Feb. 10, 1942. M. W. EATON 2,272,459

THERMOSTATIC CONTROL

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Fig. 1

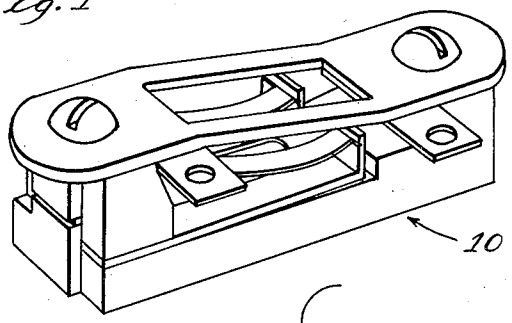


Fig. 2

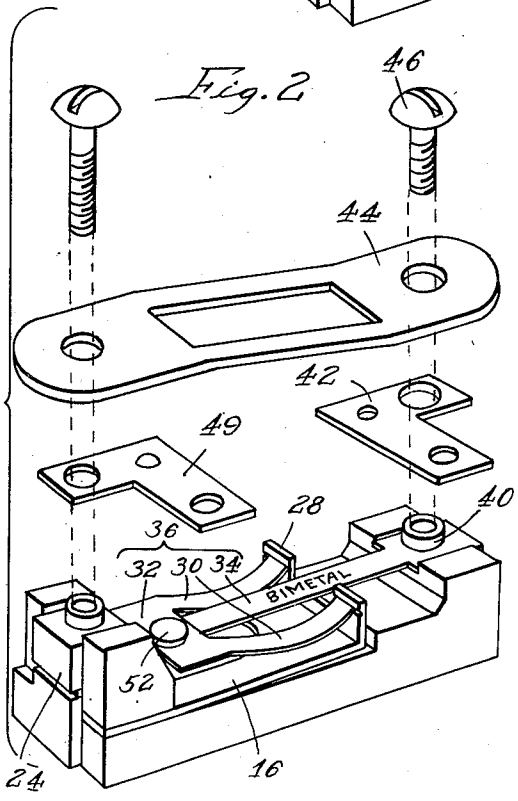


Fig. 3

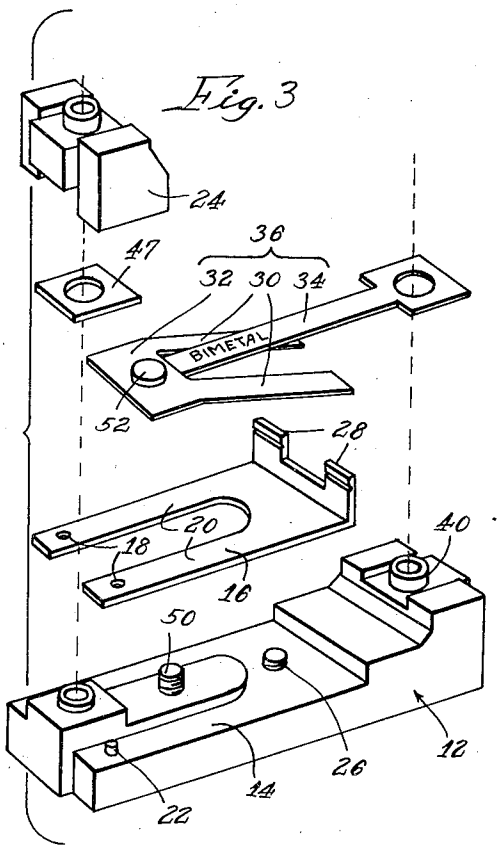
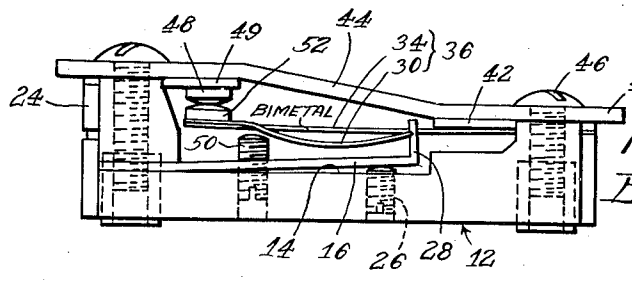


Fig. 4



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Fig. 5

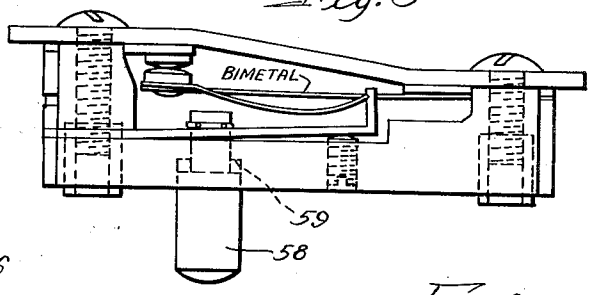


Fig. 6

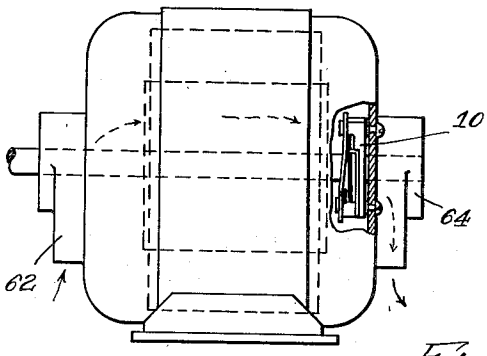
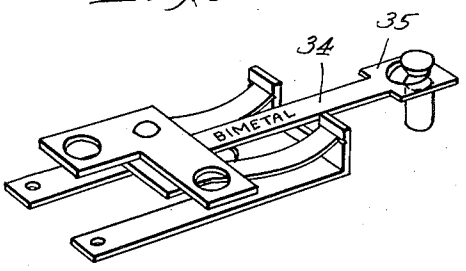


Fig. 7

Fig. 9



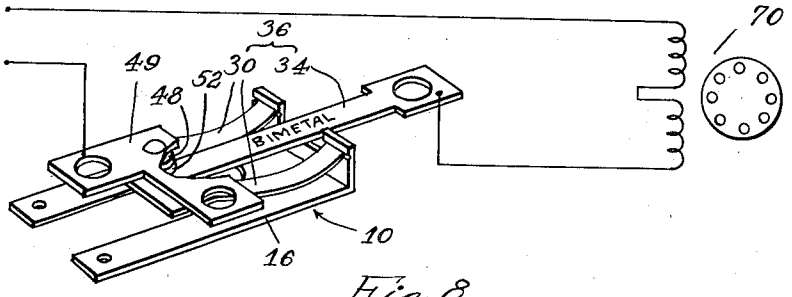
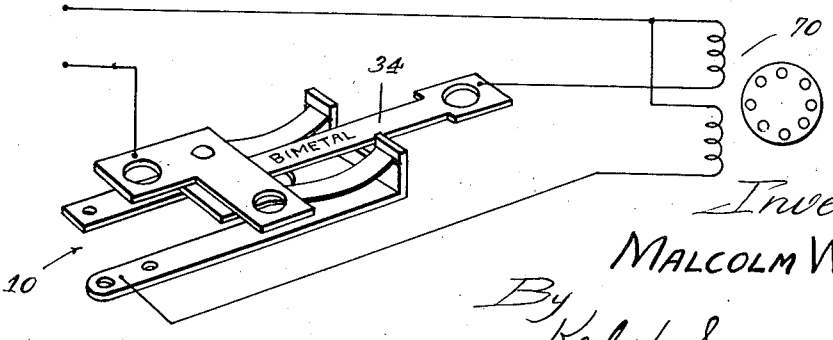


Fig. 8



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UNITED STATES PATENT OFFICE

2,272,459

THERMOSTATIC CONTROL

Malcolm W. Eaton, Freeport, Ill., assignor to Micro Switch Corporation, Freeport, Ill., a corporation of Illinois

Application June 5, 1939, Serial No. 277,436

14 Claims. (Cl. 200—138)

The present invention relates generally to snap acting thermostats, and more particularly to such thermostats for use in thermally actuated electric switches, and in thermally operated, current responsive electric switches.

Objects of the invention include the provision of a new and improved snap acting thermostat, a new and improved thermally actuated electric switch, an improved and simplified snap acting bimetallic mechanism. The invention resides in certain novel features of construction, combinations of parts, and arrangements of apparatus, and is illustrated by the specific embodiments herein shown and described by way of example. In the drawings:

Fig. 1 is a perspective view of a thermostat, or thermal relay, embodying my present invention;

Figs. 2 and 3 are partially exploded views of the device of Fig. 1 illustrating, in perspective, the various parts and their orientation with respect to each other in the assembly;

Fig. 4 is a side elevation of the device of Fig. 1;

Fig. 5 is a view similar to that of Fig. 4, of a slightly modified device;

Fig. 6 illustrates an electric motor having mounted therein the thermal device of Fig. 1;

Figs. 7 and 8 illustrate circuit arrangements in which the thermal device of the present invention may be employed for protecting an electric motor, and;

Fig. 9 illustrates a modification of the device shown in Figs. 1 to 4 inclusive.

In Figs. 1 to 4 and 6 to 8 inclusive, the protective device as a whole is designated by the reference numeral 10. An insulating base 12 includes a bed portion 14 which carries an anchor 16 formed of sheet brass. This anchor 16 is generally U-shaped (see Fig. 3), and has holes 18 at the ends of its legs 20 to fit over locating pins 22 projecting upwards from the bed 14 of the base 12. This anchor is held in place by a molded insulating block 24 (see Fig. 2) which clamps the ends of the two legs 20 of the U-shaped anchor 16 to hold the anchor in place on the pins 22. The anchor 16 being thus held only at one of its ends may be flexed to raise and lower the other end. A screw 26 threaded into the base 12 (see Figs. 3 and 4) turns up against the right hand end of the anchor 16 to raise it slightly off the bed 14 of the base 12 to adjust the operation of the device in a manner to be described presently.

The right hand end of the anchor 16 carries two upturned tabs 28 which are notched to receive the ends of a pair of bowed thin leaf compression springs 30, as shown best in Figs. 2 and 4. These compression springs 30, as shown in Fig. 3, are flat in their unstressed condition, and constitute different portions of a single U-shaped spring. At the closed end 32 of this U-shaped spring is riveted one end of a bimetal strip 34, the other end of which fits over an insulating projection 40 of the base 12. A terminal member 42 and an insulating guard 44 held under the screw 46 which threads into the base 12 itself, clamps the mounted end of the bimetal strip 34.

The bimetal element 34 constitutes a tension member or thin leaf tension spring, and the springs 30, together with the bimetal element 34, constitute a snap acting toggle 36 which carries contact 52 at its movable end. Since the radius of action of the compression springs 30 is less than the radius of action of the tension bimetal strip 34, the toggle has an over center snap characteristics, which may be changed somewhat by adjusting the position of the supporting tabs 28 of the compression springs 30 by means of the adjusting screw 26.

A contact piece 48 carried by terminal 49 clamped on top of the molded insulating block 24 and a screw 50 threaded through the base 12 serve as stops to limit the snap motion of the toggle 36.

A spacer 47 fits under the block 24, but if two stationary contacts are to be used, to make the switch "double throw" this spacer 47 and also screw 50 are omitted, and another terminal like 49 takes the place of spacer 47 and carries the additional contact. Then contact 52 carried by the toggle 36 stops against contacts in both of its positions.

The snap acting element 36 is constructed with its high expansion material of the bimetal element 34 on the upper face thereof, so that upon a rise of temperature the bimetal tends to move the contact 52 down, and similarly on a fall of temperature tends to move the contact 52 up. Assume that the toggle 36 lies in its upper position so that it is held in engagement with contact 48. Then upon a rise in temperature, the bimetal element 34, because it has its high expansion material on its upper face, tends to arch into a position concave downward, and through its cantilever, or rigid, mounting where it is clamped under screw 46, and through its similarly rigid connection to the springs 30, tends to force the contact 52 down. The beam or "cantilever" action of the bimetal strip 34 that results from its rigid end connections and the over-

center action of the toggle construction, co-act to move the contact with a snap action, and the force of the springs **30** and therefore the toggle characteristic of the action is sufficiently great compared to the rigidity of the beam action of bimetal strip **34**, that the moving contact **52** is held firmly in engagement with the upper stationary contact **50** until a certain temperature is reached, at which temperature the springs **30** and bimetal **34** suddenly snap down against stop **50** to carry the contact **52** away from its engagement with the stationary contact **48**. Subsequently, as the bimetal strip **34** cools to a lower temperature it snaps the moving contact **52** upwards, back into engagement with the stationary contact **48**.

The number of degrees difference between the two temperatures at which the bimetal element snaps respectively down and up, is determined by the spacing between its two stops, that is the spacing between contact **48** and screw **50**, compared to the dimensions of the springs **30** and the bimetal element **34** themselves. Adjustment of screw **26** to alter the position of the mounting points of the two springs **30** merely raises or lowers the two operating temperatures together without appreciably changing the difference between those two temperatures. In order that the snap action may take place, it is necessary that the longitudinal compressive force exerted by the two springs **30** be great enough compared to the dimensions of the toggle mechanism **36** and to the rigidity of bimetal **34**, to provide a net force at the contact **52** in the direction of the motion of that contact which increases with the motion of that contact.

It is not necessary that the toggle **36** actually "pass over center," but the bending stresses imposed on the bimetal strip **34** will be smallest when the bimetal lies near the pivot axis of the pivotal support of the two compression springs **30**, as for example, in the manner shown in Fig. **4**. The operating temperature on temperature rise may be set by adjusting screw **26**, and the operating temperature on temperature fall, by adjusting screw **50**. A further adjustment of screw **26** will raise or lower both operating temperatures together. For example, I have obtained successful operation with a switch in which the radius of action of the compression springs **30** (the distance between the contact **52** and the tabs **28** for supporting the springs **30**) was ¾", with the other dimensions in approximately the proportions shown in the drawings except that the thin leaf springs **30** and the bimetal **34** and thicknesses of .0085" and .012" respectively.

This thermostat, illustrated in Figs. 1 to 4 inclusive, is simple and rugged in construction, yet reliable and precise in operation. It executes a clean and full snap action, unaccompanied by such undesirable actions as "dead break" and "sizzle," and is capable of controlling substantial electrical loads. It is simple in adjustment and can be manufactured in large quantities with a high degree of uniformity of operating characteristics, and moreover maintains its initial operating characteristics in service.

Fig. 5 illustrates a modification of the device of Figs. 1 to 4 inclusive, wherein the fixed lower stop **50** is omitted, and instead a manually operable push button **58**, projecting through the base **12** serves as the lower stop for the snap acting element **36**. This pin has a shoulder, which, when the pin is moved upwards manually, stops against a counter-bore **59** in the base **12** to limit the upward motion of the button **58**. In its uppermost position the pin **58** is spaced below the upper stationary contact **48** just far enough to permit the snapping element **36** to return to its upper, or normal, position when the thermal element **34** cools to its normal low temperature. When this pin **58** falls to its lowermost position, as seen in Fig. 5, it permits the snapping element **36**, when it snaps downwards in response to a rise in temperature, to move down so far that it cannot snap back to its normal position, even though the bimetal element **34** cools to its normal temperature. After the device has cooled, the button **58** may be pushed to its uppermost position to make the contact snap back to its upper or circuit closing position. Alternatively the button may be held manually in its upper position while the thermal strip **34** cools. In that case it will snap to circuit closing position upon reaching some low temperature, just as does the device of Figs. 1 to 4 inclusive.

In Fig. 6, the thermostatic device of Figs. 1 to 4 inclusive is shown mounted within the end bell of an electric motor where it is exposed to the internal heat of the motor. The ventilating air for the motor enters the left end bell of the motor housing through the inlet opening **62**, circulates through the motor, and leaves the housing from the right end bell through the exit opening **64**. The thermostatic device **10** being located in the right end bell, as shown in Fig. 6, is exposed to the warmed air. In addition, the thermal protector **10** is exposed to radiation from the various internal parts of the motor. In addition to being mounted within the motor, the bimetal element **34** is adapted to be heated by the passage of the motor current therethrough, as will be explained presently in connection with Figs. 7 and 8. Accordingly, the thermostatic device **10**, being mounted within the motor, responds to the heat of the motor, and at the same time, being connected in circuit with the windings of the motor, responds to the load carried by the motor, and thereby responds in a measure to the rate at which heat is being generated within the motor.

Figs. 7 and 8 illustrate two different circuit connections for an electric motor with the thermostatic control device of the present invention. An alternating current motor **70** is constructed with a divided winding to adapt it for operation on either of two voltages, as for example 115 and 230 volts. In Fig. 7 it is shown connected for operation at the higher voltage. The two winding sections are connected in series with each other, and also in series with the stationary contact **50** of the thermostatic device **10** and the mounted end of the bimetal element **34**. Accordingly, the snap acting element **36**, in its normal position, holds the motor circuit closed, and the motor current is drawn through the bimetal element **34** to heat that element in accordance with the load carried by the motor. When the snap acting element **36**, responding either to the internal heat of the motor itself, or to the heating effect of the motor current on the bimetal element **34**, or in response to both, snaps downwards, it opens the motor circuit to interrupt the supply of power thereto.

Fig. 8 illustrates the same motor **70** and the same thermostatic device **10** connected for operation on the lower voltage. The current for one of the two winding sections of the motor is drawn through the bimetal element **34** to heat it in the same manner as in the system of Fig. 7, and the

current for the other winding section is drawn, through the springs 30 to avoid the bimetal element 34. Accordingly, for a given load condition, the bimetal element 34 is traversed by the same value of current, and accordingly is heated to the same extent by the motor current with either the high voltage or the low voltage connection.

Fig. 9 illustrates a modification of the thermostat of Figs. 1 to 4 wherein the supported end 35 of the bimetal strip 34 is loosely mounted so that it hinges or articulates on its support. This arrangement makes the bimetal strip less rigid in its effect on the thermostat and so lets the over-center action of the toggle predominate to a greater extent. Consequently, for parts of the same dimensions, the structure of Fig. 9 provides a more extreme snap action and so is better able to operate other mechanism. It is also particularly suitable for applications requiring extremely low electrical resistance and therefore large cross sectional area in the bimetal and spring because the greater predominance of the toggle action overcomes the stiffening effect of the heavier parts.

On the other hand, for other applications, where, for the sake of the electrical resistance, or for other reasons, the bimetal must have a small cross section, the arrangement of Figs. 1 to 4 provides a better matching of the stiffness of the parts to the toggle effect and so gives the thermostat a greater temperature sensitivity for a given contact gap. In addition the arrangement of Figs. 1 to 4 provides more uniform stresses in the bimetal and so gives it a more efficient and faster response to a given number of watts expended in the bimetal by an electric current traversing it.

It will be apparent that the invention is not limited to thermostats for operating electric contacts in the manner herein shown, but that it is capable of operating other mechanisms such as separate electric switch structures, valves and the like.

The specific constructions and embodiments, herein shown and described, are offered only by way of example to illustrate the use and practice of my present invention and the invention itself embraces all modifications and variations that fall within the scope of the appended claims.

I claim:

1. In a snap acting thermostat, a U-shaped resilient frame, a bimetal strip directly connected to the closed end of the U, separate supports connected to said frame and strip at separated points to permit movement of the point at which they are connected together, the connection between said bimetal strip and resilient frame being so constructed that the connected parts thereof are constrained thereby to move together, one connection to said bimetal strip being rigid to permit bending moments to be imposed on said strip through said connection.

2. In combination, a bimetal strip, and a resilient frame connected together at a point that is free to move, a support, said bimetal and frame each having a separate connection to said support at a point removed from their connection to each other, each of the two connections of said bimetal being rigid to permit the transmission of bending moments therethrough to said bimetal.

3. A snap acting toggle thermostat comprising a bimetallic member and a second member connected together at one point, each of said members being mounted at a point removed from said point of connection, the points of support of said two members both lying on substantially the same side of said point of connection, but lying at different distances therefrom for giving said toggle an over center characteristic.

4. A snap acting toggle thermostat comprising a bimetal member stressed in tension, a compression member directly connected to said bimetal member so that the connected parts of said members are constrained from moving independently of each other, and separate supports for said members independent of the point of connection between them so that they constitute a toggle.

5. In a thermal control system, a thermal relay comprising a movable contact and two supporting elements for said movable contact, a second contact cooperating with said movable contact and connected to an electric power circuit, each of said supporting elements constituting a separate electric conducting path from said movable contact and each being connected to a separate branch circuit so that said contacts control both said branch circuits, one and only one of said elements being thermally responsive to the current traversing it to operate said movable contact.

6. A snap acting toggle thermostat comprising a bimetal member and another member lying along side each other and connected rigidly together at one point to permit bending moments to be transmitted from one member to the other through said connection, and a separate supporting connection for each of said members independent of said connection between them.

7. A snap acting toggle thermostat comprising a bimetal member and a non-bimetal member connected rigidly together at one point to permit bending moments to be transmitted from one member to the other through the connection, a pivotal support for said non-bimetal member, and a support for said bimetal member for so stressing the members that a compressive force of one is supported by a stress in the other.

8. In combination in a snap acting toggle thermostat, a bimetal member and a second member lying along side each other and connected together at only one point, that connection being rigid to permit bending moments to be transferred to said bimetal through the connection, and means for so supporting said members that a compressive force in one of said members is supported by a stress in the other member, and so that the connected part of said members is free to move, and stops for limiting the motion of said connected part.

9. A snap acting toggle thermostat comprising a bimetal member and another member connected together at one point, that is free to move, and mountings for both said members, both the mounting for said bimetal member and the connection between said members being rigid to permit the transmission of bending moments therethrough to said bimetal, the mounting for said other member being pivotal.

10. In combination in a snap acting toggle thermostat, a bimetal member and another member lying along side each other and connected together at one point that is free to move, the connection between them being so constructed that it constrains the connected parts of said members to move together, a rigid support for said bimetal member to permit bending moments to be transmitted through said support to said bimetal member, and a pivotal support for said other member.

11. A snap acting toggle thermostat comprising

a pivotally mounted bimetal member connected to another member at a point that is free to move, the connection between them being rigid to permit the transmission of bending moments therethrough, a mounting for said other member, said mountings for said two members lying to the same side of said connected portion but at different distances therefrom.

12. A snap acting thermostat comprising a bimetal strip and a second strip lying along side each other and connected rigidly together at one end which is free to move so that each can impose bending moments on the other through said connection, separate adjacent supports for the other ends of said strips for supporting said strips and imposing strains thereon.

13. The thermostat of the immediately preceding claim wherein, there is included an electric contact carried by said movable connected end of the strips, and a contact cooperating therewith, and wherein said separate supports insulate said strips from each other, whereby said two strips provide separate electric conducting paths to said contacts.

14. A snap acting toggle thermostat comprising a bimetal member stressed in tension, a second member directly connected to said bimetal member at a movable point thereof, the connection between said members being rigid to permit the transmission of bending moments therethrough, and separate supports for said members independent of the point of connection between them.

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