

[54] **ELECTRIC HEATING ELEMENTS**

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[58] Field of Search..... 219/316, 253, 512, 219/449; 337/386, 394, 141, 383, 399, 382

[56] **References Cited**

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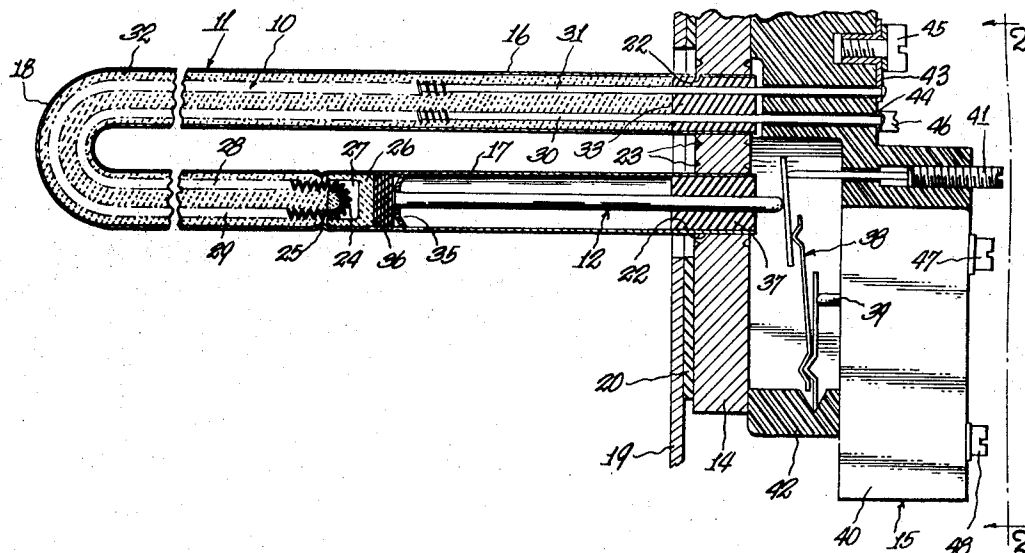
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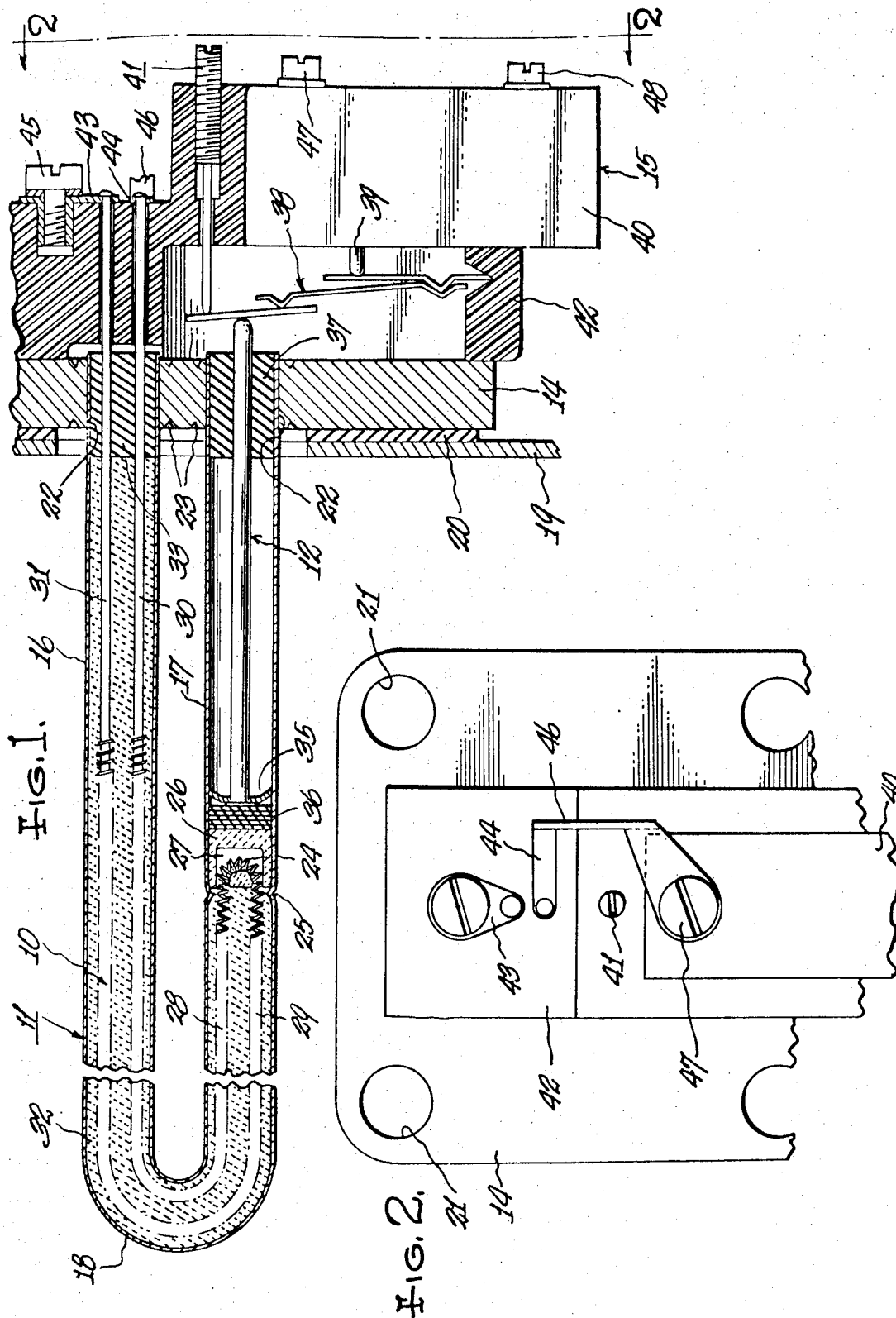
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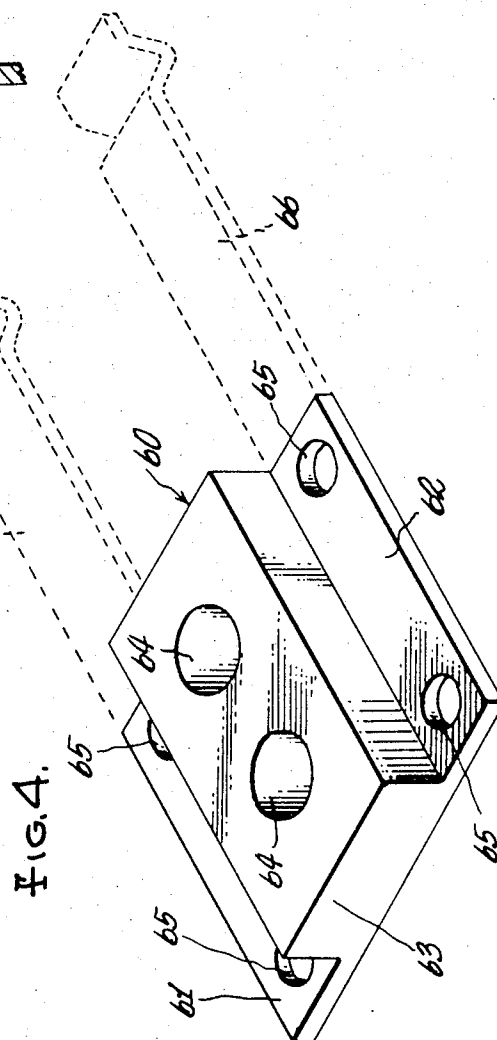
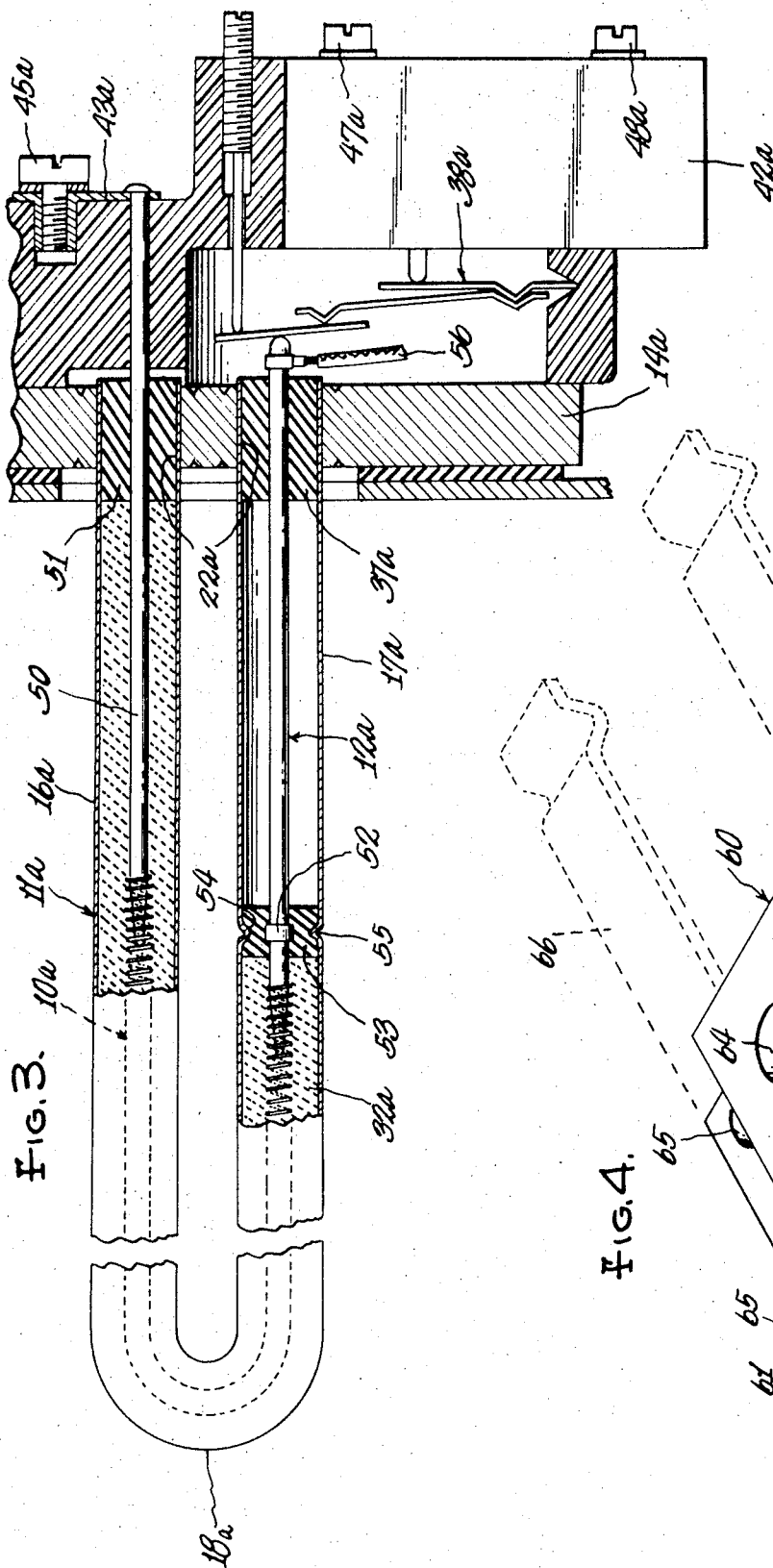
ABSTRACT

A metallic sheathed electric heating element, particularly of hairpin formation, wherein a heat responsive device forms part of the element and comprises a metal rod contained within the sheath and having its inner end affixed thereto, the rod and sheath having different thermal expansion properties whereby the rod may operate a switching device.

5 Claims, 4 Drawing Figures







ELECTRIC HEATING ELEMENTS

This application is a division of application Ser. No. 869,215, filed Oct. 24, 1969 now U.S. Pat. No. 3,585,359.

BACKGROUND AND SUMMARY

It is known to utilize a thermally responsive device to control the operation of an electric heating element, but usually such devices are either separate from the element or are combined therewith in an impractical manner.

My invention makes it possible to manufacture the thermally responsive device as an integral part of the heating element, thus not only placing the device in a most advantageous relation with the element but also facilitating manufacture of the assembly. This is of special importance when the heating element, as herein disclosed, is used to heat the liquid in a tank.

DESCRIPTION OF THE DRAWINGS

In the drawings accompanying this description and forming a part of this specification there are shown, for purpose of illustration, embodiments which my invention may assume, and in these drawings:

FIG. 1 is a fragmentary, longitudinal sectional view of a heating-element thermally-responsive structure, illustrating a presently preferred embodiment of my invention,

FIG. 2 is an end elevation corresponding generally to the line 2—2 of FIG. 1,

FIG. 3 is a view similar to FIG. 1, but showing another embodiment of my invention, and

FIG. 4 is a perspective view of a mounting plate which may be used in the embodiments illustrated.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Generally, my invention comprises an electric resistance member 10 within a sheath 11 for generating heat when an electric current is passed therethrough, the resistance member having terminals extending outwardly from one end of the sheath. An actuator member 12 has an end fixed to the sheath inwardly of the other end of the sheath, and the member has its other end disposed at the sheath other end, the latter sheath end being fixed to a support 14. A switch device 15 is also fixed to the support 14 in operating relationship with the actuating member, the sheath and actuating member being formed of materials having differential expansion properties whereby differential expansion thereof causes actuation of the switch device.

More specifically, the sheath 11 is formed of metal (copper in the particular embodiment illustrated) and is of hairpin formation, to provide legs 16 and 17 which are joined by a bight portion 18. The support 14 may take the form of a usual mounting flange such as shown in U.S. Pat. No. 3,217,138, issued to me on Nov. 9, 1965. Briefly, the mounting flange (or support 14) is adapted to support the heating element in position within a water tank 19, a gasket 20 being interposed between facing surfaces of the tank and flange to prevent the leakage of water. The flange may be secured to the tank wall by bolts (not shown) passing through openings 21 in the margin of the flange and threaded into any suitable means on the tank wall.

The flange 14 is formed with a pair of openings 22 and the ends of the sheath legs 16—17 extend through

such openings and are securely fixed therein, as by means of staking indentations shown at 23.

The resistance member 10 herein disclosed is a helically coiled resistance wire which is of hairpin formation and has its bight portion 24 anchored in position spaced inwardly of the end of sheath leg 17. At the present time it is preferred to form an inwardly extending shoulder 25 on the sheath, as by an annular indentation or a series of spaced indentations.

A dielectric bushing 26, of suitable refractory material, is formed with an opening 27 through which the resistance wire is threaded to form equal legs 28, 29 extending from the bight portion 24, and this assembly is slipped into the sheath through the open end of sheath leg 17 during an early step in the manufacture of the heater. The legs of the resistance wire extend in parallel relation through the sheath leg 17, to and through the sheath bight portion and through the leg 16, so that its terminal ends extend outwardly of the end of the sheath leg 16. Usually, the resistance wire legs stop short of the end of the sheath leg 16 and are electrically and mechanically connected to respective terminal pins 30—31 which extend outwardly of the end of the sheath leg 16. Usually compacted granular refractory material 32 serves to electrically insulate the resistance wire from the sheath and conduct heat from the wire to the sheath. A dielectric bushing 33 is usually pressed into the sheath end to hold the refractory in place during manufacturing operations.

The actuator member 12 is preferably a rod formed of any suitable metal (such as a nickel-steel alloy as herein used.) The rod 12 is contained within the sheath and at its inner end has a spring washer 35 securely attached thereto, the peripheral fingers of the washer digging into the inner surface of the sheath to anchor the inner end of the rod in position. Mica washers 36 may be interposed between the inner end of the rod 12 and the dielectric bushing 26 to insure electrical insulation from the resistance wire bight portion 24.

A slide bushing 37 is pressed into the end of sheath leg 17 to guide longitudinal movement of the rod 12, and the outer end of the rod is arranged to actuate the switch device 15. As shown, the outer rod end bears against a motion multiplying arrangement of levers 38 to operate the plunger 39 of an electric switch 40. An adjustment screw 41 is provided to regulate the operation of the switch.

The switch 40 and adjusting screw 41 are carried by a dielectric terminal block 42 which is fixed to the mounting flange 14 in any suitable manner. As herein shown, the terminal pins 30, 31 extend through openings in the terminal block and have their ends headed over contact strips 43, 44. The strip 43 has a terminal screw 45 which is adapted to be connected to one side of a source of electrical energy. The strip 44 has an offset portion 46 to reach a terminal screw 47 on the switch 40, and a further terminal screw 48 on the switch is adapted to be connected to another side of the source of electrical energy, the electrical circuit thus produced placing the switch and resistor wire in series relation so that the switch controls flow of electrical energy to the wire.

In operation, and with the sheath cold, when electrical energy is supplied to the terminals 45, 48, such as by connecting energy wires thereto, or by closing a switch (not shown) in circuit with such energy wires, the resistor wire will produce heat by resistance to flow

of electrical current therethrough. In the cold condition, or when only a predetermined amount of heat is generated by the resistance wire, the rod 12 will hold the switch 40 in position wherein it permits flow of electrical energy to the heating wire. If a certain preselected temperature condition is produced, the sheath, being of copper, will expand longitudinally a greater amount than the rod 12, and draw the latter in a direction away from the switch plunger 39 a sufficient amount to permit the switch to interrupt flow of current to the resistor wire. The switch 40 may be of the type to automatically provide for flow of current to the resistor wire when the high temperature level is removed. It also may include a manual reset button (not shown) so that attention is drawn to the fact that an overheat condition existed.

DESCRIPTION OF OTHER EMBODIMENT

The embodiment of my invention shown in FIG. 3 is somewhat similar to that shown in FIG. 1 in that it includes a resistance member 10a within a sheath 11a. As before, an actuator member 12a, in the form of a rod, has an inner end fixed to the sheath.

The sheath 11a is preferably of hairpin formation to provide legs 16a and 17a which are joined by a bight portion 18a. The ends of the sheath legs are secured in openings 22a in the mounting member of flange 14a. The resistance member 10a is in the form of a helically coiled resistance wire located centrally of the sheath and compacted granular refractory material 32a serves to hold the wire centrally of and to electrically insulate it from the sheath and, also serves to conduct heat from the wire to the sheath.

In this embodiment, one end of the coiled resistance wire is mechanically and electrically connected to the inner end of a terminal pin 50, the latter extending through dielectric bushing 51 and outwardly of the extremity of the sheath leg 16a, where it passes through an opening in a dielectric terminal block 42a and is headed over a contact strip 43a. The strip has a terminal screw 45a for attachment of a lead wire (not shown).

The other end of the coiled resistance wire 10a is mechanically and electrically connected to the inner end of the actuator rod 12a. In this embodiment the actuator rod has an enlargement 52 at its inner end which is locked within a dielectric bushing 53. The bushing may be molded about the enlargement, or may be formed in two pieces which are securely held together, the important factor being that the bushing be securely held against movement longitudinally of the actuator member. The bushing 53 has an annular groove 54 in its periphery and the sheath leg 17a has an annular indentation 55 to anchor the bushing against longitudinal movement within the sheath.

The outer end of the actuator rod 12a passes through a dielectric slide bushing 37a which is held within the end of sheath leg 17a. A current conducting lead 56 is mechanically and electrically connected to the outer end of the actuator rod 12a and is flexible so as not to interfere with movement of the rod. The lead 56 is electrically connected to a terminal screw 47a of the electrical switch device 42a, the latter having another terminal screw 48a to which a current conductor (not shown) may be attached. In this embodiment, current passes from one side of a source of electrical energy to the terminal screw 48a, through the usual switch contacts (not shown) of the switch device 42a, through the

lead conductor 56, the actuator rod 12a, the resistance wire 10a, the terminal pin 50 and to the other side of the source from the terminal screw 45a.

As before, the sheath 11a may be of copper and the actuator rod 12a may be of a nickel-steel alloy, although other materials having differential thermal expansion properties may be used. When electrical energy is supplied to the terminals 45a, 48a, and with the contacts of the switch 42a closed, electrical current will flow through the wire 10a to produce heat. When less than a predetermined amount of heat is generated, the outer end of the actuator member bears against the leverage system 38a to hold the switch contacts closed and thus permit current flow. However, when an excessive amount of heat is generated, the sheath will expand longitudinally a greater amount than the rod 12a and will draw the latter in a direction away from the leverage system 38a an amount sufficient to permit the switch contacts to automatically open and interrupt current flow through the resistance wire 10a.

FIG. 4 shows a low-cost metal mounting member of flange 60 which may be used in the embodiments of FIGS. 1 through 3. The member may be formed as a long bar having a transverse section as shown to provide thin flange portions 61, 62 and a thicker center portion 63. The rod may then be cut to produce a multiple of pieces of the form shown in full lines in FIG. 4, each piece forming a mounting member 60. Holes 64 may be formed in the center portion to receive the legs of the sheath, and holes 65 may be formed in the flange portions 61, 62 to pass bolts for attaching the mounting member to the outer wall surface of the tank.

In actual practice, the flange portions 61, 62 may be about one-sixteenth inch thick and the center portion may be about one-fourth inch thick. Thus, the center portion provides a heavy section for rigidity, while the thinner flange portions can flex to accommodate irregularities in the tank wall surface, or the interposed gasket, without stressing the center portion.

In some cases, the mounting flange may be cut to a length equal to the total of the full and dotted line portions in FIG. 4, and the center portion removed between the dotted line portions to provide two flexible legs 66. The free ends of the legs may be suitably configured to hold a thermostatic switching device (not shown) against the outer surface of the tank wall, in the manner shown in my U.S. Pat. No. 3,217,138.

I claim:

1. An electric heating element, comprising an elongated sheath, an electric resistance member within said sheath for generating heat when an electric current is passed therethrough, means for electrically insulating said resistance member from said sheath and for conducting heat from said member to said sheath, an elongated actuator member within said sheath, having an outer end extending outwardly from one end of said sheath and an inner end fixed to said sheath, one end of said resistance member being mechanically and electrically connected to the inner end of said actuator member and the other end of said resistance member being mechanically and electrically connected to a terminal pin extending outwardly from the other end of said sheath, said terminal pin and said actuator member being adapted to be connected to a source of electrical energy for conducting electrical current to the respective ends of said resistance member, said sheath and said actuator member being formed of metals having

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different thermal expansion properties and being subject to the heat generated by said resistance member, and a switch device held in position at said outer end of said actuator member and adapted to be operated by the latter upon predetermined relative movement between said sheath and said actuator member caused by differential expansion as influenced by heat generated by said resistance member

2. The construction of claim 1 wherein said one sheath end is securely fixed to a mounting plate, and said switch device is also fixed with respect to said mounting plate in position for cooperation with said outer end of said actuator member.

3. The construction of claim 1 wherein said sheath is of hairpin formation and both of its ends pass through said and are securely fixed within openings in a mounting

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plate, and said switch device is also fixed with respect to said mounting plate in position for cooperation with said outer end of said actuator member.

4. The construction of claim 3 wherein said mounting plate has opposed flange portions adapted to be connected to the outer wall surface of a water tank and an integral center portion joining said flange portions and containing said openings, said center portion being thick in section to provide rigidity for support of said sheath and said flange portions being thin to flex relative to said center portion without stressing the latter.

5. The construction of claim 4 wherein said flange portions continue beyond said center portion and form spring fingers for pressing a thermostatic control device against said outer wall surface of said tank.

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