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2,469,217

SNAP-ACTION THERMOSTATIC SWITCH

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Fig. 1.

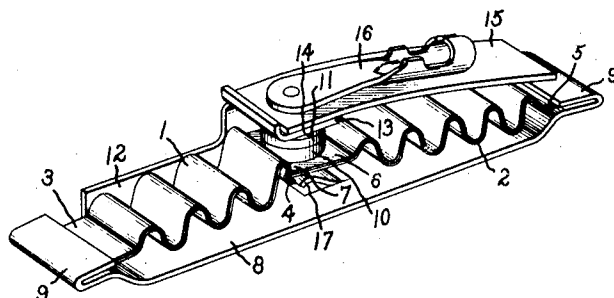


Fig. 3.

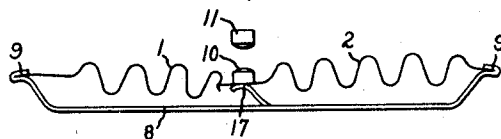


Fig. 2.

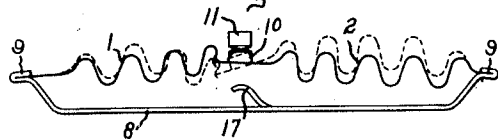


Fig. 6.

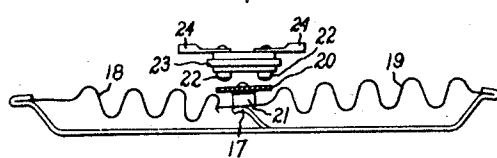
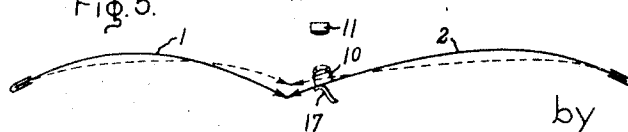


Fig. 4.



Fig. 5.



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SNAP-ACTION THERMOSTATIC SWITCH

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3 Claims. (Cl. 200—138)

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This invention relates to snap-action devices, more particularly to such devices which respond to temperature changes, and it has for its object the provision of an improved device of this character.

More particularly, this invention contemplates an improved snap-action switch which is capable of controlling relatively large loads on both alternating and direct current; which is consistent in its control; is relatively easy to adjust; and is quite inexpensive to manufacture.

This snap-action device comprises a pair of elongated undulous spring elements, that is, spring elements formed with a series of transverse corrugations, which series extends lengthwise of the elements. The elements are positioned in end-to-end relation, and their outer ends are fixed, while their inner adjoining ends are pivotally interconnected by a hinge joint. Moreover, the two elements are in longitudinal compression. Laterally spaced stops define two positions of stability for the elements. In moving from one to the other of the two positions, the elements snap through a critical unstable position with an extremely quick and positive action.

In the thermostatic control the two elements are formed of temperature-responsive material, such as bimetal.

For a more complete understanding of this invention, reference should be had to the accompanying drawing in which Fig. 1 is a perspective view of a temperature control device embodying this invention; Fig. 2 is a side elevation of the control device, the figure being shown in somewhat diagrammatic form, and illustrating the control device in one operative condition; Fig. 3 is a view similar to Fig. 2 but illustrating the device in another operative condition; and Figs. 4 and 5 are diagrammatic representations of the control device of Figs. 1-3 and illustrating the manner in which it operates; and Fig. 6 illustrates another embodiment of this invention.

Referring to the Figs. 1 to 5, this invention has been shown in one form as applied to a temperature-responsive control switch comprising a pair of corrugated or undulatory bimetallic elements 1 and 2. These elements before being corrugated are relatively elongated, flat bimetal bars. It will be understood that they will be made of two flat metal sheets having dissimilar coefficients of expansion and united together lengthwise in any suitable way, as by welding. And preferably thermostatic metal with a high modulus of elasticity will be used so that the elements will have very good resiliency. And while bimetallic elements

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have been illustrated, it will be understood that the elements may be made of many layers, or that they may vary uniformly throughout the thickness of the material as long as it has the necessary resiliency. The two undulous elements are formed from the flat sheets by corrugating them, so-to-speak.

The corrugations of element 1 are formed in the element substantially throughout its length, but so as to leave a flat section 3 at one end, and a knife edge receiving seat 4 at the other, while those in the element 2 leave a flat section 5 at one end, and a flat section 6 at the other, the latter section terminating in a knife edge 7.

The two corrugated elements 1 and 2 are mounted upon a relatively strong metallic frame 8 which may be stamped from a suitable sheet material, such as steel. As shown, the two elements are positioned in end to end relation lengthwise of the frame, and have their outer end sections 3 and 5 respectively clamped to the two ends 9 of the frame. These two ends are inclined upwardly from the base of the frame as shown so as to space the elements 1 and 2 above the base, and these two ends are folded over the flat outer ends of the elements in clamping relation and preferably will be welded to them. The two inner adjoining ends of the two elements 1 and 2 are pivotally interconnected by a hinge which is defined by the seat 4 on element 1 and the knife edge 7 on element 2 which is pivoted in the seat. And the frame length between its ends that clamps the two elements 1 and 2 is such that the two elements 1 and 2 are placed in longitudinal compression.

Mounted on the inner end of the bimetallic elements 1 and 2 is a switch contact 10 which coacts with contact 11 fixed to the frame 8. The frame, as shown, has at its rear edge, as viewed in Fig. 1, an upright wall 12, at the center of which is a forward extension 13 overhanging the contact 10. The contact 11 is riveted to this extension 13, and is insulated therefrom and from the frame, by an insulating washer 14 below the extension and an insulating sheet 15 above it. Connected to the contact 11 is a terminal 16 overlying the insulating sheet 15.

The two ends 9 of the frame which clamp the two outer ends of the bimetal elements 1 and 2 are inclined downwardly at a predetermined angle to the base of the frame as shown; so that the elements are bowed upwardly and thereby they force the contact 10 into engagement with the contact 11.

Contact 10, therefore, is forced into engage-

ment with the contact 11 by a force which is the resultant of this bowing action force, and also the force created by the longitudinal compression of the two strips. And these two forces, of course, depend upon the extent of the bowing and the degree of compression of the undulations.

The movable inner ends of the two elements 1 and 2 move from a first upper stable position wherein the contacts 10 and 11 are in engagement, as shown in Figs. 1 and 2 to a lower second stable position which is defined by a stop 17, as shown in Fig. 3. The stop 17 is positioned in the path of movement of the movable end 6 of the thermostatic element 2, and as shown, it is defined by a finger lanced from the stock of the base and then bent upwardly.

In the embodiments of the invention illustrated in the drawing the high expanding side of the thermostatic elements is the side facing the stationary contact 11. Therefore, when the temperature rises the thermostatic elements will open the contacts and move down and engage the stop 17.

Assuming that the thermostatic elements 1 and 2 are relatively cool, and the contacts 10 and 11 therefore in engagement, then when the temperature of the elements rises the elements will increase the depth of their arcs as the force tending to move away from the stationary contact 11 builds up (see Figs. 2 and 4). As this action occurs, the hinge interconnecting the inner ends of the two elements is forced downwardly toward a critical position. This causes an increase in the lengthwise compression of the two elements. This action continues until at a predetermined high temperature the critical position is reached and passed through and the elements move with a decided snap to open the contacts and engage the stop 17. As they move beyond the critical position toward the stop, lengthwise compression of the two elements 1 and 2 is relieved somewhat; that is, they are free to expand somewhat. Therefore, the two elements first oppose the movement of the contact 10 from the contact 11, to the critical position, but when they have moved through this position the two elements being free to expand assist in moving the contact 10 to the stop 17. This action of the two thermostatic elements greatly accelerates the speed of the snap from the closed to the open position. When the thermal elements 1 and 2 reach the stop 17 they are under considerable tension due to the over-centering action and the bowing caused by the angular position of the ends 9 of the frame. Therefore, assuming now that the temperature decreases, the arcs of the two elements tend to flatten out, as shown in dotted lines in Fig. 5, and the forces build up in the opposite direction; and the hinge pivot again moves in toward the critical position. This action continues until at a predetermined low temperature the critical position is reached and passed and the elements snap to close the contacts. Here again, the two elements 1 and 2 under longitudinal compression resist the movement to the critical position, and then assist it after passing the critical.

The specific embodiment of the invention illustrated in Figs. 1 to 5 is intended to control an electrical circuit in response to temperature changes so that when the contacts are closed the circuit is completed to increase temperature, whereas when they are opened the circuit is interrupted to permit the temperature to fall. One side of the circuit is connected to the ter-

minal 16, while the other side may be connected to any part of the frame so that the current flows through the thermal elements 1 and 2 to the movable contact 10.

It will be understood, of course, that the thermostat can be made to close with rising temperature, rather than to open, by placing the high expanding side of the thermostatic elements on the side of the stop 17. This reverses the operating procedure just described.

Temperature adjustments may be made in different ways: by bending the stop 17 to a different position; if the stop be adjusted upwardly the closing temperature is raised and the temperature differential between the temperatures at which the switch opens and closes is decreased—the opening temperature remaining unchanged. If the stop be bent downwardly, the closing temperature is reduced and the temperature differential is increased. Bending the top contact support 14 downwardly will lower the opening temperature and will decrease the differential by an equal amount. Conversely, if the contact 11 be elevated the opening temperature will be increased and the differential increased. Adjustment of the angles of the two ends 9 of the frame 8 varies both the temperature differential, and the calibration or temperature setting, as it changes the longitudinal compression of the two elements 1 and 2 which in turn modifies the pressure exerted by contact 10 against contact 11 and stop 17.

The device can be adjusted to have a very "close" differential. Differentials as low as 3° F. have been achieved while operating at two amperes, 115 volts. Moreover, the device controls consistently, thus the opening and closing temperatures vary less than 1° in successive operations.

The device may be made into a non-thermostatic snap action control by using non-thermal metals for the elements 1 and 2, such as spring steel, Phosphor bronze or beryllium copper. This modified device can be operated manually by pressing on one of the elements 1 or 2 about one-third the distance from the anchor point to the hinge.

The number of undulations and their size may vary, but if they are kept relatively shallow as compared with the length of the elements the flexibility is "hard" and a large temperature differential is assured. A softer action with resulting decrease in temperature differential is effected by increasing the depth of the undulations, but some of the snap is sacrificed. Also, the number of undulations per unit of length will vary with the area, thickness and type of bimetal used for any given differential, and calibration or temperature setting. In addition, while in the embodiments illustrated, the undulations are made in the form of a sine wave they can be made somewhat irregular for ease in manufacture. To minimize stress in the elements, the undulations should be as smooth as possible with no sharp bends evident.

It will be observed that the electrical current flows through the thermostatic elements. The natural resistivity of the elements causes heat to be generated due to the passage of the current. The heat increases as the current increases. This internal heating causes the thermostat to open at a lower temperature than if it were not present. This "anticipating" heating tends to reduce the differential and makes the

thermostat more sensitive to small temperature changes.

Thus, the differential may be modified by the proper choice of thermostatic metal of which many types with different resistivity are available.

This internal or "self" heating may become objectionable at high controlled currents and can be overcome by a modification of the contacts to remove the current from the elements. This modification is shown in Fig. 6, and is similar to the first form, but has a different contact arrangement. As shown in Fig. 6, the two corrugated thermal elements 18 and 19 operate a contact bar 20 which is mounted on element 19 by means of a rivet 21; preferably, the contact bar will be restrained from turning on the rivet, but will be free to rock a limited amount by pivoting on the rivet. This contact bar bridges a pair of spaced fixed contacts 22 insulated from the frame 23 and connected to terminals 24. Here the current passes only through the contacts; the thermal elements are completely insulated from it.

While I have shown particular embodiments of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I, therefore, contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A snap acting thermostat comprising a pair of elongated bi-metallic strips transversely corrugated for at least a portion of their lengths and positioned end to end and pivoted together at their juxtaposed ends, whereby said strips while undistorted have a common longitudinal axial plane, a frame having spaced arms, means rigidly clamping the free ends of said strips to said arms, at least one of said clamping means holding the end of its respective strip at an acute angle to said axial plane and the distance between said clamps being less than the combined lengths of said strips in said plane between said clamping means, whereby said strips are longitudinally compressed and tend to be bowed out of said plane, stop means secured to said frame for limiting transverse motion of said strips on both sides thereof, said stop means being positioned close enough to said strips to maintain the strips in compression in both extreme limits of motion, and contact means

adapted to be opened and closed by transverse motion of said strips.

2. A snap acting thermostat comprising a pair of elongated bi-metallic strips transversely corrugated for a portion of their lengths and positioned end to end and pivoted together at their juxtaposed ends, whereby said strips while undistorted have a common longitudinal axial plane, a frame having spaced arms, means rigidly clamping the free ends of said strips to said arms at oppositely directed acute angles to said axial plane, the distance between said clamps being less than the combined lengths of said strips in said plane between said clamping means, whereby said strips are longitudinally compressed and tend to be bowed out of said plane, stop means secured to said frame for limiting transverse motion of said strips on both sides thereof, said stop means being positioned close enough to said strips to maintain the strips in compression in both extreme limits of motion, and contact means adapted to be opened and closed by transverse motion of said strips.

3. A snap acting thermostat according to claim 2 in which the frame is formed of sheet metal having an elongated base portion with integral arms extending laterally from the ends thereof, said arms having end portions bent at acute angles to said base portion, the free ends of said strips being secure to the bent portions of said arms and said frame being rigid compared to said strips but being deformable, whereby said thermostat is adjustable by bending portions of said frame.

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