Nov. 18, 1952 C. C. DE WITT 2,618,722

TEMPERATURE CONTROLLING DEVICE

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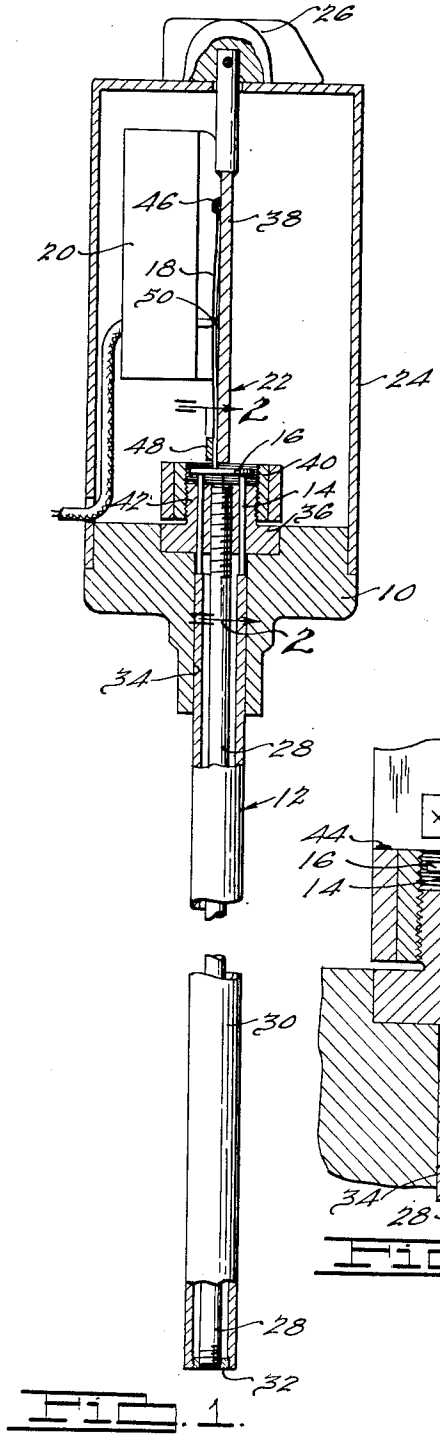

FIG. 1.

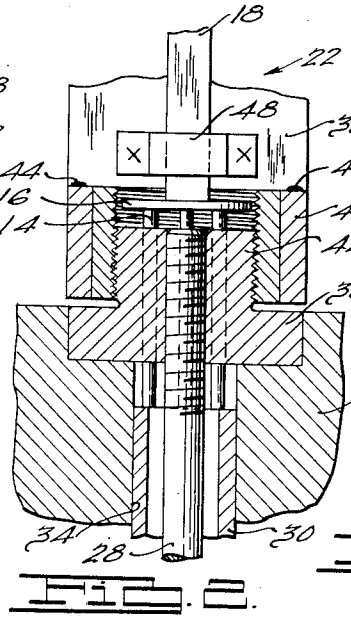

FIG. 2.

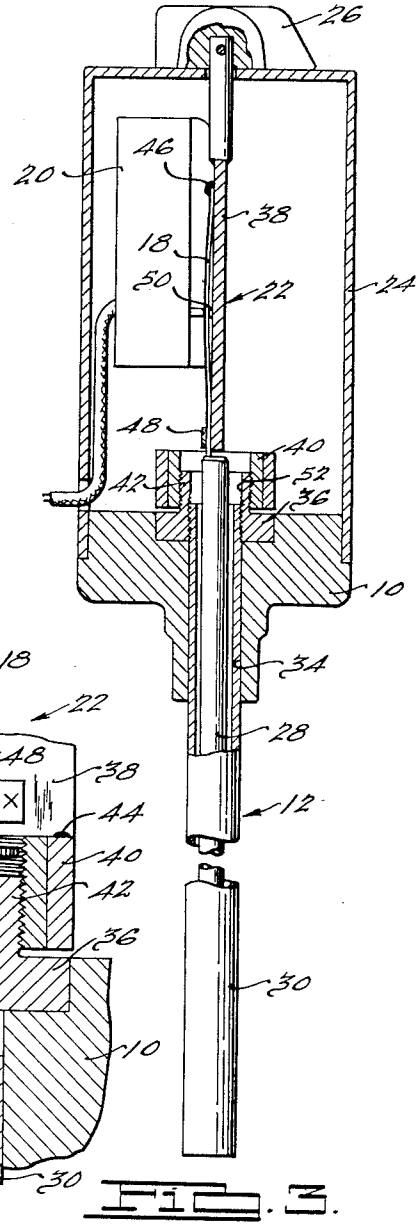

FIG. 3.

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TEMPERATURE CONTROLLING DEVICE

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6 Claims. (Cl. 200—137)

1

This invention relates to new and useful improvements in temperature control devices.

An important object of the present invention is to provide a temperature control device that is exceedingly sensitive in operation.

Another object of the invention is to provide a temperature control device that maintains its sensitivity over a wide temperature range.

Still another object of the invention is to provide a temperature control device having novel means for determining the particular temperature at which it operates.

Yet another object of the invention is to provide a temperature control device that is simple but rugged in construction and that can be manufactured relatively inexpensively.

A further object of the invention is to provide a temperature control device that is not affected adversely by exposure to temperatures other than that at which it is set to operate.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the drawing forming a part of this specification and wherein like numerals are employed to designate like parts throughout the same,

Fig. 1 is a longitudinal sectional view, showing parts in elevation, of a temperature control device embodying the invention;

Fig. 2 is an enlarged, fragmentary, longitudinal sectional view taken on the line 2—2 of Fig. 1; and

Fig. 3 is a longitudinal sectional view, showing parts in elevation, of a modified form of the invention.

In the drawing, wherein for the purpose of illustration is shown a preferred embodiment of the invention, the numeral 10 designates a mounting member which carries the operating parts of the device. A pressure-sensitive actuating means 12 depends from the mounting 10 and acts through pins 14 and metal disk 16 to flex a resilient metallic strip 18 which in turn operates a micro-switch 20. The strip 18 and micro-switch 20 are carried by an upstanding support 22 which is adjustably mounted on the mounting 10 to raise or lower the strip relative to the disk 16 and thus regulate the particular temperature at which the switch 20 is operated. All of the parts disposed above the mounting 10 preferably are enclosed in a housing 24 and a manual actuator 26 is fastened on the upper end of support 22 exteriorly of the housing to facilitate adjustment of the device.

In use, the temperature-sensitive means 12 responds to temperature changes by expanding or contracting. However, this expanding or contracting movement, in itself, is not sufficient to actuate a conventional micro-switch. In the instant construction, the thermal expansion of the means 12 causes pressure to be exerted axially against the flexible strip 18 which multiplies the thermal expansion movement. In practice, I have found that the strip 18 will multiply the thermal expansion movement 100 or more times, and this movement of the strip is sufficient to operate the micro-switch 20.

2

While a variety of temperature-sensitive means conceivably could be used to operate the strip 18, I have found the particular mechanism here shown to be far superior to other devices of this type which are known to me. The temperature-sensitive means 12 here show comprises an inner rodlike member 28 which extends axially through and is spaced from an outer tubular member 30. At the lower ends thereof the rod 28 and tube 30 are rigidly joined together by a threaded annular disk 32. The upper terminal portion of tube 30 is snugly but slidably received in an axial opening 34 provided in the mounting 10. The rod 28 extends above the tube 30 and the projected portion thereof is threaded into an insert 36 which is set into the top surface of the mounting 10 and is fixed to the mounting in any suitable manner as by soldering, welding, or brazing.

It is essential to the present invention that the rod 28 and tube 30 have different coefficients of expansion and it is desirable that the coefficients of expansion be as far apart as possible. I have found an inner rod of invar metal and an outer tube of aluminum to be satisfactory. The invar rod 28 has a very low coefficient of heat expansion and the aluminum tube has a relatively high coefficient of heat expansion. Thus, while both the rod 28 and tube 30 expand when subjected to an increase in temperature, the tube expands many times faster than the rod. Since the upper end of the rod 28 is anchored in the insert 35 which, in effect, is a part of the mounting 10 and the lower end of tube 30 is attached to the lower end of the rod, the upper end of the tube will advance in opening 34 in response to a rise in temperature and will retract in the opening in response to a drop in temperature.

The particular construction here shown has the advantage that the temperature-sensitive means 12 works equally well at high and low temperatures. For example, the means 12 will function as well at −100° F. as it will at 800° F. or 1000° F. Further, the device is in no way affected adversely

by sudden or abrupt changes in temperature. Thus, the device can be employed in one instance to maintain a heating oven at 800° F. and then used in another instance to maintain a refrigerating system at temperatures in the order of −100° F. without any change or adaptation of the device other than to adjust the strip 18 relative to the pressure-sensitive means 12. Also, the device will withstand considerable rough treatment and abuse without damage and without getting out of adjustment. Ruggedness of this order is in sharp contrast to conventional bellows-type refrigerator controls, for example, which frequently rupture if the refrigerator is merely permitted to stand at normal summer temperatures for a period of time.

Other advantages of the particular construction here shown reside in the extreme sensitivity of the device and in the fact that the sensitivity can be regulated or controlled by using metals or metal alloys having different thermal expansion characteristics for the rod 28 and tube 30 and also by varying the length of these elements. For example, an invar rod 28 and an aluminum tube 30 approximately 10'' in length is sensitive to within five hundredths of one degree Fahrenheit. Extreme sensitivity of this character is essential for some purposes. On the other hand under circumstances where a less sensitive control is satisfactory and compactness is important, it may be possible to use a much shorter rod and tube. For example, an invar rod 28 and a stainless steel tube 30 approximately 4'' in length is sensitive to within one-third of one degree Fahrenheit. A unit of this type is small, compact and sufficiently sensitive for many domestic and commercial uses.

Any desired number of pins 14 may be employed. In practice I have used an annular series of five pins which rest upon the inner end of tube 30 and support the disk 16, as shown. All of the pins are mounted to slide readily in the insert 36 so that they transmit exceedingly slight movement readily from the tube to the strip 18.

The particular support 22 here shown has an upright member 38 and an annular base member 40. Also, it will be observed that the insert 36 has an upstanding central embossment 42 and the base 40 is threaded onto the embossment. The lower end of upright member 38 extends diametrically across the base member 40 and is welded or otherwise fastened thereto as at 44 (Fig. 2).

The flexible metallic strip 18 is mounted on one side of the upright member 38 and the upper end of the strip is welded or otherwise fixed to the member as at 46. The lower terminal portion of strip 18 projects slightly below the support 38 and is held flatly against the support member by an overlying band 48. In this connection it should be noted that the band 48 holds strip 18 relatively loosely so as not to bind or in any way restrict flexure of the latter. The projecting lower portion of strip 18 rests upon the disk 16 so that the strip responds instantly to vertical fluctuations of the disk in response to movement of the temperature-sensitive means 12. A small stop 50 disposed behind and substantially midway between the ends of the strip 18 holds the latter bowed slightly in the direction of switch 20. The rate of multiplication falls off rapidly as the spring strip 18 is bowed from an initial straight position. Consequently, the initial bow caused by the stop 50 should be just enough to assure directional bowing and preferably is about 0.01 inch. As suggested, the particular arrangement of strip 18 multiplies the vertical movement of the temperature-sensitive tube as much as 100 times or more. In practice, however, the particular multiplication ratio may vary somewhat depending upon the size and shape of the spring strip 18 and upon the elasticity characteristics of the metal from which it is made.

To raise the temperature at which the device operates micro-switch 20, it is merely necessary to unscrew the base 40 on boss 42. This action moves the strip 18 away from temperature-sensitive means 12 and thus increases the distance the latter must expand before it flexes spring 18 sufficiently to operate switch 20. On the other hand, to lower the temperature at which the device operates switch 20, it is merely necessary to screw the support 22 downwardly on the embossment 42 so as to move the flexible strip 18 closer to the temperature-sensitive means 12.

In one device actually constructed, one full rotation of the support 22 varied the operating temperature of the device 200°. However, it will be readily apparent that the amount of temperature variation per rotation of the support 22 depends upon the lead of the threads which connect the base of the support to the embossment 42. Manifestly, the latter factor can be varied within wide limits.

While the above construction is operative over an exceedingly wide temperature range, I have found that it is slightly less sensitive at exceedingly low temperatures in the order of −100° F. than at higher temperatures in the order of 800° F. or 1000° F. The difference in sensitivity at low temperatures is so small as to be nonsignificant in most cases. However, where extreme sensitivity is imperative, the loss in sensitivity may be significant. I have found, however, that if the construction is modified as shown in Fig. 3, there is no loss in sensitivity at low temperatures. In general it may be stated that the form of the invention shown in Figs. 1 and 2 has maximum sensitivity at high temperatures and the form of the invention shown in Fig. 3 has maximum sensitivity at low temperatures although both forms are sufficiently sensitive for most purposes at both high and low temperatures.

The form of the invention shown in Fig. 3 is identical to the form first described except that the inner rod 28 is used to actuate the flexible metal strip 18 instead of the outer tube 30. In the latter form of the invention, the upper end of tube 30 is threaded into the insert 36 and the insert is provided with a relatively large central opening 52 through which the rod 28 extends. The pins 14 and disk 16 are omitted and the upper end of rod 28 bears directly against the lower end of the strip 18. Thus, variations in length of the outer tube 30 moves the rod 28 against or away from the strip 18 to operate the micro-switch 20 in the same manner as the form of the invention first described.

Having thus described the invention, I claim:

1. A temperature controlling device comprising a micro-switch, an elongated, flexible and inherently resilient metallic strip mounted in front and longitudinally arched only slightly from a straight rectilinear condition and in the direction of the switch and operable to actuate the switch by flexure thereof as a result of pressure imposed longitudinally thereagainst, temperature-sensitive means arranged to impose longitudinal pressure against said strip in response to temperature changes, and means for adjusting said strip bodily

relative to said temperature-sensitive means to regulate the specific temperature at which said strip operates said switch.

2. A temperature controlling device comprising a micro-switch, switch actuating means including an elongated flexible and inherently resilient metallic strip mounted in front of and longitudinally arched in the direction of the switch and operable to actuate the switch by flexure as a result of pressure imposed longitudinally thereagainst, temperature-sensitive means for flexing said strip to operate the switch, and manually operable means for adjusting said switch actuating means to move said strip bodily relative to said temperature-sensitive means to regulate the specific temperature at which said switch is actuated by said strip.

3. A temperature control device comprising a micro-switch, an elongated flexible and inherently resilient metallic strip mounted in front and longitudinally arched in the direction of said switch and operable to actuate the switch by flexure as a result of pressure imposed longitudinally thereagainst, a pair of essentially rigid metallic elements having different coefficients of expansion, one of said elements being rigidly supported at one end and rigidly supporting the other of said elements in longitudinal alignment with said strip, freely slidable means establishing contact between said other element and said strip whereby the differential in thermal expansion of said elements flexes the strip to actuate said switch, and means for adjusting said strip bodily longitudinally relative to said other element whereby to regulate the specific temperature at which, said switch is operated.

4. A temperature controlling device comprising a mounting, temperature-sensitive means including a pair of individual, essentially rigid metallic elements having different coefficients of expansion, one of said elements being rigidly secured at one end to said mounting, the other of said elements being supported by said one element and freely movable relative to the mounting, a micro-switch, an elongated flexible and inherently resilient metallic strip mounted in front and normally longitudinally arched in the direction of said switch, said strip operable to actuate the switch by pressure imposed longitudinally thereagainst by thermal expansion movement of said freely movable element, and a support for said strip adjustable on the mounting to move the strip bodily relative to said freely movable element whereby to regulate the specific temperature at which said switch is operated.

5. A temperature controlling device comprising a mounting having an externally threaded upstanding embossment thereon, a pair of essentially rigid metallic elements having different coefficients of expansion, one of said elements being fastened at its upper end to said mounting and fastened to the other of said elements at the lower end thereof, the upper terminal portion of said other element being journaled for sliding movement in said mounting, a support having an annular base portion threaded on said embossment, a micro-switch carried by said support, and an elongated flexible and inherently resilient metallic strip mounted on the support in front of said switch, said strip being normally fastened at one end to the support, being longitudinally arched in the direction of said switch and being operable by thermal expansion movement of said slidable element to actuate said switch.

6. A temperature-controlling device comprising a micro-switch, an elongated, flexible and inherently resilient metallic strip mounted in front and longitudinally arched only slightly from a straight rectilinear condition and in the direction of the switch and operable to actuate the switch by flexure thereof as a result of pressure imposed longitudinally thereagainst, temperature-sensitive means arranged to impose longitudinal pressure against said strip in response to temperature changes, and adjustable means for effecting relative movement between the strip and said temperature-sensitive means to regulate the specific temperature at which said strip operates said switch.

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