Sept. 23, 1947. L. R. PETERS 2,427,741

THERMAL SWITCH

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Fig. 1.

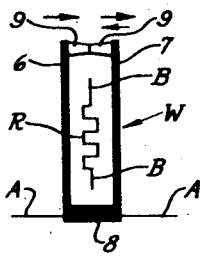


Fig. 2.

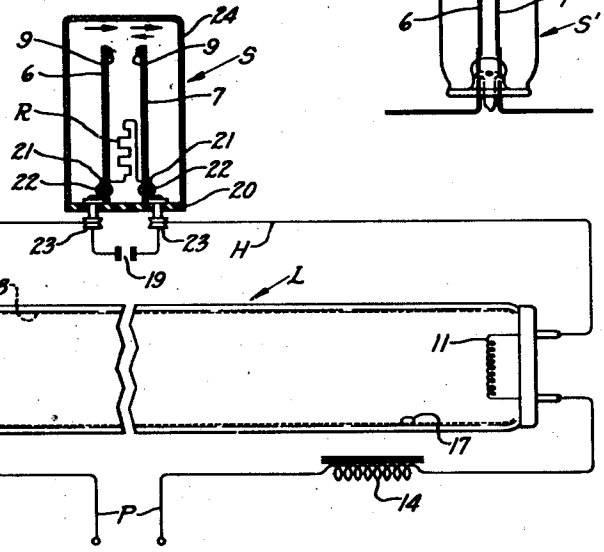
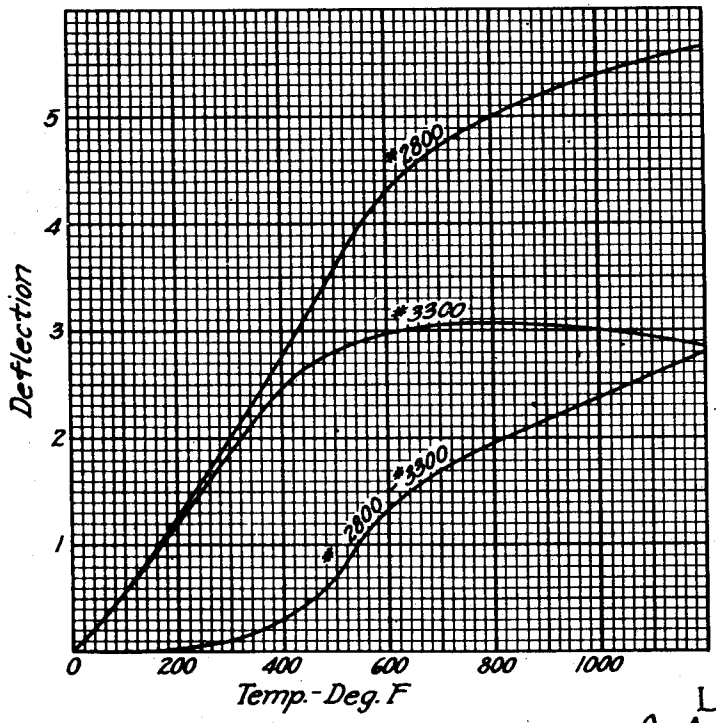


Fig. 3.

Fig. 4.



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THERMAL SWITCH

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1 Claim. (Cl. 200—113.5)

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This invention relates to thermoelectric switches, and especially to a novel type of device subject to diverse thermal influences, one of which is desired or intended to affect or determine switch operation, while another is not to do so. Such situations are exemplified in thermal switches that are associated with a heat or cold-producing means or source, to be influenced thereby, but are also unavoidably affected by more general "ambient" temperature conditions, such as hot and cold weather. Cases of this kind may arise in furnace regulation and in the starting systems of electric discharge lamps, for example, as well as in the regulation of cooling or refrigeration. Such ambient temperature compensation may be provided according to the invention either in switches that are to remain steadily closed when subject only to ambient temperature fluctuation, or in switches that are to remain open under these conditions.

Various features and advantages of the invention will appear from the description of species or forms of embodiment, and from the drawing.

In the drawing, Fig. 1 is a diagrammatic general illustration of a thermal switch embodying the invention, with associated circuits; Fig. 2 is a similar view of a fluorescent tube or lamp with circuit connections including a thermal switch embodying the invention in a somewhat different form; and Fig. 3 is a fragmentary view of a glow-switch embodying the invention, suitable for the starting circuit shown in Fig. 2.

Fig. 4 is a diagram illustrating the deflections of bimetals suitable for the purposes of the invention.

Fig. 1 illustrates the invention in a diagrammatic general form, showing my thermostatic switch W interposed in an electric circuit A that is to be closed and opened thereby. As a source of heat to which the switch W is desired to respond, there is shown a heating resistance R in another electric circuit B. This heating resistance R is arranged between approximately upright slender thermostatic bimetal strip members 6, 7 which are connected to opposite sides of the circuit A, and coact as both temperature-responsive elements and contacts for the switch W. As shown, the lower ends of these members 6, 7 are anchored by being attached to opposite sides of an insulative spacer 8, while their upper ends are free to move. Co-operating contact pieces 9, 9 (as of coin silver) are shown welded to the free ends of the members 6, 7. The members 6, 7 may preferably be made of identical dimensions so that they would tend to flex alike

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when equally heated. As shown, the switch contacts 9, 9 are closed when the switch W is unheated from the source R, but are open when the thermostatic members 6, 7 are sufficiently heated, as will presently be explained.

In accordance with my invention, the thermostatic members 6, 7 are made dissimilar as regards their inherent thermal properties: e. g., while one member 7 flexes or deflects progressively and preferably at a fairly or substantially constant rate, when heated, throughout the working range of temperature of the device W, the other member 6 has a similar progressive deflection at a more or less constant rate only over a range corresponding, practically, to the range of ambient temperature fluctuation, but shows a modification of its mode of deflection outside this range, generally in a negative sense. For example, the members 6, 7 may deflect alike and both to the right (as shown by the heavy arrows in Fig. 1) with increasing temperature up to about 200° C.; whereas above this temperature the deflection of the member 6 may slow up, stop, or even reverse so that it deflects to the left (as shown by the light arrow in Fig. 1), while the progressive deflection of the member 7 to the right continues. As a result of this differential action, the switch contacts 9, 9 will remain together to maintain the circuit A while the temperature affecting the switch W rises to 200° C., but will separate and open the circuit when heated to a somewhat higher temperature.

A material suitable for the member 7 that is to deflect in one direction rather steadily throughout the operating range of the switch is that known as "Chace 2800," comprising laminae of equal thickness welded together, the layer at the high side being an alloy of 22 per cent nickel, 8 per cent chromium, and 70 per cent iron, and that at the low side being an alloy of 42 per cent nickel and 58 per cent iron. A material suitable for a member 6 to deflect steadily throughout a service range of ambient temperature up to about 200° C. and then stop and slightly reverse its deflection at temperatures of some 400° C. is that known as "Chace 3300," comprising laminae of equal thicknesses welded together, the layer at the high side being nickel, and that at the low side being an alloy of 36 per cent nickel and 64 per cent iron. Individual and combined curves for the behavior of these bimetals are shown in Fig. 4.

Fig. 2 illustrates the application of the invention to a starting switch S for a fluorescent lamp L that is connected to a power-supply circuit P

and has a starting circuit H connected across the circuit P and including the starting switch S, which is adapted to energize and break said circuit H to start the lamp discharge.

Fig. 2 shows an ordinary fluorescent lamp L of the positive column electric discharge type with a tubular envelope 10 having spaced apart activated thermionic cathodes 11, 11 in its ends, which may be specially heated cathodes of usual coiled filament type activated with coatings of refractory oxides—such as a mixture of alkaline earth oxides including barium and strontium oxides—and are shown connected across a power-supply circuit P including the usual ballast 14, which also serves as a starting inductance, and the manual make-and-break switch 15. The envelope 10 may contain a low-pressure atmosphere of starting gas, such as argon at a pressure of 2 to 5 mm. of mercury, and also a vaporizable and ionizable working substance such as mercury. A supply of mercury, which may exceed the amount that will vaporize during operation of the lamp L, is indicated by a drop 17 inside the envelope 10, and an internal coating of fluorescent material or phosphor 18 on the envelope walls is also indicated. A starting and electrode-heating circuit H is shown connected across the circuit P through the filamentary cathodes 11, 11, with a starting switch S included therein, which may be of thermal type. A capacitor or condenser 19 of suitable capacity (e. g., 0.007 microfarad) may be connected across the switch, to minimize radio interference, as well as arcing when the switch opens and breaks the circuit H.

The general mode of operation in starting the lamp L with this circuit arrangement is that when the switch 15 is closed to turn on the lamp L, the switch device S permits flow of current through the circuit H and the cathode filaments 11, 11 in series therein for a sufficient length of time to preheat the cathodes to an adequate emissive temperature, and then suddenly opens the circuit H; and the resulting voltage kick between the cathodes 11, 11 suffices to initiate discharge between them—or, in other words, starts the lamp.

As shown in Fig. 2, the switch device S has as its base an insulative disc 20 that carries terminal brackets 21, 21 to which the thermostatic bimetal strips 6, 7 are anchored and secured by rivets 22, 22. Underneath the base disc are shown binding post connectors 23, 23 to which the wires forming the opposite sides of the circuit H are connected, and the reduced shanks of these connectors extend up through the disc 20 and the brackets 21, 21 and are riveted over on the latter to secure the latter to the disc.

A sheet metal enclosure or can 24 having an insulative lining for its cylindrical wall may enclose the whole device from the base 20 up. Instead of being in a separate circuit, the heating resistance R lying between the members 6, 7 is shown connected directly across the terminals 21, 21, thus providing a conductive path shunting that afforded by the switch contacts 9, 9, so as to respond to the energization and voltage of the main discharge circuit P during starting. Preferably this resistance R is of high value, such as some 80,000 to 100,000 ohms, in order to prevent it from seriously lowering the voltage available for starting the discharge when the switch S opens the circuit H. The thermostatic switch members 6, 7 may be essentially like those in Fig. 1, and may operate similarly, as indicated by the arrows in Fig. 2; but the switch contacts 9, 9 are arranged to be open when the switch S is unheated from the source R, and to close when the members 6, 7 are sufficiently heated from said source.

As temperatures below some 200° C. affect the members 6, 7 essentially alike, ambient temperature conditions merely cause them to deflect to the right without any resultant closing of the switch contacts 9, 9 or of the circuit H. When the switch 15 is closed, however, line voltage is applied to energize the circuits P, H and the heater R, which heats the members 6, 7 above 200° C. and brings into play their differential action. In other words, the members 6, 7 deflect alike and both to the right (as indicated by the heavy arrows in Fig. 2) with increasing temperature up to about 200° C.; whereas above this temperature the deflection of the "leader" member 7 slows up, stops, or even reverses so that it deflects to the left (as indicated by the light arrow in Fig. 2), while the progressive deflection of the "follower" member 6 to the right continues. Accordingly, the switch contacts 9, 9 close and short-circuit the heater R, which thereupon starts to cool off—as well as both the members 6, 7. Thus the contacts 9, 9 presently reopen, giving a voltage kick between the lamp electrodes 11, 11 that is generally effective to start the discharge between them; and this discharge shunts or short circuits and deenergizes the heater R (in view of its high resistance) sufficiently to prevent it from reclosing the contacts 9, 9 of switch S. If, however, the discharge in the lamp L fails to start on this cycle of operation of the switch S, the cycle will be repeated (just as above described) one or more times, until the discharge does start.

Fig. 3 illustrates the application of my invention in a manner essentially similar to what is shown in Fig. 2, except that the thermostatic bimetal strips 6, 7 are mounted by welding their anchored ends to the current inleads of a glow-switch S', inside its glass envelope 30, and coact both as switch members and as terminals or electrodes for a glow discharge, and that the conductive path shunting the cooperating contacts 9, 9 is provided by the gaseous discharge atmosphere in the envelope 30—such as argon or neon with ½ per cent admixture of argon, at a pressure of some 25 to 40 mm. The operation is essentially similar to that of ordinary glow-switches, except for the differential action of the members 6, 7 as described in connection with Fig. 2; or, to put the matter differently, the operation is the same as described in connection with Fig. 2, except that the glow discharge atmosphere between the members 6, 7 takes the place of the resistance heater R as a current path shunting the contacts 9, 9, and as a means of heating these members.

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

A glow-switch comprising a sealed envelope containing an ionizable medium and a pair of cooperating bimetallic electrode elements normally spaced apart for a glow discharge therebetween, said bimetallic elements being mounted for movement in the same direction when heated by a glow discharge therebetween, the element in the follower position having a substantially uniform deflection curve and the element in the leader position having a like deflection curve within a predetermined ambient temperature compensation range followed by modification of its rate of deflection in the negative sense upon further heating, whereby the follower element ultimately overtakes and engages the leader ele-

ient to shunt and thereby extinguish the glow ischarge therebetween.

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