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Zandonatti

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[54] **THERMAL SWITCH**

[75] Inventor: **Raymond A. Zandonatti**, Beaverton, Oreg.

[73] Assignee: **Tektronix, Inc.**, Beaverton, Oreg.

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[51] **Int. Cl.** **H01h 37/76**

[58] **Field of Search** 337/403, 401, 404, 337/405, 406, 407, 184, 153

[56] **References Cited**

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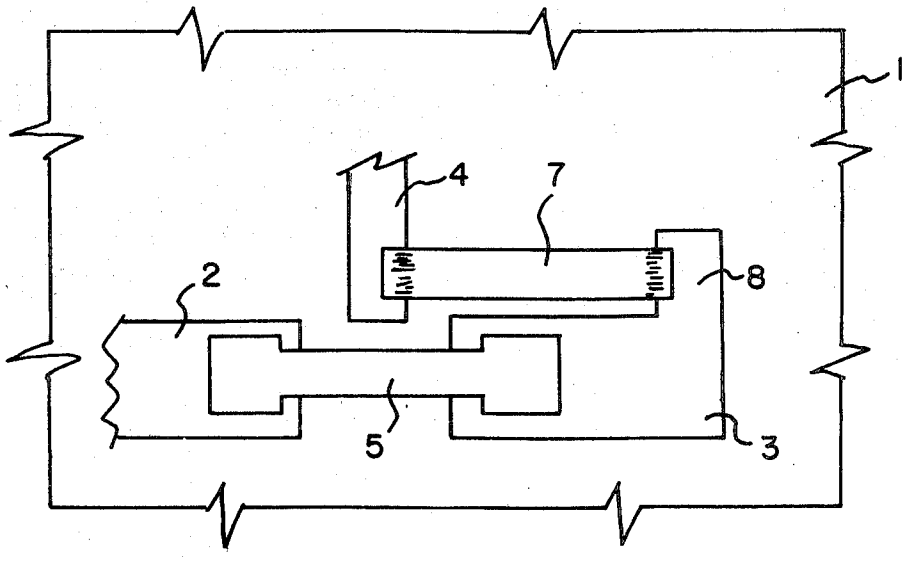
Primary Examiner—Harold Broome

Attorney—Adrian J. La Rue

[57] **ABSTRACT**

A thermal switch is provided on an insulating support member which includes conductive means carried thereby with two of the conductive means defining stationary contact means at ends thereof spaced from each other. Movable contact means has one end secured to one of the stationary contact means and the free end thereof extends over the other of the stationary contact means. Resistive means has one end connected to one of the two of the conductive means and another end connected to a further conductive means. Means is provided between the stationary contact means and the free end of the movable contact means maintaining the contact means in electrical engagement and to cause the contact means to become disengaged when the heat generated by the resistive means exceeds a predetermined limit.

8 Claims, 5 Drawing Figures



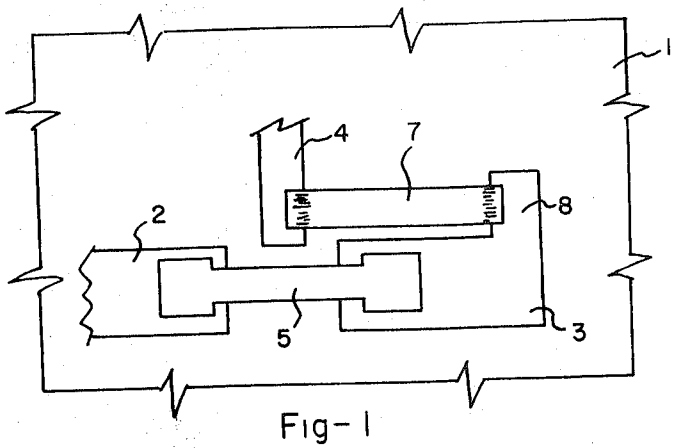


Fig-1

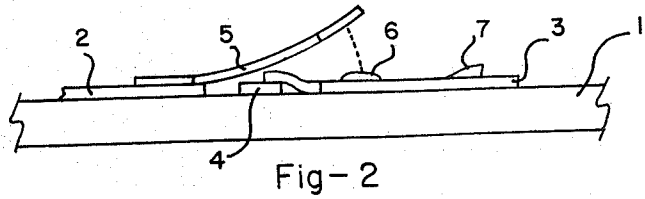


Fig-2

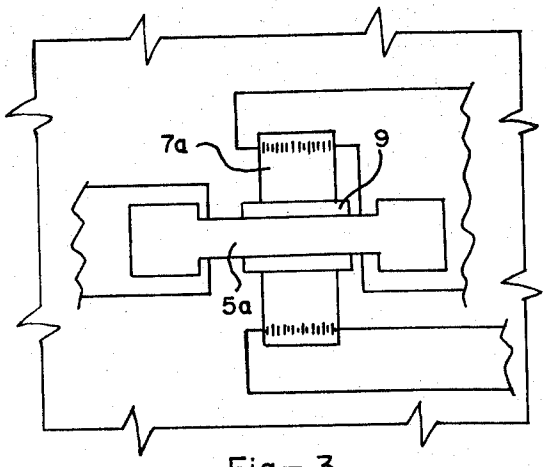


Fig-3

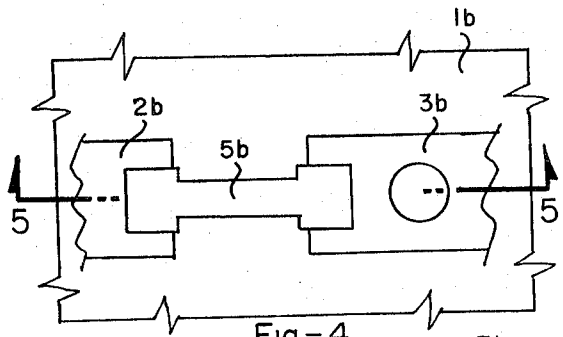


Fig-4

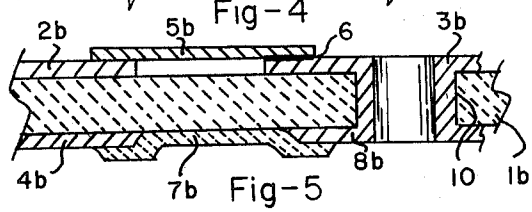


Fig-5

THERMAL SWITCH

BACKGROUND OF THE INVENTION

Electronic circuitry is typically utilized for testing purposes and it will operate within prescribed voltage limits. In using such circuitry, operators will inadvertently apply the circuitry to voltage areas in excess of the prescribed voltage limits and this will of course damage the circuitry thereby rendering the testing device incapable of further use and requiring its replacement.

One way to protect electrical circuitry is to use a fuse, but it will have to be replaced if it blows. This is expensive and time consuming as well as too large for thick film circuits.

Another way to protect electrical circuitry is to use a bimetallic member which will open the circuit when the current exceeds a certain value. Use of bimetallic members is expensive.

The present invention overcomes these drawbacks by providing a thermal switch in circuitry which will open the circuit when a predetermined temperature is reached which is determined by the current flowing therein and it can be closed again thereby enabling the circuitry to be reused.

An object of the present invention is to provide a thermal switch in an electronic or electrical circuit which will open when the current exceeds a predetermined level.

Another object of the present invention is a thermal switch for an electrical or electronic circuit which can be closed again without replacing any parts.

A further object of the present invention is the provision of a thermal switch which precisely operates at a predetermined temperature.

An additional object of the present invention is to provide a thermal switch that is inexpensive for use in connection with electrical or electronic circuitry.

A still further object of the present invention is a thermal switch having the central portion of resistor means disposed in close proximity to the low melting point solder which maintains the movable contact means in electrical engagement with the stationary contact means.

BRIEF DESCRIPTION OF DRAWINGS

Other objects and advantages of the present invention will be apparent from the detailed description of preferred embodiments thereof and from the attached drawings of which:

FIG. 1 is a top plan view of a part of a substrate on which a thermal switch is located;

FIG. 2 is a side elevational view of FIG. 1 with the movable contact member in the open position;

FIG. 3 is a top plan view of an alternative embodiment of the invention;

FIG. 4 is a top plan view of a further embodiment of the invention; and

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

DETAILED DESCRIPTION OF PREFERRED AND OTHER EMBODIMENTS

The present invention is described in conjunction with a hybrid solid state circuit, but it is to be understood that the invention can be used on macro-miniature circuits, etched circuit board circuitry and other circuitry of this general construction.

Turning now to FIGS. 1 and 2, a substrate 1 is shown which is generally made of aluminum oxide or some suitable dielectric material. Conductive members 2, 3 and 4 are carried by substrate 1. Conductive members 2 and 4 are connected to other components and other conductive members would be located on substrate 1 and these are not shown in the interest of brevity as well as not being essential to the invention. Ends of conductive members 2 and 3 are spaced from each other and they are bridged by a switch member 5 having one end secured to either end of conductive members 2 or 3 via welding or in any other conventional manner.

As can be discerned from FIG. 2, switch member 5 is shown in its open position and it is made from a suitable material having spring characteristics which is initially formed having an arcuate configuration. The material from which switch member 5 can be made is generally beryllium copper, phosphor bronze, silicon bronze, steel, or any other conductive material having the desirable spring characteristics.

Low temperature solder 6 having a predetermined melting point is placed at the end of either conductive member 2 or 3 and the free end of switch member 5 is soldered in position thereby connecting conductive members 2 and 3. Solder 6 is a conventional solder and it is selected in accordance with the melting point at which the switch means will open. The switch means is defined as stationary contact means comprising one of the ends of conductive members 2 or 3, the free end of switch member 5 and the solder 6 of a predetermined melting point.

A resistor 7 is connected between a section 8 of conductive member 3 and an end of conductive member 4 and its center is disposed in close proximity to the soldered end of the switch means and the reason for this is that the hotest point of the resistor 7 is at or about its center and this will direct the heat right at the soldered end. It is desired that substrate 1 have proper thermal conductivity to conduct the heat being generated by resistor 7 toward solder 6.

In operation, the switch means is closed by soldering the free end of switch member 5 to the end of conductive member 2 or 3 via solder 6, and, so long as the current passing therethrough and resistor 7 remains at or below a predetermined level, solder 6 will not melt and normal circuit operation will continue.

If the current exceeds the predetermined level, the heat being generated by resistor 7 causes the solder 6 to melt and the switch means opens due to its spring characteristics thereby preventing any damage to the circuitry on substrate 1. In order to reestablish the circuit, the solder 6 is reheated and the free end of switch member 5 is resoldered onto the end of conductive member 2 or 3 and the circuitry can be reused without having to be replaced. Thus, the switch means and the resistor in series therewith constitute a reuseable thermal switch means to prevent excessive voltages from permanently damaging electrical circuitry means.

FIG. 3 illustrates an alternative embodiment of the thermal switch wherein resistor 7*a* is disposed under switch member 5*a* and a thin piece of electrically insulating material 9 is secured over the central portion of resistor 7*a* in order to prevent any shorting between switch member 5*a* and resistor 7*a*. As can be discerned, the center of resistor 7*a* is positioned in close proximity to the soldered end of switch member 5*a*.

FIGS. 4 and 5 illustrate another embodiment of the invention wherein conductive member 3*b* extends through opening 10 in substrate 1*b* and has a section 8*b* extending along the bottom surface of substrate 1*b* in alignment with conductive member 3*b*. Resistor 7*b* connects conductive member 4*b* with section 8*b*, and it is disposed in alignment with switch section 5*b* which connects conductive members 2*b* and 3*b* so that the central portion of resistor 7*b* is disposed in close proximity to the soldered end.

While there have been shown and described embodiments of the present invention, it will be apparent to those skilled in the art that many changes and modifications may be made without departing from the broader aspects of the invention; therefore, it is intended that the appended claims cover all such changes and modifications as fall within the true spirit and scope of the present invention.

The invention is claimed in accordance with the following:

1. A thermal switch comprising:

a hybrid solid state means including a substrate of dielectric material having first, second and third conductive means secured on surface means thereof;

a switch member of resilient material having a first end secured to said first conductive means and a second end disposed along said second conductive means;

electrically conductive heat-softenable material securing said second end of said switch member to said second conductive means; and

resistive means having one end connected to said third conductive means and another end connected to said first or second conductive means and being disposed adjacent said switch member, said electrically conductive heat softenable material being softened upon heat generated by said resistive means reaching a predetermined limit thereby causing said second end of said switch member to move free of said second conductive means.

2. A thermal switch according to claim 1 wherein said switch member comprises an arcuate shape in its normally open position.

3. A thermal switch according to claim 1 wherein said resistive means has its central section disposed adjacent and in alignment with said heat-softenable material.

4. A thermal switch according to claim 1 wherein said resistive means extends parallel with respect to said switch member and the central portion of said resistive means is disposed adjacent said heat-softenable material.

5. A thermal switch according to claim 1 wherein said resistive means is disposed under said switch member and the central portion of said resistive means is disposed adjacent said heat-softenable material.

6. A thermal switch according to claim 5 wherein insulative means is disposed between said switch member and said resistive means.

7. A thermal switch according to claim 5 wherein said resistive means extends at a right angle with respect to said switch member.

8. A thermal switch according to claim 1 wherein said resistive means is disposed on another surface means opposite to said surface means on which said switch member is located and a central portion of said resistive means is disposed in alignment with said heat-softenable material.

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