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Senor

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[54] **NONRESETTABLE THERMALLY ACTUATED SWITCH**

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[51] **Int. Cl.²** **H01H 37/76**

[58] **Field of Search** 337/403, 404, 405, 407, 337/408, 409

[56] **References Cited**

UNITED STATES PATENTS

3,727,164	4/1973	Cartier et al.	337/409 X
3,781,737	12/1973	Henry	337/407
3,820,050	6/1974	Tyler et al.	337/408

FOREIGN PATENTS OR APPLICATIONS

1,164,589	9/1969	United Kingdom	337/409

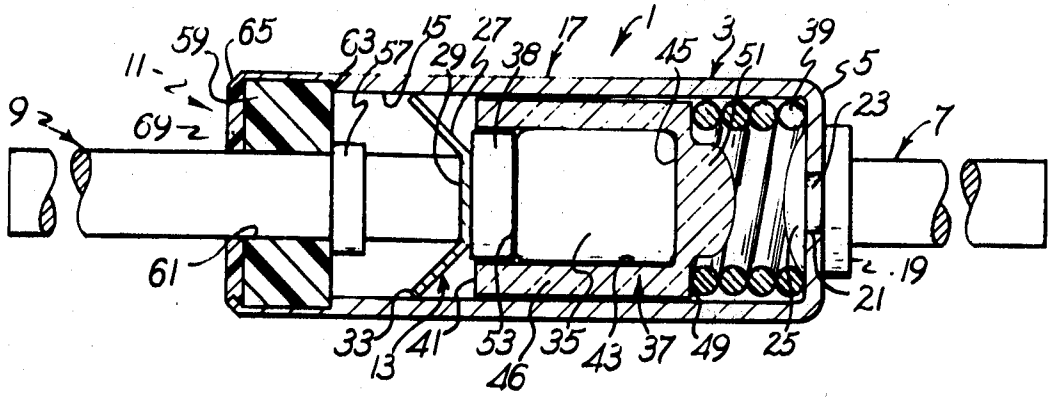
Primary Examiner—G. Harris

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[57] **ABSTRACT**

A nonresettable thermal switch comprises a conductive case, a first lead connected to the case, a second lead having a stop, and an insulator with a bore receiving the second lead and with an end engaging the stop securing and insulating the second lead relative to the case. A cup-shaped separator is disposed within the case, and a normally solid body of fusible material is disposed in the separator. A force spreader is slidable in the cup-shaped separator and a deformable connector is disposed between the force spreader and the second lead. Spring means bias the separator for pressing the spreader member via the body of fusible material into engagement with the connector for holding the deformable connector in electrical engagement with the second lead and with the case when the fusible material fuses, the force spreader slides into the cup-shaped separator which deforms the connector away from the inside surface of the case to break the circuit.

8 Claims, 3 Drawing Figures



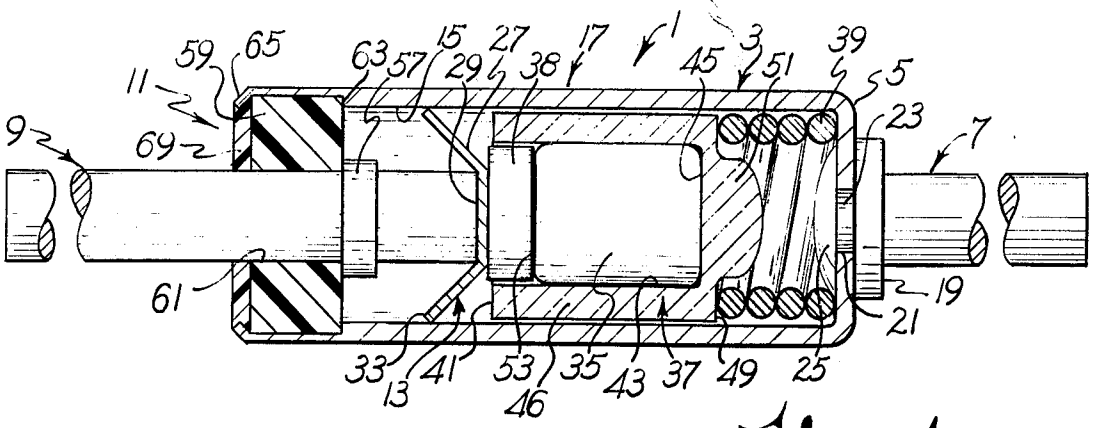


Fig. 1.

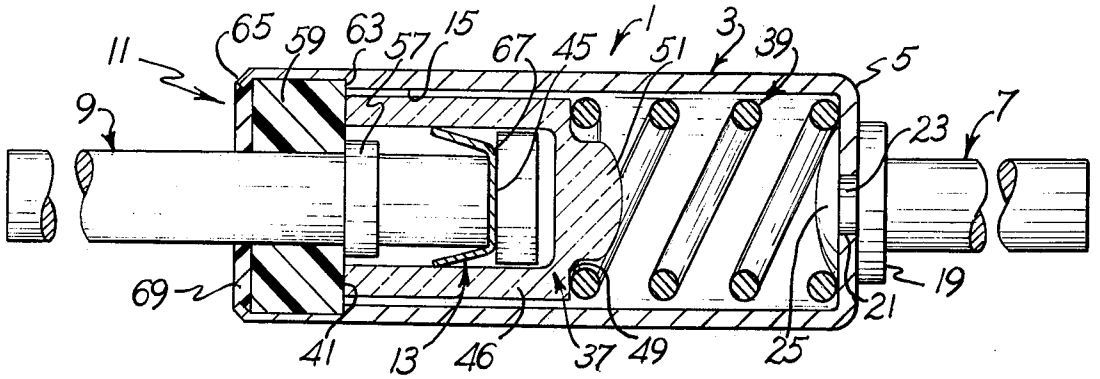


Fig. 2.

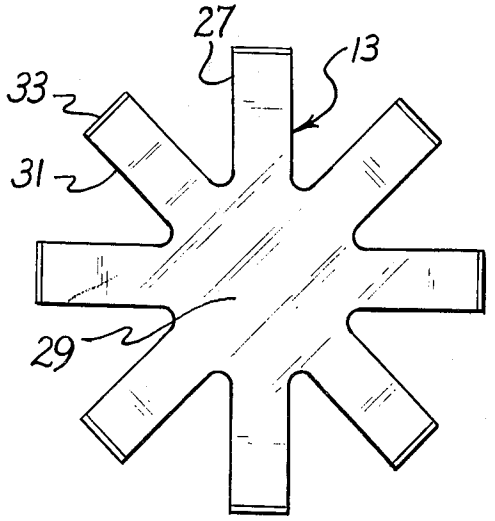


Fig. 3.

NONRESETTABLE THERMALLY ACTUATED SWITCH

BACKGROUND OF THE INVENTION

This invention relates to a thermally actuated switch, and more particularly to a one-time or nonresettable thermally actuated switch.

Generally, such one-time switches are used to protect a motor, transformer, or other electrical apparatus from operating in ambient temperature which exceed a predetermined maximum safe level. Such one-shot switches are typically used as back-up devices for protecting electrical apparatus which may also have current sensing devices or other thermostatic switches or the like adapted to provide normal overload protection for the apparatus, the switch of this invention functioning where the normally relied upon devices might fail. For example, such a one-shot switch may be serially connected to the windings of a motor so as to protect the motor by interrupting the power supplied thereto in the event that, because of overheating of the motor winding or for any other reason, the ambient temperature level to which the switch and motor are exposed exceeds a level which could cause damage to the motor. These switches are often relatively small (e.g., 0.50 inches or 1.27 cm. long and 0.135 inches of 0.34 cm. in diameter) so they may be readily incorporated in the apparatus they are to protect to be responsive to the ambient temperatures to which the apparatus is exposed. Such switches utilize a fusible material which rapidly undergoes a change of state when heated to a predetermined temperature (i.e., the fusible material melts) to effect breaking of the circuit. Reference may be made to U.S. Pat. Nos. 3,180,958, 3,291,945, 3,309,481, 3,505,630 and 3,519,972 which show such one-time thermally actuated switches.

SUMMARY OF THE INVENTION

Among the several objects of this invention may be noted the provision of a one-time thermally actuatable switch which effects a more positive interruption of an electrical circuit upon the switch being heated above a predetermined temperature; and provision of such a switch which is convenient and inexpensive to manufacture, which is reliable in operation, and which utilizes a more economical manner of securing and electrically insulating one of the power leads of the switch relative to the switch case. Other objects and features will be in part apparent and in part pointed out hereinafter.

Briefly, a nonresettable thermally actuated switch of this invention comprises a case of electrically conductive material, a first power lead electrically connected to the case, a second power lead, and an insulator for securing the second lead relative to the case and for electrically insulating it from the case. A rigid cup-shaped separator member of insulating material having an open end and having a rim or edge around the open end is disposed within the case, and a normally solid body of material which is fusible at a selected temperature is disposed within the cup-shaped member. In addition, a force spreader member of a size slidable in the cup-shaped member is disposed in engagement with the body of fusible material at the open end of the cup-shaped member. A resilient deformable connector of electrically conductive material is disposed between the force spreader member and the second lead. Spring means are arranged within the case to bias the cup-shaped member for normally pressing the spreader member via the body of fusible material into engagement with the connector, thereby to hold the connector in electrical engagement with the second lead and to normally hold the connector in resilient electrical engagement with the case to complete a circuit while the fusible material is in solid condition. When the switch is subjected to a selected temperature so that the fusible material fuses, the force spreader member is permitted to slide into the cup-shaped member and the spring means bias the cup-shaped member into surrounding relation to the connector to the point where the cup rims abuts against the insulator which secures the second lead relative to the case. In this way, the cup-shaped member deforms the connector away from the inside surface of the case and encloses the connector to assure that it is electrically isolated from the case to break the circuit. The insulator which secures the second lead relative to the case has a central bore therethrough for reception of the second lead and the second lead has a stop formed thereon engaging an inner face of the insulator. In this arrangement, the insulator and second lead are insertable into one end of the case to engage an end of the second lead with the connector, thereby to compress the spring means via the force spreader member, the solid body of fusible material, and the cup-shaped member to establish a desired preload condition in the spring means. The insulator is then secured relative to the case to maintain the spring means in the desired preload condition.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an enlarged longitudinal section of the switch of this invention showing it in its operating position in which the current is carried from one power lead through the case to a connector and to another power lead;

FIG. 2 is a view similar to FIG. 1 showing the connector deformed away from the case thereby breaking the circuit; and

FIG. 3 is an enlarged end elevational view illustrating the deformable connector.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

BRIEF DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawings and more particularly to FIG. 1, a nonresettable (or one-time) thermally actuated switch of this invention, generally indicated at 1, is shown to comprise a cylindric case or housing 3 of electrically conductive material, such as formed from silver-plated red brass or the like. One end of the case is closed, as indicated at 5, and a first power lead or terminal 7 is secured in electrical contact with the closed end 5 of the case. A second power lead 9 is electrically insulated from the case and secured thereto by insulator and securement means 11. This second lead extends into an open end of the housing opposite closed end 5. A deformable connector 13 of electrically conductive material, such as silver sheet material or the like, is normally in electrical contact with an inside surface 15 of case 3 and in electrical contact with the inner end of lead 9. As generally indicated at 17, means are provided which are actuable in response to being heated above a predetermined ambient tem-

perature of deforming (i.e., bending) connector **13** away from inside surface **15** of case **3** and for electrically insulating the connector from the case thereby to break the circuit.

More particularly, lead **7** is shown to have a flange **19** adjacent its end and a short portion **21** extending beyond the flange insertable through an opening **23** in end **5** of case **3.** Once inserted through opening **23,** portion **21** is upset, as indicated at **25,** with flange **19** abutting end **5** of the case so as to positively secure the lead to the case in electrical contact therewith and to seal the case end.

Connector **13,** as best shown in FIG. **3,** is a star-shaped contact member having **8** bendable legs or contact portions **27** and a center portion **29.** The legs are each bent, as indicated at **31,** from the plane of the center portion so that only the outer peripheral edges **33** of the legs contact the inner surface **15** of case **3** thereby to provide electrical contact between the case and connector **13.** The center portion **29** of connector **13** is adapted to bear against the inner end of connector of power lead **9** thereby to complete the circuit between case **5** and lead **9.** As the span of connector **13** between opposed outer edges **33** is somewhat greater than the inside dimensions of case **3** and because its legs **27** are resilient, the legs bend inwardly upon being inserted in the case and thus are resiliently biased into contact with inside wall **15** of case **3** to provide good electrical contact between the case and the connector. While connector **13** is shown as star-shaped to provide readily deformable legs, it will be understood that connectors of other configurations, such as a cup-shaped, radially slotted connector may be used.

Means **17** for deforming connector **13** is shown to comprise a solid body **35** of fusible material, a force spreader member **38** engageable with the fusible body and with the center portion **29** of the connector **13,** a rigid, cup-shaped separator member **37** of ceramic or other electrically insulating material, and a spring **39.** The fusible material is preferably an organic compound or the like of a type well known in the art (see the patents previously noted) which remains solid upon being heated to a predetermined temperature but then rapidly changes state from a solid to a liquid with very small additional increase in temperature. Separator member **37** is spaced from connector **13** by the fusible body **35** and by the force spreader member **38** while the fusible body is in its solid preformed shape (i.e., before it melts). Separator member **37** has an edge **41** engageable with connector **13** for deforming the connector (i.e., for bending legs **27** of the connector) so as to break electrical contact between the legs and the inside surface of the case. Spring **39** is a compression coil spring interposed between end **5** of case **3** and the inner end of separator member **37** to bias the separator member, the fusible body **35,** the force spreader member **38** and the connector **13** to hold the connector in positive current-carrying engagement with the inner end of lead **9,** this inner end of lead constituting an abutment for connector **13.** Separator member **37** is a generally cylindric cup-shaped member having outer dimensions somewhat less than those of the inside of case **3.** In this arrangement the separator is freely movable longitudinally within the case from a retracted position (see FIG. **1**) in which the fusible material and the force spreader member maintain it spaced from connector **13** and an advanced circuit-breaking position (see FIG. **2**) in which its rim or edge **41** is moved between the case and the connector **13** and deforms the latter to break the circuit. Preferably as shown in FIG. **2,** the cup-shaped separator member **37** has sufficient depth for permitting the edge **41** of the cup-shaped member to engage the insulator and securement means **11** when the body **35** has been fused. Separator member **37** is movable from its retracted position (see FIG. **1**) to its circuit-breaking position by spring **39** upon fusible member **35** melting. It will be understood that with the separator in its retracted position, coil spring **39** is compressed in a preloaded position and contains sufficient stored energy to move the separator forward to deform legs **27** of connector **13** and to break the circuit.

Separator member **37** has a central bore or recess **43** having a base wall **45** at its inner end facing fusible member **35,** has cylindric side walls **46,** and has an edge **41.** The separator member **37** also has a shoulder **49** against which one end of spring **39** bears and a central hub portion **51** extending into the coil spring.

Fusible body **35,** like separator member **37** is cylindric and has a generally flat face **53** engageable with the force spreader member **38.** As shown, the fusible body **35** is preferably proportioned to fit entirely within the cup-shaped member **37.** The force spreader member **38** preferably comprises a disc of metal such as copper which is of selected thickness to rest on the fusible body **35** to extend a short distance out of the cup-shaped separator member **37** and which is of selected size or diameter slightly smaller than the inner dimensions of the cup-shaped member to substantially fill the open cup end and to be freely slidable in the cup-shaped member while permitting the fusible material of the body **35** to flow around the member **38** when the body melts. In this way, the spreader member **38** assures that the forces between the connector **13** and the fusible body **35** are distributed over a large area of the fusible body to avoid significant penetration of the body and to minimize the occurrence of any localized initial melting of the fusible body, such as might permit creep-like movement of the connector, when the body is heated close to the temperature at which the body material fuses.

Insulator and securement means **11** comprises an integral collar or stop **57** formed on lead **9** and spaced from the inner end of the lead. Means **11** further comprises an insulator ring **59** of a ceramic or other relatively rigid insulator material, such as is commercially available under the trade designation ALSIMAG 645 from American Lava Corporation of such as teflon, having a central aperture or opening **61** therethrough for reception of lead **9.** The outer diameter of insulator **59** is only slightly less than the inner diameter of the open end of case **3** so as to be conveniently insertable into the open end of case **3.** An inwardly projecting abutment or shoulder **63** within case **3** is engageable with the outer periphery of the inner face of the insulator upon inserting the insulator into the case and thus serves as a locating stop for the insulator to prevent inward movement of the insulator into the case beyond a desired point. Lead **9** with insulator **59** thereon is inserted endwise into the open end of case **3** until the inner end of lead **9** is positioned within the case such as is shown in FIG. **1.** The outer end of the case is crimped, as indicated at **65,** adjacent the back or outer face of insulator **59** thereby to positively secure and to electrically insulate lead **9** relative to the case. If desired, an epoxy potting or sealing compound **69** is dis-

posed around the lead **9** for sealing the lead in the case **3.** In this way, hermetic sealing of the device **10** is achieved.

As will be understood, the switch **1** as illustrated in FIG. **1** is adapted to be serially connected in an electrical circuit by connecting the leads **7** and **9** into the circuit. Upon switch **1** then being heated above a predetermined ambient temperature level, member **35** melts. Melting of the fusible material **35** permits the material to flow around the edge of the force spreader member **38** and permits spring **39** to rapidly move the separator member **37** from its retracted position shown in FIG. **1** to its circuit-breaking position shown in FIG. **2.** As separator **37** moves forward, its leading edge **41** engages legs **27** of connector **13** and forces the connector to bend to move the outer edges **33** of the connector away from the inner face **15** of case **3.** At the same time, the spreader member **38** is moved to the bottom of the cup-shaped separator. Upon continued further movement of separator member **37** by spring **39,** separator edge **41** moves the connector legs **27** completely away from the inner surface **15** of the case (i.e., to move radially inwardly toward lead **9**) to interrupt the switch circuit. Edge **41** of the separator then moves into engagement with the insulator ring **59** and thus provides a hard stop for the separator. With the separator in its circuit-breaking position, a portion of the insulator is interposed between the connector and the inside surface **15** of the case thereby to positively insulate the connector and lead **9** from the case. Further, the insulating separator **37** and the insulating ring **59** completely enclose the connector for assuring complete electrical isolation of the connector from the case even if the switch circuit should be subjected to unusually high potentials. It will be understood that upon melting of the organic material of member **35,** the melted organic material will merely pool (not shown in FIG. **2**) in the lower portion of case **3** and does not prohibit separator **37** from moving from its retracted to its circuit-breaking position. It will further be understood that the fusible material is not electrically conductive.

In assembling a nonresettable thermally actuated switch of this invention, spring **39,** separator **37,** member **35,** force spreader **38** and connector **13** are inserted in the above-stated order into the open end of case **3,** such as shown in FIG. **1.** Insulator ring **59** with lead **9** received in center bore **61** is inserted into the open end of the case until the inner face of the ring engages stop shoulder **63.** With the outer face of collar **57** on lead **9** in engagement with the inner face of insulator ring **59,** spring **39** is compressed to a desired preload position via connector **13,** force spreader **38,** member **35** and separator **37** as the insulator ring and lead **9** are inserted into case **3.** When insulator ring **59** is in engagement with shoulder **63,** spring **39** is compressed to its desired preload condition. The case **3** on the outer side of the insulator is then deformed or crimped around the insulator **59,** as indicated at **65,** to grip the insulator and to thus secure the insulator relative to the case and to maintain spring **39** in its desired preload condition. The sealant compound **69** is then added over the insulator as will be understood.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. A nonresettable thermally actuated switch comprising a case of electrically conductive material, first power lead means electrically connected to said case, second power lead means, means securing said second lead means relative to said case in electrically insulated relation to said case, a deformable connector of electrically conductive material in electrical engagement with said second lead means and normally in electrical engagement with said case to complete the electrical circuit between said first and second lead means, a cup-shaped separator of rigid electrically insulating material having an open end and an edge around said open end, a normally solid body of material fusible at a selected temperature disposed in said cup-shaped separator, a force spreader member of a size slidable in said cup-shaped separator normally disposed in engagement with said solid body of fusible material at said open end of said cup-shaped separator, and spring means biasing said separator to normally press said force spreader member via said fusible body against said connector to permit said connector to maintain said circuit while said fusible body is solid and for moving said separator when said fusible material is heated to said selected temperature to allow said force spreader member to move into said separator and to move said separator edge into engagement with said connector to deform and to separate said connector from said case to break said circuit.

2. A switch as set forth in claim **1** wherein said force spreader member normally extends a selected distance into said open end of said separator.

3. A switch as set forth in claim **2** wherein said force spreader member is of a size to substantially fill said open separator end while permitting said fusible material to move around said force spreader member when said fusible material is heated to said selected temperature.

4. A switch as set forth in claim **1** wherein said cup-shaped separator has a selected cup depth for permitting movement of said separator in response to bias of said spring means to abut said separator edge with said second lead securing means for enclosing said connector in said separator to isolate said connector from said case in breaking said circuit.

5. A switch as set forth in claim **1** wherein said means securing said second lead means relative to said case comprises a stop formed on said second lead and an electrical insulator having a central bore therethrough for reception of said second lead, said insulator having an inner face engageable by said stop thereby to prevent movement of said second lead in outward direction relative to said insulator, said insulator and said second lead being insertable in one end of said case so that the end of the second lead extends into said case beyond the inner face of said insulator and engages said connector means and compresses said spring means via said force spreader member, said fusible body and said separator to a selected preload condition, said insulator being secured relative to said case in position therewithin to maintain said spring means in said preload condition.

6. A nonresettable thermally actuated switch as set forth in claim **5** wherein the case includes an abutment

there-within engageable with said insulator for preventing inward movement of the insulator beyond a selected position within the case.

7. A nonresettable thermally actuated switch as set forth in claim **6** wherein said case is deformed inwardly adjacent the outer face of said insulator thereby to positively secure the insulator in said selected position within the case.

8. A nonresettable thermally actuated switch comprising a generally cylindrical case of electrically conductive material, having an open end and a closed end, a first power lead electrically connected to said case, a second power lead having a stop portion intermediate the ends of said second lead, an insulator ring having a central bore receiving said second lead and having a face engaging said second lead stop, said ring being disposed in said open case end with said face facing inwardly of said case, said case being deformed at said open case end for securing said ring relative to said case disposing said second lead in electrically insulated relation to said case, a deformable connector of electrically conductive material in electrical engagement with said second lead and normally in electrical engagement with said case to complete a circuit between said first and second leads, a cup-shaped separation of rigid electrically insulating material having an open end, having an edge around said open end and having a selected depth disposed within said case, a normally solid body of material fusible at a selected temperature disposed in said separator, a force spreader member of a size slidable in said separator normally disposed in engagement with said solid body of fusible material at said open end of said separator, and spring means disposed between said separator and said closed case end biasing said separator to normally press said force spreader member via said fusible body against said connector to permit said connector to maintain said circuit while said fusible body is solid and for moving said separator when said fusible material is heated to said selected temperature to allow said force spreader member to move into said separator and to move said separator edge between said connector and case to abut said ring to deform said connector and to isolate said connector from said case to break said circuit.

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