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THERMAL TIMER SWITCH

Filed June 24, 1960

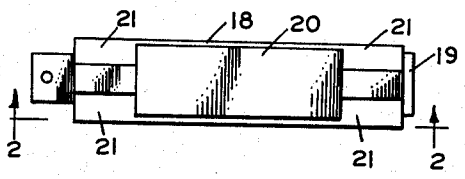


FIG.1

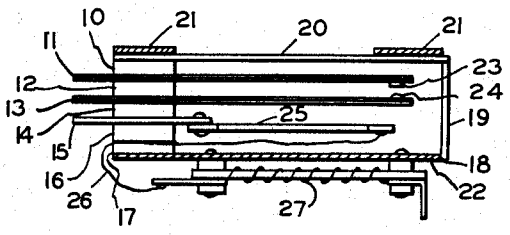


FIG.2

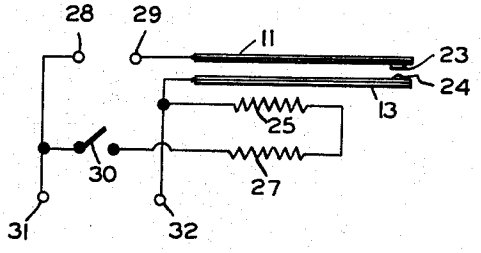


FIG.3

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THERMAL TIMER SWITCH

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This invention relates to thermal timer switches of the type which employ a bimetal element heated by an electric heater to operate switch contacts after energization of the heater for a predetermined time period.

In thermal timer switches of this type, the heater may be energized from a power source which may have substantial voltage fluctuations. Such voltage fluctuations vary the rate at which the bimetal element is heated and as a result, the operating time of the thermal timer switch is not precise enough for many applications. It is, therefore, one of the objects of the present invention to provide a thermal timer switch of the electrically heated bimetal type that is not appreciably affected by variations in the applied voltage.

In the past, it has been proposed to employ a negative-temperature coefficient resistor for heating the bimetal element of thermal switches for the purpose of minimizing the effect of supply voltage variations. However, such an arrangement was unsuitable for many applications because the time delay would vary with the ambient temperature. Even at a given ambient temperature, the time delay would vary considerably between two consecutive operations because of the effect of the increased temperature within the switch enclosure following a prior operation of the switch.

It is therefore another object of this invention to provide a thermal timer switch of the above character that is also unappreciably affetced by ambient temperature variations.

In the preferred embodiment of the present invention, a bimetal element is heated by a heater having non-linear voltage-current characteristics and which tends to decrease in resistance with an increase in voltage. The heater is connected in series with a resistor so disposed that it will have no appreciable heating effect upon the bimetal element. With this arrangement, the energy dissipated in the heater is substantially constant regardless of variation in the voltage applied to the heater circuit and the bimetal element consequently will actuate switch contacts in a substantially constant time period independent of the applied voltage.

Other objects, advantages and features of the invention will be apparent from the following description and the accompanying drawing in which:

FIG. 1 is a plan view of a thermal timer switch embodying the present invention;

FIG. 2 is a sectional view taken along the line 2—2 of FIG. 1; and

FIG. 3 is a wiring diagram illustrating an application of the switch in a control circuit.

Referring to the drawing, there is shown a thermal timer switch having a stack which includes an insulator **10**, a bimetal strip **11**, an insulator **12**, a bimetal strip **13**, an insulator **14**, a metal terminal **15**, and two insulators **16** and **17**. This stack is mounted in the open end of an enclosure consisting of a metal channel-shaped case **18** with end wall **19** and an insulating plate **20** supported upon the stack and the edge of end wall **19**. Four ears **21** formed integrally with case **18** are bent over plate **20** to clamp the parts in assembled relation. The bottom wall **22** of the case and the stack parts may have interfitting apertures and projections to insure their permanent alignment.

A first electrical contact **23** is attached to strip **11** near the free end thereof and a second electrical contact **24** is attached to strip **13** near the free end thereof for cooperation with contact **23**. Mounted upon terminal **15** is an electrical heating element **25** which is connected by a conductor **26** in series with a resistor **27** that is supported on the case wall **22** in a conventional manner. Bimetal strips **11** and **13** are each composed of superposed layers of metals having different coefficients of expansion disposed such that both strips will deflect toward plate **20** when heated. Bimetal strip **13** faces the heating element **25** and responds principally to heat emitted therefrom. Bimetal strip **11** is shielded from the heating element **25** by strip **13** and responds principally to the ambient temperature to provide ambient temperature compensation. The bottom wall **22** of the case **18** is disposed between resistor **27** and the strips **11** and **13** and shields the strips from the resistor so that the latter has no appreciable heating effect upon the strips.

In accordance with an important feature of the present invention, the heating element **25** is an elongated resistor of strip-like or rod-like material having a non-linear electrical resistance characteristic which provides for greatly increased current flow as the voltage increases. While other materials may be used, it is preferred to use a material consisting of silicon carbide particles fixed in a binder material. This resistance material is commonly made by pressing silicon carbide particles with a suitable ceramic binder at high pressure and then heating it to a temperature of approximately 1200° C. The electrical characteristics of this material are such that the current flow therethrough will vary approximately as a fourth power of the applied voltage.

As shown in FIG. 3, the thermal timer switch is connected to terminals **28** and **29** of an electrical device to provide for delayed operation of the latter following closing of a normally open control switch **30**. A suitable source of electric power is connected to lines **31** and **32**. When switch **30** is closed, a circuit is completed to connect heating element **25** and resistor **27** in series to lines **31** and **32**. As a result of the completed circuit, the heating element **25** generates heat which causes bimetal strip **13** to flex toward bimetal strip **11**. After a predetermined time interval, strip **13** will carry contact **24** into engagement with contact **23** thereby completing a circuit to terminals **28** and **29** from the power lines **31** and **32**.

If the supply voltage exceeds its normal value, the resistance of heating element **25** will tend to decrease in response to the increased voltage. This causes a relatively large increase in current flow which increases the proportion of the line voltage which is applied across resistor **27**, thus maintaining a substantially constant power dissipation in heating element **25**. In the event the supply voltage drops below its normal value, the heating element **25** similarly acts to provide a relatively larger decrease in current with a corresponding decrease in the proportion of the line voltage which is applied across resistor **27** to again maintain a substantially constant power dissipation in heating element **25**. By thus compensating for voltage fluctuations to maintain the power dissipation in heating element **25** at substantially its desired value, it is possible to heat the bimetal strip **13** at a uniform rate substantially independent of voltage variations. Since the time delay period of the thermal timer switch depends upon the rate at which it is heated, it also will be substantially constant.

It will be obvious that the resistance of heating element **25** should be relatively unaffected by changes in temperature. However, any tendency of the resistance of heating element **25** to decrease with increase in temperature can be substantially compensated for by constructing re-

sistor 27 of material having a corresponding positive temperature coefficient of resistance.

It will also be apparent that by rearranging the strips 11 and 13 to deflect in a direction opposite from that described above, the thermal timer switch may be constructed to have normally closed contacts. This and other modifications will be obvious to those skilled in the art and it should be understood that the invention is not to be limited to the precise details herein illustrated and described since the same may be carried out in other ways falling within the scope of the invention as claimed.

What is claimed is:

1. In a thermal timer switch, the combination comprising: supporting means; an actuator bimetal member and a compensator bimetal member each of strip form and supported at one end by said supporting means; a first contact carried on the free end of said actuator bimetal member and a second contact carried on the free end of said compensator bimetal member for cooperation with said first contact; said compensator bimetal member being arranged to move in the same direction as said actuator bimetal member with changes in ambient temperature; an electric heating element disposed in proximity with only said actuator bimetal member for heating only said actuator bimetal member; a case enclosing said bimetal members and said heating element; an electrical resistor supported upon the outside of said case and electrically connected in series with said heating element; said bimetal members being shielded from said resistor by said case; said heating element being formed of resistance material whose resistance value varies inversely with a change in voltage impressed across said heating element due directly to the voltage gradient existing therein.

2. A thermal timer switch according to claim 1 wherein said heating element is of strip form and is supported by said supporting means to extend along one side of said actuator bimetal member.

3. In a thermal timer switch, the combination comprising first and second bimetal strips both movable in the same direction when heated; said first strip being supported at one end in fixed relation to the adjacent end of said second strip and extending in the same direction as said second strip; switch contacts mechanically connected with said strips and arranged to move into and out of contact with each other in response to relative movement of said strips; an electric heating element having an elongated strip-like form and being supported to extend along one side of said first strip; said first strip being disposed between said second strip and said heating element whereby said heating element has relatively great heat transfer relationship with said first strip and relatively small heat transfer relationship with said second strip; an electrical resistor having a linear electrical resistance characteristic and electrically connected in series with said heating element; a case enclosing said strips and said heating element; said resistor being mounted outside of said case whereby said strips are shielded from said resistor; said heating element having a non-linear resistance characteristic provided by forming said heating element of resistance material whose resistance value varies inversely with a change in voltage impressed across said element due directly to the voltage gradient existing therein.

4. In a thermal timer switch, the combination comprising: a bimetal member supported at one end and provided at the free end with means for operating switch contacts in response to heating of said bimetal member; an electric heating element disposed in proximity to said bimetal member for heating it to cause movement of said free end; an electrical resistor disposed out of appreciable heat transfer relationship with said bimetal member whereby the latter is unaffected in its operation by the heat radiation from said resistor; means for electrically connecting said resistor in series with said heating element to a source of voltage; said heating element being formed of resistance material whose resistance value varies inversely with a change in voltage impressed across said heating element due directly to the voltage gradient existing therein for minimizing the changes in electric power dissipation in said heating element resulting from voltage fluctuations of said source; said electric heating element having a small negative temperature coefficient of resistance; and said resistor having a positive temperature coefficient of resistance such that a change in the resistance value of said heating element resulting from a temperature variation is at least partially compensated for by a corresponding inverse change in the resistance value of said resistor.

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