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DUPLEX THERMAL SWITCH WITH A U-SHAPED BI-METAL MEMBER EACH LEG OF WHICH BEING INDIVIDUALLY OPERABLE AND ADJUSTABLE

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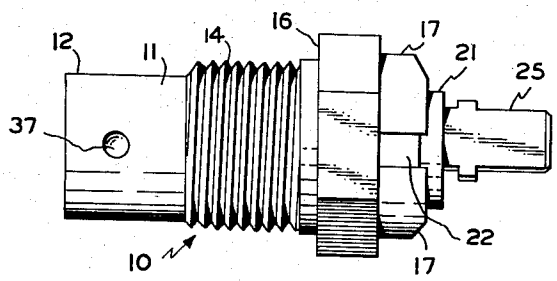


FIG.1

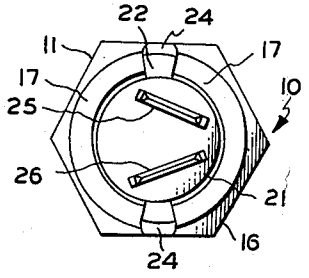


FIG.2

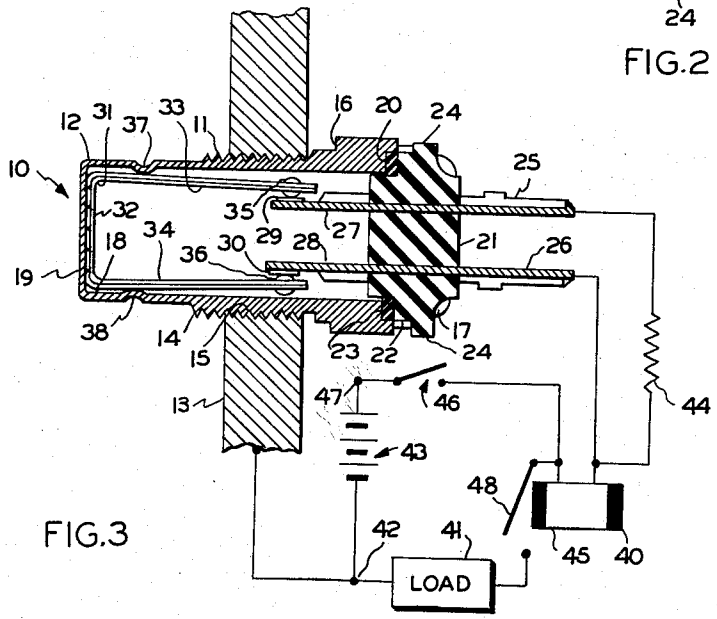


FIG.3

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DUPLEX THERMAL SWITCH WITH A U-SHAPED BI-METAL MEMBER EACH LEG OF WHICH BEING INDIVIDUALLY OPERABLE AND ADJUSTABLE

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This invention relates to a duplex thermal switch mounted in a sealed envelope for immersion in a fluid and particularly to such a switch having two bimetallic contact elements individually responsive to variations in the temperature of the fluid to control a pair of electrical circuits.

In heating systems and the like, it is customary to use one or more thermal switches to control the temperature of a fluid in which the thermal switch is immersed. Such thermal switches are hermetically sealed and include a bimetal element which responds to changes in fluid temperature to operate circuit opening and closing contacts. In certain instances, it is desirable to employ a duplex thermal switch having two bimetal elements individually operable at different temperatures for individual control of two circuits.

An object of this invention is to provide an improved duplex thermal switch of the type set forth in the preceding paragraph which is simple in construction, inexpensive to manufacture, small in size and reliable in operation.

Another object of this invention is to provide a sealed duplex thermal switch having the above advantages which has a fast heat response and may be accurately calibrated to provide accurate control of the heating circuit in which it is used.

These objects are attained by a thermal switch comprising a metal tubular housing having a closed end to which the base of a generally U-shaped bimetal member is secured in electrical and heat conducting relation. The two legs of the bimetal member extend lengthwise within the housing adjacent opposite sides thereof toward the open end of the housing. A terminal cap of insulating material is secured in the open end of the housing and carries two terminal contact members which extend within the housing for cooperation with the free contact end portions of the two bimetal legs. The two bimetal legs are individually adjusted or calibrated to operate their respective contact ends at predetermined temperatures by means of indentations or dimples formed in opposite sides of the housing. The indentations or dimples each have a required inward displacement to engage the respective bimetal leg near its supported end and to provide the required stressing of the bimetal leg to effect its operation at the predetermined temperature.

Other objects and features of the invention will be apparent from a consideration of the following description of the invention and the accompanying drawing, in which:

FIGURE 1 is a plan view of a duplex thermal switch embodying the present invention;

FIGURE 2 is a top view of the thermal switch shown in FIGURE 1; and

FIGURE 3 is a sectional view of the thermal switch of FIGURE 1 shown inserted in the threaded opening of a fluid-containing device.

As shown in the drawing, the duplex thermal switch 10 of this invention has a generally cylindrical tubular housing or casing 11 of brass, stainless steel or other suitable corrosion-resisting metal having high heat conductivity. The housing 11 comprises a closed end portion 12 adapted to be surrounded by fluid in a container 13 partially shown in FIGURE 3, an externally threaded portion 14 adapted for screw engagement with the threaded opening 15 of the container 13, a shoulder 16 having a hexagonal external surface for accommodating a turning tool during installation of the switch 10 in the container 13, and a flange portion at the open end of the housing 11 consisting of two flanges 17. The housing 11 has an internal cylindrical bore 18 extending to the end wall 19 at the end portion 12 and enlarged counterbore 20 adjacent the open end of the housing 11. While the portions of the housing 11 may be formed as an integral unit as shown in the drawing, it is apparent the housing 11 may also consist of two or more parts suitably secured together.

The open end of the housing 11 is closed by an insulator cap 21 of suitable insulating material such as a phenolic thermosetting resin. The cap 21 is generally cylindrical with an intermediate rim portion 22 which is seated in the housing counterbore 20 upon a gasket washer 23. The rim portion 22 is provided with two diametrically opposite lugs 24 which extend between the flanges 17 of the housing 11 to prevent turning of the cap 21. The flanges 17 are crimped over the rim portion 22 to secure the cap 21 with the gasket washer 23 in sealed assembled relation with the housing 11. The cap 21 is molded about two contact terminal members 25 and 26 which terminate within the housing, respectively, in parallel, spaced-apart contact arms 27 and 28. At their ends, the contact arms 27 and 28, respectively, carry the fixed electrical contacts 29 and 30 which each face the adjacent side wall of the housing 11.

Disposed within the bore 18 of the housing 11 is a generally U-shaped bimetal strip 31 which consists of a generally flat and rectangular base 32 and two transverse legs 33 and 34 which are equal in length and generally perpendicular to the base 32. The base 32 is secured by welding to the housing end wall 19 to provide cantilever mounting for the two legs 33 and 34. The legs 33 and 34 extend along the inner side wall of the housing bore 18 with their respective free ends disposed adjacent the contact arms 27 and 28. The free end of the leg 33 carries a movable electrical contact 35 cooperable with the fixed contact 29 and the free end of the leg 34 carries a movable electrical contact 36 cooperable with the fixed contact 30. As the base 32 is mounted directly upon the housing end wall 19 and the legs 33 and 34 extend along substantial portions of the housing 11, the bimetal strip 31 is extremely sensitive to the temperature changes to which the housing 11 is subjected.

The bimetal strip 31 is composed of superposed layers of metal having different temperature coefficients of expansion such that when it is heated the legs 33 and 34 will deflect toward each other. The bimetal strip 31 is of an initial shape at ordinary temperatures that its legs 33 and 34 are inherently biased or resiliently urged apart so that the contact pairs 29–35 and 30–36 are separated. Thus, when the temperature of the strip 31 rises the two legs 33 and 34 will individually move to close their respective contact pairs. The legs 33 and 34 are individually calibrated to close their respective contact pairs at predetermined temperatures by means of indentations or dimples 37 and 38 permanently formed in the wall of the housing end portion 12 opposite the legs 33 and 34 near their supported ends. The dimples 37 and 38 are indented into the housing end portion 12 with just the proper abutting engagement with the respective bimetal legs 33 and 34. This desired engagement is such that the legs 33 and 34 are stressed to the extent necessary to accomplish their closing of the respective

contact pairs 29–35 and 30–36 at the desired temperature.

In calibrating the thermal switch 10, it is heated to the temperature at which one bimetal leg is to operate. A dimple is then pressed in the housing against the bimetal leg with a punch or other suitable tool until the movable contact of the bimetal leg engages its respective fixed contact. Such engagement may be indicated by a lamp connected in circuit with the contacts. The thermal switch is next heated to the temperature at which the other bimetal leg is to operate and a similar forming of its respective dimple is performed. In the event either bimetal is improperly calibrated at an operating temperature higher than that desired, the housing end portion 12 may be pressed together slightly at portions located at 90° with respect to the dimples 37 and 38. This flattens the housing end portion 12 somewhat to reduce the stressing effect of the dimples upon the bimetal legs and the thermal switch 10 may be re-calibrated with the above described procedure.

In FIGURE 3 there is shown a wiring diagram of an automotive vehicle heating control circuit employing the thermal switch 10. In this circuit, the thermal switch 10 is responsive to the temperature of the vehicle engine cooling liquid in the container 13 to control the energization of a relay 40. The relay 40, in turn, controls a load means 41, which may be, for instance, a motor driven fan which forces air through a heat exchanger to cool the heated cooling fluid of the vehicle engine. The threaded connection of the switch housing 11 with the container 13 electrically connects the housing 11 to the container 13 which is connected to the grounded terminal 42 of the vehicle battery 43. The switch terminal 25 is connected by a resistor 44 to one end of the relay coil 45 while the other switch terminal 26 is connected directly to the same one end of the coil 45. The other end of the coil 45 is connected by the control switch 46 to the terminal 47 of the battery 43. The temperature varying load means 41 is connected to the battery terminal 42 and one contact of the normally open relay switch 48. The other contact of the relay switch 48 is connected by the switch 46 to the battery terminal 47.

For use in the control circuit of FIGURE 3, the thermal switch 10 is calibrated such that it will require a temperatrue rise of the bimetal leg 33 to a first predetermined temperature to effect engagement of the contacts 29 and 35 and a temperature rise of the bimetal leg 34 to a second slightly higher predetermined temperature to effect engagement of the contacts 30 and 36. For example, the leg 33 may close at 205° F. and the leg 34 may close at 210° F. Thus, as the temperature of the cooling fluid in the container 13 rises after the vehicle engine has been started, the bimetal leg 33 will move the contact 35 into engagement with the contact 29. This completes a holding circuit established from the battery terminal 47 through the switch 46, relay coil 45, resistor 44, terminal 25, contacts 29 and 35, bimetal leg 33, housing 11 and casing 13 back to the battery terminal 42. The resistor 44 has a resistance value such that insufficient current passes through the relay coil 45 to operate switch 48 to a closed position. As the temperature of the cooling fluid further increases, the bimetal leg 34 subsequently moves the contact 36 into engagement with the contact 30 to establish an energizing circuit from the battery terminal 47 through the switch 46, relay coil 45, terminal 26, contacts 30 and 36, bimetal leg 34, the housing 11 and back through the container 13 to the battery terminal 42. The relay coil 45 is now energized with the entire voltage of the battery 42 and will close the relay switch 48 to energize the load means 41. The load means 41 acts to reduce the temperature of the cooling fluid causing the bimetal leg 34 to re-open the contacts 30 and 36. This interrupts the above mentioned energizing circuit but a reduced current still flows through the initially energized holding circuit which is sufficient to maintain the relay switch 48 closed. The load means 41 continues its cooling of the cooling fluid until the bimetal leg 33 opens the contacts 29 and 35, to completely deenergize the relay coil 45 and allow the relay switch 48 to open. The load means no longer will cool the cooling fluid and as the temperature of the cooling fluid again rises, the above cycle of operation will be repeated.

It will be noted that in the above described control circuit, the load means 41 is operated with a positive action because only the first closing of the contacts 30 and 36 and the first opening of the contacts 29 and 35 controls the operation of the relay 40. Further, the operating differential of the control circuit, that is, the temperature difference required to effect energization and deenergization of the load means 41, may have a very low value since the present invention provides for accurate calibration of the operating temperatures of the two bimetal legs.

While the duplex thermal switch of the present invention has been shown and described as of utility in a specific heating control circuit, it is obvious that its use is not limited to such a circuit and that it may be employed for other temperature control and indicating functions. It will also be realized that by forming the bimetal strip with a reversed arrangement of its layers, the thermal switch may be constructed to individually open normally closed contact pairs upon a temperature rise to different predetermined temperatures.

Although a specific embodiment of the invention has been shown and described, it is to be understood that the invention is not to be limited to the precise details herein shown and described since the same may be carried out in other ways falling within the scope of the invention as claimed.

What is claimed is:

1. A duplex thermal switch for controlling a pair of electrical circuits comprising:

(*a*) a tubular housing of high heat conductive metal having an open end and a closed end adapted for immersion in a fluid;

(*b*) a terminal cap of insulating material secured in the open end of said housing;

(*c*) two contact terminal members secured in said terminal cap and extending in spaced apart relation into said housing toward said closed end;

(*d*) a temperature responsive element positioned within said housing and comprising a flat strip of bimetal material bent intermediate its ends to form a generally U-shaped member having a base section and two leg sections;

(*e*) said closed end of the housing having an end wall to which said base section is secured in electrical connection to provide cantilever mounting of said two leg sections in substantially parallel, laterally extending spaced relationship, said leg sections extending lengthwise within said housing adjacent opposite sides of the inner walls thereof toward said terminal cap and being individually movable independently of each other in response to temperature change;

(*f*) one of said leg sections having a free contact end portion adapted to move into and out of electrical contact with one of said contact terminal members in response to changes in temperature of said one leg section;

(*g*) the other of said leg sections having a free contact end portion adapted to move into and out of electrical contact with the other of said contact terminal members in response to changes in temperature of said other leg section;

(*h*) each of said opposite sides of said housing adjacent the supported ends of said leg sections having a permanent indentation extending toward and engaging a respective leg section of said U-shaped member to provide individual adjustment of the contact-operating temperatures of said leg sections independently of each other; and

(*i*) means on said housing for providing an electrical connection to said housing end wall.

2. A duplex thermal switch for controlling a pair of electrical circuits comprising:

(*a*) tubular housing of high heat conductive metal having an open end and a closed end adapted for immersion in a fluid;

(*b*) a terminal cap of insulating material secured in the open end of said housing;

(*c*) first and second contact terminal members secured in said terminal cap and extending in spaced relation within said housing toward said closed end;

(*d*) first and second fixed electrical contacts secured, respectively, to said first and second contact terminal members;

(*e*) a temperature responsive element positioned within said housing and comprising a flat strip of bimetal material bent at an intermediate portion to form a generally U-shaped member having a base section and two generally parallel leg sections;

(*f*) said closed end of the housing having an end wall to which said base section is secured in electrical and heat conducting relation to provide cantilever mounting of said leg sections in substantially parallel, laterally spaced relationship, said leg sections extending lengthwise within said housing adjacent opposite sides of the inner walls thereof toward said terminal cap and being individually movable independently of each other in response to temperature change;

(*g*) a first movable electrical contact carried by one of said leg sections and adapted to engage and disengage said first fixed contact in response to changes in temperature of said one leg section;

(*h*) a second movable electrical contact carried by the other of said leg sections and adapted to engage and disengage said second fixed contact in response to changes in temperature of said other leg section;

(*i*) each of said opposite sides of the housing adjacent said leg sections having a permanent indentation extending toward and engaging a respective leg section near the cantiliver-mounted end thereof and to provide individual and independent adjustment of the contact operating temperatures of said leg sections; and

(*j*) means on said housing for providing an electrical connection to said end wall of the housing.

3. A duplex thermal switch according to claim 2 wherein each of said leg sections is formed to have an inherent resiliency urging it toward its respective adjacent side of said housing at ordinary temperatures, said indentations each having a predetermined inward displacement providing the required stressing of the respective leg section to effect contact operation thereby at a predetermined temperature.

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