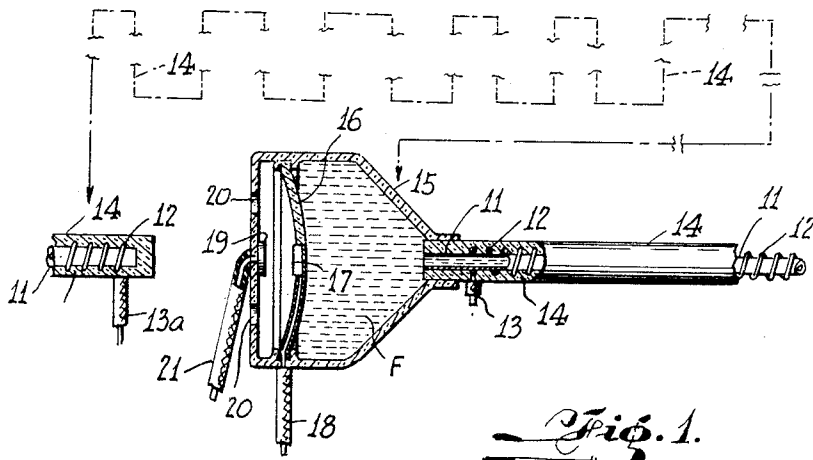
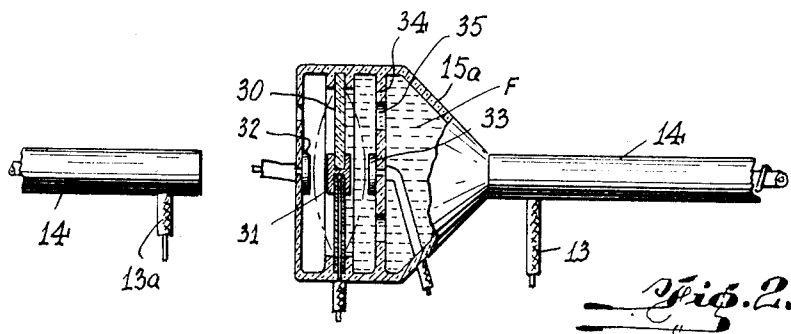
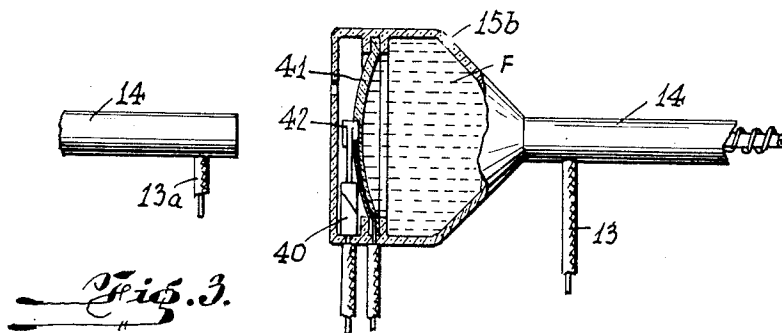


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THERMALLY OPERATED DIAPHRAGM SWITCH
DEVICE FOR ELECTRIC CIRCUITS
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THERMALLY OPERATED DIAPHRAGM SWITCH DEVICE FOR ELECTRIC CIRCUITS

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The present invention relates to protective devices and more particularly to temperature responsive protective devices adapted to control electric circuits in accordance with temperature changes.

While not limited thereto, the present invention has particular utility as a protective device for preventing over-heating of flexible electric heaters such as electric blankets, electric heating pads and the like, which employ a flexible heating member.

The conventional electric heating unit of the above type comprises a fabric covering having woven or stitched channels through which are threaded electric heating conductors. These conductors are energized from a suitable source of supply and generate sufficient heat to maintain the unit at some desired temperature during normal conditions of operation. Considering an electric blanket, for example, it occasionally happens that during use the blanket becomes bunched or folded, or after use is rolled up at the bottom of the bed while still energized. Under such conditions, the heat lost from the folded or rolled section of the heating conductor is greatly reduced, and this tends to cause localized heating with the attendant possibility of fire. The main temperature control units presently in use are unresponsive to a local rise in temperature because, at most, they respond only to the average temperature of the entire blanket. Therefore, protective thermostatic devices have been incorporated in the body of the blanket adapted to open the heating circuit in the event of excessive heating within the neighborhood of the respective device. Heretofore, these devices have taken the form of bi-metallic strips cooperating with electrical contacts. Considerable difficulty has been encountered, however, with conventional constructions in obtaining satisfactory electro-mechanical operation, and numerous expediences have been resorted to. Furthermore, these devices are only suitable for being placed at selected points within the blankets and, therefore, do not afford adequate protection because the blanket acts as an insulator and does not readily transfer heat from one locality to another so that a hot spot in the vicinity of a thermostatic device may not cause the device to operate.

It is, therefore, an object of the present invention to provide an improved protective thermostat which will afford greater protection than those devices known heretofore.

A more specific object of the invention is to provide a protective thermostat which will be coextensive with the convolutions of the heating conductor to thereby afford substantially complete protection of the electric circuit in question.

A still further object of the invention is to provide a protective device of the above nature which relies for its operation upon the volumetric expansion qualities of a fluid at its boiling point as it changes into the gas phase.

Another object of the invention is to provide a fluid operated temperature responsive switch which is inherently fail-safe in nature.

Further objects and advantages will become apparent from the following description when read in connection with the accompanying drawing, in which:

Fig. 1 shows an embodiment of the invention to an exaggerated scale with portions shown in section for illustration.

Figs. 2 and 3 are views similar to Fig. 1, but showing modifications.

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Referring to the drawing, there is shown a heating conductor constructed in accordance with the invention, the ends alone being illustrated. It should be understood that the conductor extends throughout the entire area of a blanket or similar article as indicated diagrammatically in Fig. 1. The conductor consists of a hollow tubular member 11, which extends throughout the entire length of the conductor. The conductor itself, designated by the reference numeral 12, is wound upon the tubular member 11, as shown, the ends being brought out at 13 and 13a for connection to the source of power. Suitable insulation 14 surrounds the conductor 12. The entire combination including the tube 11, the conductor 12 and the insulation 14, must be constructed so as to be flexible and yet resist internal collapse under the pressure which might be exerted by the weight of a human body. The member 11 is preferably constructed from one of the plastics materials such as polyethylene or trifluorochloroethylene or polyvinylalcohol and may have a wall thickness of $\frac{3}{64}$ of an inch with an inside diameter of $\frac{1}{4}$ of an inch. As will be apparent, these dimensions are not critical but solely a function of the material employed and the use to which the protected conductor of the invention will be applied.

One end of the heating conductor has the tubular member 11 protruding from the insulated conductor and sealed to an enlarged vessel 15. The other end of tubular member 11 is sealed in a suitable manner, as shown. Vessel 15 contains a diaphragm 16 which may be constructed from metal or plastics and which is provided with an electrical contact 17, as shown. Obviously a bellows (not shown) may be substituted for the diaphragm. Wire 18 is connected to the metallic diaphragm, or directly to contact 17, if diaphragm 16 is non-conductive, for connecting contact 17 to an external circuit. A second electrical contact 19 is located on the outer wall of the vessel 15, adjacent contact 17, and is provided with a lead 21 for external connection. The space enclosed by the tubular member 11, as well as the vessel 15 to the right of the diaphragm is filled with a fluid F, such as water, under sub-atmospheric pressure, causing the diaphragm 16, whose outer surface is exposed to the atmosphere through a plurality of apertures 20, to curve inwardly thereby maintaining contacts 17 and 19 in spaced-apart relationship. Instead of water, it is possible to use organic or inorganic fluids whose boiling points are in the neighborhood of 180° F. or whatever temperature the device is intended to function at. However, it is important that the selected fluid be inert to the material forming the tubing and that the tubing material have a low enough permeability to the fluid so that the fluid will have an extremely low transmission rate through the tube walls.

The arrangement should be such that the volumetric change of the fluid under increasing temperature will be insufficient to flex the diaphragm 16 outwardly until vaporization takes place which, for water, might occur at about 180°-200° F. However, when vaporization occurs, it is accompanied by a substantial increase in volume (about 3000:1 for water) which is more than adequate to flex the diaphragm and cause contacts 17 and 19 to close.

When installed in the electrical heating device, the leads 13 and 21 are connected to suitable apparatus for interrupting the supply of current to the heating conductor 12 upon closure of contacts 17 and 19.

The operation of the device should be readily apparent. With the dimensions given above, let us assume that a portion of the protected conductor, 1 inch in length, becomes sufficiently hot to vaporize one inch of the fluid within the tube 11 at that point. If the fluid is water, and if it vaporizes at 180° F. as a result of the existing pressure conditions, then the vaporized water will occupy $\frac{3}{8}$ of a cubic inch in volume. This change in volume will be transmitted along the tubing to the diaphragm 16.

It is important to notice that in the event of failure of the walls of the tubing or vessel, the fluid pressure increases, and the action will be to close contacts 17 and 19, ordinarily signalling an overheated condition, e. g., a faulty thermostat. In other words, the device fails safe.

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If the fail-safe feature is not required, the fluid may be at atmospheric pressure, in which case, the diaphragm would be normally relaxed.

Various constructional modifications will appear obvious to one skilled in the art of plastics fabrication and the like and, therefore, the illustrated embodiment should be considered only as an example of one possible mode of construction. In another form, it may be desirable to construct the contacts 17 and 19 so that they normally are closed, but will open in response to expansion of the fluid involved. It may also be desired that the electrical contacts be physically isolated from the exterior of the device so that water cannot reach them if the blanket is washed. For this purpose, the wall of vessel 15 which contains the apertures 20 can be replaced by a second diaphragm while the contact 19 is supported by a fixed side wall of the vessel. In another form, the heater wire 12 may be wound separate from the tubing.

Further modifications are illustrated in Figs. 2 and 3 wherein the fluid in the fluid portion of the system is held within the tube at above atmospheric pressure. In Fig. 2, the diaphragm 30 carries the moving contact 31. In this case there are two fixed contacts 32 and 33, respectively. Contact 32 is fixed to the outer wall of the vessel 15a adjacent contact 31, and the lead for external connection is secured to fixed contact 32. The fixed contact 33 is secured adjacent contact 32 on a rigid wall 34 located in the vessel 15a. The wall 34 is provided with orifices 35 for communicating the fluid to the one side of the diaphragm 30. In this modification, when the pressure increases, indicating an overheat, the diaphragm 30 is flexed toward the contact 32 fixed on the outer wall, thus interrupting the supply of current to the heating conductor 12. However, if the pressure decreases, indicating a ruptured fluid system, the diaphragm 30 will flex in the opposite direction causing contacts 31 and 33 to close, thus interrupting the supply of current to the heating conductor 12.

In the modification shown in Fig. 3, there is a single fixed contact 40 secured to the wall of the vessel 15b, and the diaphragm 41 carries movable snap action spring arm 42, which engages or disengages the fixed contact 40 when the diaphragm 41 is flexed in either direction from its normal closed position. When the pressure increases in the system, the diaphragm 41 will flex to the left, as seen in Fig. 3, causing the snap action spring contact 42 to disengage the fixed contact 40, thereby interrupting the supply of current to the heating conductor 12. When the pressure in the system decreases, the diaphragm will be caused to flex to the right from the position shown in Fig. 3, thus causing the snap action spring arm to disengage the fixed contact 40, thereby again interrupting the supply of current to the heating conductor 12.

It should be noted that although prior devices have been responsive only to the average temperature of an entire blanket or to peak temperature at selected points in the blanket, the present invention responds to peak temperatures occurring anywhere throughout the blanket. This is brought about by the "cold" fluid transmitting to the diaphragm switch any expansion due to boiling at any point throughout the entire blanket area.

Having thus described the invention, what is claimed is:

1. A thermally operated switch device comprising an hermetically sealed tubular member having a movable

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diaphragm serving as a closure of one end of said tubular member, said diaphragm being coupled with an electrical contact for variably positioning said contact with respect to a second contact fixed with respect to said one end of said member, and a thin filament of liquid within said tubular member for flexing said diaphragm in response solely to vaporization of at least a portion of said liquid.

2. A thermally operated switch according to claim 1, wherein said liquid is normally at sub-atmospheric pressure.

3. A thermally operated switch according to claim 1, wherein said liquid is normally above atmospheric pressure.

4. A thermally operated switch according to claim 1, wherein at least a portion of said tubular member is provided with a heating conductor arranged in heat transfer relation thereto.

5. A thermally operated switch device comprising an hermetically sealed tubular member having a movable diaphragm located as a closure in one end thereof, said diaphragm being coupled with an electrical contact for variably positioning said contact with respect to a second contact fixed with respect to said one end of said tubular member, a thin filament of liquid normally at a pressure other than atmospheric pressure within said tubular member for flexing said diaphragm in response solely to vaporization of at least a portion of said liquid, and a heating conductor arranged in heat transfer relationship with at least a portion of said tubular member.

6. A thermally operated switch device comprising an hermetically sealed container having a movable diaphragm located as a closure of an opening in a wall thereof, one surface of said diaphragm being exposed to the atmosphere, said diaphragm being coupled with an electrical contact for variably position said contact with respect to a second contact fixed with respect to said container, a liquid within said container for flexing said diaphragm in response solely to vaporization of at least a portion of said liquid, and a heating conductor arranged in heat transfer relationship with at least a portion of said container, said portion being formed of a flexible tubular element.

7. A protective device for an electrical heating conductor comprising a hollow tubular member upon which said conductor is supported in heat transfer relationship, said member having a relatively small bore, the walls of said member being about twice as thick as the diameter of said bore one end sealed and its other end joined to an enlarged vessel, said vessel comprising a movable diaphragm forming part of an hermetically sealed chamber communicating with said tubular member, a first electrical contact supported by said diaphragm and a second electrical contact supported by an adjacent wall of said vessel, and a liquid contained within the hermetically sealed part of said device.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
851,420	Hewitt et al.	Apr. 23, 1907
1,501,019	Lippincott	July 8, 1924
1,595,749	Anderson	Aug. 10, 1926
2,202,550	Elkin	May 28, 1940