

[72] Inventor **Walter P. Graber**
Cadillac, Mich.
 [21] Appl. No. **885,026**
 [22] Filed **Dec. 15, 1969**
 [45] Patented **Oct. 12, 1971**
 [73] Assignee **Kysor Industrial Corporation**
Cadillac, Mich.

2,840,657 6/1958 Roeser 200/166 CT X
 2,395,007 2/1946 Leupold 337/315 X

FOREIGN PATENTS

ST10,179 11/1956 Germany..... 337/315

Primary Examiner—Bernard A. Gilheany
Assistant Examiner—Dewitt M. Morgan
Attorney—Price, Heneveld, Huizenga & Cooper

[54] **THERMAL-RESPONSIVE SWITCH**
 11 Claims, 10 Drawing Figs.

[52] U.S. Cl. **337/315,**
 200/166 CT, 337/327, 339/176

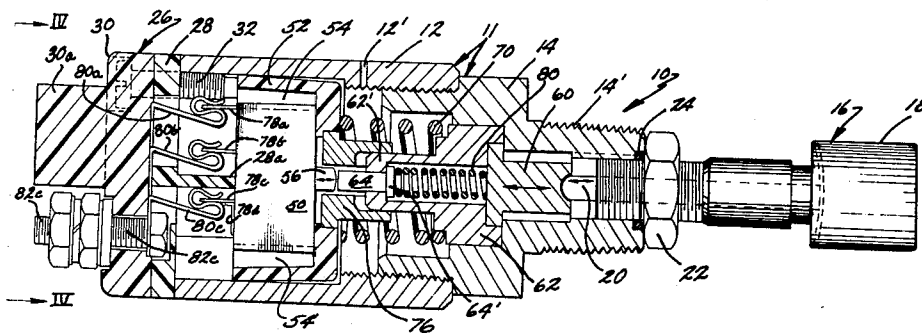
[51] Int. Cl. **H01h 3/00,**
 H01h 9/02, H01h 37/04

[50] Field of Search..... 200/153 T,
 166 CT; 337/314, 315, 327, 354, 388, 393, 394,
 398; 339/45 R, 45 M, 47 R, 47 C, 48, 49 R, 49 B,
 176

[56] **References Cited**
UNITED STATES PATENTS

3,082,306 3/1963 Howard..... 337/398 X

ABSTRACT: A thermal-responsive switch assembly of the type employing a temperature-responsive expansion means to shift electrical switch means. The switch means has terminal projections held in compressive engagement with cooperative terminal spring clips, such compression being by compressed biasing means that also functions as a return shifter for the temperature-responsive expansion means. The terminal spring clips are on the inner end of a special end cap removably secured to the switch assembly housing, such clips being separated by insulating fence means, and being electrically connected to external connector posts also separated by insulating fence means.



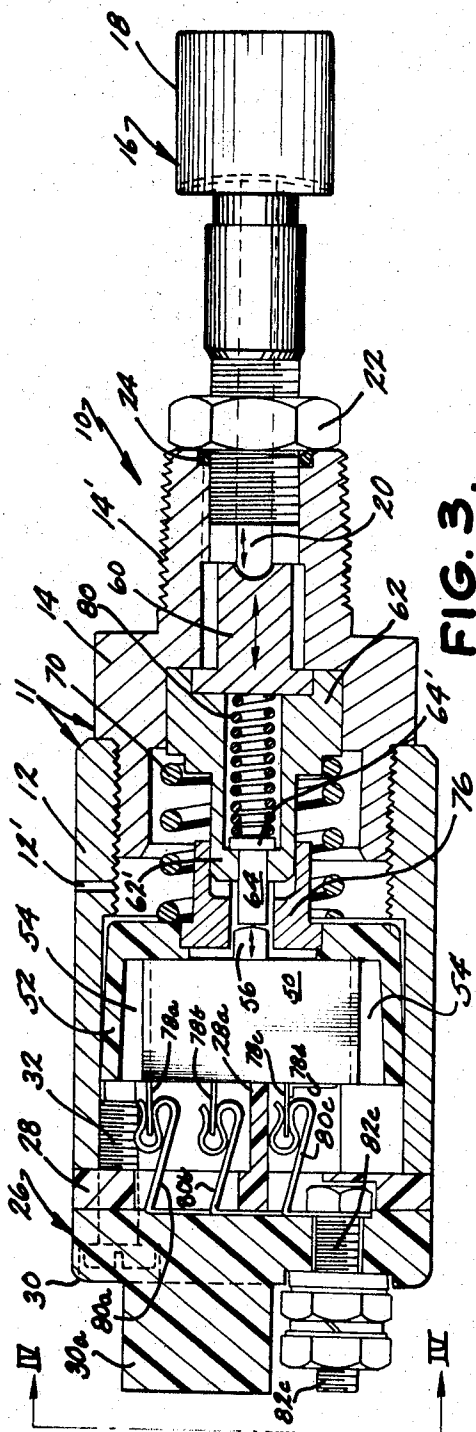


FIG. 3.

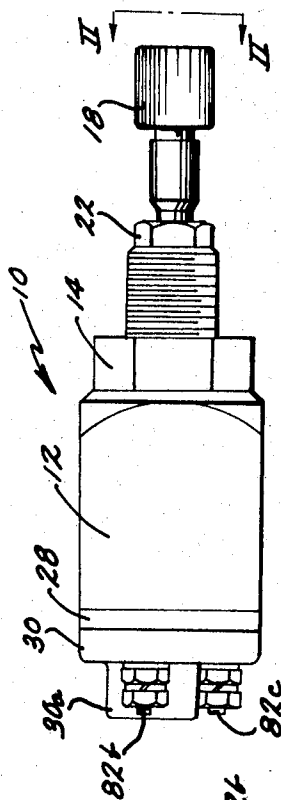


FIG. 1.

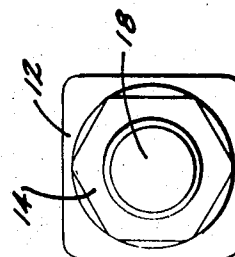


FIG. 2.

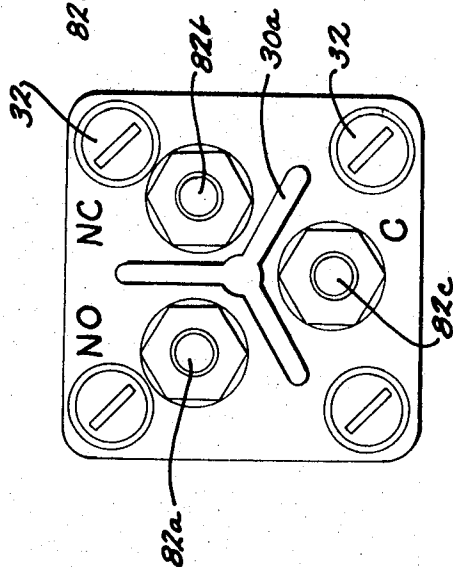


FIG. 4.

INVENTOR
WALTER P. GRABER
BY *Chas. H. Hensley*
Hensley & Cooper
ATTORNEYS

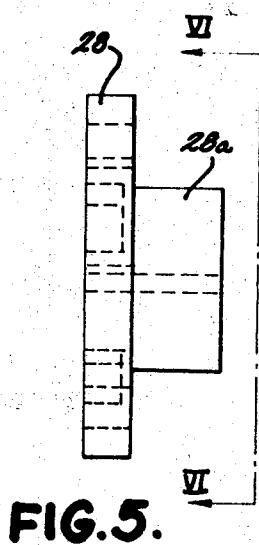


FIG. 5.

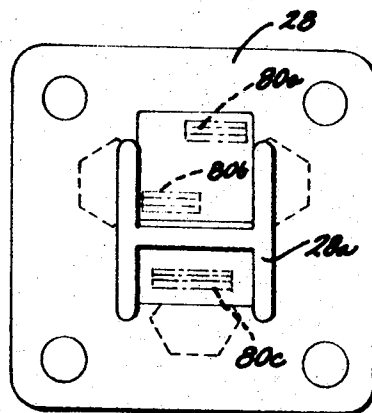


FIG. 6.

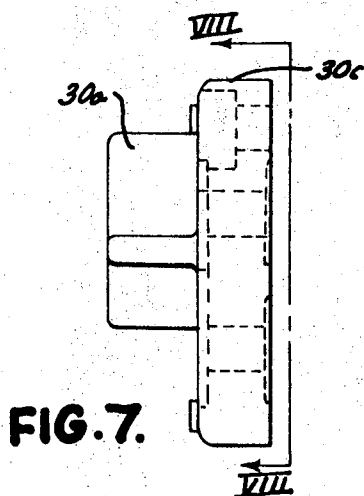


FIG. 7.

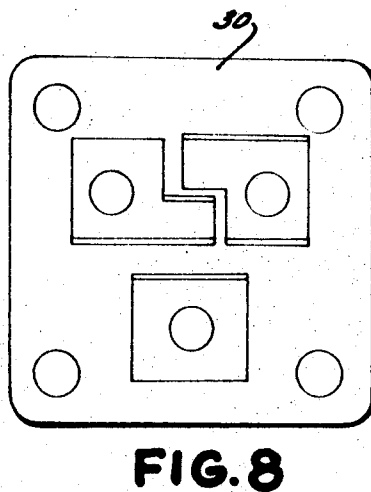


FIG. 8

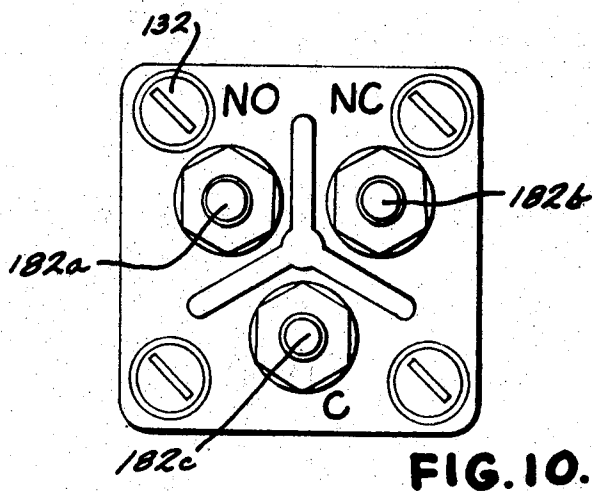


FIG. 10.

INVENTOR.
WALTER P. GRABER
BY *Quis, Kinsveld*
Hingens & Cooper
ATTORNEYS

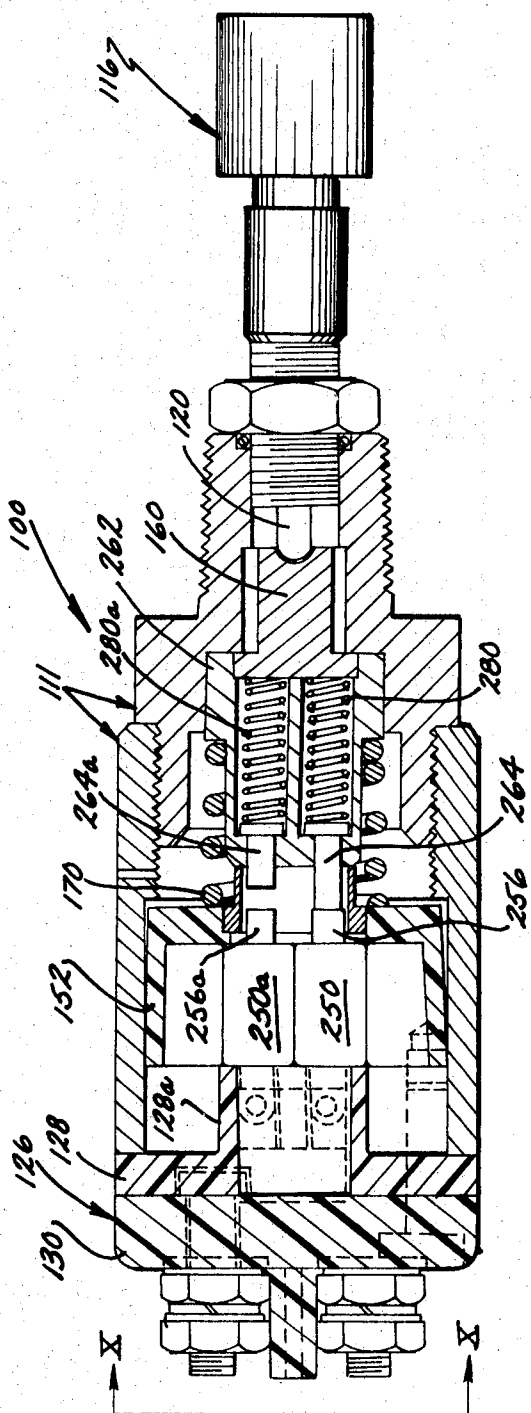


FIG. 9.

INVENTOR
WALTER P. GRABER
BY *Wm. Hennefeld*
Hingenga & Cooper
ATTORNEYS

THERMAL-RESPONSIVE SWITCH

BACKGROUND OF THE INVENTION

This invention relates to thermal-responsive switch assemblies, and more particularly to thermal switch assemblies having exceptional stability and reliability under rugged operational conditions.

Since vehicle engines are susceptible to self-destructive overheating under abnormal conditions that do occur, temperature-responsive switches have been employed heretofore to activate an alarm and/or engine shutdown when overheating is detected. Such units, although important for all vehicular engines, are crucial for engines of large commercial vehicles. This presents difficulties however. Specifically, because overheating is most likely to occur after an engine has logged many miles and hours, the switch units must remain inactive for long periods of time, subject to the constant and vigorous vibrations of the vehicle and engine, and yet be constantly reliable for instantaneous reaction with the occurrence of an overheating condition. Some assemblies have in the past been potted (with resin) to anchor the components. However, most of the components must be left free to move. Also, practical disassembly of a potted apparatus cannot be accomplished as for servicing.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a thermal-responsive switch assembly uniquely constructed to have excellent stability against vibrational failure. The assembly is particularly suitable for detecting overheated conditions in the cooling system of an internal combustion engine. The unit requires no potting. It is capable of simple disassembly for servicing. The internal components are specially retained under compression inside the housing, effecting stable electrical connections between slip-fitted terminal members. The spring functioning to provide this compression action has a dual function, for it also effects a return bias for the components that have extended with temperature actuated expansion.

Insulation fences separate the terminal posts on the assembly exterior, and separate the terminal connections on the assembly interior.

The thermal switch assembly has a housing enclosing the shiftable components. These components move in response to expansion of an exposed sensor. The components are under compression in the housing, effecting secure electrical engagement between the terminal fingers of an inserted switch device and cooperative spring clip terminals of the housing end cap. The cap has inner insulator fences between its spring clip terminals and outer insulator fences between its outer terminal posts.

Other features, advantages, and objects of the invention will be apparent upon studying the following specification and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of the novel switch assembly;

FIG. 2 is an end elevational view of the switch assembly, taken on plane II—II of FIG. 1;

FIG. 3 is an enlarged sectional view of the switch assembly in FIGS. 1 and 2;

FIG. 4 is an end elevational view of the switch assembly taken on plane IV—IV of FIG. 3;

FIG. 5 is an enlarged side elevational view of one portion of the end cap structure in the switch assembly;

FIG. 6 is an elevational view of the element in FIG. 5 taken on plane VI—VI of FIG. 5;

FIG. 7 is a side elevational view of the other portion of the end cap subassembly of the switch assembly;

FIG. 8 is an end elevational view of the end cap portion in FIG. 7, taken on plane VIII—VIII;

FIG. 9 is an enlarged sectional view of a second form of the novel switch assembly; and

FIG. 10 is an end elevational view of the assembly in FIG. 9, taken on plane X—X.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now specifically to the drawings, and firstly to the first embodiment illustrated in FIGS. 1—8, the novel thermal-responsive switch assembly 10 includes a housing composed of a hollow sleeve or body member 12, illustrated as generally rectangular or square in cross section, and a coupling or base 14 threadably attached to this body 12. Threadably engaged with one end of this housing 12, 14 is a temperature sensing and responsive subassembly 16. Subassembly 16 includes a thermally responsive actuating element or button 18 which may be any of several well known, commercially available items containing a thermally expandable material, usually a semisolid, which functions to extend a pushpin 20 therefrom when the temperature of the button increases. Sensor 16 is threadably connected to base 14, with nut 22 forming a locking means therebetween when sensing subassembly 16 is threadably inserted to the desired extent into housing subassembly 11. A ring seal 24 between nut 22 and base 14 seals this connection.

On the opposite end of housing subassembly 11, and specifically on the open end of body 12 opposite base 14 and sensor subassembly 16, is an end cap subassembly 26 composed of a first inner portion 28 and a second outer portion 30. A plurality of fasteners such as screws 32 secure both elements 28 and 30 to body 12 to close off this open end of the housing. Elements 28 and 30 are formed of a polymeric material having electrical insulating characteristics, e.g. nylon, Teflon, polypropylene, or the like. Positioned within body 12 is an electrical switch subassembly 50 basically of type in U.S. Pat. No. 2,840,657, the body of which is received within a pair of facing grooves 54 and 54' of a peripheral sleeve 52. This polymeric sleeve 52, having a circular periphery, is slidably engaged within the cylindrical inner periphery of body 12, so as to have a limited axial movement therein. Switch 50 includes a trigger 56 projecting therefrom toward sensor subassembly 16. Specifically, trigger 56 is arranged to cooperate with shiftable means affiliated with pushpin 20. This shiftable means includes member 60 engaging pushpin 20 on one end and engaging axially movable member 62 on its opposite axial end. Projecting from the opposite axial end of element 62 is a pin 64 aligned with trigger 56. Thus, axial movement of pushpin 20 causes axial movement of element 60, which in turn shifts element 62, which in turn shifts pin 64 to shift trigger 56 inwardly of switch 50. This movement of element 62, and thus of the entire shiftable means just noted, is against the bias of compression coil spring 70 abutting an axial face on one end of element 62, and abutting an axial face of sleeve 52 on the opposite end of the spring. Spring 70 is put under compression with assembly of the mechanism, as explained more fully hereinafter, but this shifting of the components with extension of pushpin 20 causes the spring to be put under further compression so that, with subsequent contraction of the material in bulb 18 and retraction of pushpin 20, the mechanism can be returned by spring 70 to the initial condition. Pin 64 has a portion protruding into engageable position with trigger 56, and also has its opposite end portion in slidable relationship within the nose of hollow element 62. Within element 62 is an enlarged head 64' on pin 64 limiting extension of pin 64 from element 62, and engaging a second smaller compression coil spring 80 within element 62 and engaging the axial end of element 60 opposite pushpin 20. The purpose of spring 80 is to allow pin 64 to depress trigger 56 until the switch is thrown, after which any excess extension of the shiftable means from excess expansion of the semisolid within sensor 18 compresses spring 80 to prevent damage to the switch by overextension of trigger 56 and the internal mechanism of the switch. The bias of compression spring 80 subsequently returns the pin to its position with head 64' in engagement with the nose of element 62, when the shiftable means is retracted.

Vent 12' in housing 12 enables the components within the housing to shift without creating a compressed air pocket. The nose of element 62 and hence pin 64 are kept aligned with trigger 56 by sliding engagement of the nose 62' of element 62 with a surrounding sleeve 76 that rests against sleeve 52.

Switch trigger 56 is biased to its most extended position by spring means within switch 50 in the fashion illustrated in U.S. Pat. No. 2,840,657. The switch is in one thrown condition normally. When trigger 56 is shifted inwardly of the switch, the switch is thrown to the opposite position against the bias. Extending from the opposite axial face of switch 50 from trigger 56 is a plurality of electrical terminal fingers 78a, 78b, 78c, and 78d. In this particular construction illustrated, 78d is interconnected to 78c to act as a common terminal. Hence, this common terminal will be in circuit with terminal finger 78a in one position of the switch, and in circuit with terminal finger 78b in the second position of the switch.

These three axially protruding terminal fingers are in sliding contacting engagement with three physically and electrically separated spring clip terminals 80a, 80b, and 80c. The base portions of these spring clip terminals are secured to end cap portion 30 by three studs 82a, 82b, and 82c which also project through the end cap and beyond to form electrical terminal posts as illustrated. The inner ends of these spring clip terminals 80a, 80b, and 80c are configured to have a limited spring action, preferably by extending slightly diagonally toward the terminal fingers 78a, 78b, and 78c, and include generally U-shaped portions providing axially oriented receiving slots between the legs of the U for the terminal fingers 78a, 78b, and 78c.

The length of compression spring 70 is purposely made of a length to necessitate it being put under compression when end cap assembly 26 is forced into engagement with the end of housing or body 12 for connection of screws 32. Hence, when screws 32 are tightened down to secure the assembly, terminal fingers 78a, 78b, and 78c are forced into tight engagement with spring clip terminals 80a, 80b, and 80c no matter which position trigger 56 of switch 50 is in, i.e. no matter whether the sensor 18 is exposed to a low or high temperature, enabling the assembly to maintain good electrical contact between these slidably interfitted components, in spite of the extensive vibration to which this assembly is normally subjected.

Switch 50 is retained in position in its receiving sleeve 52 by having the inner edge of an H-shaped insulating fence 28a (FIGS. 3, 5, and 6) on end cap element 28 engage the axial face of switch 50 from which terminal fingers 78a, 78b, and 78c protrude. This projecting fence therefore serves a dual function. For clarity, the position of spring clips 80a, 80b, and 80c with respect to this fence are illustrated in phantom lines in FIG. 6.

Also, preferably an electrical insulating fence 30a is provided on the outer face of end cap portion 30, this fence being composed of three radially extending fence walls separating the three terminal posts to prevent accidental shorting between them.

In normal usage, the apparatus is intended to cause an alarm to be activated, or alternately to shut down a vehicular electrical system or the like upon sensing the abnormally high temperature condition. Typically, the sensor bulb 18 is positioned within the coolant flow circuit of a vehicle, such attachment being made for example by threadably connecting body 14 with threads 14' to a drilled and tapped hole in the wall of the coolant system. Electrical connections of the controlled circuit are made to terminal posts 82a, 82b, and 82c. Upon bulb 18 sensing an abnormally high temperature of the coolant, extension of pushpin with expansion of the semisolid within bulb 18 causes elements 60, 62, and 64 to extend axially (to the left as the unit is illustrated in FIG. 3) shifting switch trigger 56 inwardly to throw the switch 50 to activate a visual and/or audio alarm, shut down the engine, or both. Excess extension of pushpin 20 and elements 60 and 62 causes element 64 to compress safety spring 80, preventing overextension of trigger 56 to damage switch 50. Movement of element 62 is also against

the bias of compression spring 70, such that, when the high-temperature condition no longer exists, and contraction of the semisolid material in bulb 18 retracts pushpin 20, spring 70 will return elements 60, 62, and 64 to their original position, allowing switch trigger 56 to extend again and reverse the switch due to the bias of the internal return spring in switch 50.

Because of the unique structure of the mechanism of this assembly, the switch can remain in a dormant position for many hours, subjected to the vibrations of the engine and vehicle in general, yet be instantly responsive to the condition to be sensed.

In FIGS. 9 and 10 is illustrated another form of the novel device, very similar to the previous form already described, except that the axially shiftable means is capable of activating two switches sequentially. This can, for example, first cause an alarm with a predetermined elevated undesirable temperature, and subsequently shut down the engine with a predetermined higher undesirable temperature condition. This assembly 100 includes the same sensor subassembly 116 and basically the same housing subassembly 111 with its end cap subassembly 126. Likewise, the pushpin 120, shiftable axially with expansion of the sensor means, engages like element 160 which in turn is axially engaged with a modified element 262. Element 262 supports two pushpins 264 and 264a, each protruding from the forward axial end of element 262, and having respective safety springs 280 and 280a to account for excessive extension of the axially shiftable means. These respective pins 264 and 264a cooperate with switches 250 and 250a respectively which are retained within an axially slidable sleeve 152 by the fence 128a of end cap portion 128. Switches 250 and 250a include protruding triggers 256 and 256a respectively aligned with pins 264 and 264a to be shifted thereby. The terminal fingers of these two switches interengage with terminal spring dips attached to end cap portion 130 in the same fashion as previously, to complete an electrical connection to the three terminal posts 182a, 182b, and 182c. The end cap means is secured to the housing by screws 132, putting the slide connections between the spring clips and the terminal fingers under compression, due to the compression of coil spring 170 between the axial face of sleeve 152 and an axial face of element 262.

Pins 264 and 264a are made of a different length to cause triggers 256 and 256a to be thrown sequentially with continued axial extension of the shiftable means in response to expansion of the semisolid sensor material in the sensor assembly 116. Specifically, as pushpin 120 extends away from the sensor bulb, i.e. to the left as the unit is illustrated in FIG. 9, and pushes element 160, and as element 160 pushes element 262, first pushpin 264 will engage and axially shift trigger 256 of switch 250, causing it to throw, with subsequent further movement of the shifting means causing compression of spring 280 by pin 264. This could activate an alarm, for example. Subsequently, if the engine overheats still further, continued shifting of the elements 160 and 262 to the left (FIG. 9) would ultimately cause pin 264a to engage and shift trigger 256a of switch 250a, to throw another circuit, e.g. to shut down the engine.

It is entirely conceivable that certain details of this construction may be modified without departing from the concept presented herein. Hence, the invention is intended to be limited only by the scope of the appended claims and the reasonable equivalents thereto, rather than by the specific details of the illustrative embodiments described.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A thermal-responsive switch assembly comprising: a housing; expandable thermal sensor means at one end of said housing; shiftable means extending from said expandable sensor means in said housing; electrical switch means in said housing including trigger means cooperatively arranged with respect to said shifting means to be shiftablely actuated thereby; said switch means having terminal fingers extending

5

therefrom; spring clip terminal means secured in said housing and in engagement with said terminal fingers by a slip fit; and biasing means in said housing arranged to bias said switch means toward said spring clip terminal means sufficiently to put said slip fit engagement under compression.

2. The assembly in claim 1 wherein said biasing means comprises spring means positioned to bias said switch means as defined, and also to apply a return bias on said shiftable means toward said thermal sensor means.

3. The assembly in claim 1 wherein said shiftable means is resiliently compressible between said trigger means and said sensor means to compress and absorb excess expansion of said sensor means toward said shiftable means after shiftable activation of said trigger means.

4. The assembly in claim 2 wherein said shiftable means is resiliently compressible between said trigger means and said sensor means to compress and absorb excess expansion of said sensor means toward said shiftable means after shiftable activation of said trigger means.

5. The assembly in claim 1 including end cap means secured to the opposite end of said housing from said sensor means, with said spring clip terminal means on the inside thereof, and having terminal posts on the outside thereof.

6. The assembly in claim 5 including electrical insulator fences between said spring clip terminal means and electrical insulator fences between said terminal posts.

7. The assembly in claim 1 wherein said switch means includes dual trigger means, and said shiftable means includes dual shifting portions aligned with said dual trigger means but spaced different amounts with respect thereto to activate said dual trigger means sequentially with expansion of said sensor means.

6

8. The assembly in claim 7 wherein each of said dual shifting portions is compressible between said trigger means and said sensor means to compress and absorb excess expansion of said sensor means toward said shifting portions after shifting activation of said trigger means.

9. The assembly in claim 1 including a receptor supporting said switch means and mounted for limited movement in said housing by said biasing means.

10. The assembly in claim 1 wherein said trigger means extends from said switch means toward said shifting means, and said terminal fingers extend from said switch means in the opposite direction as said trigger means.

11. A thermal responsive switch assembly comprising; a housing; expandable thermal sensor means at one axial end of said housing; end cap means removably secured to the opposite axial end of said housing; switch means in said housing, having limited axial movability therein; said switch means including a trigger means protruding toward said sensor means, and a plurality of terminal elements protruding toward said end cap means; said end cap means having a plurality of terminal members slidably interfitting with said switch terminal elements; compression spring means in said housing positioned to be compressed by said switch means with attachment of said end cap means to said housing for forcibly retaining said terminal elements and terminal members in engagement; trigger-shifting pusher means between said sensor means and said trigger means; and said compression spring means operably engaging said pusher means to alternatively be compressed by said pusher means and then to extend to return said pusher means.

35

40

45

50

55

60

65

70

75