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E. N. LIGHTFOOT
THERMOSTATIC APPARATUS

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Fig. 1

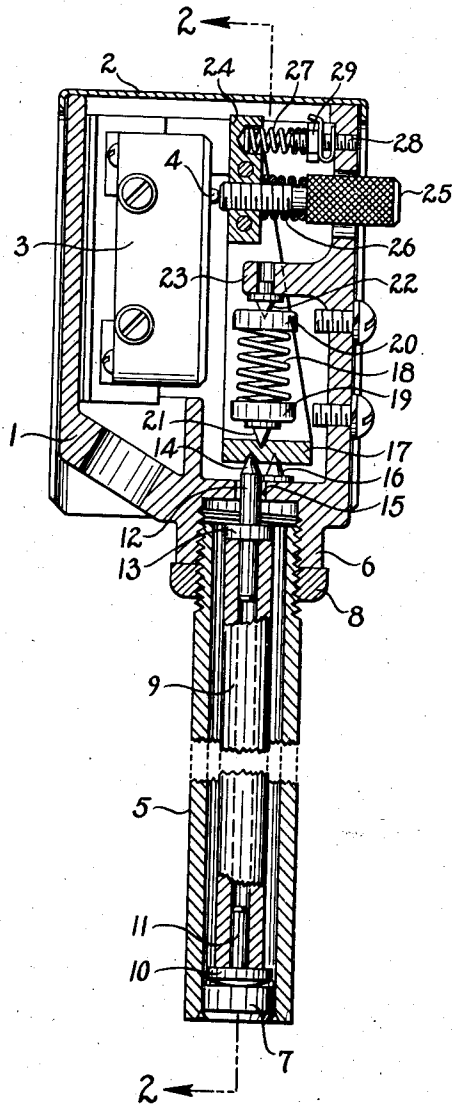
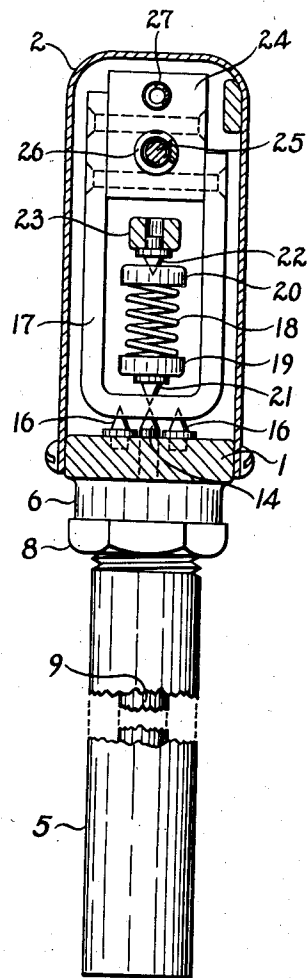


Fig. 2



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THERMOSTATIC APPARATUS

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8 Claims. (Cl. 200—137)

This invention relates to thermostatic apparatus and while not limited thereto it is particularly applicable to thermostatically operated electric switches.

An object of the invention is to provide an improved thermostatic operating mechanism which is simple in construction and easily assembled and maintained.

Another object is to provide a mechanism which may be adjusted to operate between very close limits of temperature variations, while being at the same time adjustable at will for operating ranges from very low to very high average temperatures.

Another object is to provide a mechanism which is not overstrained if it is subjected to a temperature which greatly departs from the operating limits for which it is adjusted.

Another object is to provide a thermostat the operation of which is independent of the position in which it is mounted.

Thermostatic apparatus in accordance with the present invention provides for a pivoted actuator or lever which is supported for limited rotary movement in two spaced open pivotal bearings each comprising cooperating elements, one of the bearings having one element thereof provided on the lever and the other on a base, while one element of the other bearing is also provided on the lever and the cooperating element on one end of a thermally responsive rod the other end of which is attached to the base. The two elements of both bearings are biased into respective engagement by a spring acting on the lever whose rotary motion may be limited in either direction in any suitable manner. If the rod expands or contracts beyond the limit corresponding to the rotation of the lever in one or the other direction, the elements of the respective bearing separate and thus prevent undue strain on the lever or the parts connected thereto.

Thus by providing for a limitation of the rotary movement of the actuator about an open pivotal bearing, the pivot and cooperating bearing surface of the bearing are separated from each other by a relative radial movement when the limit of rotation about such bearing is reached, that is when the device is subjected to temperatures outside of the range of its adjustment. This prevents excess rotary motion from being transmitted to the delicate parts of the device and overstraining of the parts.

Other objects and advantages will hereinafter appear.

The accompanying drawing is illustrative of an embodiment of the invention.

In the drawing, Figure 1 is a longitudinal section through a thermostat, while

Fig. 2 is a section along the lines 2—2 of Fig. 1.

Referring to the drawing a cast metal frame 1 forms with a sheet metal cover 2 a housing for an electric switch 3, which may be of any of a number of types of snap switches, but is preferably of a type requiring a minimum of movement and operating force and closing and opening its contacts with a snap action. The switch shown has its contacts totally enclosed in an insulating casing and is provided with a reciprocable operating rod 4 which projects outside of said casing. The switch casing is mounted on the frame 1.

A tube 5 of a material which expands and contracts with changes in temperature has its one end threaded into a boss 6 of the frame 1, while its outer end is closed by a plug 7 which is soldered or otherwise fastened in the end of the tube. The tube 5 may be screwed into the base a greater or lesser distance to adjust its length and it is locked in the proper position by a lock nut 8. Inside of the tube 5 is arranged a second tube 9 of a temperature expansible material having a temperature characteristic differing from that of the tube 5, so that upon changes in ambient temperature the two tubes expand and contract by different amounts. The tube 9 has preferably a very low coefficient of expansion which is negligible in relation to that of tube 5. The lower end of the tube 9 is provided with an abutment 10 which has a reduced shank 11 and which is guided in the tube 9 to hold the abutment 10 tightly to the rod 9. The upper end of the tube 9 is equipped with an operating pin 12 which transmits the thrust of the tube 9 and which for that purpose is provided with a shoulder 13, abutting the end of tube 9 while its outer end is a cone 14 which protrudes into the housing through a hole 15.

Inside of the base, adjacent to the hole 15 are two hardened fulcrum points 16 which are so arranged on one side of the pin 12 that the plane through the apices of said points and of said cone is substantially perpendicular to the axis of the pin 12. A U-shaped operating lever 17 is provided at its intermediate transverse outer surface with three recesses which respectively engage the cone 14 and the points 16 and which form with the latter open pivotal bearings. The respective bearing elements are kept

in engagement with each other by a helical load spring 18, which is provided with cups 19 and 20 at its respective ends. Mounted centrally of the cup 19 is a point 21 which engages a recess on the inner surface of the lever 17 opposite of the bearings and above and within the area bounded by the three points 14 and 16. The cup 20 is provided with a central indentation to receive a point 22 which is mounted on a lug 23 which forms part of the frame 1.

The load spring is compressed to apply a pressure upon the bearings thereby maintaining the tube 9 in compression, while at the same time it tends to rotate the lever 17 counterclockwise as depicted in Fig. 1, as the lever fulcrums about the points 16.

The upper ends of the lever 17 are bridged by a block 24 which is riveted to the lever. A screw 25 is threaded into the block 24 at a point opposite to the operating rod 4 so that one end of the screw normally bears against the rod. The other end of the screw has a knurled head to facilitate manual adjustment thereof. A spring 26 which is held in compression between the block 24 and the knurled head of the screw 25 is wound about the screw to increase the frictional engagement of the screw and prevent the latter from turning and thereby change its adjustment. Another compression spring 27 may be interposed between the lever 17 and the frame 1 to amplify the bias of the spring 18, but the spring 27 may also be omitted. Furthermore, the spring 27 may be arranged to transmit its pressure to the frame 1 through a screw 28, fastened to the frame 1 and provided with a thread which engages a nut 29. By turning the nut the compression of the spring 27 may be varied to thereby vary the bias of the lever 17.

The tube 5 is preferably the element having a high coefficient of expansion, while the tube 9 should have a low or zero coefficient of expansion and is preferably made of quartz. The tube 9 may be replaced by a solid rod, and it is also possible to arrange the elements 5 and 9 in parallel arrangement side by side in place of the concentric arrangement shown. The device may be employed to respond to temperature changes of gaseous or liquid media and by suitable changes of the temperature responsive elements it may be used to respond to the temperature variations of a solid object.

In operating the device it is so adjusted that for the minimum desired temperature the lever 17 permits the operating rod 4 to occupy its outermost position. If now the temperature increases the element 5 expands more than the element 9. This causes the lever 17 to rotate counterclockwise until the screw 25 pushes the rod 4 sufficiently inwardly to operate the switch 3. Thereafter decreased temperature will cause shortening of tube 5 and clockwise rotation of the lever 17 until the switch 3 is again operated in the reverse direction. If the device while adjusted to operate in a very high temperature range should be exposed to very low temperature, the lever continues to rotate clockwise until ultimately its rotation is stopped. Thereafter the lever is lifted off the points 16, while the spring 18 is further compressed without any undue strains being exerted on the operating parts. If the temperature rises again the lever ultimately again engages the pivots 16. It will also be noted that if the device is adjusted for a low average temperature and this is greatly reduced, the pin 12 leaves the lever 17 which then remains at rest

on the pivots 16 to be engaged again by the pin 12 upon a rise in temperature to within the adjusted range. Thus the mechanism is protected at all times from excessive stresses and is always ready to operate at its adjusted temperature level after having been exposed to temperatures far outside of said level.

It is obvious that the relation of the parts may be reversed so that the lever 17 rotates in a direction opposite to that described for corresponding temperature changes.

It is obvious that the points of bearings 16 and the cone bearing 14 may also be replaced by a knife edge or other type of abutment providing open pivotal bearings.

What I claim as new and desire to secure by Letters Patent is:

1. In a thermostatic switch the combination of a base, an electric switch mounted on said base and having an actuator to operate the switch, a lever for operating said actuator, an adjustable abutment for said actuator on said lever, two supporting points on said base, two parallel thermoresponsive rods having different temperature coefficients of expansion and having one of their respective ends joined together, the other end of one of said rods being adjustably attached to said base, a third supporting point at the other end of said other rod, said supporting points being arranged in a triangle whose plane is substantially normal to said rods, a lever having bearing surfaces for said points, each of the surfaces forming with the respective point an open pivotal bearing, and a spring between said base and said lever and applying to the latter a biasing force in a direction substantially parallel with said rods and passing through said triangle to bias said lever toward said points.

2. In a thermostatic mechanism, the combination of a base, a lever, an open pivotal bearing interposed between said base and one end face of said lever, a thermoresponsive rod having its one end fastened to said base, a second open pivotal bearing interposed between said end face of the lever and the other end of said rod, and a spring bearing against the opposite face of said end of the lever and arranged to normally bias the elements of the respective bearings into engagement with each other and to afford rotation of said lever about said bearings simultaneously.

3. In a thermostatic mechanism, the combination of a base, a lever, an open pivotal bearing having cooperating bearing surfaces on said base and one end face of said lever, a thermoresponsive rod having its one end adjustably fastened to said base, another open pivotal bearing having cooperating bearing surfaces on said rod and said end face of the lever, and a spring interposed between said base and the opposite face of said end of the lever to normally maintain the cooperating surfaces of the respective bearings in contact with each other and to afford rotation of said lever about said several bearings simultaneously.

4. In a thermostatic mechanism, the combination of a base, a lever, an open pivotal bearing having cooperating bearing surfaces on said base and one end face of said lever respectively, two parallel thermoresponsive rods having different temperature coefficients of expansion and having one pair of their respective ends joined together, the other end of one of said rods being adjustably attached to and positively locked in adjusted position relatively to said base, another

open pivotal bearing having cooperating bearing surfaces on the other end of said other rod and on said end face of the lever, and a spring interposed between said base and the opposite face of said end of the lever to normally maintain the cooperating surfaces of the respective bearings in contact with each other and to afford rotation of said lever about said several bearings simultaneously.

5. In a thermostatic mechanism, the combination of a base, a lever, an open pivotal bearing having cooperating bearing surfaces on said base and on one end face of said lever, a thermoresponsive rod having its one end fastened to said base, another open pivotal bearing having cooperating bearing surfaces on said rod and said end face of the lever to cause the latter to rotate about said first bearing in response to temperature changes of said rod, and a spring interposed between said base and the opposite face of said end of the lever to normally maintain the cooperating surfaces of the respective bearings in contact with each other and to afford rotation of said lever about said several bearings simultaneously.

6. In a thermostatic mechanism, the combination of a base provided with an abutment, a thermoresponsive rod having one end attached to said base and its other end provided with another abutment spaced laterally from said former abutment, a lever provided with bearing surfaces on one end face thereof for engaging said abutments, each of said bearing surfaces forming with the respective abutment an open pivotal bearing for rotational movement of the lever thereabout, and a spring at the opposite face of said end of the lever normally maintaining said surfaces in engagement with the respective abutments and affording rotation of said lever about said several bearings simultaneously, while permitting separation of the bearing surface and abutment of one of the bearings upon

changes in temperature of said rod beyond a given limit.

7. In a thermostatic switch the combination of a base, an electric switch complete in itself mounted on said base and having an actuator to operate the switch, a lever for operating said actuator, an open pivotal bearing having cooperating bearing surfaces on said base and on one end face of said lever, a thermoresponsive rod having its one end fastened to said base, another open pivotal bearing having cooperating bearing surfaces on said rod and said end face of the lever, and a spring interposed between said base and the opposite face of said end of the lever to maintain the cooperating surfaces of the respective bearings in contact with each other and to afford rotation of said lever about said several bearings simultaneously.

8. In a thermostatic switch the combination of a base, an electric switch complete in itself mounted on said base and having an actuator to operate the switch, a lever for operating said actuator, an open pivotal bearing having cooperating bearing surfaces on said base and on one end face of said lever respectively, two substantially parallel thermoresponsive rods having different temperature coefficients of expansion and having one of their respective ends joined together, the other end of one of said rods being adjustably attached to and positively locked in adjusted position relatively to said base, another open pivotal bearing having cooperating bearing surfaces on said other end of said other rod and on said end face of the lever, and a spring interposed between said base and the opposite face of said end of the lever to normally maintain the cooperating surfaces of the respective bearings in contact with each other and to afford rotation of said lever about said several bearings simultaneously.

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