Jan. 8, 1957 H. K. BURCH 2,777,032

SNAP SWITCH AND BLADE THEREFOR

Filed May 12, 1953 2 Sheets-Sheet 1

FIG. 1

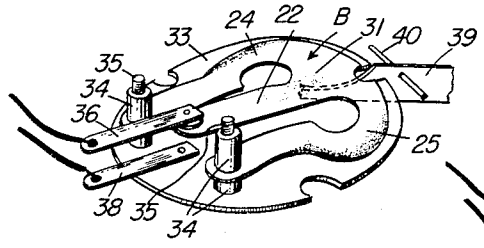
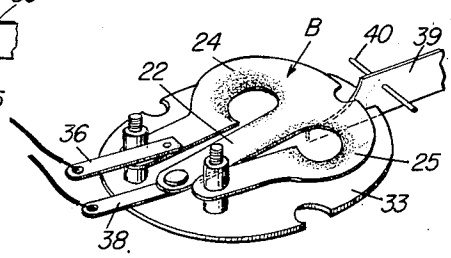


FIG. 2



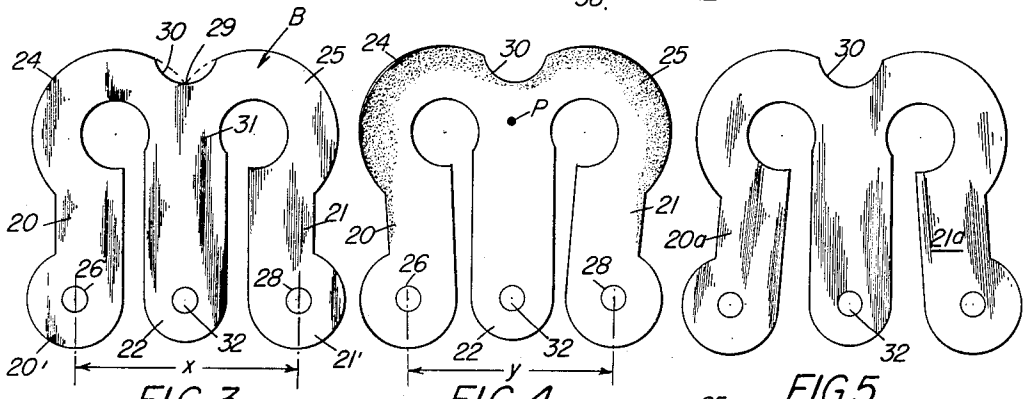
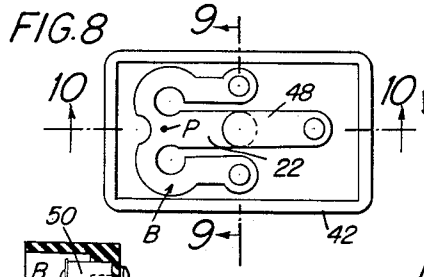


FIG. 3 FIG. 4 FIG. 5

FIG. 8



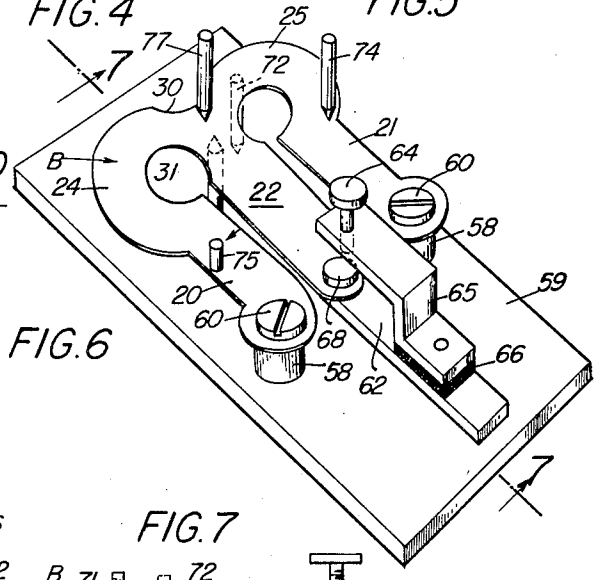


FIG. 6

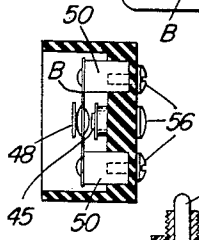


FIG. 9

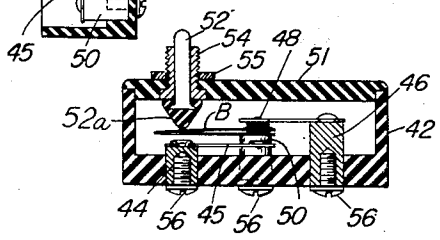
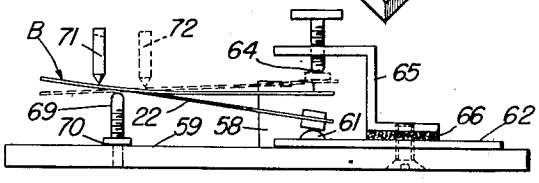


FIG. 10

FIG. 7



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SNAP SWITCH AND BLADE THEREFOR

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FIG. 11

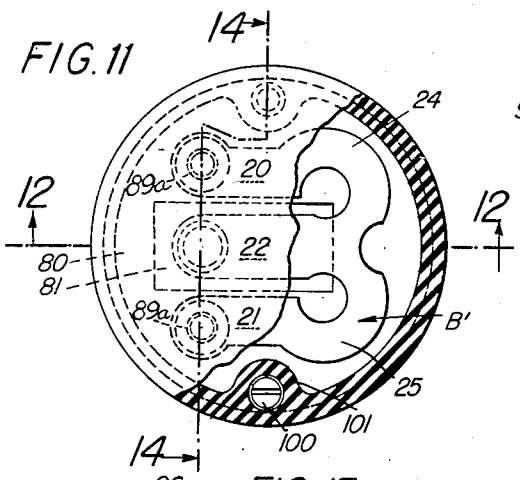


FIG. 12

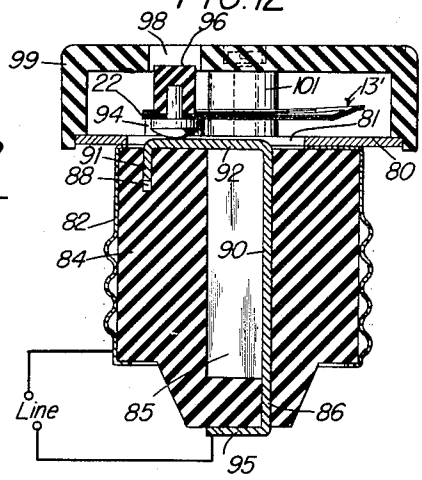


FIG. 13

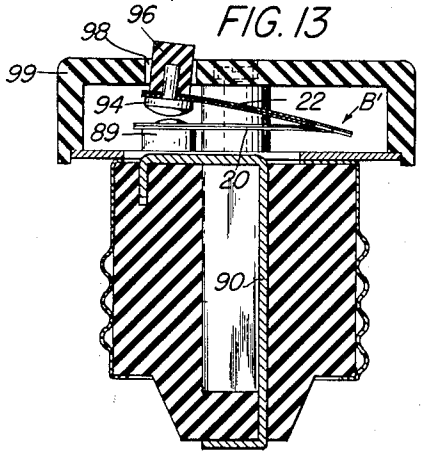


FIG. 14

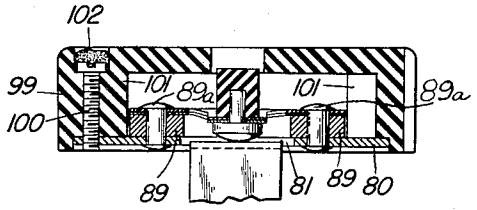


FIG. 15

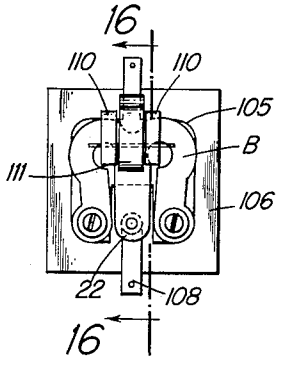


FIG. 16

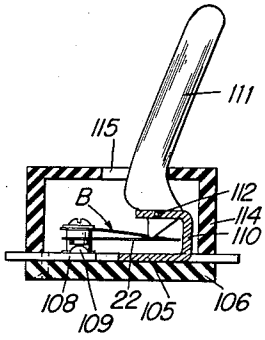
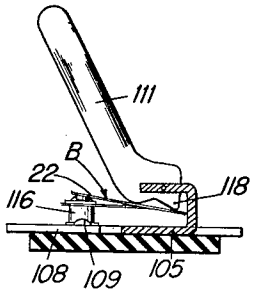


FIG. 17



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2,777,032

SNAP SWITCH AND BLADE THEREFOR

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Application May 12, 1953, Serial No. 354,573

7 Claims. (Cl. 200—113)

This invention relates to electrical switches, particularly snap-action switches, and to a novel resilient blade for use therein.

Among the objects of the invention are: To provide a snap-acting blade which may be either thermoresponsive or mechanically actuated and which occupies a minimum of space permitting compact construction; to provide a blade which can be actuated in a variety of ways, including actuation in opposite directions from one side only; to provide a switch having a high amplification of the actuating movement; to provide a snap switch which can be actuated by a very small movement; to provide a stressed snap-acting blade which is non-critical with respect to the amount of stress applied and is adapted to mass production techniques.

Other objects of the invention are to provide various improved switches embodying the novel blade of the invention and novel means for actuating the blade. Further objects and advantages will in part appear and in part will be obvious from the following detailed description of the illustrative embodiments of the invention hereinafter described, taken in conjunction with the drawings in which:

Fig. 1 is a perspective view of the essential elements of one form of switch showing the blade in actuated position;

Fig. 2 is a similar view of the same elements showing the blade in normal position;

Fig. 3 is a plan view of one form of blade in its normal or unstressed condition;

Fig. 4 is a similar view of the same blade under compression;

Fig. 5 is a plan of a modified form of blade in unstressed condition;

Fig. 6 is a perspective view of a mounted blade illustrating various methods of actuation;

Fig. 7 is an elevation taken on the line **7—7** of Fig. 6;

Fig. 8 is a plan of one form of snap-switch with the cover removed;

Fig. 9 is a section taken on the line **9—9** of Fig. 8;

Fig. 10 is a section on the line **10—10** of Fig. 8;

Fig. 11 is a plan of a plug-type thermoresponsive circuit breaker embodying the blade of the invention;

Fig. 12 is a vertical central section on the line **12—12** of Fig. 11, showing the switching elements in closed position;

Fig. 13 is a similar view showing the same circuit breaker in tripped position;

Fig. 14 is a sectional elevation of the head portion of the same switch taken on the line **14—14** of Fig. 11;

Fig. 15 is a plan of one form of toggle switch with the cover removed;

Fig. 16 is a sectional elevation of the same switch on the line **16—16** of Fig. 15 with the cover in place and the switch in closed position; and

Fig. 17 is a view of the same switch in open position without the cover.

Referring to Figs. 3 and 4, the novel blade of the invention is a unitary element stamped or otherwise formed in one piece from resilient thin sheet metal, such as beryllium copper, which comprises a pair of spaced apart supporting legs **20** and **21**, a center leg **22** extending therebetween, the supporting legs being connected to the center leg by a pair of substantially semicircular loops **24** and **25**.

The supporting legs **20** and **21** may be provided with enlarged ends **20'** and **21'** having openings **26** and **28** to receive mounting studs or screws and to provide adequate clamping surfaces. The spacing of these openings is designated *x* in Fig. 3. In use the blade is supported in such manner that the ends **20'** and **21'** are drawn together, reducing the spacing of the openings **26** and **28** to the distance designated *y* in Fig. 4, the amount by which *y* is less than *x* constituting what is herein referred to as the compression of the blade. The supports for the blade are such that the ends **20'** and **21'** of the supporting legs are maintained in a plane and rigidly held. This method of support has the effect of causing the loops **24** and **25** to become slightly dished so that they are concave on one side of the blade and convex on the other, as indicated by shading in Fig. 4. This distortion also extends part way down the legs **20** and **21** toward the ends by which they are supported, which of course remain stationary. The effect of this distortion is to throw the center leg **22**, which is integral with both loops, to one side or the other of the initial plane of the blade, the deflection of the center leg in all cases being toward that side of the blade on which the loops are convex. Thus the blade has two potentially stable positions in which the center leg **22** is deflected to one side or the other of the initial plane of the unstressed blade, and by exerting force on the stressed blade the blade can be snapped with an over-centering action from one position to the other.

Referring to Fig. 3, instead of carrying the outer margins of the loops **24** and **25** continuously around with a circular periphery to a sharp junction as indicated at **29** by dotted lines, it has been found preferable, in order to reduce fatigue at this point and also to provide greater flexibility at a better snap-action, to provide the blade with the reentrant arcuate portion **30** opposite the root or base porion **31** of center leg **22**.

Fig. 5 shows a modified form of blade which differs from that of Fig. 3 in that the supporting legs **20***a* and **21***a*, instead of being initially parallel, are slightly divergent so that when the ends of the legs are drawn together in mounting they may be approximately parallel. Otherwise the construction and functioning of this modified blade is the same as that of Fig. 3.

The forms of blade just described may be made either from a single piece of metal for mechanical actuation or from bimetal for thermal actuation, depending upon the use to which the blade is to be put. Several uses illustrating both embodiments will now be described, in all of which the blade is used as the movabe portion of an electric switch in which the center leg is the movable contact carrying member. For this reason it is provided with a hole **32** into which a suitable electrical contact can be riveted.

Referring to Figs. 1 and 2, which illustrate the essential elements of a simple snap switch, a blade of the type described, generally designated B, is supported on a base **33** of dielectric material between collars **34** on a pair of fixed threaded posts **35**, the ends of the blade being drawn together slightly as shown in Fig. 4. Carried by the base and by another part of the switch housing (not shown), respectively, are an upper contact **36** and a lower contact **38**, between which the center leg **22** moves and which it is adapted to engage. The normal position of the switch elements is shown in Fig. 2 wherein leg **22** rests against contact **38**. An actuator **39** pivoted on a pin **40** sup-

ported in any suitable manner in the switch housing has its end underlying the base portion 31 of leg 22. When it is moved from the position shown in Fig. 2 to the position shown in Fig. 1, blade B is caused to reverse itself, the upper sides of loops 24 and 25 changing suddenly from the concave shape shown in Fig. 2 to the convex shape shown in Fig. 1, which it does with a snap action. In order to make the center leg 22 return to the position shown in Fig. 2 when actuator 39 is released, the contact 36 is so positioned as to act as a stop so that the blade, when leg 22 is in engagement with contact 36, is in an unstable condition when the pressure of the actuator is removed.

The switch of Figs. 1 and 2 illustrates one mode of actuating the blade which is the same mode employed in the switch shown in Figs. 8, 9 and 10, but with somewhat different structure. This switch has a box-shaped housing 42 into the base of which are set a post 44 carrying a lower contact 45 and a post 46 carrying an upper contact 48. The blade B is mounted on posts 50 which are seated in recesses in the bottom of the housing. The cover 51 carries an actuator 52 sliding in a bushing 54 secured by a nut 55. The insulating point 52*a* of the actuator rests on blade B at a point P (Fig. 8) at the root of the center leg 22, the blade B being so mounted that this leg is normally urged upwardly against contact 48. Depression of the blade causes the center leg to snap downwardly into engagement with contact 45, in which position the blade is unstable, returning automatically when released. Electrical connections may be made to the posts 44, 46 and 50 by screws 56 entering these posts through the bottom of the housing.

Referring to Figs. 6 and 7, other methods of actuating the blade will now be described. Blade B is mounted under compression on posts 58 attached to an insulating base 59 by screws 60 with its supporting legs drawn slightly together. Also supported on the base is a lower contact 61 attached to a conductor 62 and upper adjustable contact 64 in the form of a screw threaded through an angle bracket 65 supported on conductor 62 but insulated therefrom by dielectric material 66. Thus contacts 61 and 64 provide an adjustable gap between which the contact 68 on leg 22 may move. Beneath blade B at approximately the point P shown in Fig. 4 is a stationary support or fulcrum 69 which may be in the form of a screw passing through nut 70 and base 59, so as to be adjustable as to height. Actuation of the blade may be by means of a pressure member 71 which engages the base portion of center leg 22 at a point slightly removed from the point P in a direction away from contact 68. This method of actuation has the advantage of requiring an extremely small movement by member 71 to cause the blade to snap. After it has snapped and the pressure of member 71 has been removed, leg 22 will either remain in position or will return to its original position in engagement with contact 61, depending upon the position of contact 64. As this contact is moved downwardly, a point will be reached where the blade will automatically return to engagement with contact 61. If it is desired, however, to have a switch which must be manually reset, then contact 64 is raised so that leg 22 does not return automatically and a second actuator 72, shown in dotted lines, is employed, positioned on the opposite side of support 69 from actuator 71.

Assuming contact 64 to be so set as to act as a stop which causes automatic return of the blade to its position in engagement with contact 61, it may also be caused to reverse its distortion by pressure applied at any other point which will cause the concavity of the loops 24 and 25 to reverse. For example, the blade may be engaged at a point near the junction of one of the loops with a supporting leg, for example the junction of loop 25 with leg 21, by an actuator 74. This point of pressure may also be moved closer to the supporting post 58, and the further it is moved in this direction the less will be the movement required to actuate the blade. The point of pressure may also be moved out around the periphery of loop 25, but as it is moved in this direction greater movement will be required and a less positive snap will be obtained. An actuator positioned as just described may also be used to snap the blade without using the fixed support 69. Another manner of actuating the blade is by a force applied substantially parallel to the plane of the blade. This may be done by attaching a post 75, as shown, on the supporting leg 20, to which pressure may be applied in the direction indicated by the arrow. Such an actuator may be used with or without the fixed support 69.

It will thus be seen that the invention provides a snap action blade capable of a number of different modes of actuation suitable for numerous uses. The blade may be made in a wide range of sizes suitable for different kinds of service ranging from sub-miniature switches to switches adapted to carry heavy currents.

Referring to Figs. 11–14, the blade of the invention is shown as made of bimetal and incorporated in a thermoresponsive circuit breaker. A circular metal plate 80 having an aperture 81 is attached to the top of a threaded metal shell 82 which surrounds an insulating plug 84 having a central aperture 85 connected with a slot 86 opening through the bottom, and also having a slot 88 in its upper surface. The bimetal blade B′ is mounted under compression on posts 89 by rivets 89*a* which secure it to plate 80. Thus legs 20 and 21 of the blade are electrically connected to plate 80 and to shell 82. Inserted in plug 84 is a metal bar 90 having a bent end 91 which fits in slot 88 and an adjacent flat top section 92 which is engaged by contact 94 attached to the center leg 22 of the blade. After bar 90 has been inserted through opening 86 in plug 84 its lower end is bent to form the external contact 95. If the plug is screwed into the conventional socket of an electrical circuit, current will thus flow, as indicated in Fig. 12, through bar 90, contact 94, center leg 22 of the blade and in two paths through supporting legs 20 and 21 to plate 80 and shell 82, thus completing the circuit. Center leg 22 is normally depressed so as to maintain contact 94 in engagement with section 92 of bar 90, maintaining the circuit closed. The upper sides of loops 24 and 25 of blade B′, as seen in the drawings, under these conditions are concave. The high expanding side of the bimetal is uppermost and current flowing through the blade in excess of a predetermined amount will cause it to reverse itself into a position wherein the upper surfaces of the loops are convex and center leg 22 snaps into the position shown in Fig. 13, opening the circuit. When this occurs, a button 96 of dielectric material attached to leg 22 in line with contact 94 pops through the hole 98 in the cover 99 which is attached to plate 80 by screws 100. These screws pass through and have their heads sunk in cavities in the bosses 101 which are filled with insulating cement 102. When the circuit is broken, the blade of course begins to cool, and when it has cooled sufficiently it can be reset by pressing inwardly on button 96, which is in the position shown in Fig. 13. The parts are so dimensioned that if the button is brought flush with cover 99, a cold blade will snap back into the position shown in Fig. 12 and again close the circuit, pulling the head of button 96 below the surface of the cover.

In the circuit breaker just described the bimetal blade is heated by current passing through it, the blade serving as the sole conductor for the current. Obviously a shunt may be employed and incorporated in the unit so that only a portion of the current passes through the blade. Other types of units may employ separate heating elements to actuate the blade in a manner well known in the art. If the blade is mounted so that its open circuit position is unstable, the blade automatically returning to circuit closing position when it cools, it can serve as the switching element of a flasher. Thermoresponsive

switches and flashers of very high sensitivity may be made using very small blades not over half an inch in length.

If a bimetal blade is mounted in a manner similar to that shown in Fig. 6 and with the omission of the fixed support **69**, the temperature at which it will snap can be controlled by providing an adjustable support under one edge positioned as is the actuator **74**. Such support may be in the form of a screw, which may be calibrated in terms of temperature, and would engage the blade on the low expansion side.

Figs. 15–17 show one type of toggle switch which may be made employing the blade of the invention. A U-shaped metal plate **105** is attached to an insulating base **106** which also carries a fixed contact strip **108** having a contact **109**. A pair of bent legs **110**, integral with the base, pivotally support a toggle lever **111** which rotates on a pin **112**. The switch may be enclosed in a cover **114** having a slot **115** which serves to limit the throw of the lever. Blade B is mounted on posts **116** which attach it to plate **105** under compression. As seen in Figs. 16 and 17, lever **111** has a point **118** which engages the root of center leg **22** of the blade and has a sliding movement thereon as the lever is rotated. In the position shown in Fig. 16, the point of the lever has moved forwardly on the center leg and has caused the blade to snap into a position where the contact carried by center leg **22** engages contact **109**. When the lever is moved to the position shown in Fig. 17, point **118** has moved rearwardly and the blade has reversed with a snap and the contacts are separated. This embodiment is one illustration of how the blade above described may be actuated from one side only to cause its center leg to snap up or down by shifting the point of pressure longitudinally of the center leg near its root or base portion.

A number of applications of the novel switch blade have been described to illustrate some of the ways in which it can be used but it is capable of use in many other ways. The invention, therefore, is not to be limited to the specific illustrative embodiments but is to be construed in accordance with the appended claims. As above indicated, the switch blade, whether of a single layer of material, such as sheet metal, or of bimetal, is flat before being mounted under compressive stress and therefore may be accurately described as "normally flat." This expression as used in some of the appended claims is not to be taken, however, as precluding the possibility that the free end portion of the center leg **22**, which performs no function in producing the snap action, other than that of engaging a stop or contact, may be formed in some suitable fashion so as not to be flat.

What is claimed is:

1. A snap switch comprising, a support, a resilient normally flat conductive blade having spaced apart supporting legs and a center leg joined thereto and extending therebetween, means attaching said supporting legs to said support with their ends in a plane and drawn toward one another to distort the blade, a fixed contact adapted for engagement by said center leg to make and break a circuit, a fulcrum engaging one side of the center leg in the vicinity of its base portion, and an actuator adapted to engage the other side of the center leg at a point further from the free end of the center leg than said fulcrum.

2. The switch of claim 1 wherein there is a second actuator adapted to engage the center leg at a point closer to the free end of the center leg than said fulcrum.

3. A snap switch comprising, a support, a normally flat conductive resilient blade having spaced apart supporting legs and a center leg joined thereto by looped portions, means securing said blade to the support with the ends of said supporting legs in a plane and drawn toward one another to distort the blade, contact means adapted to be engaged by said center leg, and means for reversing the distortion of the blade to move the center leg comprising a member extending substantially normal to one of said supporting legs, and means for applying pressure to said member in a direction substantially parallel to the plane of the blade.

4. A snap switch comprising, a support, a resilient normally flat conductive blade having spaced apart supporting legs and a center leg joined thereto by looped portions, means for mounting said blade on said support with the ends of the supporting legs in a plane and drawn together, whereby said blade is distorted to dish said looped portions and raise adjacent portions of the outer edges of said supporting legs from and move the center leg out of the initial plane of the blade; and means for reversing the direction of distortion of said blade comprising a fulcrum adapted to engage said blade at the base of said center leg on the side toward which the center leg has initially moved, and an actuator adapted to engage a raised marginal portion of the blade on the opposite side from said fulcrum.

5. A switch according to claim 4 wherein said actuator engages the outer marginal portion of one of said supporting legs.

6. A thermoresponsive snap switch comprising a conductive support, a bimetallic blade having a pair of spaced apart supporting legs and a center leg connected thereto through looped portions, conductive means attaching said blade to said support at the ends of said supporting legs and drawing them together to distort said blade, a fixed contact normally in engagement with said center leg, means for connecting said contact and said support in an electrical circuit whereby current passes through said blade, the high expansion side of said blade being on the side away from said contact whereby heating of the blade by resistance to the passage of current in excess of a predetermined amount will reverse the distortion of the blade and cause said center leg to snap away from said contact, an insulating apertured cover mounted over said blade, and a non-conductive member adapted to extend through the aperture in said cover for resetting said blade after said blade has moved into circuit-opening position, whereby said blade can be manually returned to circuit-closing position after cooling by pushing on said member.

7. A blade for a snap action switch or the like comprising a normally flat body of thin resilient conductive material formed to have a pair of substantially parallel spaced apart supporting legs having a high width to thickness ratio, a center leg extending therebetween, said center leg being joined to each of said supporting legs by semicircular loops internally and externally bounded by concentric substantially circular edges, the internal edges of said loops being nearly complete circles broken only by the gaps between the center leg and the supporting legs, said gaps being adjacent the root of said center leg, the external edges of said loops extending from the outer margins of the supporting legs to points opposite the root of said center leg and there being joined by a reentrant arcuate edge disposed axially of said center leg, said loops being of less width throughout than said supporting legs and having their narrowest portions adjacent said reentrant arcuate edge, and said loops extending outwardly of the extended outer edges of the supporting legs, said loops forming dished surfaces under stress applied to the blade by drawing the supporting legs together at their ends while maintaining said ends in a plane whereby said center leg under such stress is thrown out of plane toward the convex sides of the loops.

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