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[56] **References Cited**
UNITED STATES PATENTS

2,432,367	12/1947	Andresen	200/61.04
2,835,754	5/1958	Lewis	200/166(B1)UX
2,932,698	4/1960	Barden	200/67(C)X
3,030,459	4/1962	Elliott et al.	200/6(A)
3,255,319	6/1966	Paine	200/166(SD)X
3,274,355	9/1966	Francy	200/166(.1)X

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[54] **SWITCH CONSTRUCTION**
12 Claims, 11 Drawing Figs.

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200/166, 102/70, 200/61.04

[51] Int. Cl. **H01h 1/06,**
H01h 35/42

[50] Field of Search **200/166B1,**
166B4, 61.04, 67C, 153, 166SD, 6A, 166.1, 153,
153.9; 102/70.2

ABSTRACT: A switch construction including a movable actuating means and a spring-loaded contact movable by said actuating means. A contact end is positioned against a first barrier, and this barrier is removed upon initial movement of the actuating means at which time the contact end is positioned against a second barrier. A distinct movement of the actuating means results in removal of the second barrier, and movement of the contact end to a closed contact position.

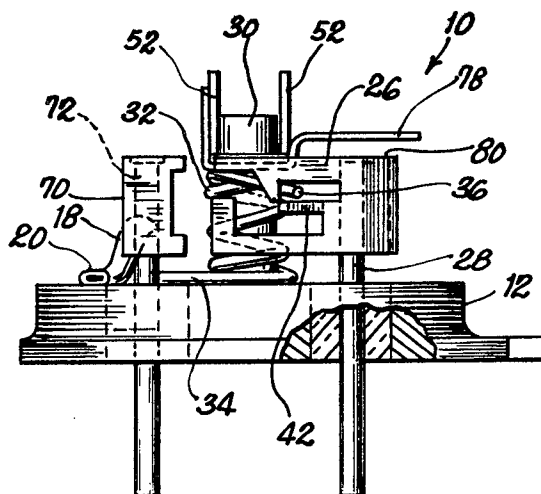


FIG. 1

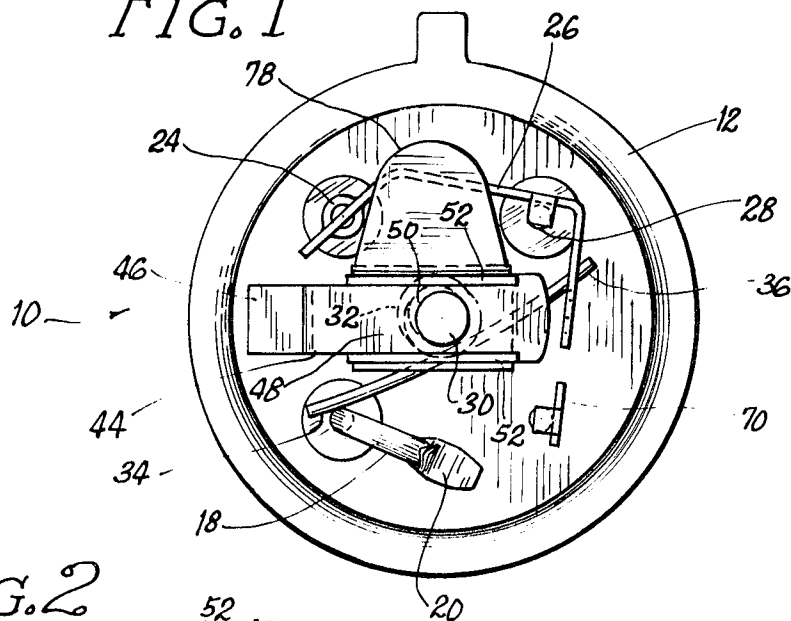


FIG. 2

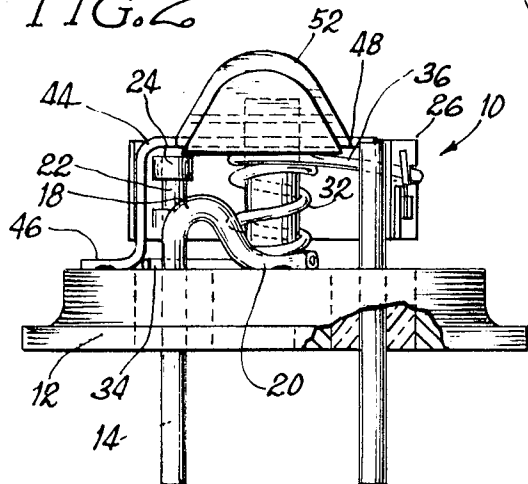
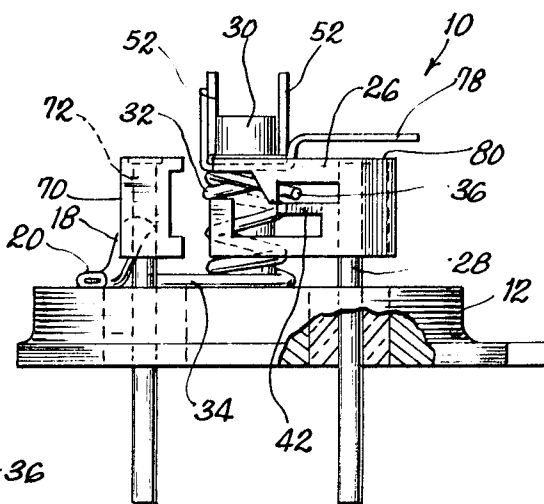
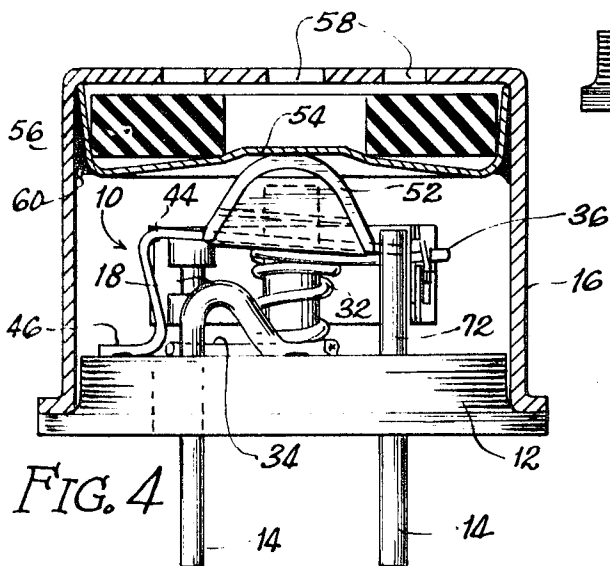


FIG. 3



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FIG. 5

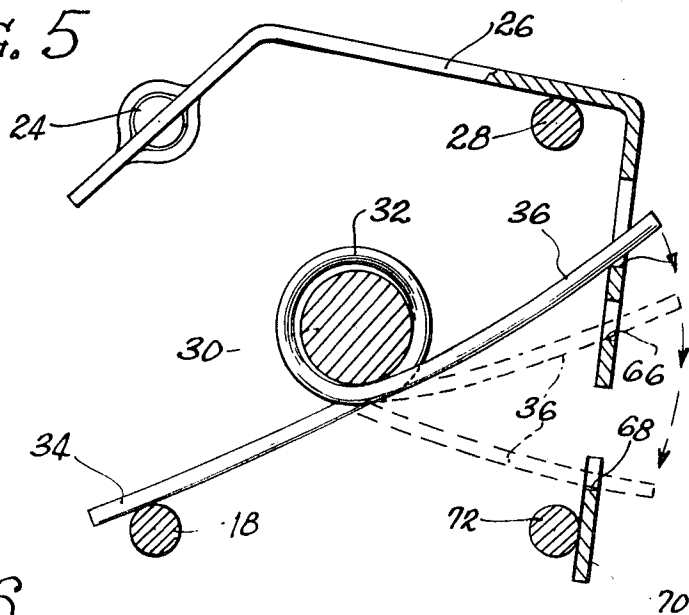


FIG. 6

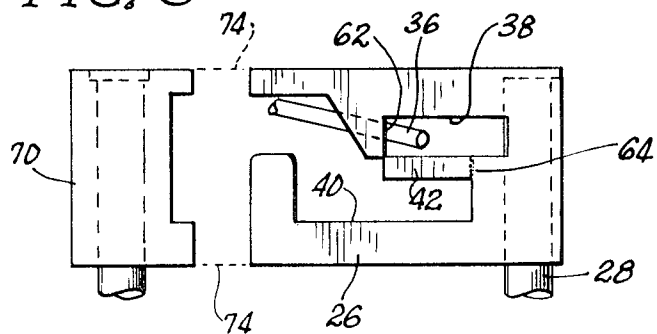


FIG. 7

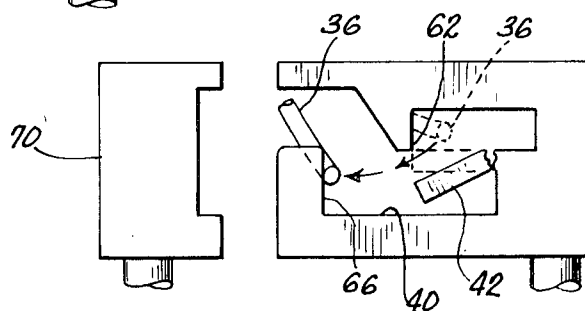
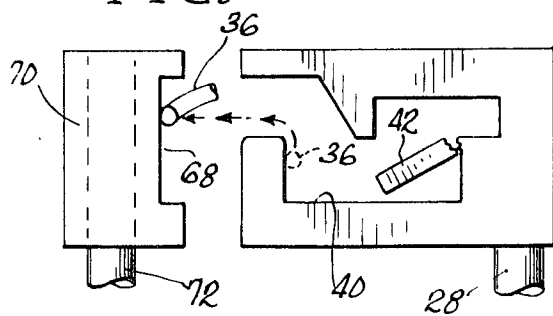


FIG. 8



SHEET 3 OF 3

FIG. 9

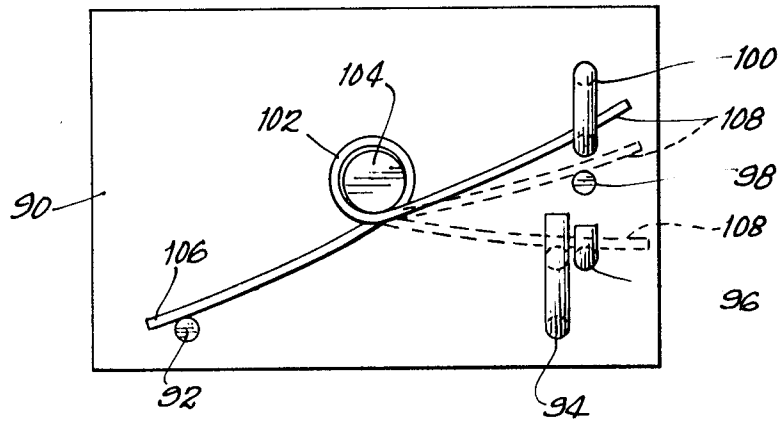


FIG. 10

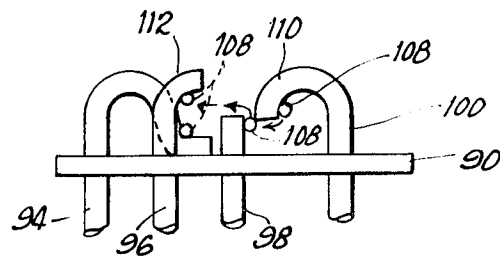
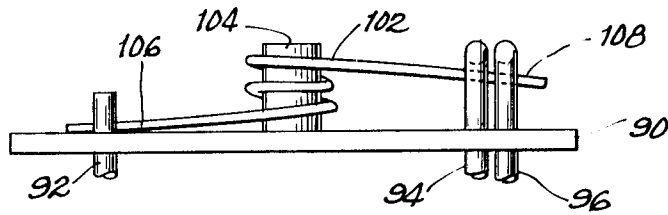


FIG. 11



SWITCH CONSTRUCTION

This invention relates to an improved switch construction. The switch construction to be described is particularly suitable for use in applications requiring miniaturized components which have highly reliable operating characteristics. When considering the following description, however, it will be appreciated that the concepts can be adapted to larger scale applications.

It is a general object of this invention to provide an improved switch construction which will operate in a highly reliable fashion even when produced on a miniature scale.

It is a more particular object of this invention to provide a switch construction of the type referred to which is particularly adaptable for operation in response to changes in the environmental conditions to which the switch construction is exposed.

These and other objects of this invention will appear hereinafter and for purposes of illustration, but not of limitation, specific embodiments of the invention are shown in the accompanying drawings in which:

FIG. 1 is a plan view of the switch construction;

FIG. 2 is a front elevational view partly cut away;

FIG. 3 is a side elevation partly cut away;

FIG. 4 is a vertical sectional view illustrating the switch construction in combination with a housing, and including internal mechanisms adapted to effect operation of the switch in response to environmental changes to which the assembly is exposed;

FIG. 5 is an enlarged sectional view illustrating the movements of the contact means in the course of the switch operation;

FIGS. 6, 7 and 8 comprise enlarged sectional views illustrating the respective positions of the contact means in the course of switch operation;

FIG. 9 is a plan view illustrating an alternative form of the invention;

FIG. 10 is a front elevation of the construction shown in FIG. 9; and,

FIG. 11 is a side elevation of the construction shown in FIG. 9.

The switch construction of this invention generally comprises a movable actuating means and a spring-loaded contact movable by the actuating means. The contact is adapted to bear against a first barrier in an initial position of the switch. Upon movement of the actuating means, the first barrier is removed, and thereafter the contact is held by a second barrier. A separate, distinct movement of the actuating means will result in removal of the second barrier whereby the switch contact will be moved to a new position which, in most applications, will comprise the closed position of the switch.

One particular application for the switch of this invention involves actuation by an element subject to environmental changes. It is specifically contemplated that use of a material, such as silicone rubber, which in the dry state, will occupy a certain confined space. Upon exposure to a fluid, for example alcohol, the silicone rubber will expand to a substantial degree and when properly associated with a switch of this invention, the expansion will result in movement of the actuating member of the switch. If the construction is then exposed to the atmosphere, the alcohol will gradually evaporate whereby the silicone rubber will contract thereby resulting in a distinct movement of the actuating means.

In a typical application, the switch construction is set with the spring loaded contact means pressing against a first barrier, this condition comprising a "safe" switch condition. The initial expansion of the silicone rubber will result in movement of the contact whereby the first barrier can be overcome and whereby the contact will snap into position adjacent a second barrier. This will comprise the "ready" condition of the switch.

The closing of the switch is accomplished during contraction of the silicone rubber at which time the contact end overcomes the second barrier and snaps into position against a sta-

tionary contact. This latter position may be the "burn" position of the switch.

The switch can be used for military applications where it is ultimately to be included in a circuit for setting off an explosive charge. The safe position is desired so that handling of the switch will not result in accidental setting off of the charge. In the arrangement described, this safe condition can be maintained as long as the silicone rubber is kept in a substantially dry state.

The ready condition is desired so that timing control of a sort can be achieved. Thus, switches of the type described can be placed in the ready condition by immersing them in a suitable solution. The switches will remain in this ready condition as long as they remain in the solution. In addition, the timing with respect to movement to the burn position can be determined with a fair degree of accuracy since the evaporation rate can be measured.

FIGS. 1 through 8 illustrate a construction 10 comprising one example of a switch arrangement characterized by the features of this invention. The switch includes an insulating base 12 having wire leads 14 extending through the base. A housing 16 is supported by the base for enclosing the switch components and actuating means.

One of the leads 14 includes a bent over portion 18 with the end of the lead being secured to the support 12 at 20. A second lead 14 includes an upper end 22 which is received within cylindrical sections 24 defined by an escapement element 26. The upper end 28 of a different lead 14 contacts an interior wall of the escapement 26, and the escapement is welded to the lead portions 24 and 28.

A center post 30 is mounted on the support 12, and a coil spring 32 extends around this post. One end 34 of the coil spring bears against the lead portion 18. In the operation of the specific switch described, the lead 18 constitutes a common connection, and the coil spring 32 comprises a movable contact element. The opposite end 36 of the spring comprises the movable contact portion, and a connection with the lead portion 18 will always be maintained irrespective of the position of the contact end 36.

The escapement 26 includes a first cutout portion 38, and this cutout portion is separated from a second cutout portion 40 by means of a strip 42. The escapement 26 is preferably conductive material, and in the embodiment shown, the lead portion 24 constitutes a ground connection. When the contact end 36 is in the position shown in FIG. 5, the common lead portion 18 will be connected to ground.

The actuating means for the switch comprises a strip 44 having one end 46 secured to the support 12. The opposite end 48 of the strip defines an opening 50 for receiving the center post 30. A pair of ears 52 is mounted on the strip 44, and these ears extend into contact with an inverted cap 54. An annular element 56 is received within the cap, and this element may comprise silicone rubber which is adapted to absorb certain liquids. Openings 58 are defined by the housing 16 whereby liquids can enter into contact with the silicone rubber, and so that evaporation can take place. The edges of the cap are sealed as shown at 60 with respect to the housing 16 to prevent entry of liquids into the section of the housing confining the switch 10.

The bottom surface of the strip 44 bears against the upper turn of the coil spring 32. When a suitable solution is introduced through the openings 58 into contact with the silicone rubber 56, expansion will take place. The sealing material 60 permits downward movement of the cap 54. An engagement of the cap with the ears 52 will cause the strip 44 to pivot downwardly. This results in compression of the spring 32, and downward movement of the contact end 36.

The contact end 36 initially bears against the edge 62 defined by the cutout portion 38. This edge forms a first barrier to movement of the contact end 36. However, if the contact end is moved downwardly, it will ride against the edge 62 and eventually engage the strip 42. This strip is preferably weakened at 64 whereby the contact end will cause the strip

42 to break off so that the contact end can bypass the edge 62 and move to the left as shown in FIG. 7.

When moved in the manner described, the contact end 36 will be positioned against an edge 66 defined by the cutout portion 40. This edge forms a second barrier to the movement of the contact end. When the silicone rubber 56 contracts due to evaporation of the solution absorbed therein, the contact end will begin upward movement while bearing against the edge 66. Eventually the barrier presented by this edge is overcome whereby the contact end will shift to the position shown in FIG. 8.

In the position shown in FIG. 8, the contact end bears against an edge 68 defined by a conductive member 70 secured to an upper portion 72 of one of the leads 14. This lead is electrically separated from all of the other leads and, therefore, when the contact end 36 is in the position shown in FIG. 8, a completely new electrical circuit is introduced.

The switch position of FIG. 6 constitutes a "safe" position for the switch. Thus, the contact end is connected to ground, and even if the contact is moved beyond the barrier presented by the edge 62, a change in electrical condition will not result. Thus, movement of the contact end to the position shown in FIG. 7 still maintains connection through ground.

The position shown in FIG. 7 is the "ready" position since movement beyond the barrier presented by the edge 66 will result in a change in electrical condition. Specifically, the further movement of the contact end 36 will result in contact with the element 70 whereby the ground connection is broken and whereby a "burn" position can be achieved.

In the fabrication of the switch, the escapement 26 can be formed from a flat sheet of conductive material and then cut out in the manner illustrated. The escapement is then bent into shape and welded to the lead portions 24 and 28 as illustrated. The contact element 70 preferably consists of an integral part of the escapement 26 until the escapement is attached to the lead portions. Thus, as shown by the dotted lines 74 in FIG. 6, the contact element 70 may form a connected part of the escapement 26, and this contact element can be welded to the lead portion 72 at the same time as the other escapement portions are attached to the lead portions 24 and 28. The separation between the contact element 70, and the main body of the escapement can then be made with a suitable cutting instrument.

The switch construction of FIGS. 1 through 8 includes a resetting feature. The resetting is accomplished through the use of an extension 78 formed integrally with the strip 44. This extension hangs over the upper edge 80 of the escapement 26. If fluid is returned into contact with the silicone rubber 56, expansion will again occur, and the extension 78 will be moved downwardly into contact with the escapement. This will short out the switch, and this condition will remain as long as the silicone rubber remains in the expanded state. When evaporation occurs, the extension 78 will withdraw whereby the burn position of the switch will again become operative. The switch can be reset any number of times with an arrangement of this type.

It will be appreciated that the operating principals of the switch described are not dependent upon the use of the actuating arrangement consisting of the the silicone rubber and cap 54. Thus, a simple manual switch operation is clearly possible. Furthermore, it will be noted that leads 14 which are connected to ground in the embodiment illustrated could be otherwise connected to serve various electrical functions. Obviously, the switch could also be employed as a normally closed switch with the contact element 70 serving as a ground or open connection. Finally, different electrical functions could be accomplished due to movement of the contact end 36 beyond the first barrier. Thus, the escapement 26 could be separated between these barriers, and the "ready" position utilized to serve a specific electrical function, for example, to actuate a warning light.

A modified form of the invention is shown in FIGS. 9 through 11. This construction includes a base 90 having leads

92, 94, 96, 98 and 100 extending therethrough. A contact spring 102 is located around center post 104. One end 106 bears against the lead 92 which may comprise a common connection. The opposite end 108 of the contact spring comprises a movable contact portion.

In a position corresponding to the "safe" position described, the contact end 108 bears against a first barrier provided by a hook portion 110 formed in the lead 100. When the contact end 108 is pressed downwardly, for example, by actuating means of the type previously described, the contact end will snap into engagement with the lead 98. Upward movement will cause the contact end to snap into engagement with the lead 96. The lead 98 provides a "ready" position, and the lead 96 a "burn" position. The lead 96 is bent over as shown at 112 to confine the contact 108 adjacent the upper portion of the lead when the actuating means has undergone the return movement for shifting the contact to the burn position.

A resetting capability is also provided in this modified form of the invention. The lead 94 is positioned along side the lead 96, and in the burn position, the contact end 108 will not engage the lead 94. Resetting movement of the actuating means will, however, cause the contact end 108 to move downwardly, and this will drive the contact end into engagement with the lead 94. The lead 94 then acts as a cam to move the contact end out of engagement with the lead 96. Return movement of the actuating means will, of course, return the switch to the burn position. Any number of resetting operations can be accomplished.

The switch design of FIGS. 9 through 11 presents certain advantages. The electrical leads themselves form the barriers, and contact-engaging surfaces whereby assembly operations such as are required where the escapement is used can be eliminated. In addition, each of the leads can be easily electrically insulated from the others whereby great versatility from the standpoint of electrical function of the switches is available.

The arrangement shown in FIGS. 9 through 11 can be easily modified without departing from the basic spirit of the switch design. For example, the switch described is essentially a three-step switch; however, additional steps can be interposed without difficulty thereby adding to the versatility of the switch. For example, a lead such as the lead 100 could be interposed between the leads 96 and 98 whereby the hook portion 110 would engage the contact 108 after the contact overcomes the barrier presented by the lead 98. Subsequent downward movement will then result in movement of the contact 108 on to the next barrier which may be an intermediate barrier such as the lead 98 or a final barrier such as a lead 96. Where a lead similar to the lead 100 is employed as an intermediate barrier, it will be understood that the vertical section of the lead must be out of the path of the contact end 108 so as to interfere with this contact end.

It will be understood that various other changes and modifications may be provided in switch constructions of the type described which provide the characteristics of this invention without departing from the spirit thereof particularly as defined in the following claims.

We claim:

1. A switch construction comprising a movable actuating means, a contact element movable by said actuating means, said contact element comprising a coil spring, one end of said spring being stationary and in contact with a common electrical connection, the other end of said spring comprising a movable contact, a first barrier holding said contact element in a first position, initial movement of said actuating means operating to compress said spring and to thereby move said movable contact, said first barrier comprising a first protruding contact pin extending outwardly from said support, said initial movement causing said movable contact to move beyond the end of said first pin and to thereby put said contact element in a ready condition, and a second barrier holding said contact element while in said ready condition, said second

barrier comprising a second protruding contact pin extending outwardly from said support, and wherein additional movement of said actuating means in a direction different than said initial movement causes said movable contact to move beyond the end of said second member and to snap under spring action into contact with a third contact pin at a new position of the switch, said contact element being included in a common electrical circuit when engaged with said first and second pins, with said third pin being included in a different circuit.

2. A switch construction according to claim 1 wherein the opposite ends of said pins extend outwardly from the opposite side of said support, said opposite ends providing means for including the pins in electrical circuits.

3. A switch construction according to claim 1 including a resetting pin mounted on said support adjacent said third contact pin, and wherein recycling of said actuating means in the direction of said initial movement operates to move said movable contact into engagement with said resetting pin and out of engagement with said third pin, and wherein return movement of said actuating means in a different direction operates to return said movable contact into engagement with said third pin and out of contact with said resetting pin.

4. A switch construction according to claim 3 wherein said resetting pin is included in an electrical circuit different than said third pin.

5. A switch construction comprising a support, a plurality of upstanding barrier means carried on said support, a spring-loaded contact element having a movable contact portion bearing against at least one of the barrier means depending on the switch position, and an actuating means for moving said movable contact portion relative to said support, the movement of said actuating means in an initial direction operating to move the contact portion over the surface of a first barrier and beyond the end of the barrier whereby the contact portion will snap into position against a second barrier, and wherein the switch operation includes at least one additional movement of said actuating means in a different direction which operates to move said contact portion over the surface of said second barrier and beyond the end of said second barrier whereby the contact end snaps into position adjacent a third barrier, each of said barriers including means attached to and extending outwardly from said support, and wherein at least one of said barriers is conductive thereby operating to include said movable switch portion in an electrical circuit.

6. A switch construction comprising a movable actuating means, a contact element movable by said actuating means, said contact element comprising a coil spring, one end of said spring being stationary and in contact with a common electrical connection, the other end of said spring comprising a movable contact, a first barrier holding said contact element in a first position, initial movement of said actuating means operating to compress said spring and to thereby move said movable contact, said initial movement causing said movable contact to move beyond said first barrier and to thereby put said contact element in a ready condition, and a second barrier holding said contact element while in said ready condition, and wherein additional movement of said actuating means in a direction different than said initial movement causes said movable contact to move beyond said second barrier and to snap under spring action to new position of the switch, said contact element being included in a common electrical circuit when engaged with said first and second barriers, and said contact element being included in a different circuit when in said new position, and including an escapement part mounted on said support and formed of conductive material, said first and second barriers comprising protruding portions formed by cutouts defined by the escapement, and including a third protruding member carried by said support forming said new position.

7. A switch construction according to claim 6 wherein said escapement is formed from a strip of conductive material, and wherein said third protruding member initially constitutes a section of said strip whereby the strip can be mounted as a unit

on said support, and including a complete separation cutout between said third portion and the main body of said strip after mounting of the strip on said support.

8. A switch construction according to claim 6 including a contact arm carried by said actuating means, and wherein recycling movement of said actuating means in the direction of said initial movement operates to move said contact arm into contact with the escapement part defining said first and second barriers, said contact arm being electrically connected to said movable contact to provide a short circuit through said escapement part and through the movable contact.

9. A switch construction according to claim 6 wherein the cutout defining said first barrier is separated from the cutout defining the second barrier by means of an elongated arm portion forming a part of said escapement, and wherein the movable contact within said first cut out bears against said elongated arm in response to movement of said actuating means and eventually forces said elongated arm out of the way as the movable contact overcomes the first barrier and moves into position against the second barrier.

10. A switch construction comprising a support, a switch-actuating means movable relative to said support, a spring-loaded contact element engageable by said actuating means for movement therewith, first and second barriers each defining a contact-engaging surface said barriers being mounted in stationary positions relative to said support, the first barrier extending in a position away from said support and the second barrier extending in an opposite direction relative to said support, each of said barriers terminating in a free end, said spring-loaded contact element pressing against the contact-engaging surface of one of said barriers in one position of said switch, movement of said actuating means in one direction relative to said support, operating to drive said spring-loaded contact element beyond the free end of said one barrier, said spring-loaded contact element then moving to a second position of said switch by snapping into pressure engagement with the other barrier, movement of said actuator means in a different direction relative to said support operating to drive said spring-loaded contact element beyond the free end of said other barrier, a third position of said switch, said spring-loaded contact element moving to said third position when it has been moved beyond said free end of said other barrier.

11. A switch construction comprising a movable actuating means, a contact element movable by said actuating means, said contact element comprising a spring having a movable portion and an end portion held stationary and in contact with a common electrical connection, a first barrier holding said movable contact portion in a first position, initial movement of said actuating means operating to compress said spring and to thereby move said movable contact portion, said first barrier comprising a first protruding contact member extending outwardly from said support, said initial movement causing said movable contact portion to move beyond the end of said first protruding member and to thereby put said contact element in a ready condition, and a second barrier holding said contact element while in said ready condition, said second barrier comprising a second protruding contact member extending outwardly from said support, and wherein additional movement of said actuating means in a direction different than said initial movement is required to move said movable contact portion beyond the end of said second protruding member and to snap under spring action into contact with a third contact member at a new position of the switch, said contact element being included in a common electrical circuit when engaged with said first and second members, with said third member being included in a different circuit.

12. A switch construction comprising a support, a switch-actuating means movable toward and away from said support, a spring-loaded contact element engageable by said actuating means for movement with the actuating means toward and away from the support and for movement transversely of the support, first and second barriers each defining a contact-engaging surface, said barriers being mounted in stationary posi-

tions relative to said support, the first barrier extending in a direction away from said support and the second barrier extending in the opposite direction relative to said support, each of said barriers terminating in a free end, said spring-loaded contact element pressing against the contact-engaging surface of one of said barriers in one position of said switch, movement of said actuating means in one direction relative to said support operating to drive said spring-loaded contact element beyond the free end of said one barrier thereby releasing said spring-loaded contact element for movement to a second position

tion of said switch by snapping into pressure engagement with the other barrier, movement of said actuator means in the opposite direction relative to said support operating to drive said spring-loaded contact element beyond the free end of said other barrier thereby releasing said spring-loaded contact from engagement with said other barrier, and including a third position of said switch, said spring-loaded contact element moving to said third position when it has been released from said other barrier.

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