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THERMAL RESPONSIVE ASSEMBLY, PARTICULARLY FOR ELECTRIC HEATERS

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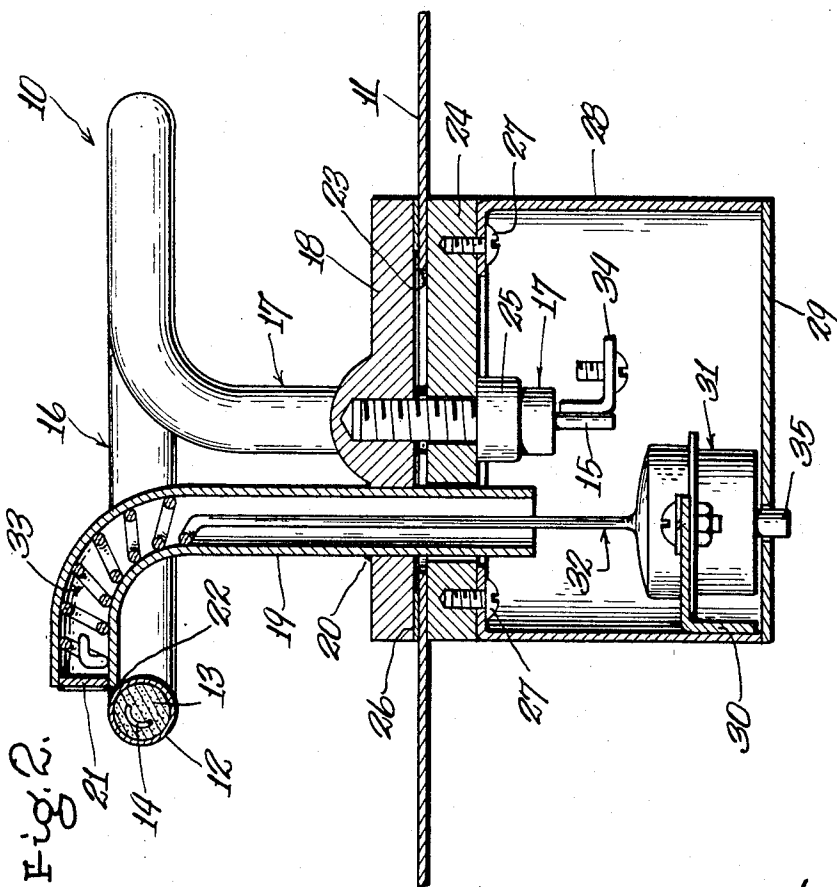


Fig. 2.

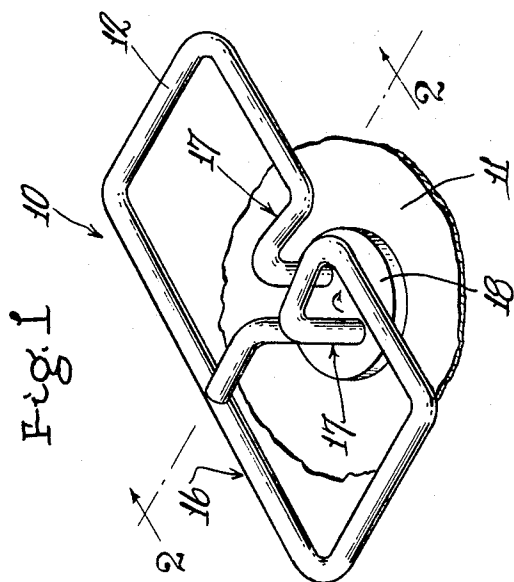


Fig. 1

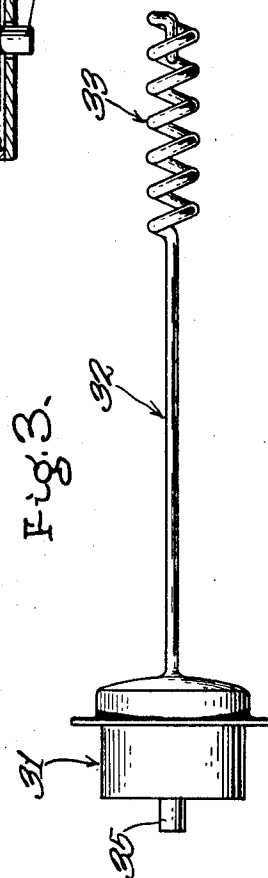


Fig. 3.

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THERMAL RESPONSIVE ASSEMBLY, PARTICULARLY FOR ELECTRIC HEATERS

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1 Claim. (Cl. 219—331)

ABSTRACT OF THE DISCLOSURE

An immersion-type electric heater assembly has a thermally responsive device in proximity to the heat generating portion of the heating element. The thermally responsive device includes a flexed convolutedly coiled capillary tube within a sharply curved housing, wherein the housing terminates adjacent the heating element. The capillary tube convolutions effect good thermal contact with the housing to effect reliable control of electric power applied to the heating element.

My invention provides a highly efficient easily assembled thermally responsive unit associated with an electric heating element wherein an initially rectilinear convolutedly coiled capillary tube associated with a thermally responsive unit is of substantially the same diameter as a sharply curved housing therefor as seen in the drawings. Thus, the convolutedly coiled capillary tube in extending through the curve of the housing to a point adjacent the closed end thereof and in a plane substantially parallel to the plane of the heater element, is in flexed, substantially continuous line contact relation throughout the curve of the housing, a rectilinear portion of the capillary tube extending from the curved portion of the housing through a rectilinear portion thereof and to a thermally responsive unit. The heating element and the tube housing are preferably carried by a mounting plate.

The present invention relates to thermally responsive assemblies, more particularly to electric heater assemblies having over-heat protective devices, and the principal object of the invention is to provide new and improved assemblies of the character described.

Many modern temperature responsive devices function on the principle of exposing a confined material, usually a volatile liquid, to an environment whose temperature is to be sensed, and utilizing the temperature-induced change in pressure exerted by the material as it, for example, changes from liquid to a gas, to operate a gauge, an electric switch, or the like. In most of such devices, the material is in part contained in a flexible, very small bore tube known as a capillary tube. In order to provide the requisite material volume, the capillary tube must either be of considerable length or be provided with a bulb, or radially enlarged portion.

While the device types above mentioned are suitable for many applications, either type, i.e., with or without the bulb, they present a problem when the capillary tube must be enclosed in a well, or housing. When the capillary is thus enclosed, it is difficult to establish a good thermal transfer relationship between the capillary and the housing or between the latter and the bulb. The problem is further complicated if the housing is longitudinally curved rather than rectilinear and if the capillary or its bulb must be inserted into the curved housing portion.

By means of a novel approach, the present invention combines a temperature responsive device of the bulbless, capillary tube type with a tubular housing in a highly efficient, commercially superior manner, the assembly hereinafter being disclosed in combination with

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an electric resistance heating element in an arrangement which prevents an excessive temperature rise of said element and consequent damage thereto. These and other advantages will readily become apparent from a study of the following description and from the drawing appended hereto.

In the drawing accompanying this specification and forming a part of this application there is shown, for purpose of illustration, an embodiment which the invention may assume, and in this drawing:

FIGURE 1 is a perspective view of an electric heater assembly embodying the present invention,

FIGURE 2 is an enlarged sectional view generally corresponding to the line 2—2 of FIGURE 1, and

FIGURE 3 is a side elevational view of a detail seen in FIGURE 2.

With reference to FIGURES 1 and 2, there is illustrated an immersion heater assembly 10 of the type adapted to be disposed in the bottom wall 11 of a tank. For present purposes, it may be assumed that the tank of which bottom wall 11 is a part forms a portion of a steam table, the tank being adapted to contain water which is heated as required by the heater assembly. As herein disclosed, the heater assembly 10 comprises the usual elongated tubular metallic sheath filled with compacted electric-insulating, heat-conductive material 13. An intermediate portion of the sheath has a coiled resistor conductor wire 14 disposed therein and embedded in the material 13, such wire stopping short of the sheath ends and being connected to respective terminal conductor pins 15 which extend from respective conductive wire ends and project outwardly of respective sheath ends for connection to an electrical power circuit.

The intermediate portion 16 of the sheath 12, i.e., that portion which encloses the resistor wire 14, is frequently described as the heat-generating portion and is herein shown as being formed to a rectangular configuration for disposition within the tank. The heat-generating portion as illustrated is of generally planar configuration. The sheath portions 17 enclosing the terminal pins 15 are frequently described as terminal ends, such ends presently extending in spaced, side-by-side relation transversely of said heating portion and passing through respective, close-fitting apertures in a flange plate 18 for disposition outside the tank. In order to form a liquid-tight, unitary assembly between the element terminal ends 17 and the flange 18, such parts may be brazed or welded together.

Also extending through the flange 18 is a metal tube 19 which is curved adjacent the element heat-generating intermediate portion to dispose its end thereagainst. Tube 19, or housing as it will hereinafter be referred to, is also brazed or welded to the flange 18 along a rectilinear portion of the housing, in a similar manner to the element terminal portions 17 as shown at 20, to provide an integral, liquid-tight assembly. In order to close the housing end adjacent the element intermediate portion, such end may have a plug 21 welded or brazed therein. Finally, to dispose the housing 19 in heat-transfer relation with the element intermediate portion, the housing will preferably be welded or brazed thereto as shown at 22. As seen in FIGS. 1 and 2, the housing end portion in the area of plug 21 lies in a plane substantially parallel to the active heating element plane.

While only a single heating element has herein been disclosed, it is to be understood that two or more heating elements could well be used. In such case, the housing could be in thermal transfer relation with heat-generating portions of both elements or with only one, for example, the one which will first be exposed when the water level falls in the tank in which the heater is installed. More-

over, and although not shown, the portion of the element heat-generating portion to which the housing 19 is secured may, if desired, be elevated slightly to insure that the element portion whose temperature is being sensed is first to become exposed when the water level aforesaid falls.

For clamping the plate 18 against the tank wall 11 in overlying relation with an aperture 23 therein through which project the element terminal ends 17 and the housing 19, a clamping plate 24 is provided. The plates 18, 24 are drawn together by means of a cap screw 25 to clamp the wall 11 tightly therebetween, a gasket 26 being interposed intermediate the plate 18 and the wall 11 to insure against leakage. Secured to the plate 24, as by means of screws 27, is a conduit box 28 with a removable cover 29. Plate 24 together with the conduit box 28 is, of course, apertured to freely pass the element terminal portions 17 and the housing 19.

Secured within the conduit box 28, as by means of a bracket 30, is a thermally responsive device 31 which, in the present instance, is a normally closed, heat-responsive switch. A capillary tube 32 extends from device 31 into the housing 19, its free end being formed to a helical configuration 33 (see also FIGURE 3) so that it will closely but slidably fit within the housing 19. Thus, as seen in FIG. 2, the helical convolutedly coiled portion of the capillary tube is of a diameter substantially equal to the inside diameter of the housing, thereby readily permitting the close but sliding fit. Note that the coiled capillary portion 33 is disposed adjacent the closed end of the housing 19, as shown, for maximum sensitivity to the temperature of the element heat-generating portion 16. As seen in FIG. 2, the coiled portion 33 extends substantially throughout the curve of the housing and is connected to the switch 31 by a rectilinear capillary portion disposed within the rectilinear portion of housing 19.

It will readily be apparent that assembly of the switch device 31 with the heater assembly can easily be effected, once the heater is secured to the wall 11, by inserting the capillary portion 33 into the lower end of the housing and pushing upwardly on the device until the capillary portion 33 assumes the position illustrated. Because of the longitudinal flexibility of the coiled capillary portion 33, it will readily flex to conform to the curvature of the housing 19 without binding therein.

It is to be noted that since the coiled capillary portion 33 is a close sliding fit within the housing 19, each convolution thereof will theoretically have line contact with the housing interior. In actual practise, although less than perfect contact will exist between the convolutions of the capillary portion 33 and the housing, each convolution will nevertheless engage the housing interior at a sufficient number of places to insure satisfactory thermal transfer relationship between the capillary tube and the housing. Close contact between the housing and the coiled capillary portion will be enhanced since, with the resiliency and flexibility provided by such coiled capillary portion, a closer fit with the housing can be provided without danger of the latter binding in the housing during the assembly operations previously outlined.

In operation and assuming the element is connected to a source of electrical energy by suitable connections to terminals 34 carried by its terminal pins 15 and that the switch 31 is in circuit between the element and the electrical source, passage of current through the element will cause its intermediate portion 16 to give off heat. So long as the heater intermediate portion is immersed, the heat generated thereby will be conducted away fast enough to prevent an excessive temperature rise of the element. If, however, the level of the water in which the element is immersed falls below the element heat-generating portion, the temperature of the latter will immediately increase to the point where the element will burn out if it is not deenergized.

If for any reason, such as a low liquid level, the temperature of the heat-generating portion should rise to the danger point, such temperature will quickly be transmitted to the housing 19 and thence to the contained, coiled capillary portion 33. The increase in temperature of the capillary tube will, in a manner which need not be discussed since it forms no part of the present invention, causes the switch 31 to interrupt flow of electrical energy to the element. Preferably, the electrical circuit to the element will remain interrupted until a manual reset button 35 on the switch 31 is pressed. It is to be noted that a significant factor in rapid response to the switch 31 to temperature rise of the element is that a considerable length of the capillary tube 32 is subjected to element heat since there are many closely disposed convolutions, provided by the capillary portion 33, positioned close to the element heat-generating portion 16.

While the thermally responsive device herein disclosed comprises a switch for controlling operation of an electric immersion heating element in accordance with the temperature thereof, it is to be understood that devices other than switches are within the scope of the present invention as is the control of devices other than electric immersion heaters.

In view of the foregoing it will be apparent to those skilled in the art that I have accomplished at least the principal object of my invention and it will also be apparent to those skilled in the art that the embodiment herein described may be variously changed and modified, without departing from the spirit of the invention, and that the invention is capable of uses and has advantages not herein specifically described; hence it will be appreciated that the herein disclosed embodiment is illustrative only, and that my invention is not limited thereto.

I claim:

1. An electric immersion heater assembly formed of a metal-sheathed electric resistance heating element having a substantially planar-disposed heat-generating portion for immersion in a liquid to be heated and a terminal portion disposed substantially perpendicular to said heat-generating portion for connection into an electrical power circuit, and a mounting member through which said element terminal portion projects and to which the latter is secured in fluid-tight relation with said element heat-generating portion disposed on one side of said mounting member,

a tubular metal housing having an arcuate portion terminating in a closed end adjacent to said element heat-generating portion and disposed in a plane substantially parallel thereto, and having a rectilinear portion extending from said arcuate portion and disposed substantially perpendicular to said closed end and extending through said mounting member in fluid-tight relation,

a thermally responsive unit carried by said mounting member on the other side thereof and in circuit with said element for disconnecting the latter from the power circuit upon an excessive temperature rise of said element heat-generating portion,

a capillary tube extending from said unit and containing a material for actuation of said unit upon changing pressures exerted by said material as a result of temperature variations thereof, said capillary tube having an initially rectilinearly extending convolutedly coiled portion having a diameter substantially equal to said housing inside diameter, said coiled portion extending within said arcuate housing portion to a point closely adjacent said closed end thereof and flexed thereby into substantial conforming curvature therewith, the flexed convolutions of said coiled portion having substantial line contact with said arcuate housing portion to effect thermal transfer relationship therewith, said capillary tube further having a rectilinear portion extending from said convolutedly coiled portion

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through said rectilinear housing portion to said thermally responsive unit.

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