcenter position with respect to the overcenter mechanism. Thus, when the relay is de-energized and its armature returns to its normal position, the snap-acting mechanism is immediately caused to function in a reverse direction, driving the snap-actuated contact back into electrical engagement with the contact associated with the bimetal cantilever. A primary advantage of this circuit arrangement is that the heater is required to work only on intermittent duty, being normally energized only once a day at dawn for a few seconds. Thus, the heater power can be made high enough to secure positive operation of the switch without danger of overheating either the heater or other parts in the control assembly.

Although the scope of this invention is not to be limited, except by a fair interpretation of the appended claims, further details of the invention as well as additional objects and advantages thereof, may better be understood in connection with the accompanying description and the drawings wherein:

Figures 1 and 2 represent isometric views of a relay incorporating a novel time delay snap-actuated switch constructed in accordance with the principles of this invention;

Figures 3, 4 and 5 are enlarged views of the snap-actuated switch of Figures 1 and 2 shown in different stages of its operation;

Figure 6 is a plan view partially cut away of an alternate construction of the snap-actuated switch; and

Figure 7 is a diagrammatic representation of an electrical control circuit incorporating the present invention.

The relay shown in Figures 1 and 2 is provided with the customary operating winding 1 which, when energized, attracts the armature 2 to initiate the action of the time delay snap action switch to be described. Armature 2 functions as the actuating arm of a snap action switch which includes a pre-stressed element 3 provided for effecting a snap action movement of a movable contact 4 between two discrete circuit affecting positions. In the preferred form shown a pre-stress is applied to element 3, which is formed of a spring material, by squeezing the two parallel projections 5, thereby causing the spring element to assume a dished shape. In this pre-stressed condition the element 3 accomplishes the function of a snap action mechanism by having an instability when caused to assume a flattened condition. The instability is such that the spring member when stressed toward and beyond a critical position represented by its flat configuration snaps into a stable condition wherein its dished shape is convex in an opposite direction.

Normally, movable contact 4 is biased by spring member 3 to a position in which it is in engagement with an additional contact 6 better shown in Figures 3, 4 and 5. The latter contact is affixed to the free end of a cantilevered bimetallic member 7, the fixed end of which is supported on the relay frame in electrical contact with electrical terminal 8. The bimetallic member is so constructed that an increase in temperature thereof causes

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it to flex in a direction toward movable contact 4 tending to force the spring member 3 toward its critical configuration.

For purposes of increasing the temperature of the bimetal cantilever a strip heater 9 is applied thereto which may take the form of a "painted" resistance on a thin composition "tape resistor," one end of which is in electrical contact with conducting member 11; the other end of which is in electrical contact with the free end of the bimetal cantilever. Otherwise, the strip heater is electrically insulated from the bimetal by an insulating tape as indicated by the surface shading shown thereon. The current supplied to strip heater 9 must pass through terminal 8 and bimetallic member 7 to its free end; thence through strip heater 9 to conducting member 11, through normally open contacts 12 and out through terminal 13. It is to be observed that the normally opened contacts 12, being resiliently mounted, are urged into circuit closing position by actuating movement of the relay armature 2 through the medium of an extending arm 14 and bumper pad 15. It is apparent therefore that the bimetallic member cannot be heated until and unless the relay armature 2 is pulled downward into its actuated position by a magnetic field set up by winding 1.

Figures 3, 4 and 5 illustrate different stages in the action of the present improved time delay snap action switch. In Figure 3 contacts 4 and 6 are shown in their normally closed or actuated positions wherein the spring member 3 biases the movable contact 4 into engagement with contact 6. At this point bimetallic member 7, being unheated, exerts no additional influence upon the snap-actuating overcenter mechanism. When the actuating arm 2 is initially moved downward into its actuated position as shown in Figure 4, the pre-stressed spring member 3 of the overcenter mechanism is flexed toward, but not past, its critical position at which a snap-actuated opening of the contacts 4 and 6 would occur. These contacts therefore remain in engagement as the bimetallic member 7 begins to heat up under the influence of strip heater 9. After a suitable time interval which may be varied depending upon the current supplied to strip heater 9, its rate of heat dissipation, and the temperature constants of the bimetallic member 7, the bimetallic member will have flexed to such a degree that in pressing against movable contact 4, the critical limit of the spring member 3 will have been exceeded, at which point an immediate snap action occurs opening contacts 4 and 6 as shown in Figure 5. At this stage movable contact 4 rests against a stop member 16 so positioned that reverse movement of the armature 2 to its normal position will force the snap actuated contacts back into engagement with each other, as shown in Figure 3. When contacts 4 and 6 are in engagement, the circuit through these contacts is completed through terminal 8 and bimetallic member 7; through contacts 6 and 4; thence through spring member 3 to armature 2 which is electrically connected through a flexible cable 17 to a base member having terminal 13 thereon. Although the aforesaid apparatus will operate as described under normal ambient temperature conditions, very low ambient temperature conditions tend to cause bimetal 7 to bend away from stop 16 and to cause separation of contacts 4 and 6. Accordingly, a further stop element, 8a, is provided to preclude such occurrences. As shown, stop 8a may conveniently comprise an integral extension of terminal 8.

The practice of this invention is not limited to the use of the specific snap action mechanism above described but other equivalent mechanisms may as well be employed. In Figure 6, for example, wherein similar reference numerals are used to denote similar parts, another time delay switch is shown incorporating a familiar snap action mechanism. In this case the actuating armature 2 of the relay causes movement of an extended arm 21 which bears against a flat flexible metallic member 22. Movable contact 4 is carried by an additional movable

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arm 23. The snap action is effected through the medium of the pre-stressed C-shaped spring member 24. Thus, as armature 2 moves downward and the extended arm 21 moves to the right carrying with it movable arm 22, the pre-stressed spring member 24 is carried almost to a critical position beyond which it would cause immediate snap action movement of contact 4 away from contact 6. As above described, contact 6 is carried on the free end of a bimetal cantilever 25 and has affixed thereto a strip heater 26. The contacts are insulated from each other by insulating spacers 27, and electrical connections, not shown, are made in a similar manner to that shown above. The bimetal cantilever is arranged in the same manner described above to flex in a direction toward movable contact 4 so that when the armature occupies an actuated position, C-shaped spring member 24 is forced beyond its critical position causing opening of the contacts. Upon return of the armature to its normal actuated position, the critical limit of the overcenter mechanism is again reached and passed causing the contacts to engage once more.

In Figure 7 there is shown a control circuit making particularly advantageous use of the concepts of this invention. Terminals 31 are provided for connection to a source of power for energizing a load circuit 32, which, in a preferred form, is a street lighting system utilizing mercury vapor lamps. Power to the load circuit 32 is controlled through contacts 4 and 6 of the presently described time delay snap action switch. As shown, a photosensitive element 33 of the type whose conductivity increases when light is incident thereon controls the flow of current through operating winding 1 of the relay. At night time when no significant amounts of light reach the photosensitive element, no current exists in winding 1 and the lighting circuit is energized through the normally closed contacts. As daylight approaches and the level of light intensity increases, the magnitude of the current in winding 1 will increase until the armature represented by the dotted line moves downward closing switch 34, thereby applying a current to the heater 9 associated with bimetallic member 7. Actuating movement of the armature also causes snap actuated switch 35 to be placed in a cocked or armed condition so that further heating of the bimetallic cantilever 7 forces the contacts downward until the critical limit of the overcenter mechanism is reached, thereby opening contacts 4 and 6 and removing power from the load circuit 32. By connecting switch 34 on the load side of contacts 4 and 6, the heater 9 is immediately de-energized permitting the bimetallic member 7 to cool and reposition itself. When night falls and the relay is again de-energized, contacts 4 and 6 immediately snap closed applying power to the load but not to the heater since the auxiliary switch 34 is then opened.

During night time, transient beams of light such as lightning flashes, airplane beacons or automobile headlights falling on the photosensitive element 33 may cause photosensitive element 33 to conduct sufficient current to energize the relay. Momentary energization will close the normally open switch 34 and begin to apply energy to the bimetallic member. However, as soon as such transient flashes of light cease, the relay armature will spring back to its unactuated position before contacts 4 and 6 can be opened. Because the delayed action occasioned in this circuit occurs at dawn when the ambient light intensity is increasing which is when the lamps are to be switched off, the exact length of the time delay is not critical and very wide variations in delay caused, for example, by changes in ambient temperature can be tolerated.

In describing the present invention I have chosen to show specific preferred embodiment thereof. The choice of these preferred embodiments should be considered as illustrative only and not limiting on the concepts set forth herein. To those skilled in the art to which this invention

pertains there will naturally occur certain alternative constructions encompassed by these teachings. For example, it is not essential to a practice of this invention that the electrical contacts affected by the contact time delay mechanism described herein be normally closed. In one instance the switch could be normally open with the free end of the bimetal cantilever functioning purely as a stop member and with the cooperating electrical contact affixed instead to stop member 16. Alternatively the switch could be a single-pole, double-throw switch with cooperating contacts affixed both to the free end of the bimetal and also to stop member 16. As yet another modification the heater could be wire wound about the bimetal instead of applied to one surface as a strip heater as shown. Furthermore, it may not always be desirable for the heater to be electrically connected at one end to the bimetallic member itself, since it may be preferred to operate the heater from another circuit for other types of functions. These and other modifications and substitutions may well be made without departing either in spirit or scope from the invention described in the following claims.

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

1. A time delay snap action switch comprising: stationary means; a first stop member mounted on said stationary means; a bimetallic member fixed at one portion to said stationary means and having a second stop member mounted on another portion for movement toward said first stop member upon increase in temperature of said bimetallic member; an electrical contact on at least one of said stop members; a movable electrical contact arranged for movement between said stop members to cooperate with said first-mentioned electrical contact; a snap action overcenter arrangement for causing snap action movement of said movable contact between said stop members; a switch controlling member cooperating with said overcenter arrangement and movable between a first actuating position in which said overcenter arrangement biases said movable contact toward a normal position against said second stop member and a second actuating position in which said overcenter arrangement is caused to approach a critical snap actuation limit relative to said movable contact; means for applying heat to said bimetallic member upon movement of said switch controlling member to said second actuating position, whereby said bimetallic member flexes said movable contact to a position past said critical snap actuation limit forcing said overcenter arrangement to move said movable contact to a position against said first stop member.

2. A time delay snap action switch comprising: stationary means; a bimetallic member affixed at one portion to said stationary means and being free to flex with changes in temperature; a first electrical contact mounted on said bimetallic member for movement with said member due to changes in temperature thereof; a movable electrical contact cooperating with said first contact; overcenter means for causing snap actuated movement of said movable contact toward and away from said first contact, said overcenter means normally biasing said movable contact into engagement with said first contact; an actuating member movable between normal and actuating positions for operating said overcenter means, said actuating member in said normal position cooperating with said overcenter means to prevent disengagement of said contacts, said actuating member in said actuating position cooperating with said overcenter means to permit snap actuated disengagement of said contacts; means for applying heat to said bimetallic member when said actuating member occupies said actuating position, said bimetallic member being adapted upon increase of its temperature to flex in a direction toward said movable contact causing snap actuated disengagement of said contacts when said actuating member occupies said actuating position.

3. A time delay snap action switch comprising a movable contact, an over-center snap action mechanism movable in opposite directions and carrying said contact for movement between first and second circuit controlling positions upon movement of said over-center mechanism across a predetermined point, a second contact at one of said positions for engagement by said movable contact, primary actuating means operable to move said over-center mechanism in one direction across said point to carry said movable contact from the first said circuit controlling position to the second position and operable reversely to move said over-center mechanism in the opposite direction substantially to but not across said point while maintaining said movable contact at said second circuit controlling position, a supplemental bimetallic actuating means engageable with said over-center mechanism and adapted, when heated, to flex in a direction to complete the movement of said over-center mechanism in said opposite direction across said point to carry said movable contact from said second circuit controlling position to the first position, heater means for said bimetallic actuating means, and circuit closure means controlled by the reverse movement of said primary actuating means to close an electrical circuit to said heater means and thereby energize the bimetallic actuating means.

4. A time delay snap action switch comprising contact means, thermal means, an over-center snap action mechanism operatively connected to said contact means for causing opening or closing of said contact means when moved across a predetermined point, means including an electromagnet operatively connected to said over-center mechanism for moving said mechanism in one direction across said point to actuate said contact means and for moving said mechanism in the opposite direction substantially to but not across said point while maintaining the existing relationship of said contact means, said thermal means being operatively engageable with said over-center mechanism and arranged, when heated, to move said mechanism in said opposite direction across said point to actuate said contact means, and circuit closure means operable upon the movement of said over-center mechanism in said opposite direction to close an electrical circuit to said thermal means to thereby heat and actuate the same.

5. A time delay snap action switch comprising contact means, thermal means, an over-center snap action mechanism operatively connected to said contact means for causing opening or closing of said contact means when moved across a predetermined point, means including an electromagnet operatively connected to said over-center mechanism for moving said mechanism in one direction across said point to close said contact means and for moving said mechanism in the opposite direction substantially to but not across said point while maintaining the contact means closed, said thermal means being operatively engageable with said over-center mechanism and arranged, when heated, to move said mechanism in said opposite direction across said point to open said contact means, and circuit closure means operable upon the movement of said over-center mechanism in said opposite direction to close an electrical circuit to said thermal means through said contact means to thereby heat and actuate said thermal means.

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