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BIMETAL WITH HEATER MOUNTED THROUGH A CHANNEL FORMED BY ALTERNATELY SPACED PORTIONS SEPARATED BY SLITS

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Fig. 1.

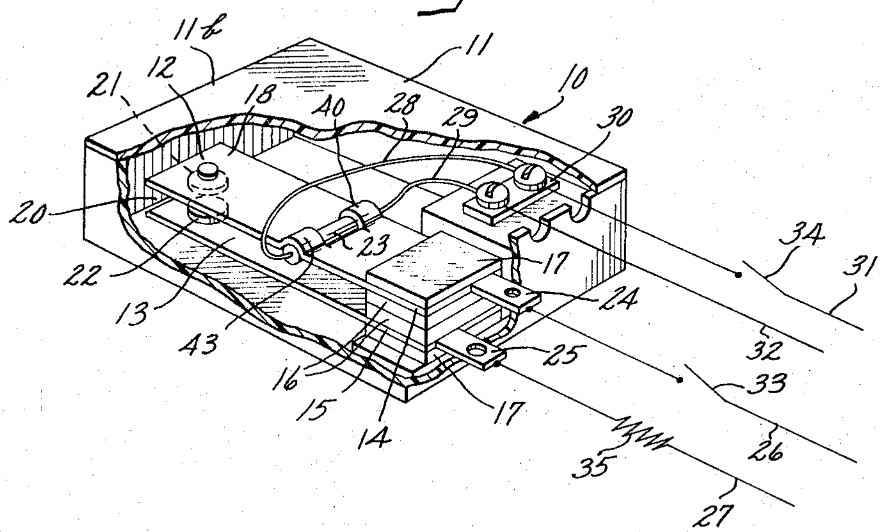


Fig. 2.

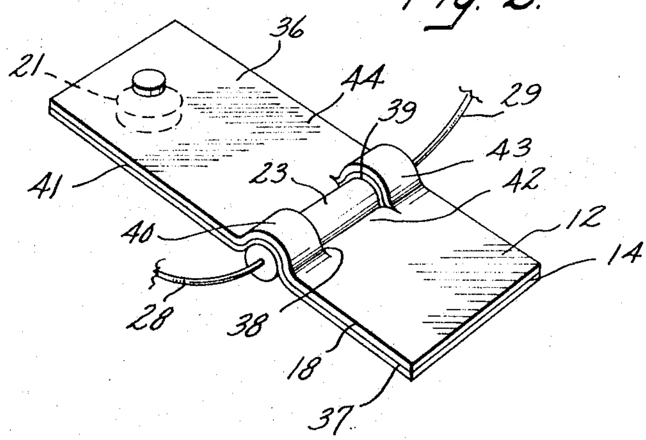
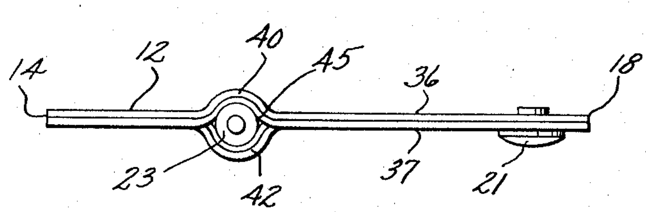


Fig. 3.



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3,312,802
BIMETAL WITH HEATER MOUNTED THROUGH A CHANNEL FORMED BY ALTERNATELY SPACED PORTIONS SEPARATED BY SLITS

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The present invention relates to electrically heated bimetallic strips and to electrical switches using these strips.

In the manufacture of electrical switches it has long been known to take advantage of the fact that different metals have different coefficients of thermal expansion. To this end, switches have been constructed wherein a bimetallic strip is influenced by changes in the room ambient temperature to cause deflection of the strip, and a contact carried by the strip is moved into or out of engagement with another contact in the switch depending on the ambient temperature surrounding the strip. It has also been known to provide auxiliary heating means to influence the temperature surrounding the bimetallic strip so that deflection of the strip can be controlled independently of room temperature. Many of the prior devices have utilized a heater comprising a resistance wire coiled in helical fashion around the bimetallic strip. The devices just mentioned are relatively costly to manufacture in that a helical winding operation is necessary, and further manufacturing problems may be encountered in satisfactorily anchoring the helically wound wire to the strip in effective heat transfer relation to the strip. Other prior devices have a resistance element mounted in the switch in a location adjacent the bimetallic strip. Problems which may be encountered in the latter devices reside in obtaining sufficient and uniform heat transfer to the bimetallic strip with attendant problems of switch response time to heat from the heating element. Furthermore, in certain switch constructions it is desirable to localize the heat in the sense that while the bimetallic strip to be influenced must receive sufficient heat to be deflected, the heat transmitted to other components in the switch from the heater associated with this strip must be kept at a minimum. Thus, while it is desirable to mount a heater directly onto a bimetallic strip so that the heat may be localized, problems are encountered in that the mounting must be able to tolerate flexure of the strip in the region of the mounting while still retaining the heater securely in place on the strip.

An object of the present invention is to provide a bimetallic strip with improved means to facilitate secure mounting of an electrical heater thereon in effective heat transfer relationship between the heater and each of the different metals forming the strip.

A further object is the provision of a bimetallic strip with improved means to mount a heater thereon in such a manner that the mounting is not substantially affected by flexure of the strip in the region of the mounting so that the heater will remain securely attached to the strip both before and during the time when heat is supplied from the heater.

Another object is to provide a thermally responsive switch using an electrically heated bimetallic strip of the character described which is fast-acting in response to current flow in the heater, and wherein heat transmitted from the heater to components in the switch other than the strip with which it is associated is minimized.

Briefly stated, in accordance with one aspect of my invention, I provide an improved construction for securely mounting an electrical heater directly on a bimetallic strip for use in a thermally responsive switch. The mounting arrangement comprises a channel which is defined by a plurality of aligned arcuate portions spaced alternately

in opposite directions from the plane of the strip. Adjacent arcuate portions are separated from each other by a slit through the strip so that an electrical heater may be inserted through the slit and confront each of the metals forming opposite surfaces of the strip. Thus, any tendency of one portion to move away from the heater under influence of heat is counteracted by the tendency of an adjacent portion to move toward the heater.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which I regard as my invention, it is believed the invention will be better understood from the following description taken in connection with the accompanying drawing in which:

FIGURE 1 is a partial perspective view of a switch in accordance with the present invention;

FIGURE 2 is a perspective view of a preferred embodiment of a bimetallic strip and electrical heater; and

FIGURE 3 is a side view of the strip of FIGURE 2.

With reference to FIGURE 1 there is illustrated a thermally responsive switch **10** comprising a housing **11** which is preferably formed of moldable plastic and includes a base **11***a* and a cover **11***b*. Bimetallic strips **12** and **13**, which deflect under the influence of heat, are spaced from each other at one end, **14** and **15** respectively, through the medium of electrically insulating blocks **16**. The assembly, including the blocks **16** and the strips **12** and **13**, is attached to the base, and other blocks **17** may be used if it is necessary to insulate the other surfaces of the end of the strips from the base. So that the strips may have freedom of movement either in unison or one with respect to the other under the influence of heat, the interior of the housing is hollow. The strips carry electrical contacts **21** and **22** respectively, and these contacts are adapted to be engaged with each other to permit electrical current to flow through the strips when the switch is "on." The contacts may be connected to the strips such as by riveting, welding or the like. An electrical heater **23** is intimately associated with the bimetallic strip **12** in a manner to be described later in more detail. This electrical heater is for supplying auxiliary heat to the strip **12** when it is desired to deflect the strip **12** with respect to the strip **13**.

It is desirable that the bimetallic strips do not deflect relative to each other unless auxiliary heat is being supplied by the electrical heater. To this end, I prefer to make the strips out of materials having similar deflection properties, and I arrange the strips in the base so that under normal changes in ambient temperature they deflect substantially equal distances in the same direction. Thus, the contact **22** on the strip **13** is on the surface of the metal having a low coefficient of thermal expansion; while the contact **21** on the strip **12** is on the surface of the metal having a high coefficient of thermal expansion.

The switch further includes electrical conductors for supplying electrical current through the strips to the contacts **21** and **22**, and for supplying current to the electrical heater **23**. For this, I have provided conducting lugs **24** and **25** on the ends of the bimetallic strips for connection across electrical power lines **26** and **27**; and I have provided conductors **28** and **29** which lead from opposite ends of the heater to a terminal board **30** on the switch, thence across power lines **31** and **32**.

The thermostatic switch of FIGURE 1 operates in the following manner: Line switches **33** and **34** are open and there is no current flowing through either the heater **23** or a load device **35**, and the thermostatic switch contacts **21** and **22** are engaged. When the line switch **33** is closed, current flows through the contacts **21** and **22** and through the load. Now, if it is desired to interrupt power to the load with the line switch **33** closed, the line switch **34** is closed, and current flows through the electric heater **23**.

The heater supplies heat primarily only to the bimetallic strip **12**. Under the influence of the heater, the strip **12** is rapidly heated to a greater extent than strip **13** thereby causing the contact **21** to move out of engagement with the contact **22** as a result of deflection of the strip **12** relative to the strip **13**. It is to be understood that any suitable means, manual or automatic, may be used to open and close the line switches **33** and **34**. It is to be further understood that the electrical circuit illustrated at FIGURE 1 is by way of illustration only. In certain instances, such as when cyclical operation is desired, the electrical heater may be connected in series connection with the load and supplied with power from the same power source as is connected across the switch.

At this point, as an aid to understanding one of the primary features of the present invention, a brief general description of the manner in which a curved portion of bimetal responds to heat may be helpful. If the metal having a relatively high coefficient of thermal expansion is along the inner radius of the curved portion, and the metal having a relatively low coefficient of thermal expansion is along the outer radius; then, upon application of heat to the curved portion, the ends of the curved portion tend to separate from each other and the curve tends to become more planar. On the other hand, if the metals are reversed so that the metal having a relatively low coefficient of thermal expansion is along the inner radius of the curved portion; then the ends of the curved portion tend to approach each other or, in other words, the curvature becomes more pronounced under the influence of heat to the curved portion.

My preferred embodiment of a bimetallic strip **12** as illustrated in detail at FIGURES 2 and 3, presents a top surface **36** of a metal having a different coefficient of thermal expansion than the coefficient of thermal expansion of the metal forming the bottom surface **37**. The strip has a pair of parallel slits **38** and **39** extending therethrough. A first integrally formed portion **40** is curved upwardly in an arcuate pattern spaced above the top surface **36** and extends from the slit **38** to one side edge **41** of the strip. A second integrally formed portion **42** with a facial contour similar to the first is formed by curving the material of the strip between the slits downwardly below the bottom surface **37**. A third integrally formed portion **43** similar to the first extends between the slit **39** and the opposite side edge **44** of the bimetallic strip. These integrally formed portions thereby define a channel **45** extending transversely across the strip and having an axis through the slits. The cross sectional configuration of the channel taken as a whole may be said to be generally circular. The distance between the two slits **38** and **39** is approximately equal to the distance between the slit **38** and side edge **44** plus the distance between the slit **39** and side edge **44** for a reason which will hereinafter be pointed out.

The electrical heater **23**, in the form of a molded composition resistor of general cylindrical configuration, is snugly positioned in the channel **45** and preferably extends across the entire width of the bimetallic strip **12**. The heater should be located at an optimum point along the length of the bimetal to obtain maximum deflection for a given amount of heat supplied. This optimum point is a function of such characteristics as heat loss at the ends of the bimetal, heat losses from the surfaces, and the shape of the bimetal. I have found that for the bimetal strip illustrated, this optimum point is from one-fourth to one-third of the distance from the fixed end **14** to the free end **18**. The heater is in surface contact with the top surface of the bimetallic strip **12** in the area of the second integrally formed portion **42**, and is in surface contact with the bottom surface of the bimetallic strip in the area of the first and third integrally formed portions **40** and **43** respectively.

It will be appreciated that with the above construction the channel will essentially retain the same cross sectional

shape both when the heater is supplying heat and when the heater is inactive. The reason for this is that any tendency of the portions **40** and **43** to open or pull away from the heater (assuming the surface **37** to have a relatively high coefficient of thermal expansion) is counterbalanced by the tendency of the portion **42** to close or tighten about the heater. The effect of this counterbalancing of forces principle may be increased by increasing the number of arcuate portions, keeping in mind the fact that the portions should not be made so narrow as would cause rupturing thereof.

The electric heater is coated with a material which is electrically insulating and thermally conducting. The heater may be held in position by frictional contact engagement with the surfaces forming the channel; however, in certain instances, it may be desirable to use a thermally conducting adhesive material to aid in holding the resistor in place and further aid in transmitting heat between the contacting surfaces. In case the heater does not occupy the entire volume of the channel it may be desirable to fill the unoccupied portions with a thermally conducting material such as silicone grease to enhance thermal transfer to the surfaces confronting the channel.

While preferred embodiments of the invention have been shown and described, various other embodiments and modifications thereof will be apparent to those skilled in the art, but will fall within the spirit and scope of invention as defined in the following claims.

What I claim is:

1. A thermally responsive switch element comprising:

(a) a bimetallic strip carrying a first contact adapted to be engaged with a second contact in the switch, said strip including a plurality of integrally formed channel-defining portions separated from each other by slits and spaced alternately in opposite directions from the top and bottom surfaces of the strip; and

(b) an electrical heater securely mounted on said strip in said channel, a first surface portion of said heater confronting the top surface of said bimetallic strip in one of said channel-defining portions, and a second surface portion of said heater confronting the bottom surface of said bimetallic strip in an adjacent one of said channel-defining portions.

2. The element as set forth in claim **1** wherein the area of said first surface portion of the electrical heater is approximately equal to the area of said second surface portion of the electrical heater.

3. A thermally responsive switch element comprising:

(a) a bimetallic strip carrying a first contact adapted to be engaged with a second contact in the switch and having a pair of spaced parallel slits extending through top and bottom surfaces thereof, said strip including first, second and third integrally formed portions spaced alternately in opposite directions from the surfaces of the strip and defining a channel having an axis through said slits; and

(b) an electrical heater snugly positioned in said channel whereby respective surface portions of said heater along the length thereof are alternately in surface to surface contact with the top and bottom surfaces of the bimetallic strip.

4. The structure as set forth in claim **3** wherein the total area of surface contact of the heater with the top surface of the blade is approximately equal to the total area of surface contact of the heater with the bottom surface of the blade.

5. A thermally responsive switch comprising:

(a) a housing having a first contact member secured thereto;

(b) a bimetallic strip secured at one end to said housing and being free to deflect at the other end, and including a plurality of aligned arcuate integral portions separated from each other by slits through the strip and spaced alternately in opposite directions from the surfaces of said strip, said arcuate portions thereby defining a channel;

(c) an electrical heater snugly received in said channel;

(d) a second contact member carried by said strip and adapted to be engaged with said first contact member; and

(e) electrical conductors for supplying electrical current through said contacts when said contacts are engaged and for supplying electrical current through said electrical heater to cause deflection of said bimetallic strip.

6. The structure as set forth in claim **5** wherein said heating resistor is positioned from the secured end transversely across the blade one-fourth to one-third the distance between the secured end and the free end.

7. A thermally responsive switch comprising:

(a) a housing;

(b) a switch assembly including first and second deflectable bimetallic strips spaced from each other in said housing and connected thereto at one end of the strips, the opposite end of the strips being free to move within the housing, said first and second strips having similar deflection properties and positioned to deflect in the same direction under the influence of heat, and said first strip including three aligned arcuate integral portions separated from each other by slits through the strip and spaced alternately in opposite directions from the surfaces of said strip and thereby defining a channel through said strip;

(c) an electrical heater snugly received in said channel to supply auxiliary heat primarily only to said first strip;

(d) relatively movable and engageable contact members carried respectively by said first and second strips; and

(e) electrical conductors for supplying electrical current through said strips when said contacts are engaged and for supplying electrical current through said electrical heater to cause deflection of said first strip relative to said second strip.

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