Feb. 7, 1956 A. J. HILGERT 2,734,113

THERMOSTAT

Filed April 22, 1953

Fig. 1.

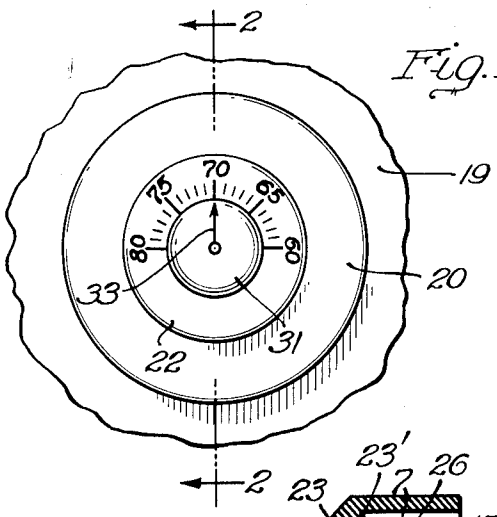
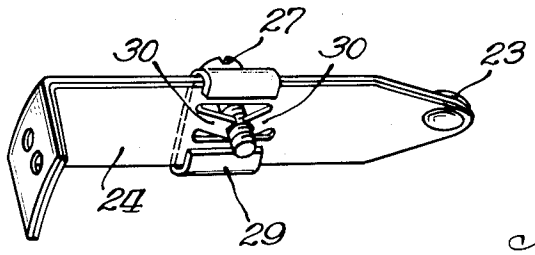


Fig. 2.

Fig. 3.



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THERMOSTAT

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10 Claims. (Cl. 200—138)

This invention relates to improvements in thermostats and more particularly to thermostats of the type having the contacts thereof encapsulated within a hermetically sealed enclosure.

My copending application Serial No. 291,047, filed May 31, 1952, shows and describes an improved condition responsive device adapted for the control of low power circuits, such as thermoelectrically powered circuits, and having a pair of contacts encapsulated within a hermetically sealed expansible and contractible enclosure having a temperature responsive volatile fluid fill. The device described in the referred to application has extremely high sensitivity and low differential characteristics heretofore unattainable in thermostats and the like. The encapsulation of the contacts in a hermetically sealed enclosure prevents contamination of said contacts by foreign matter, oxidation, films, corrosion and the like, and is a major factor contributing to the sensitivity and constancy of operation attained by the aforementioned device. The use of a volatile temperature responsive fluid fill in the enclosure, however, limits the application of the aforementioned device to circuits in which the power is low enough so that no substantial arcing is produced at the contacts, since arcing tends to break down a volatile fill and thereby render the device inoperative.

It is a general object of the present invention to provide an improved thermostat of the type having contacts encapsulated within a hermetically sealed expansible and contractible enclosure in the form of a bellows, said device being adapted for use in higher voltage control circuits, for example 24 volt circuits, and said device being so constructed that arcing at the contacts has no deleterious effect on its operational characteristics.

Another object of the invention is to provide an improved thermostat of the character described wherein the sealed enclosure contains a gaseous fill which is stable under normal arcing conditions, there being temperature responsive biasing means externally of and cooperable with said enclosure for actuating the latter and the contacts therein.

Another object of the invention is to provide an improved control device of the character described having means within the enclosure for providing quick-make and quick-break of the circuit through its contacts to thereby minimize arcing at said contacts.

A more specific object of the invention is to provide an improved thermostat wherein the temperature responsive biasing means take the form of a bimetallic arm carrying an adjustment screw which engages an end wall of the enclosure, said arm being cooperable with an indicia bearing centrally bored temperature adjustment knob having a cam surface engaging one end of said arm, and said knob being rotatably mounted on a bearing sleeve aligned with said adjustment screw, there being a cap removably fixed to said sleeve and closing the outer end of said sleeve and knob, said cap having pointer means cooperable with the indicia on said knob, and removal of said cap providing access to said adjustment screw through said bearing sleeve.

Another specific object of the invention is to provide an improved thermostat of the character described wherein the adjustment screw has a screwed support on the bimetallic biasing arm, there being friction means on said arm cooperable with said screw to lock the latter in a selected position.

Still another object of the invention is to provide an improved thermostat of the character described wherein one of the contacts is made of magnetic material and is coated with metal having low electrical resistance, said contact being fixed to one end wall of the enclosure, the other contact being fixed to the opposite end wall of the enclosure, and there being a permanent magnet within said enclosure adjacent and fixed with respect to said other contact, said magnetic contact cooperating with said permanent magnet to provide quick-make and quick-break of the circuit between said contacts.

Other and further objects and advantages of the invention will appear as the description proceeds, reference being had to the accompanying drawing illustrating one complete embodiment of the invention and wherein like characters of reference indicate the same parts in all of the views.

In the drawing:

Figure 1 is a side elevational view of the improved thermostat mounted on a wall, the latter being shown fragmentarily.

Figure 2 is an enlarged vertical sectional view taken approximately along the line 2—2 of Figure 1; and

Figure 3 is a perspective view of the bimetallic biasing arm of the improved thermostat showing in detail one form of friction means for locking the adjustment screw in a selected position.

Referring more particularly to Figure 2 of the drawing, the improved thermostat comprises a hermetically sealed expansible and contractible metal bellows 5 which is closed at one end by a centrally apertured fixed wall 6 and is closed at its opposite end by a movable wall 7. A fixed contact stem 8 projects through the central aperture of the wall 6, being insulated therefrom by a glass insulator 9. The stem 8 is provided with a terminal tip 10 which is insulated from the wall 6 by an insulator 11 and is provided with means for effecting an electrical connection therewith, such as an integral stud 10' on which a nut 12 is threaded. The inner end of the stem 8 is provided with a rounded contact 13, and fixed to said stem adjacent the contact 13 is a U-shaped permanent magnet 14. Fixed to a central portion of the inner surface of the wall 7 in alinement with the contact 13 and magnet 14 is a flat contact 15 of magnetic material. The contact 15 is preferably plated with metal of low electrical resistance such as silver.

A bracket 16 has a generally U-shaped intermediate portion which straddles the bellows 5 in generally diametrical relation and is formed with an aperture 17 coaxial with said bellows. The fixed wall 6 is secured to the bracket 16 in any suitable manner, and the outer ends of said bracket are apertured to receive screws 18 for attachment of the thermostat to a wall 19 or other support. The base plate 6 is provided with a means, such as a screw 20, for effecting an electrical connection therewith. It will be noted that the bracket 16 supports the base plate 6 in spaced relationship with respect to the wall 19 to provide a space for the accommodation of the stud 10' and nut 12, and screw 20, as well as conductors 34 and 35 connected thereto. An annular removable bezel 20' surrounds the periphery of the fixed wall 6 and the adjacent portion of the bracket 16 as shown, thereby concealing the end portions of said bracket and the attaching screw 18.

A bearing sleeve 21 is fixed at one end in the aperture 17 of the bracket 16 and is coaxial with the bellows 5. A centrally bored dial or temperature adjusting knob 22 is rotatably mounted on the fixed bearing sleeve 21 and carries temperature indicia as shown in Figure 1. A spring

washer 28 surrounds the bearing sleeve 21 and is interposed between the knob 22 and the bracket 16 as shown in Figure 2. The knob 22 has an annular cam surface 23 which is inclined and which cooperates with a temperature responsive biasing means which in the illustrated embodiment takes the form of a bimetal arm 24 having a free end 23' in engagement with said cam surface. The arm 24 extends diametrically across the movable end wall 7 of the bellows 5 and has its opposite end fixed to the bracket 16, as by rivets 25. The bracket 16 is provided with an opening 26 through which the arm 24 projects.

An adjustment screw 27 is carried by the biasing arm 24 and is coaxial with the sleeve 21 and bellows 5, said screw engaging the wall 7 and serving as a force transmitting member between the arm 24 and said wall. The screw 27 provides for factory adjustment of the improved thermostat to obtain the proper range setting, and means are provided for locking the screw 27 in the selected position of adjustment. Referring to Figure 3, a nut 29 which is C-shaped in cross-section is clamped around the arm 24, and portions of said arm adjacent the nut 29 are blanked out to provide a pair of jaws 30. The space between the jaws 30 is smaller than the pitch diameter of the screw 27, so that when the latter is turned into the nut 29 and between the jaws 30, said jaws frictionally engage the screw and bend in the direction of axial movement of the screw to exert a back-thrust on said screw. This thrust loads the screw in the direction in which it is normally loaded and thus avoiding backlash as well as frictionally locking the screw against turning from the selected position.

A cap 31 covers the outer end of the sleeve 21 as well as that of the knob 22, and said cap is provided with a friction member 32 which projects into the sleeve 21 and frictionally engages the inner surface of the latter. The member 32 provides a means for removably mounting the cap in fixed relationship with respect to the sleeve 21. It will be noted that removal of the cap 31 provides access to the adjustment screw 27 through the sleeve 21. As shown in Figure 1, the cap 31 is also provided with pointer means, such as the arrow 33 cooperable with the indicia on the knob 22 for indicating the temperature setting of the thermostat.

The bellows 5 is filled with a gaseous fill which is stable under arcing conditions, said fill also being of the type which will not react with the contacts or form a film thereon, or in any other way adversely affect the electrical connections provided by said contacts. Illustrative of suitable gaseous fills for use in the bellows 5 are dry nitrogen, hydrogen and helium. The fill is normally under substantially atmospheric pressure within the bellows 5.

The operation of the illustrated embodiment of the invention is as follows:

The bellows 5 inherently biases the movable wall 7 toward the adjustment screw 27. The bimetal arm 24 senses the temperature of the ambient atmosphere, and when said temperature rises above that set by the cooperation of the cam surface 22 with the arm 24 at the position to which the knob 22 is turned for the desired setting, said arm deforms to move the screw 27 toward the bellows 5. The aforementioned screw movement moves the bellows wall 7 and magnetic contact 15 toward the fixed contact 13 and magnet 14 against the inherent bias of the bellows 5. The attractive force of the magnet 14 on contact 15 increases exponentially as said contact approaches the magnet, and the contact 15 is thereby drawn into engagement with the contact 13 with a quick-make or snap action to close the circuit between said contacts. The tip of the contact 13 projects slightly beyond the plane of the pole faces of the magnet 14 in the direction toward the contact 15, so that the contact 15 does not actually touch said pole faces, but is spaced, for example, a few thousandths of an inch therefrom when the contacts 13 and 15 are engaged.

Upon a drop in the temperature of the ambient atmosphere below that set by the knob 22 and the cooperation of the cam surface 23 with the bimetal biasing arm 24, said arm tends to straighten out, to retract the screw 27 and thus permit the inherent bias of the bellows 5 to urge the movable wall 7 and contact 15 away from the contact 13 and magnet 14. The biasing force of the bellows overcomes the attractive force of the magnet, and since said attractive force decreases exponentially as the contact 15 moves away from the pole faces of the magnet, said contact is pulled away from the contact 13 with a quick-break or snap action. The quick-make quick-break action of the contacts minimizes arcing of said contacts.

The encapsulation of the contacts 13 and 15 within the hermetically sealed bellows 5 brings to the higher voltage field a thermostat whose sensitivity and other operational characteristics remain constant, because of its immunity to many environmental conditions which adversely affect conventional thermostats. The encapsulated contacts 13 and 15 never become fouled by dust, films, oxidation, corrosion or the like as do contacts which are exposed to the ambient atmosphere. Not only is arcing at the contacts minimized by the quick-make quick-break operation of the contacts, but the stable nature of the gaseous fill within the bellows prevents said arcing from deleteriously affecting the operation of the improved thermostat.

While a bimetallic biasing arm is shown in the illustrated embodiment of the invention, it is obvious that other suitable temperature responsive biasing means may be utilized within the invention concept. The embodiment of the invention selected for illustration is for the purpose of disclosure only and is not to be construed as a definition of the limits or scope of the invention. Various other changes and modifications may be made without departing from the spirit of the invention, and all of such changes are contemplated as may come within the scope of the claims.

What I claim as the invention is:

1. In a thermostat, the combination of: an expansible and contractible hermetically sealed enclosure having a pair of opposite end walls one of which is movable toward and away from the other, said enclosure having a gaseous fill which is stable under arcing conditions and has a pressure substantially equal to atmospheric pressure, said movable wall being biased away from the other wall; a pair of cooperating contacts within said enclosure fixed respectively to said opposite end walls; and temperature responsive mechanism positioned in engagement with said movable wall, said mechanism being responsive to a predetermined temperature to effect movement of said movable wall toward said other wall against said bias to thereby effect circuit-making engagement of said contacts, said mechanism being responsive to a temperature below said predetermined temperature to permit movement of said movable wall in the reverse direction under said bias to thereby interrupt the circuit between said contacts.

2. In a thermostat, the combination of: an expansible and contractible enclosure having a pair of opposite end walls one of which is movable toward and away from the other, said enclosure having a gaseous fill which is stable under arcing conditions and has a pressure substantially equal to atmospheric pressure, said movable wall being biased away from the other wall; a pair of cooperating contacts within said enclosure fixed respectively to said opposite end walls; and temperature responsive mechanism including a bimetal biasing arm coacting with said movable wall, said mechanism being responsive to a predetermined temperature to effect movement of said movable wall toward said other wall against said bias to thereby effect circuit-making engagement of said contacts, said mechanism being responsive to a temperature below said predetermined temperature to permit movement of said movable wall in the reverse direction

under said bias to thereby interrupt the circuit between said contacts.

3. In a thermostat, the combination of: an expansible and contractible enclosure having a pair of opposite end walls one of which is movable today and away from the other, said enclosure having a gaseous fill which is stable under arcing conditions and has a pressure substantially equal to atmospheric pressure, said movable wall being biased away from the other wall; a pair of cooperating contacts within said enclosure fixed respectively to said opposite end walls, one of said contacts being made of magnetic material; a permanent magnet within said enclosure cooperating with said magnetic contact to provide quick-make and quick-break of the circuit between said contacts; and temperature responsive mechanism including a bimetal biasing arm coacting with said movable wall, said mechanism being responsive to a predetermined temperature to effect movement of said movable wall toward said other wall against said bias to thereby effect circuit-making engagement of said contacts, said mechanism also being responsive to a temperature below said predetermined temperature to permit movement of said movable wall in the reverse direction under said bias to thereby interrupt the circuit between said contacts with a snap action.

4. A thermostat, comprising: an expansible and contractible enclosure having a base plate adapted to be fixed to a support and having an opposite movable wall; cooperating contacts encapsulated within said enclosure; a bracket fixed to said base plate and straddling said enclosure, said bracket having an opening alined with the movable wall of said enclosure; a temperature responsive bimetal arm fixed at one end to said bracket and extending across the movable wall of said enclosure; a bearing sleeve fixed in the opening of said bracket; a range adjustment screw carried by said arm and cooperating with said movable wall, said screw being alined with said bearing sleeve; an indicia bearing annular temperature adjusting knob rotatably mounted on said fixed bearing sleeve and having a cam surface cooperating with said bimetal arm for varying by rotation of said knob the force applied to said movable wall by said arm through said screw; and a cap removably fixed to and closing the outer end of said bearing sleeve, said cap being provided with pointer means cooperable with the indicia on said knob, and removal of said cap providing access to said range adjustment screw through said bearing sleeve to permit adjustment of the range setting of said thermostat.

5. A thermostat, comprising: an expansible and contractible enclosure having a base plate adapted to be fixed to a support and having an opposite movable wall; cooperating contacts encapsulated within said enclosure; a bracket fixed to said base plate and straddling said enclosure, said bracket having an opening alined with the movable wall of said enclosure; a temperature responsive arm fixed at one end to said bracket and extending across the movable wall of said enclosure; a bearing sleeve fixed in the opening of said bracket; a range adjustment screw having a screwed support on said arm; friction means on said arm cooperable with said screw to lock the latter in a selected position, said screw cooperating with said movable wall and being alined with said bearing sleeve; a temperature adjusting knob rotatably mounted on said fixed bearing sleeve and having a cam surface cooperating with said arm for varying by rotation of said knob the force applied to said movable wall by said arm through said screw; and a cap removably fixed to and closing the outer end of said bearing sleeve, removal of said cap providing access to said range adjustment screw through said bearing sleeve to permit adjustment of the range setting of said thermostat.

6. In a thermostat, the combination of: A pair of relatively movable contacts; a biasing arm adjacent said contacts; an adjustment screw carried by said arm and cooperating with one of said contacts; a fixed bearing sleeve aligned with said adjustment screw; a temperature adjusting knob rotatably mounted on said fixed bearing sleeve and having a cam surface cooperating with said biasing arm for varying by rotation of said knob the force applied to said one contact by said arm through said screw; and a cap removably closing one end of said bearing sleeve, removal of said cap providing access to said adjustment screw through said sleeve to permit adjustment of said screw.

7. In a thermostat, the combination of: A pair of relatively movable contacts; a biasing arm adjacent said contacts; an adjustment screw carried by said arm and cooperating with one of said contacts; a fixed bearing sleeve aligned with said adjustment screw; an indicia bearing temperature adjusting knob rotatably mounted on said fixed bearing sleeve and having a cam surface cooperating with said biasing arm for varying by rotation of said knob the force applied to said one contact by said arm through said screw; and a cap removably closing one end of said bearing sleeve, said cap being provided with indicia cooperable with the indicia on said knob and removal of said cap providing access to said adjustment screw through said sleeve to permit adjustment of said screw.

8. In a thermostat, the combination of: A pair of relatively movable contacts; a temperature responsive bimetal biasing arm adjacent said contacts; an adjustment screw carried by said arm and cooperating with one of said contacts; a fixed bearing sleeve aligned with said adjustment screw; an indicia bearing temperature adjusting knob rotatably mounted on said fixed bearing sleeve and having a cam surface cooperating with said biasing arm for varying by rotation of said knob the force applied to said one contact by said arm through said screw; and a cap removably closing one end of said bearing sleeve, said cap being provided with indicia cooperable with the indicia on said knob and removal of said cap providing access to said adjustment screw through said sleeve to permit adjustment of said screw.

9. In a thermostat, the combination of: A pair of relatively movable contacts; a temperature responsive biasing arm adjacent said contacts; an adjustment screw carried by said arm and cooperating with one of said contacts; a fixed bearing sleeve aligned with said adjustment screw; a temperature adjusting knob rotatably mounted on said fixed bearing sleeve and having a cam surface cooperating with said biasing arm for varying by rotation of said knob the force applied to said one contact by said arm through said screw; friction means on said arm cooperable with said screw and tending to hold the latter in a selected position; and a cap removably closing one end of said bearing sleeve, removal of said cap providing access to said adjustment screw through said sleeve to permit adjustment of said screw.

10. A cycling thermostat comprising: A pair of relatively movable contacts biased toward circuit-interrupting relation, one of said contacts being magnetically permeable; a temperature responsive bimetallic biasing member coacting with one of said contacts and operable in response to a predetermined temperature to move said contacts into circuit-making relation against the bias thereof; and a permanent magnet positioned for cooperation with said permeable contact to impart snap action to said thermostat.

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