DIRECT-ACTION SWITCH

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ABSTRACT

A movable blade incorporating conducting surfaces is disposed between an actuator and a biasing resilient fulcrum assembly, all of which are positioned within a housing. The movement of the actuator against the blade initially causes the blade to pivot about the fulcrum points of the fulcrum assembly. This pivoting movement causes the conducting end portions of the movable blade to increase the contact force with a first set of conductors mounted to the housing, creating a wiping contacting action. This causes an increasingly firm engagement between the conductors until the movement of the actuator prevents further pivoting and, instead, compresses the blade and the resilient fulcrum assembly sufficiently to wipeingly break the initial contact, and move the conducting end portions of the blade into pressed contact with a second set of conductors mounted to the housing. When actuator pressure is removed, the biasing force of the resilient fulcrum assembly returns the blade and its conductors to their original position.

10 Claims, 6 Drawing Figures
SUMMARY OF THE INVENTION

This invention relates to switches and more particularly to direct action switches of the type wherein the switching conductor forceably moves in the direction of actuation, thereby completely eliminating contact bounce.

Existing switches are generally snap action type, with inherent contact bounce when actuated and which require repeated actuation from one position to the other. These switches generally incorporate endwise-tension and compression conducting members, including a blade having conductors which rapidly move away from one conductor, mounted to the switch housing, toward another such conductor in the opposite direction from the actuator's movement. This arrangement causes the contact force between the fixed conductors and the movable conductors of the blade to decrease during actuation. The result is a switch which is not highly reliable and is prone to unwanted and uncontrollable switching during shock and vibratory conditions, especially, when the switch is actuated slowly. Furthermore, the pressure decrease between the conductors during actuation also creates a condition where arcing may occur and produce deposits which cannot be broken or wiped away. Also, arcing, due to snap-action contact bounce, under certain conditions, may render the switch completely ineffective by welding the contacts together.

OBJECTS OF THE INVENTION

It is an object of this invention to provide a precision switch wherein the movable contact surfaces move in the direction of actuation, and are biased to return to their original position.

Another object of this invention is to provide a switch of the above character wherein the contact force between the fixed and movable conductors increases during actuation until this contact force is overcome, thereby having high electrical current interrupting ability.

Another object of this invention is to provide a switch of the above character which is highly reliable and capable of withstanding high vibratory conditions, without malfunctioning.

Another object of this invention is to provide a switch of the above character in which the conductors are self-cleaning, especially during low voltage switching.

Another object of this invention is to provide a switch of the above character which has a simple, compact design and is inexpensive to manufacture.

A still further object of this invention is to provide a switch of the above character which is fail-safe and possesses high reliability.

Another object of this invention is to provide a switch which has a long mechanical and electrical life and has high repeat accuracy during actuation.

Another object of this invention is to provide a switch wherein actuation forcelessly breaks welded or stuck contacts, thereby possessing fail safe switching.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The direct action switch of this invention comprises a movable blade, which incorporates conducting surfaces, preferably at its extremities, and which is disposed within the switch housing between an actuator and a resilient fulcrum assembly. All or part of the fulcrum assembly is preferably spring-loaded and normally biases the movable blade into contact with the actuator. The fulcrum points associated with the fulcrum assembly are disposed between the conducting end portions of the movable blade and the initial driving contact point between the blade and actuator.

With this arrangement, the movement of the actuator towards the movable blade causes the blade to pivot about the fulcrum points. This causes an increase in the contact forces between the movable conducting end portions of the blade and a first set of conductors mounted to the switch housing. This contact force continues to increase until the actuator is able to control the movement of the blade in the housing. The resilient fulcrum assembly is then compressed until the pivoting motion of the blade ceases and, instead, the fulcrum assembly and the blade and its conducting-end portions are driven towards a second set of conductors mounted to the switch housing. The actuation force is continued until the movable conducting-end portions are in firmly pressed contact with the second set of fixed conductors. When the actuation force is removed, the resilient fulcrum assembly returns to its original position, while also biasing the movable blade and its conducting-end portions and the actuator to their initial position.

The invention accordingly comprises a product possessing the features, properties and the relation of components which will be exemplified in the products hereinafter described and the scope of the invention will be indicated in the claims.

THE DRAWINGS

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a cross sectional view of one embodiment of the switch according to this invention in its non-actuated mode;

FIG. 2 is a view similar to that of FIG. 1 with the switch partially actuated;

FIG. 3 is a view similar to that of FIG. 1 showing the switch experiencing further actuation;

FIG. 4 is a view similar to that of FIG. 1 with the switch in its fully actuated mode;

FIG. 5 is a cross sectional view of an additional embodiment of the switch according to this invention in its non-actuated mode; and

FIG. 6 is a view similar to that of FIG. 5 with the switch in its fully actuated mode.

The same reference numbers refer to the same elements throughout the several views of the drawings.

DETAILED DESCRIPTION

Referring to FIG. 1, direct action switch 20, shown in its non-actuated mode, comprises housing 22, a first set of fixed conductors 24, and a second set of fixed conductors 26. Leads 28 are connected to conductors 24 and 26. Housing 22 also comprises a cavity 50 which incorporates base 48.

Movably disposed within cavity 50 of housing 22 are actuator 30, movable blade 32, and fulcrum assembly 34. In this embodiment of the invention, fulcrum assembly 34 comprises helical coil springs 36 and 38.
Movable blade 32 comprises a thin sheet of conductive material and incorporates an upper set of conductors 40 and a lower set of conductors 42 at its extremities. Conductors 40 and 42 are preferably rounded, but may comprise any desired configuration. Also, blade 32 preferably includes position-maintaining depressions 37 and 39 for cooperation with springs 36 and 38. In this embodiment, actuator 30 comprises a convex base which performs a cam-like function in guiding movable blade 32; however, the actuator could have various other shaped bases, such as the flat base shown by actuator 44 in phantom.

In operation, coil springs 36 and 38 bias movable blade 32 into driving contact with actuator 30, while conductors 24 and 40 are maintained in contact. When a force is applied to actuator 30, the actuator attempts to drive movable blade 32 towards base 48 of cavity 50. In doing so, the points of contact between movable blade 32 and springs 36 and 38 perform as fulcrum points. This causes the portions of movable blade 32 between springs 36 and 38 and the contact area with the actuator to be driven towards the bottom of housing 22 while the remaining portions of movable blade 32 pivot about their respective pivot points, causing the contact forces between conductors 24 and 40 to be continually increased.

The contacting forces between the conductors are continually increased until actuator 30 has reached the position shown in FIG. 2. Actuator 30 is now in firm driving contact of a portion of movable blade 32 that includes the fulcrum points. This prevents further pivoting and allows actuator 30 to compress fulcrum assembly 34.

Further movement of actuator 30 rapidly breaks the maximized contact force between conductors 40 and 24 and brings conductors 42 into contact with conductors 26, while further compressing springs 36 and 38. This position is shown in FIG. 3. Continued movement of actuator 30 causes the contact forces between conductors 42 and 26 to increase and springs 36 and 38 are further compressed, until movable blade 32 comes into frictional contact with base 48 of cavity 50. This position is shown in FIG. 4. When the actuating force is removed from actuator 30, springs 36 and 38 return to their normal position and in so doing bias movable blade 32 and actuator 30 to their original position with conductors 40 in contact with conductors 24, as shown in FIG. 1.

Another embodiment of a switch according to this invention is shown in FIG. 5. In this embodiment, direct action switch 120 comprises housing 122, actuator 130, movable blade 132, and fulcrum assembly 134. Housing 122 incorporates fixed conductors 24 and 26 while blade 132 incorporates upper conductors 40 and lower conductors 42 at its extremities. Connection leads 28 are mounted in housing 122 and connected to conductors 24 and 26.

Actuator 130, blade 132 and fulcrum assembly 134 are disposed within cavity 150 of housing 122. Cavity 150 comprises a base 148, and fulcrum assembly 134 comprises a leaf spring 151 and a helical coil spring 153. Fulcrum assembly 134 is arranged to bias movable blade 132 into engagement with actuator 130 in the unactuated mode, shown in FIG. 5. The V-shaped section 157 of blade 132 is in contact with V-shaped section 155 of actuator 130.

In operation, a force is applied to actuator 130 causing the actuator to move toward base 148 of cavity 150. This actuation force causes extremities 159 and 161 of leaf spring 151 to perform as fulcrum points for movable blade 132. As the portion of blade 132 between V-shaped section 157 and fulcrum points 159 and 161 is forced to pivot about the fulcrum points in a downward direction, the remaining sections of blade 132 attempt to counteract the downwardly pivoting movement by attempting to pivot upwardly about fulcrum points 159 and 161. This causes the contact force between conductors 24 and 40 to continually increase until ends 163 and 165 of actuator 130 come into contact with blade 132. At this point, actuator 130 prevents further pivoting of blade 132 and, instead, breaks the contact between conductors 24 and 40 by moving blade 132 and leaf spring 151 towards base 148 of cavity 150 while compressing spring 153. The actuation force is applied until movable blade 132 is in contact with leaf spring 151 while spring 151 is in contact with base 148 of cavity 150 and coil spring 153 is under greater compression. With this arrangement, as shown in FIG. 6, conductors 42 of blade 132 are in firm con- tact with conductors 26 of housing 122. When the actuation force is removed, coil spring 153 expands to its normal position, causing the entire switch assembly to move to its original position, as shown in FIG. 5.

The switch according to this invention possesses several advantages not found in prior art switches. Of primary importance is the biasing arrangement provided by the fulcrum assembly. This arrangement assures a clean break of the movable conductors from the fixed conductors while supplying the switch with a memory to assure the conductors' return to the non-actuated mode. The biasing fulcrum assembly allows the switch to be highly reliable under shock and vibration while providing a switch wherein the movable conductors move in the same direction as actuation. Furthermore, the construction of the switch when operated prevents cross switching by the movable contact blade slanting and thereby contacting unwanted diagonally opposite fixed contacts.

Another advantage of the switch of this invention is its self-cleaning capabilities. The preferably rounded conductors of the movable blade rock and thereby wipe the fixed conductors of the housing, causing any deposit to be broken. Furthermore, since the contact force between conductors is maximized before actual contact break occurs, a clean and precise contact break is assured. This substantially reduces deposit build-up and eliminates malfunctioning and switch breakdowns.

As would be obvious to one skilled in the art, many variations of the switch described in this disclosure could be employed without departing from the inventive step disclosed therein. These variations include substituting resilient rubber-like material for the coil springs in the fulcrum assembly and/or the actuator, or employing a torsion spring as the fulcrum assembly. Also, the switch of this invention can be arranged for sequential switching by mounting the fixed contacts 24 or 26 in varying horizontal planes, such as by non-symmetrically located blade and base fulcrum locations, and/or by unequal fulcrum biasing constructions. Furthermore, the movable blade could be constructed with conductors mounted at only one extremity while the other extremity is fixedly mounted to the switch hous-
ing. With this arrangement, only one resilient pivot point would be required. Also, the entire movable blade may comprise one or more conducting surfaces, and thereby complete an electrical circuit in both the actuated and unactuated mode.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above article without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A switch comprising:
   A. a support;
   B. at least one fixed electrical switch conductor mounted to said support;
   C. at least one electrical switch conductor movable into and out of engagement with said fixed electrical conductor;
   D. a linearly deformable blade to which said movable switch conductor is mounted for directly proportional bending in response to an actuation force;
   E. an actuator incorporating a first portion and a second portion movably mounted on said support engageable with said blade for applying a force thereto; and
   F. means forming a resilient fulcrum for engagement with said blade
      a. said fulcrum acting on the opposite side of said blade from said actuator, and
      b. incorporating at least one fulcrum point biased into contact with said blade at a point along the blade between the blade extremities and the blade center point, whereby the engagement of said first portion of said actuator causes portions of said blade to pivot about said fulcrum means, providing a wiping action between the movable conductor and the fixed conductor, until the second portion of the actuator engages the blade and overrides the pivoting motion, thereby separating the conductors driving said movable con-
   ductor in the same direction as the actuator.

2. A switch, as defined in claim 1, wherein said movable conductor is mounted at the extremity of said deformable blade.

3. A switch, as defined in claim 2, wherein a pair of switch conductors are mounted to said blade and a pair of switch conductors are mounted to said support.

4. A switch as defined in claim 1, wherein said deformable blade incorporates upper and lower conductors mounted at its extremity and said support comprises upper and lower conductors.

5. A switch as defined in claim 4, wherein said blade conductors and said support conductors are rounded.

6. A switch as defined in claim 4, wherein said fulcrum means comprise two helical coil springs, each having one end mounted in said support and the other end in biasing contact with said deformable blade, maintaining the upper blade conductor in firm contact with the upper support conductor prior to and following actuation.

7. A switch as defined in claim 4, wherein said fulcrum means comprise a helical coil spring having one end mounted in said support and the other end in biasing contact with a leaf spring, maintaining said leaf spring in contact with said deformable blade whereby the extremities of the leaf spring serve as fulcrum points for the deformable blade while normally biasing the upper blade conductor into contact with the upper support conductor.

8. A switch as defined in claim 1, wherein the surface of said actuator which comes into contact with said deformable blade is convex, providing a cam-like surface for controllably generating and terminating the pivoting motion of said blade.

9. A switch as defined in claim 1, wherein the surface of said actuator is flat and said deformable blade is biased into contact with said actuator, thereby allowing said actuator surface to controllably generate and terminate said pivoting motion of said blade.

10. A switch as defined in claim 1, wherein the surface of said actuator in contact with said deformable blade comprises an outwardly extending boss at the center of said actuator surface and at each end of this surface other outwardly extending bosses, whereby said center boss contacts said deformable blade causing the pivoting motion of said blade during actuation until the other bosses contact the blade surface terminating further pivoting motion.

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