United States Patent

Wells

[15] **3,656,080**

[45] **Apr. 11, 1972**

[54] THERMOSTAT OR THE LIKE HAVING TWISTED BIMETAL STRIP THEREIN

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[52] **U.S. Cl.**.....**337/111,** 73/363.5, 337/107

[51] **Int. Cl.**.....**H01h 37/52,** H01h 61/01

[58] **Field of Search**.....337/38, 39, 40, 89, 92, 95, 337/96, 99, 100, 101, 102, 103, 107, 111, 112, 336, 337, 370, 371, 378, 379, 380; 73/363.5

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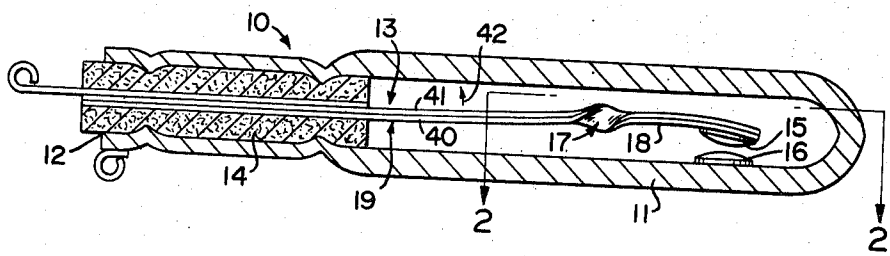
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[57] **ABSTRACT**

In this thermostat, thermal protector, or the like, a casing has at least one initially open end and a bimetal strip extends into the casing as a cantilever, being positioned thereby by insulation means securing the strip in position and sealing the initially open end of the casing. The strip has layers of different metals on the top and bottom surfaces thereof, and the strip has about a 180° twist therein intermediate the secured portion and the free end portion thereof whereby improved cycling in the thermostat is obtained.

9 Claims, 8 Drawing Figures



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SHEET 1 OF 2

FIG. 1

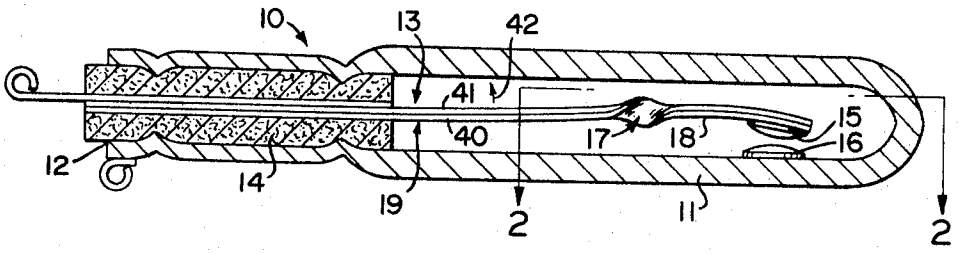


FIG. 2

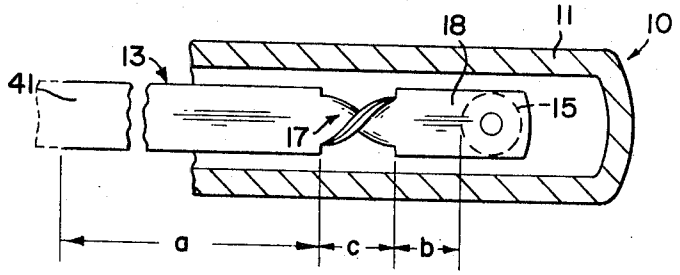
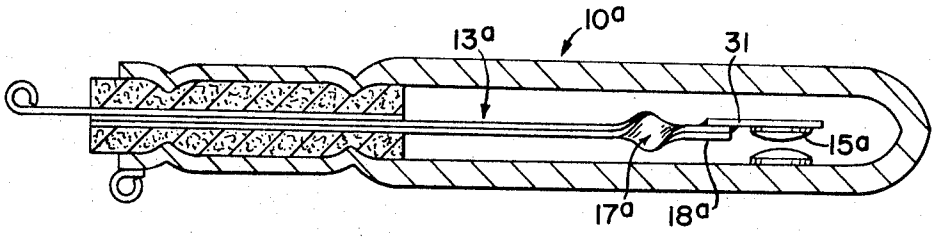


FIG. 3



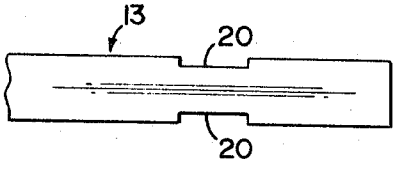


FIG. 4

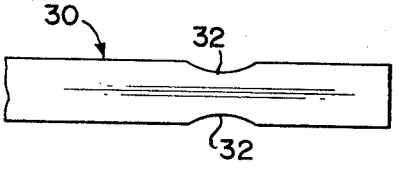


FIG. 5

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FIG. 6

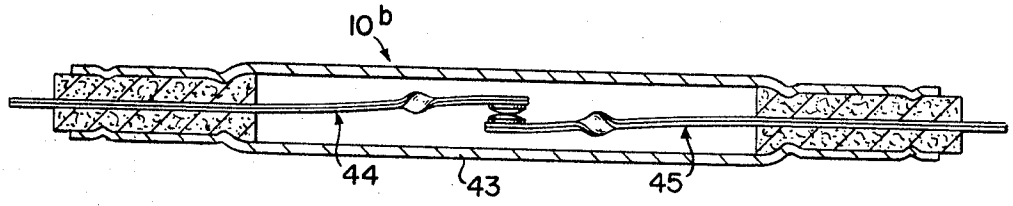
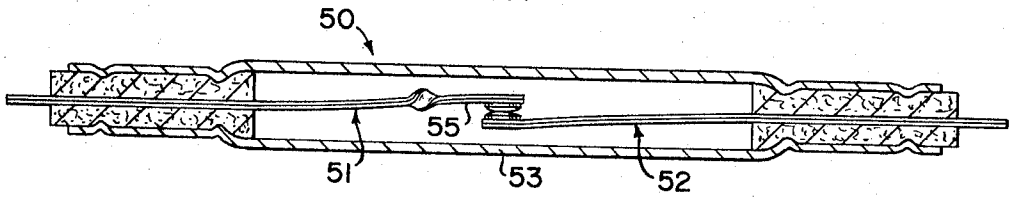


FIG. 7



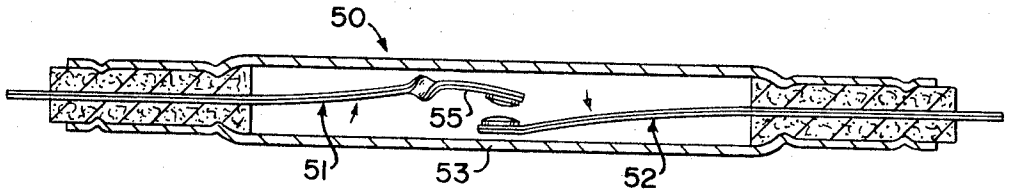


FIG. 8

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THERMOSTAT OR THE LIKE HAVING TWISTED BIMETAL STRIP THEREIN

The novel thermal protector, thermostat or equivalent article of the invention is particularly designed to have a controllable, and slower cycle rate than that of similar cantilever type bimetal thermostats.

In the various control functions obtained by previous types of thermostats or other thermal protectors in industry, in some instances it is very desirable to have a relatively rapid on-off cycle for the thermostat and the "on" and "off" times in such cycles can be varied in some control articles as heretofore made. However, most of these cantilever types of thermal controls as made heretofore have not been able to provide slow operating cycles with temperature differentials in the thermostat between the "open" and the "closed" conditions for the thermostat or other article and the circuit controlled thereby.

The general object of the present invention is to provide a novel and improved thermal protector including a bimetal cantilever strip positioned in a thermostat casing and wherein the bimetal strip has a substantially 180° twist therein intermediate the secured portion thereof and the free end of the cantilevered section of the strip whereby reverse bending action occurs in the two portions of the cantilever section of the strip and improved control actions can be obtained therein.

Another object of the invention is to provide a thermal protector wherein reverse bending conditions are provided in a cantilevered bimetal strip in different portions or sections of the cantilevered length of the strip and wherein the free end portion of the strip is curved by heat to move towards a contact on the thermostat casing whereby no contact opening action will occur until after such bimetal end portion is appreciably curved towards an associated contact.

A further object of the invention is to obtain a relatively slow cycle thermostat wherein the cycle rate and the temperature variation between open and closed conditions can be controlled by the location of substantially a 180° twist in the cantilevered portion of the bimetal strip.

The foregoing and other objects and advantages of the invention will be made more apparent as the specification proceeds.

Reference now is made to the accompanying drawings, wherein: thermostat cantilevered bimetal

FIG. 1 is a vertical section through a thermostat embodying the principles of the invention indicating a cantilevered bimental arm as the contacts are opening;

FIG. 2 is a fragmentary horizontal section taken on line 2—2 of FIG. 1;

FIG. 3 is a vertical section through a modified embodiment of the invention;

FIG. 4 is a plan view of the bimetal strip of the thermostat of FIG. 1 prior to providing the twist in such strip;

FIG. 5 is a plan of a modification of the strip of FIG. 4;

FIG. 6 is a longitudinal section of a modification of the invention, the contacts being closed;

FIG. 7 is a section of a further modification of the invention; and

FIG. 8 shows the thermostat of FIG. 7 with its contacts open.

When referring to corresponding members shown in the drawings and referred to in the specification, corresponding numerals are used to facilitate comparison therebetween.

Attention now is particularly directed to the details of the structure shown in the drawings and a novel and improved thermostat or thermal protector of the invention is indicated as a whole by the numeral **10**. This thermostat **10** includes a conductive case **11** which initially normally has one open end **12** provided therein. A bimetal strip **13** is secured in the initially open end **12** of the casing **11** by conventional means such as a fiberglass-resin impregnated sleeve **14** or equivalent means positioned around the bimetal strip **13** and suitably sealed in relation to the strip **13** and the initially open end of the casing **11**, all in a conventional manner whereby the major portion of the bimetal strip **13** extends into the casing **11** normally towards the closed end thereof and is positioned as a

cantilever within the casing **11**. Any suitable terminal means and/or leads can connect to the casing **11** and the bimetal strip **13** in a conventional manner for connecting a circuit to the thermostat **10** to be controlled thereby.

Usually a contact **15** is carried by the free end of the strip **13** and a contact **16** is secured to the inner wall of the casing to be positioned in opposed relation to the contact **15** for opening and closing the circuit to be controlled by the thermostat.

As a feature of the invention, the bimetal strip **13** is twisted through a substantially 180° arc at a twist area **17** formed therein. This twist, or twist area **17** thus positions the bimetal forming the free end of the strip **13** in a different manner from the bimetal in the portion of the strip **13** adjacent the sealed or positioned end thereof. Hence, a free end reverse acting section **18** is provided in the bimetal strip **13** and a secured normal action base section **19** is formed in such bimetal strip **13**. Normally the strip **13** is formed from top and bottom layers of metal whereby the vertically upper metal in the base section **19** of the strip **13** is different from the bimetal material which is on the upper portion of the end section **18** of the strip **13**. Hence, if the base section **19** normally would move up under heating conditions, then the end section **18** moves downwardly under heating conditions, such as when an electrical current is flowing therethrough, or from external heating means.

It has been found that the provision of the twist area or zone **17** in the bimetal strip **13** is facilitated as by forming notches **20** as shown in the strip **13** of FIG. 4, which shows such strip prior to providing the 180° or approximately 180° twist therein. FIG. 5 shows a modified strip **30** having arcuately contoured notches **32** formed in opposed lateral margins thereof. It should be noted that the notches **20** and the notches **30** each can extend, at most, one-third of the lateral width of the strips **13** or **30** in which they are formed as any greater notching of the bimetal strips normally may form too hot an area at the notched and twisted section when current is conducted through such strips when the thermostats in which they are positioned are in use. By the provision of these notches **20**, **32**, or equivalents, in a bimetal strip, then the twisting of the strips is facilitated and the bimetals comprising the strips are not torn or otherwise injured for operative use in a thermostat. By the improvement of the invention, the thermostat **10** has been reduced, for example, to 22 cycles per hour while a similar thermostat with a conventional bimetal strip therein and under the same load had cycled seven times a minute.

The casing **11** may be conductive or not, as desired, and the contact **16** may have a lead extending therefrom to and through the open end of the casing. Both ends of the casing may be open, if desired, and the thermostat may have a second arm extending thereinto as shown, for example, in U.S. Pat. No. 2,586,309. The thermal protectors may be calibrated as disclosed in U.S. Pat. Nos. 2,497,397 and 2,586,309. The sealed end or ends of the thermal protector may be of the construction disclosed in U.S. Pat. No. 3,209,107.

Preferably the bimetal strip has a 180° twist therein but minor or slight variations therefrom can be tolerated.

Any conventional bimetal strips may be used with the base section **19** normally having, for example, a layer **40** of high expansion metal such as a nickel-chrome-steel alloy, and a layer **41** of a low expansion metal, such as nickel-iron alloy therein. W.M. Chace Co. of Detroit, Michigan makes a number of known types of bimetals and its No. 2400 is typical of the strips in use today.

Some of the advantages resulting from the present invention include the following:

a. Purchase of bimetal strips and storage thereof is flexible as conventional straight laid bimetal strips can be converted into compound bimetal strips with a simple, single operation with minimum labor costs and no additional material costs.

b. The cycle rate in the thermostat can be controlled from a substantially normal cycle action rate in cantilever types of thermostats or the like, to an extremely slow cycle rate, such as from about five per minute to about one every 3 minutes by

the location of the twist in the cantilevered portion of the bimetal; and the opening temperature may, for example, be about 30° F. above the circuit closing temperature in ordinary operation, but there could be an 80° to 100° differential, if desired.

c. An increase of "hot on time" due to reverse action of the strip end carrying the contact.

d. Increased positiveness and speed of circuit opening action due to the fact that the reverse acting bimetal is normally at a substantial deflection before opening action takes effect and the reverse acting bimetal then starts to cool and move upward as no current is flowing therethrough, thus increasing the opening between the contact points.

e. Increased speed and/or positiveness of closing circuit contacts as any heat created at the contacts immediately causing the reverse acting bimetal to increase its closing velocity and/or strength.

f. A tendency of a contact arc to reopen a normal straight blade bimetal strip is positively eliminated.

g. Obtain advantages of a compound bimetal strip without the technical problems of making such compound bimetal strip and controlling the manufacture so that the product will meet the specifications therefor. Many bimetals are expensive and are not available commercially in short or small length sections.

In making the strip **13** of the invention and the end section **18** and base section **19** therein, usually the bimetals are so positioned in the base section **19** as to have an upwardly moving action under heating conditions, as indicated by the arrow **42**, and the end section has the reverse or downwardly extending curving action under heated conditions. It also should be realized that the positioning of the bimetal materials in the strip **13** can be reversed whereby the base section **19** can be provided with a downwardly extending curving movement under elevated temperatures, whereas the end section **18** then would be provided with an upwardly directed curving action under heating conditions and this would appreciably change and alter the circuit opening and closing actions and the cycle rate of the thermostat. In the preferred construction of the invention, the advantages set forth hereinabove are particularly provided in a strip **13** that has an upwardly curving action in the base section **19**.

FIG. **3** shows a modified thermostat **10***a* where a bimetal strip **13***a* is twisted at **17***a* and a heater strip **31** is suitably secured, usually welded, to the free end section **18***a* and extends axially therefrom. A contact **15***a* is secured to the heater strip **31** which may be made from any conventional material such as brass or an Inconel, such as Inconel **320–7**. Such a construction can increase the rate of deflection of the free end section of the heater strip. If Inconel is used, a higher electric resistance heating action is obtained and heat flows back to the short arm **18***a* to make it operate so that the contacts are opened at a relatively higher temperature than that secured by the action solely of the base section **13***a* of the bimetal strip, or by the strip **13**. Hence, the "hold in" sensitivity of the thermostat in relation to an equivalent strip **13***a* without a heater strip **31** can be controlled, and higher opening temperatures can be obtained.

FIG. **6** shows a thermostat **10***b* where two twisted bimetal strips **44** and **45** are provided. These strips extend into a casing **43** from two initially open ends thereof. These strips **44** and **45** can be of the construction of the strip **13** and will, normally, double the differential of a one arm thermostat as in FIG. **1**.

By the improved thermostat or motor protector, or thermal controls of the invention, an improved slow cycle thermostat control has been provided and found to be very desirable in commercial use. By the reduced cycles in a protected device, such as in an electric motor, measurably greater operative point or contact life can be obtained, and more consistent action is obtained in the motor control function by the thermostat opening and closing circuit therefor at optimal temperature conditions for a much greater period of time. In fact, this design causes the temperature cycle to be of greater repetitive consistency and predictability and in effect accomplishes the temperature control cycle pattern of the well known and highly used snap action thermostats, but with the temperature control action being provided at reduced manufacturing and selling costs to ultimate user. The embodiment of the invention also does not have the disadvantage of a snap action thermostat, namely mathematical probability of contact opening at the maximum point of the sine wave power which results in a maximum arc potential. In addition, the amperage capacity of the thermostat is substantially increased and this is valuable in small or miniature controls.

In the thermostats of the invention, as the current increases, the heat at the twisted zone of the bimetal strip increases and tends to flow to the adjacent end of the section **18** of the bimetal strip. This aids in providing long cycles of operation in the thermostat, especially when short lengths, relatively speaking, are provided in the bimetal section **18**. FIG. **2** shows that the base arm section **19** may have a length "*a*" from the secured end portion thereof to the twist area and the free end section **18** has a length "*b*" from the contact **15** to the twist area and with the twist area having a length "*c*". Thus, the distance "*a*" *may be, for example, from about ¼ to ⅝ inch, the distance or length* "*b*" may be about 1/32 to 5/16 inch, and the length "*c*" about 5/32 inch. It is preferred that the length of the arm section **19** " *a*" from its secured end thereof to the twisted area or zone would be about two to three times the length of the arm section **18** or "*b*". In making the twists in the bimetal strips, naturally it is desirable to avoid any tear of the metal and this twist does increase the strength of the bimetal strip and hence aids in increasing the operative strength of the produced unit. The thickness of these bimetal arms or strips may be, usually, about 0.010 to 0.12 inch, but may go as high as from 0.015 to 0.030 inch in some instances where heavy or large currents are involved. The strips, for example, may usually be about six times the thickness in width.

In view of the foregoing, it is submitted that an improved thermostat or thermal control has been provided that has very desirable properties and that such thermostat can be readily calibrated for different cycle rates by varying the axial location of the twisted area or zone **17** in relation to the contact point. The temperature differential for circuit opening and closing is determined by the location of the twist **17** and the relation of the length of the bimetal strip sections **18** and **19**. The farther the twist is from the contact **15**, the greater the differential, providing the twist does not approach the center point of the arm, and usually the length "*a*" would be about twice the length of "*b*".

The thermostat usually is of the circuit breaker type and has a higher break temperature than the make temperatures for the circuit controlled by the bimetal arm or arms in the thermostat. This differential between opening and closing temperatures may be as low as 8° to 10°.

The thermostats function fairly effectively on direct current but are particularly effective with AC to eliminate arcing in circuits with the slow lock-in action of the thermostat which in many instances may have a 600 to 1,000 watt capacity at 120 or 240 volts.

FIG. **7** shows a novel thermostat **50** wherein one twisted bimetal arm **51** is provided and a conventional bimetal arm **52** is provided in this initially two open end type of a casing **53** whereby a further modified circuit control action can be obtained. The open position of the bimetal arms of the thermostat **50** of FIG. **7** is shown in FIG. **8** where an end arm section **55** is curved downwardly when the contacts are opened.

The thermostats are described as being horizontally positioned with the bimetal strip **13**, for example, also being horizontally positioned or substantially so.

It also has been noted that the contacts as positioned and used in the thermostats described tend to have a wiping action between the semi-spherical surfaces of the contacts upon temperature change. This aids in maintaining the contacts clean and smooths the surfaces thereof.

A new and improved thermal control is provided which has a substantial differential in opening and closing temperatures, and which has a slow cycle rate so that the objects of the invention have been achieved.

While several complete embodiments of the invention have been disclosed herein, it will be appreciated that modification of these particular embodiments of the invention may be resorted to without departing from the scope of the invention.

What is claimed is:

1. A thermostat, thermal protector or the like connectable to an electric circuit comprising a casing having at least one open ed, a bimetal strip extending into the casing as a cantilever, insulation means securing said strip at the initially open end of said casing and sealing said open end and around said bimetal strip, and opposed contact means operatively positioned in said casing including one contact means on the free end of said bimetal strip for movement into and out of engagement with the other contact means for circuit openings and closing action, characterized by said bimetal strip being of generally rectangular shape in section and having layers of different metals on the opposite longer surfaces thereof, said bimetal strip having a substantially 180° twist therein intermediate the ends thereof in a section of reduced width to form two axially spaced sections in said bimetal strip whereby different bending actions are obtained in said sections when heated, the secured end section of said strip being of the major length of the said strip and the free end section of minor length.

2. A thermostat, thermal protector or the like as in claim 1 where the major length is a relatively long axial section and the minor length is a relatively short axial section.

3. A thermostat, thermal protector or the like as in claim 1 where said bimetal strip has a notch provided on each side thereof at the twisted portion thereof.

4. A thermostat thermal protector or the like as in claim 3 where each notch extends into said bimetal strip up to one third the width thereof.

5. A thermostat, thermal protector or the like as in claim 1 where said bimetal strip has a heater metal strip secured to it at its cantilevered end, said heater strip projecting beyond said bimetal strip, and one of said contact means is secured to said heater.

6 A thermostat, thermal protector or the like comprising a conductive casing having at least one open end, a bimetal strip extending into the casing as a cantilever, insulation means securing said strip at the initially open end of said casing and sealing said open end and around said bimetal strip, and opposed contact means on said casing and the free end of said bimetal strip, characterized by

said strip having layers of different metals on the vertically opposite surfaces thereof, said strip at the free end thereof having a different metal on the top surface thereof than at and adjacent the secured end thereof, said strip having a substantially 180° twist therein intermediate the ends thereof,

said strip adjacent the supported end thereof moves upwardly when heated and said strip at the free end thereof moves downwardly when heated whereby a circuit formed by the thermostat when said contacts engage is opened only after said free end portion curves downwardly to an appreciable extent; and

the open and close circuit cycle rate being controlled by the axial location of the twist in said strip in the cantilever portion thereof, the distance from the secured end of said strip to the adjacent edge of the twist being longer than the distance from the contact carried by the free end of the strip to the adjacent edge of the twist.

7. A thermostat as in claim 6 where the 180° reversed position of the free end of the single bimetal strip results in a temperature of contact closing being significantly lower than the temperature of contact opening.

8. A thermostat, thermal protector or the like as in claim 6 where said strip has a second metal strip secured to and projecting beyond the cantilevered end thereof, and one of said contacts is secured to said second strip which is a heater strip.

9. A thermostat as in claim 6 where the position of the bimetal strip in relation to normal is reversed and the bimetal strip in the longer section thereof tends to curve toward a circuit closing position under heating conditions and wherein the temperature of contact closing is significantly higher than the temperature of contact opening and where the longer length section has the high expansion part of the bimetal on the opposite side thereof than that side to which the contact is attached.

* * * * *