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THERMAL RELAY HAVING SEPARATE HEATER MEANS  
TO OPEN OR CLOSE THE RELAY

3,405,380

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2 Sheets-Sheet 1

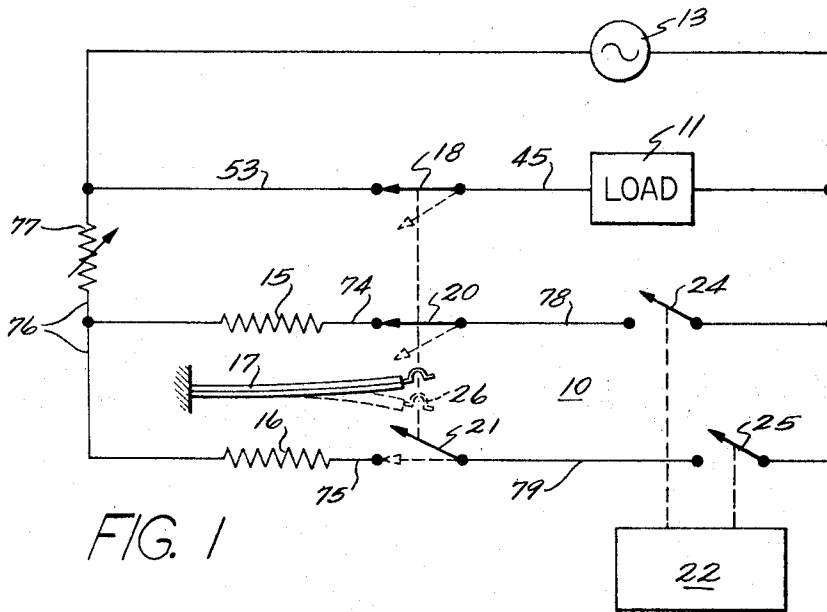


FIG. 1

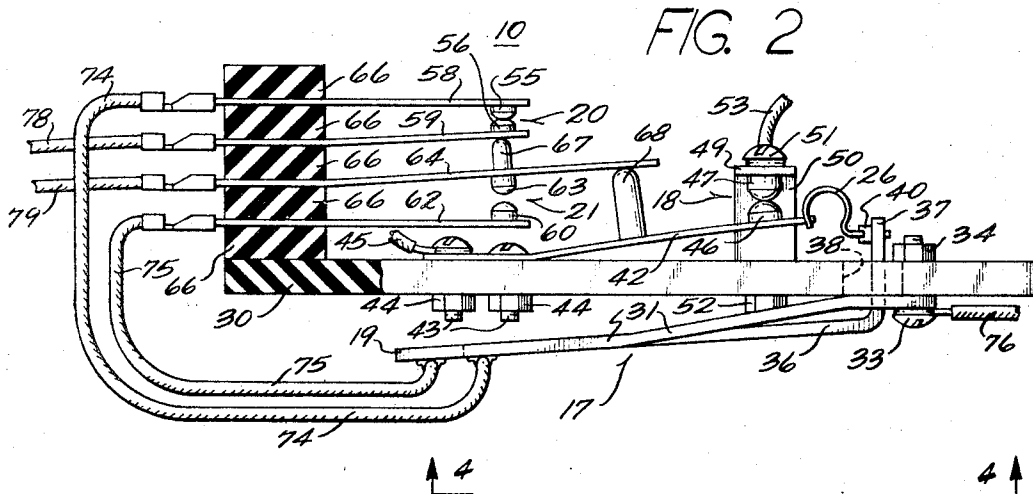


FIG. 2

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FIG. 3

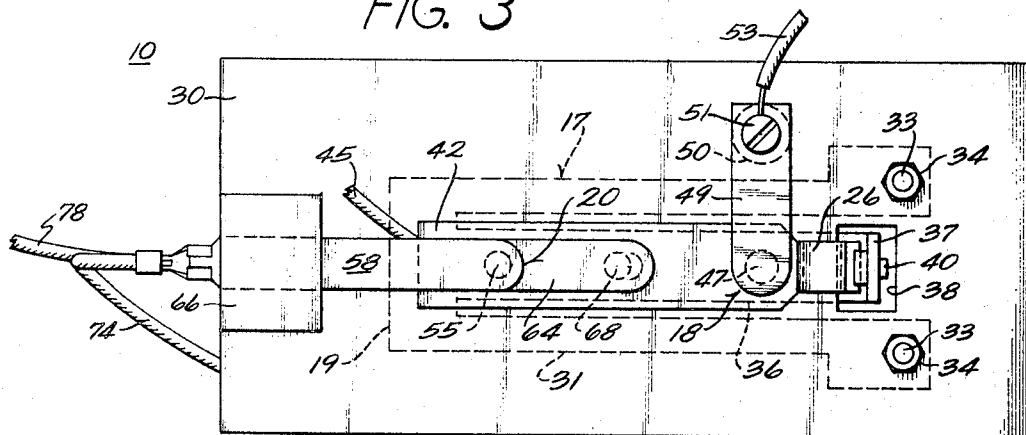


FIG. 4

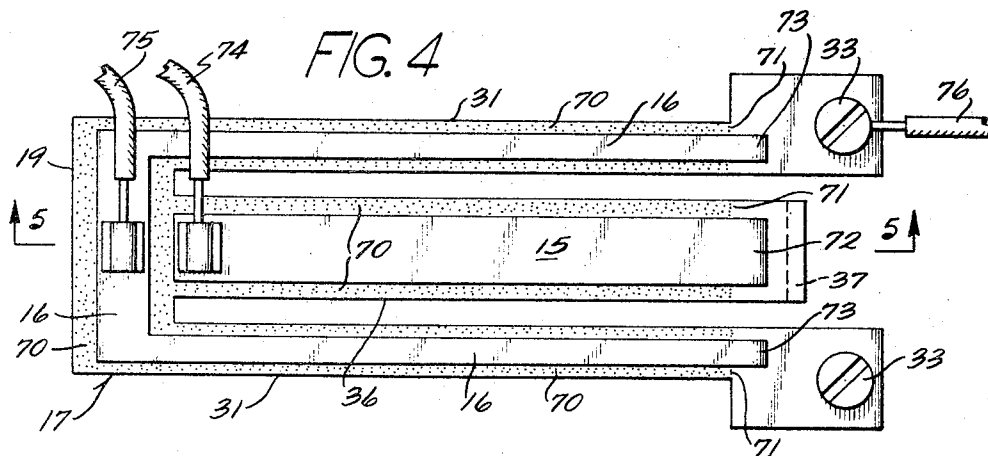
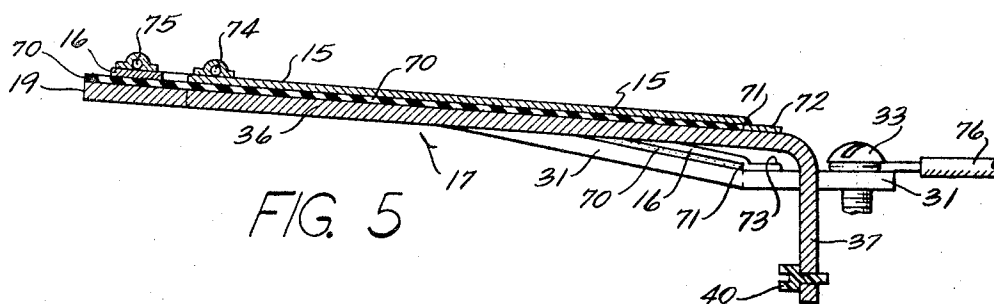


FIG. 5



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## THERMAL RELAY HAVING SEPARATE HEATER MEANS TO OPEN OR CLOSE THE RELAY

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### ABSTRACT OF THE DISCLOSURE

A thermal relay having a complex bimetallic element for operating main switch means and including first resistance heater means on a first portion thereof for operating said element in a switch open direction, second resistance heater means on a second portion thereof for operating said element in a switch closed direction and resilient means for holding the element in its operated direction. The relay also includes auxiliary switch means operative to open circuit the first resistance heater means when the element operates in the switch open direction and to open circuit the second resistance heater means when the element operates in the switch closed direction.

#### Background of the invention

This invention relates to thermal relays, and more particularly, to a bistable thermal latching relay.

It is an object of the invention to provide a new and improved thermal relay.

Another object of the invention is to provide a new and improved bistable thermal latching relay.

A further object of the invention is to provide a thermal relay which remains latched in each of its open and closed positions.

A still further object of the invention is to provide a thermally actuated latching relay having separate thermal means for producing open and closed positions wherein movement of the relay from one position to the other, open circuits the energized one of the thermal means.

A still further object of the invention is to provide a thermal latching relay having a predetermined time delay.

Yet another object of the invention is to provide a thermally actuated latching relay wherein the heater is automatically de-energized when the predetermined contact position is achieved.

It is also an object to provide a new and improved element for a thermal latching relay.

#### Brief description of the drawings

FIG. 1 schematically illustrates the thermal latching relay according to the instant invention;

FIG. 2 is a side elevational view, with parts broken away, of the thermal latching relay according to the instant invention;

FIG. 3 is a top plan view of the relay shown in FIG. 1;

FIG. 4 is a view taken along line 4—4 of FIG. 2; and,

FIG. 5 is a view taken along lines 5—5 of FIG. 4.

#### Summary of the invention

According to one of its aspects, the invention comprises a thermal latching relay having a first thermal means operative when electrically energized to cause contact operation in a first sense, second thermal means operative when electrically energized to cause contact operation in an opposite sense, resilient means operative to maintain contact position upon the de-energization of the thermal means, and means operative to open circuit the first thermal means upon operation in the first sense and to open

circuit the second thermal means upon operation in the opposite sense.

According to another of its aspects, the invention comprises a thermal latching relay comprising an elongate expanding solid type thermoresponsive element having a first portion operative when heated to move the element in a first sense and a second portion operative when heated to move the element in an opposite sense, first resistance heater means in thermal association with the first element portion and second resistance heater means in thermal association with the second element portion, resilient means operative to move a contact portion into a switch closed position when the element moves in a first sense and to move the contact portion into a switch open position when the element moves in the opposite sense, the resilient means also being operative to maintain contact position upon the de-energization of the resistance heaters.

According to yet another one of its aspects, the invention comprises an expanding solid type thermal responsive element comprising a relatively flat member at least partially covered by an insulating coating and having first and second leg portions joined at a common end, and a separate resistive coating applied to each leg portion, wherein at least a portion of each of the resistive coatings is electrically isolated from each other and from their respective leg portions by the insulating coating.

#### Description of the preferred embodiment

Referring now to the drawings in greater detail, FIG. 1 schematically illustrates the thermal latching relay 10 according to the instant invention as being operative to connect a load 11 to an energy source 13. The thermal latching relay 10 as shown in FIG. 1 to include a pair of heater resistors 15 and 16 disposed in close proximity to an expanding solid type thermally responsive member, which in the illustrated embodiment comprises a bimetallic element 17 for controlling a main switch 18 in circuit with the load 11 and a pair of auxiliary contacts 20 and 21 in circuit with the heater resistors 15 and 16, respectively. In addition, a control device 22, of any suitable type well known in the art, is constructed and arranged to selectively operate a second pair of auxiliary contacts 24 and 25 which are in circuit with the auxiliary contacts 20 and 21, respectively.

It will be appreciated with reference to FIG. 1, that when each of the auxiliary contacts 20 and 24 are closed, the heater resistor 15 will be connected to the source 13 and when the auxiliary contacts 21 and 25 are closed, this energizing circuit will be completed to the heater resistor 16. It can also be seen that when the bimetallic element 17 is flexed upwardly as seen by full lines in FIG. 1, the main switch 18 and the auxiliary contacts 20 will be closed while the auxiliary contacts 21 will be open. On the other hand, when the bimetallic element 17 is deflected downwardly, as shown by phantom lines in FIG. 1, the main switch 18 and the auxiliary contacts 20 will be open while the auxiliary contacts 21 will be closed. As will be explained in greater detail hereinbelow, a toggle spring 26 couples the bimetallic element 17 to the main switch 18 and each of the auxiliary contacts 20 and 21 so that the switch positions will be maintained until the element 17 is deflected in the opposite direction by one of the heaters 15 or 16.

The thermal relay 10 is shown in greater detail in FIG. 2 to include a nonconductive base 30 of any suitable insulating material. As seen in FIGS. 2-5, the element 17 has a generally W-shaped configuration consisting of a pair of generally parallel outer legs 31 which are each affixed at one end to the underside of the base 30 by bolts 33 and nuts 34. The element 17 also includes a center leg 36 which extends from a common end 19 and in parallel with the outer legs 31. As those skilled

in the art will appreciate, ambient temperature compensation is provided by the tendency of the common end 19 to deflect in one direction due to ambient heating in counteraction to the tendency of the center leg to deflect in the opposite direction.

As seen in FIGS. 2 and 3, the free end 37 of the central element leg 36 is bent upwardly and extends through a generally rectangular opening 38 in the base 30 and to the opposite side thereof where it carries a nylon pad 40 for engaging one end of an inverted generally U-shaped toggle spring 26. The other side of the toggle spring 26 engages the free end of a resilient conductive contact arm 42 which extends generally parallel to the element 17 and whose other end is affixed to the upper surface of the base 30 by bolts 43 and nuts 44. The contact arm 42 carries a movable contact 46 adjacent its free end for cooperative engagement with the fixed contact portion 47 of main switch 18. Contact portion 47 is mounted at one end of a conductive terminal member 49 affixed in spaced relation above the base 30 by an insulating stud 50. A bolt 51 secured by a nut 52 affixes the terminal 49 and the stud 50 to the base 30 and also serves to electrically connect a conductor 53 to said terminal.

The auxiliary contacts 20 are shown in FIG. 2 to include an affixed contact 55 and a movable contact 56 each of which is mounted in an opposed relation at one end of one of a pair of flat, elongate, resilient, conductive members 58 and 59, respectively. Also, the stationary contact 60 of the auxiliary contacts 21 is carried at one end of a similar member 62 and the movable contact thereof is carried above the stationary contact 60 by a substantially longer resilient conductor member 64. The resilient conductive members 58, 59, 62 and 64 are disposed in a generally parallel relation and are each affixed at their other ends and insulated from each other by a plurality of insulating blocks 66 which are suitably mounted in a stacked relation on the base 30. A first nonconductive pad member 68 is mounted on the contact arm 42 and is engageable with the free end of the elongate member 64 for coupling the auxiliary contacts 20 and 21 to the main switch 18. In addition, a second nonconductive pad member 67, which is mounted on the upper surface of the elongate member 64 and below the auxiliary contacts 20, couples the latter contacts to the main switch 18 and also serves to prevent electrical contact between the members 59 and 64.

As seen in FIGS. 4 and 5, one side of the bimetallic element 17 is covered with any suitable electrical insulation 70, such as varnish, and which extends from the common end 19 and over each of the legs 31 and 36 to a line designated by the reference numeral 71, which is short of the ends of said legs.

Each of the heater resistors 15 and 16 comprises an elongate coating of electrical resistive material, such as a mixture of graphite, metal particles and thermosetting resin, which is applied in any suitable manner such as by spraying or silk-screening. A suitable resistance material has been found to be FH-441 conductive coating of Atchinson Colloids Company, which has a resistance of 20 ohms per square plus or minus 20 percent symbolized at 75° F.

The first heater resistor 15 is disposed on the center leg 36 and extends from the common end 19 past the edge 71 of the insulating material 70 and onto the electrically conductive bimetallic element 17. Similarly, the second resistance heater 16 is generally U-shaped and is applied to each of the outer legs 31 and across the common end 19 and also extends past the edge 71 of the electrical insulating material 70.

It can be seen from FIGS. 4 and 5 that the insulation 70 electrically separates the resistance heaters 15 and 16 from each other and also from the bimetallic element 17 except for the small portions of said resistance heaters

which extend over the end 71 of the insulation 70 at the ends of the arms 31 and 36.

A pair of conductors 74 and 75 are each connected at one end to the heater resistors 15 and 16, respectively, in any suitable manner such as by a coating of conductive epoxy. The other ends of the conductors 74 and 75 are respectively connected to the elongate conductive members 58 and 62 so that one end of the heater resistor 15 is connected to stationary contact 55 of auxiliary contacts 20 and one end of the heater resistors 16 is connected to the stationary contact 60 of auxiliary contacts 21. In addition, a third conductor 76 is connected by screw 33 and bolt 34 to the uninsulated portion of one of the legs 31. The current path between conductors 74 and 76, therefore, is through the bimetallic element 17 to the end 72 of the heater resistor 15 and then through substantially the entire length thereof to the conductor 74. Similarly, the current path between conductors 75 and 76 is through the bimetallic element 17 to the ends 73 of the heater resistor 16 and then through the parallel path defined by each of the legs of said heater resistor. It will be appreciated that the resistance of each of the heater resistors 15 and 16 can be made substantially equal by controlling their thicknesses and surface areas.

Conductor 78 connects the movable contact 56 of auxiliary contacts 20 to the auxiliary contacts 24 as seen in FIG. 1 and conductor 79 connects movable contact 63 of auxiliary contacts 21 to auxiliary contacts 25.

When the thermal relay 10 is in its position shown in FIGS. 1 and 2, the main switch 18 is closed so that the load 11 is connected to the source 13. In addition, as seen in FIG. 2, the nonconductive pad member 68 mounted on the contact arm 42 flexes the conductive member 64 upwardly to hold the auxiliary contacts 20 closed through the agency of nonconductive pad member 67. Also, the upward bending of member 64 holds the auxiliary contacts 21 open. This position of the assembly is symbolized by full lines in FIG. 1.

The spring 26 is generally U-shaped and is under stress so that it acts as an overcenter device as the end 37 of the element leg 36 moves upwardly and downwardly. Thus, as the leg 36 moves upwardly as seen in FIG. 2, due to the energization of resistor 15, the spring 26 will move overcenter as its right end moves upwardly so that the contact arm 42 and the movable contact 46 are snapped downwardly to their open position. Conversely, when the heater 16 is energized to cause movement of the leg 36 downwardly, as viewed in FIG. 2, the spring 26 will again be moved overcenter to snap the contact 46 to its closed position. It will be understood that while there will be a slight degree of movement of the element leg 36 when either of the heaters 15 or 16 are de-energized to relax the element 17, this will not be sufficient to move the spring 26 overcenter so that the main switch 18 will be held in its previous position.

When it is required to de-energize the load 11, control 22 is made operative to close auxiliary contacts 24 thereby energizing heater resistor 15 mounted on the center leg 36 of bimetallic element 17. After a time delay, the central leg 36 will flex upwardly so that the contact arm 42 will be snapped from its closed position shown in FIG. 2 to its open position by the toggle spring 26. This opens the main switch 18 to de-energize the load 11. In addition, the downward movement of the contact arm 42 will allow the conductive member 64 to straighten thereby opening auxiliary contacts 20 to de-energize heater resistor 15 and closing auxiliary contacts 21 as symbolized by phantom lines in FIG. 1. Heater resistor 16 is, however, not energized because auxiliary contacts 25 remain open. Control 22 may then be made operative to open auxiliary contacts 24.

If it is desired thereafter to re-energize the load 11, the control 22 is made operative to close auxiliary contacts 25 thereby energizing heater resistor 16. After a

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time delay, the left end of element 17 will deflect upwardly to move the end 37 of leg 36 downwardly as seen in FIG. 2 and as symbolized by full lines in FIG. 1 to close the main switch 18 and open the auxiliary contacts 21 to de-energize the heater resistor 16.

It will be appreciated that the time delay for the opening and closing of the main contacts 18 will be determined by the characteristics of the bimetallic element 17, the resistance of each of the heater resistors 15 and 16, and the applied voltage. An adjustable resistor 77 is connected between the common conductor 76 and the source 13 so that these time delays can be modified.

While only a single embodiment of the instant invention has been shown and described, it is not intended to be limited thereby but only by the scope of the appended claims and by the prior art.

I claim:

1. A thermal latching relay comprising a thermal assembly including thermally responsive means, a first electrically actuable thermal means in thermal association with the thermally responsive means for operating said thermally responsive means in a first direction, a second electrically actuable thermal means in thermal association with the thermally responsive means for operating said thermally responsive means in an opposite direction, first and second energizing circuit means respectively coupled to said first and second thermal means and constructed and arranged to be connected to a source of electrical energy, switch means including a movable contact portion and resilient means coupling said thermally responsive means to said movable contact portion, said thermally responsive means and said resilient means being operative to move said contact portion into a switch closed position when said thermally responsive means operates in said first direction and to move said contact portion into a switch open position upon operation of said thermally responsive means in said opposite direction, said resilient means also being operative to hold said movable contact portion in either of its positions upon de-energization of said first and second thermal means, and operating means coupled to said thermally responsive means and to said first and second energizing circuit means for open circuiting said first energizing circuit means and closing said second energizing circuit means upon operation of said thermally responsive means in said first direction and for open circuiting said second energizing circuit means and closing said first energizing circuit means upon operation of said thermally responsive means in said opposite direction.

2. The relay set forth in claim 1 and including first and second auxiliary contact means respectively operable when closed to complete an energizing circuit to said first and second thermal means, said thermal assembly being coupled to said auxiliary contact means and being operable to open said first auxiliary contact means upon operation in said first sense and operable to open said second contact means upon operation in said opposite sense.

3. The relay set forth in claim 1 wherein said thermal assembly includes an expanding solid type element and said first and second thermal means comprises a resistance heater in thermal association with said element.

4. The relay set forth in claim 3 and including first and second auxiliary contact means respectively operable when closed to complete an energizing circuit to said first and second resistance heaters, said element being coupled to said auxiliary contact means and being operable to open said first auxiliary contact means upon operation in said first sense and operable to open said second contact means upon operation in said opposite sense.

5. The relay set forth in claim 3 wherein said element comprises a member having a first and a second surface portion, said first resistance heater being applied to said first surface portion and said second resistance heater be-

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ing applied to said second portion and being electrically isolated from said first portion, said element being operative to move in a first sense when its first portion is heated and to move in an opposite direction when its second portion is heated.

6. The relay set forth in claim 5 wherein said element is relatively flat and said first and second portions comprise first and second leg means joined at a common end, the other end of said first leg means being fixed and the other end of said second leg means being coupled to said resilient means.

7. The relay set forth in claim 6 wherein a portion of said member is covered with an insulating coating and a first resistive coating is applied to said first leg means and a second resistive coating is applied to said second leg means, at least a portion of each of said resistive coatings being electrically isolated from each other and from their respective legs by said insulating coating.

8. The relay set forth in claim 7 wherein said legs extend in the same general direction from said common end, said insulating coating being disposed on said common end and on a substantial portion of said legs adjacent to said common end, said resistive coatings extending along said legs and from said common end and to an uninsulated portion thereof, and electrical circuit means connected to each of said resistance coatings adjacent said common end.

9. A thermal latching relay comprising an elongate expanding solid type thermoresponsive element having the legs extending in the same general direction from a common end, an insulating coating disposed on said common end and on a substantial portion of said legs adjacent to said common end, a first resistive coating disposed on one side of said member and extending across said common end and on each of the outermost two of said legs, a second resistive coating disposed on the center one of said legs, at least a portion of each of said resistive coatings being electrically isolated from each other and from their respective legs by said insulating coating, said coatings extending from said common end to an uninsulated portion of said legs, said outer legs being fixed at a point remote from said common end, said element being operative when said first resistive coating is energized to move said element in a first sense and when said second resistive coating is energized to move said element in an opposite sense, switch means including a movable contact portion and resilient means coupling the other end of said center leg to said movable contact portion and operative to move said movable contact portion into a switch closed position when said element moves in a first sense and to move said contact portion into a switch open position when said element moves in the opposite sense, and resilient means coupled to said movable contact portion and operative to hold said movable contact portion in either of its positions upon the de-energization of said resistance heaters.

10. The relay set forth in claim 9 and including first and second auxiliary contact means respectively operable when closed to complete an energizing circuit to said first and second resistance coating, said element being coupled to said auxiliary contact means and being operable to open said first auxiliary contact means upon movement in a first sense and operable to open said second contact means upon movement in an opposite sense.

11. An expanding solid type thermal responsive element comprising a relatively flat member having three legs joined at a common end and extending in the same general direction, the other end of the outer two legs being fixed, an insulating coating covering said common end and a substantial portion of said legs adjacent said common end, a first resistive coating applied to one side of said member and extending across said common end and onto each of the outer two legs, a second resistive coating applied to the center leg, at least a portion of each of said

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resistance coatings being electrically isolated from each other and from their respective legs by said insulating coating and extending along said legs and from said common end and to an uninsulated portion thereof, and electrical circuit means connected to each of said resistance coatings adjacent said common end.

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