United States Patent

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[54] **ELECTRIC HEATING ELEMENTS**
7 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **219/328,** 219/331, 337/141
[51] **Int. Cl.** **F24h 1/00**
[50] **Field of Search** 219/327, 328, 331, 512; 337/141; 338/296

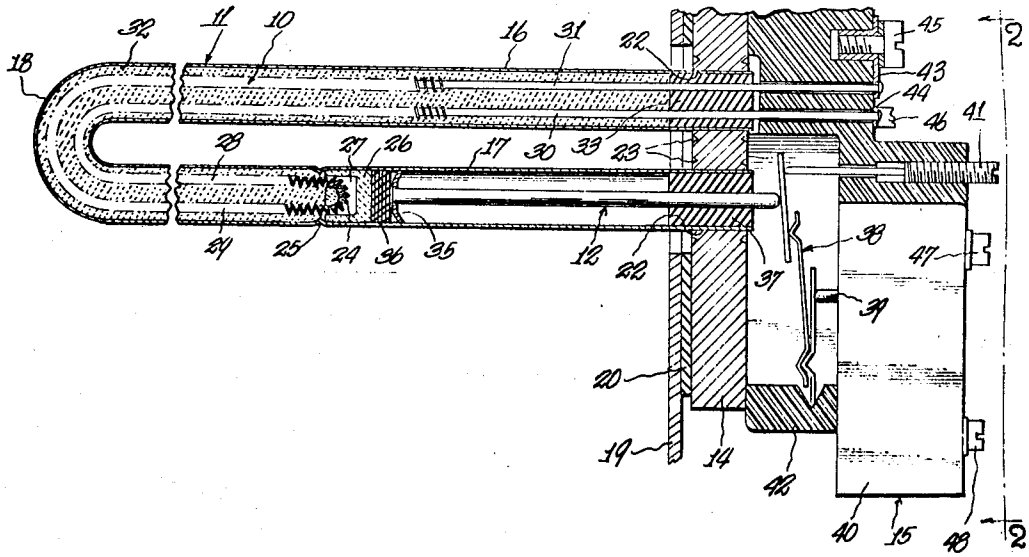
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ABSTRACT: A metallic sheathed electric heating element, particularly of hairpin formation, wherein a heat responsive device forms part of the element and comprises a metal rod contained within the sheath and having its inner end affixed thereto, the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



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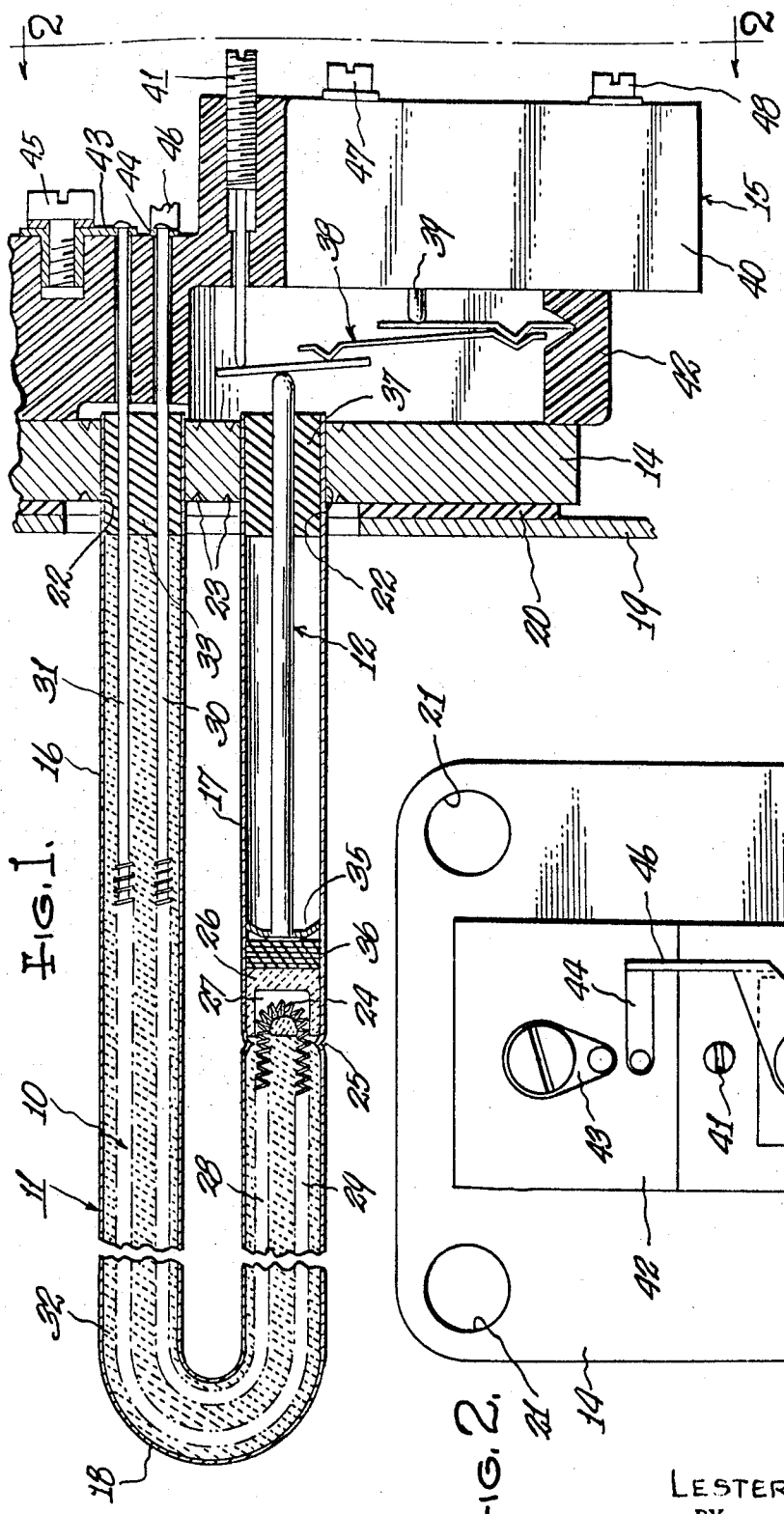


FIG. 1.

FIG. 2.

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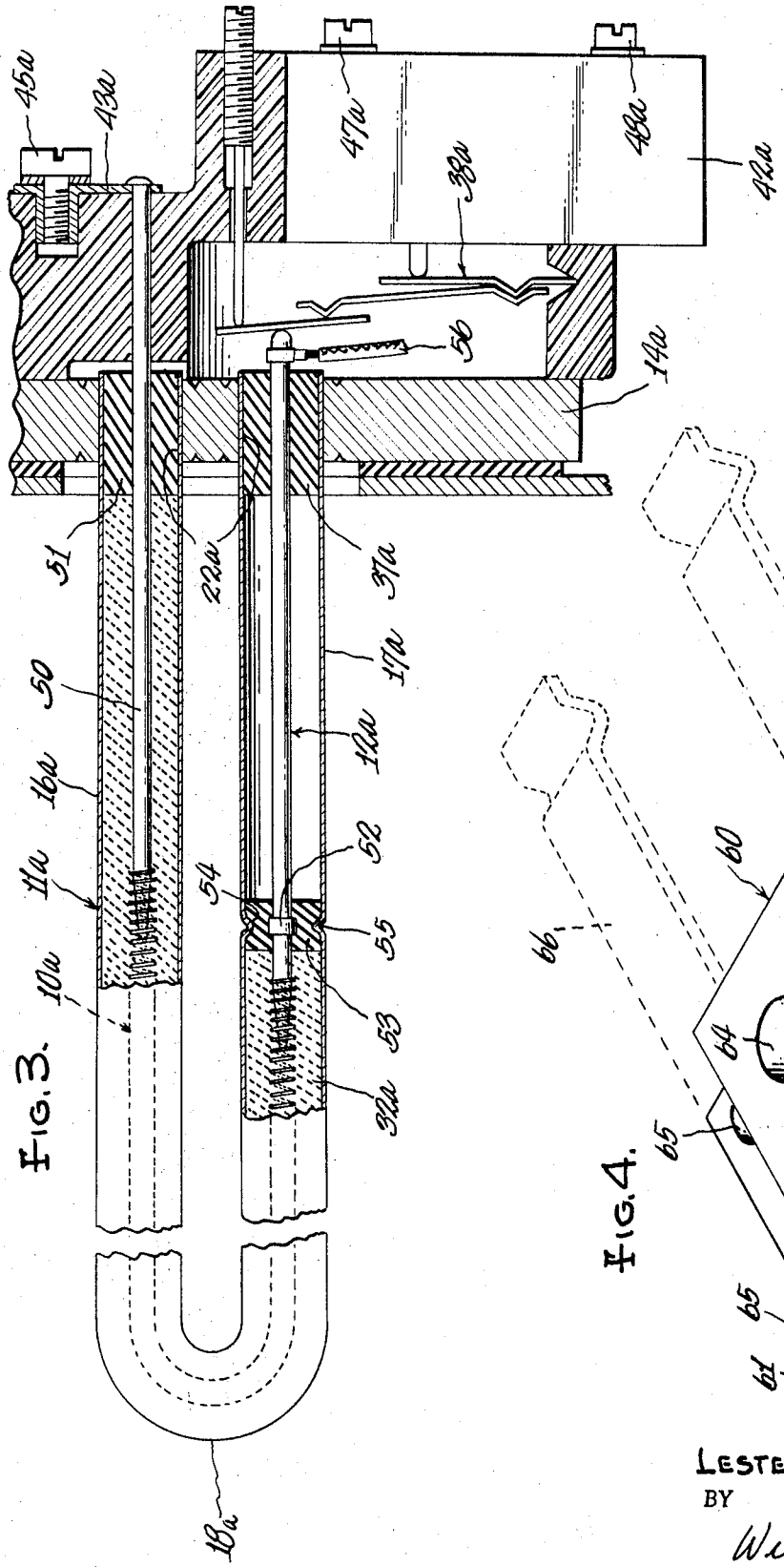


FIG. 3.

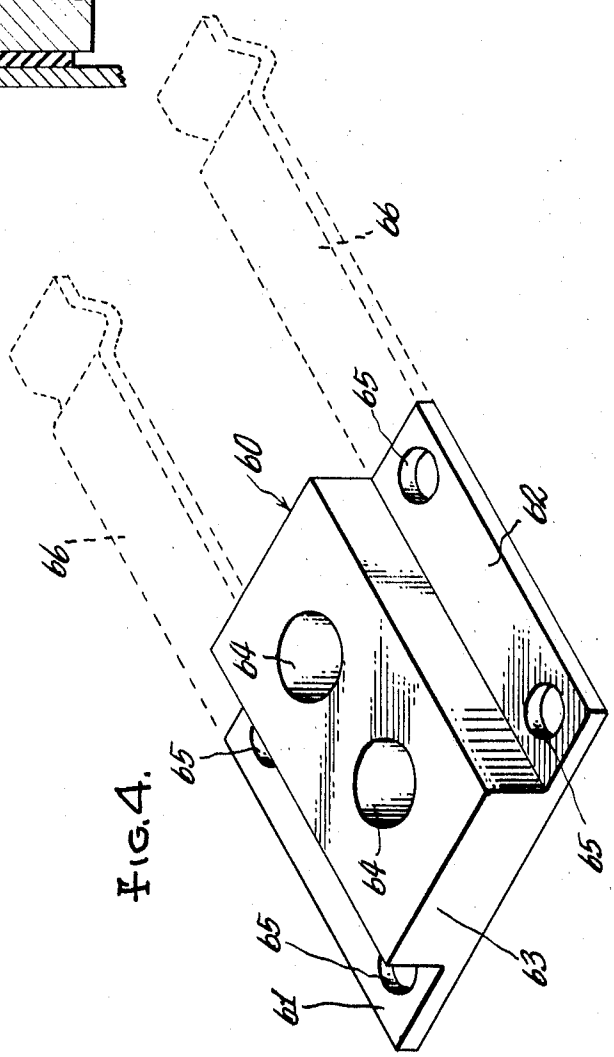


FIG. 4.

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ELECTRIC HEATING ELEMENTS

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 **10*a*** within a sheath **11*a***. As before, an actuator member **12*a***, in the form of a rod, has an inner end fixed to the sheath.

The sheath **11*a*** is preferably of hairpin formation to provide legs **16*a*** and **17*a*** which are joined by a bight portion **18*a***. The ends of the sheath legs are secured in openings **22*a*** in the

mounting member or flange **14***a*. The resistance member **10***a* is in the form of a helically coiled resistance wire located centrally of the sheath and compacted granular refractory material **32***a* 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 a dielectric bushing **51** and outwardly of the extremity of the sheath leg **16***a*, where it passes through an opening in a dielectric terminal block **42***a* and is headed over a contact strip **43***a*. The strip has a terminal screw **45***a* for attachment of a lead wire (not shown).

The other end of the coiled resistance wire **10***a* is mechanically and electrically connected to the inner end of the actuator rod **12***a*. 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 **17***a* has an annular indentation **55** to anchor the bushing against longitudinal movement within the sheath.

The outer end of the actuator rod **12***a* passes through a dielectric slide bushing **37***a* which is held within the end of sheath leg **17***a*. A current conducting lead **56** is mechanically and electrically connected to the outer end of the actuator rod **12***a* and is flexible so as not to interfere with movement of the rod. The lead **56** is electrically connected to a terminal screw **47***a* of the electrical switch device **42***a*, the latter having another terminal screw **48***a* 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 **48***a*, through the usual switch contacts (not shown) of the switch device **42***a*, through the lead conductor **56**, the actuator rod **12***a*, the resistance wire **10***a*, the terminal pin **50** and to the other side of the source from the terminal screw **45***a*.

As before, the sheath **11***a* may be of copper and the actuator rod **12***a* 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 **45***a*, **48***a*, and with the contacts of the switch **42***a* closed, electrical current will flow through the wire **10***a* 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 **38***a* 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 **12***a* and will draw the latter in a direction away from the leverage system **38***a* an amount sufficient to permit the switch contacts to automatically open and interrupt current flow through the resistance wire **10***a*.

FIG. **4** shows a low-cost metal mounting member or 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 central 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 for a water tank, comprising a mounting flange and a metal tubular sheath of hairpin formation, said flange having a pair of openings in which the ends of the legs of the sheath are securely fixed, said flange being securable to the exterior of the wall of a water tank with the sheath extending through an opening in said tank wall to dispose said legs and the bight connecting the same within said tank, a dielectric terminal block secured to said mounting flange and an electric switch carried by said terminal block, a helically coiled resistance wire of hairpin shape, having its bight held within said sheath inwardly of the end of one leg thereof, the legs of said wire extending through said one sheath leg, through the sheath bight and through the other sheath leg and having terminal pins extending respectively from the leg ends of the wire and outwardly of said other sheath leg for electrical connection to terminals carried by said terminal block and said switch, said switch also having another terminal, and its terminals being connectable to a source of electrical energy, the switch controlling flow of electrical energy to said resistance wire, a metal rod within said sheath, having one end fixed to said sheath adjacent to said wire bight and its other end extending outwardly of said one sheath leg and in position to operate a switching member of said electric switch, said rod and sheath being formed of metals having different thermal expansion properties whereby when a preselected temperature is reached, the differential expansion is sufficient to operate said switch.

2. An electric heating element, comprising a tubular sheath, an electric resistance member within said sheath for generating heat when an electric current is passed therethrough, means electrically insulating said resistance member from said sheath and conducting heat from said member to sheath, said resistance member having terminal means at one end of said sheath and extending within said sheath toward but spaced from the other sheath end, an actuator rod within said sheath and extending longitudinally thereof, said actuator rod being disposed in the space at said other sheath end which is left by said resistance member and having an inner end anchored to said sheath and an outer end passing through and outwardly of said other sheath end, said sheath and said actuator rod being formed of metals having different thermal expansion properties whereby the outer end of said actuator rod and said other sheath end are relatively movable in a longitudinal direction, and a switching device positioned in fixed relation with respect to said other sheath end and having an operating member abuttable with the outer end of said actuator rod.

3. The construction of claim **2** wherein said other sheath end is anchored to a flange, and said switching device is fixed to said flange.

4. The construction of claim **2** wherein said resistance member is of hairpin formation, with both terminals at said one sheath end, and with the bight of said hairpin formation spaced inwardly of said other sheath end, said inner end of said actuator member being anchored adjoining said bight.

5. The construction of claim **2** wherein the outer end of said actuator rod is slidably carried by an insulating bushing fixed within said other sheath end.

6. The construction of claim **2** wherein said sheath is of hairpin formation with both sheath ends anchored to a mounting plate, and with said switching device fixed to said mounting plate.

7. The construction of claim **6** wherein said mounting plate has integrally formed spring fingers extending therefrom to resiliently hold a thermostatic device.