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THERMAL TIMING APPARATUS

Filed June 24. 1960

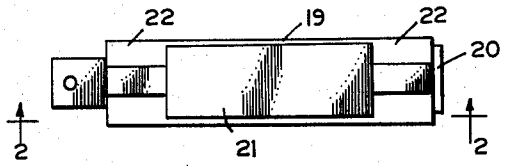

FIG. 1

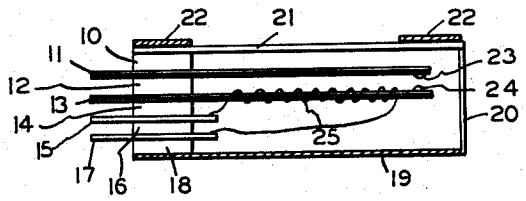

FIG. 2

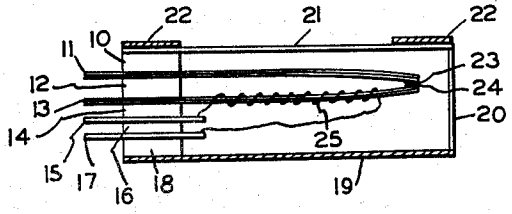

FIG. 3

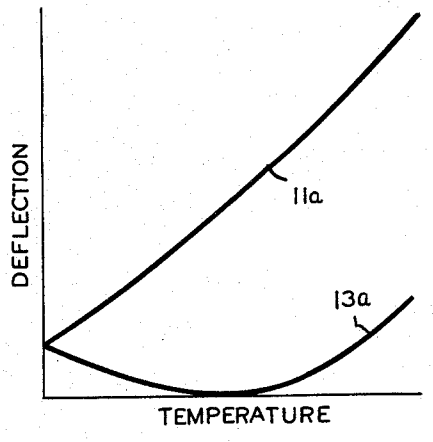

FIG. 4

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THERMAL TIMING APPARATUS

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This invention relates to thermal timing apparatus and more particularly to thermal time delay switches of the type which employ bimetallic elements responsive to an electric heater to actuate switch contacts.

In devices of this type, the heater is energized from a voltage source which may have substantial voltage fluctuations. Unless provision is made to compensate for the variation in heating rate resulting from such voltage fluctuation, the operating time of the thermal time delay switch is not precise enough for many applications. It is, therefore, one of the objects of the present invention to provide thermal timing apparatus of the electrically heated bimetal type that is not appreciably affected by variations in voltage of the heater.

Another object of this invention is to provide an improved thermal timing apparatus of the foregoing character which is of simple construction and few parts and which may be easily and inexpensively manufactured.

The thermal timing apparatus constructed in accordance with this invention comprises generally a first bimetal member having a substantially uniform deflection-temperature curve and a second bimetal member having a deflection-temperature curve which reverses at a predetermined temperature. An electric heating element is provided for heating both bimetal members to cause operation of switch contacts in a predetermined time interval by the differential action of the bimetal members. The bimetal members are so disposed in relation to each other that when initially heated they both act in a manner tending to operate the switch contacts. However, when the second bimetal member is heated to the temperature at which its deflection reverses, it will act to oppose operation of the switch contacts. By constructing the apparatus to operate with energizing voltages for the heating element which cause the second member to be heated to a temperature exceeding that at which the second member reverses its deflection, the effective contact-operating action of both members are proportional to the energizing voltage but in opposition to each other. Thus the differential action of the bimetal members is made substantially independent of voltage variations to provide a substantially constant time delay.

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 time delay switch embodying the present invention;

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

FIG. 3 is a sectional view of a modified embodiment of the switch of FIGS. 1 and 2; and

FIG. 4 is a graphic illustration of the deflection-temperature characteristics of the bimetals used in the switches of FIGS. 1, 2 and 3.

The thermal time delay switch shown in FIGS. 1 and 2 of the drawing has 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**, an insulator **16**, a metal terminal **17** and an insulator **18**. This stack is mounted in the open end of an enclosure consisting of a metal channel-shaped case **19** with an end wall **20** and an insulating plate **21** supported upon the stack and the edge of end wall **20**. Four ears **22** formed integrally with case **19**, are bent over plate **21** to clamp the switch

parts in assembled relation. The case and 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. A heater coil **25** of insulated wire is wrapped around strip **13** in close heat transfer relation thereto. Strip **11** faces the heater coil **25** and also responds to heat emitted therefrom. The heater coil **25** is electrically connected to terminals **15** and **17** for energization from a suitable power source.

The disposition and specific material of the bimetal strips **11** and **13** are important features of the present invention. The deflection-temperature characteristics of the bimetal strips are shown in FIG. 4 where **11***a* is the deflection curve of strip **11** and **13***a* is the deflection curve of strip **13**. It will be noted that the material of strip **11** deflects at a substantially constant rate throughout the temperature range in which it operates. Many of the commonly used bimetal materials such as those composed of superposed layers of iron-nickel alloys of different compositions have a substantially uniform deflection curve within a certain temperature range. The material of strip **13** has a variable deflection curve and first deflects in one direction until a certain temperature is reached but at higher temperatures reverses its direction of deflection. Such materials are also well known and for a specific example reference is made to U.S. Pat. No. 2,315,565 of April 6, 1943, to Romaine G. Waltenberg.

The bimetal strips **11** and **13** are disposed so that upon an initial increase in temperature from normal ambient temperatures, the strips will deflect toward each other. The heater coil **25** is suitably designed to heat strip **13** to at least the temperature at which its deflection reverses when a specified minimum operating voltage is applied to coil **25**. The dimensions of the strips **11** and **13** are preferably chosen so that contacts **23** and **24** will engage after heater coil **25** has been energized for a desired time period at the minimum operating voltage.

It will be apparent that if a voltage higher than the minimum operating voltage is applied to heater coil **25**, the increased heat delivered by coil **25** will cause bimetal strip **11** to deflect toward bimetal strip **13** at a higher rate. Strip **13** is also heated faster when the voltage is higher and will more quickly reach the temperature at which its deflection reverses. Before contacts **23** and **24** can engage, bimetal strip **13** will reverse its direction of deflection and deflect in the same direction that strip **11** is deflecting. This increases the distance which strip **11** must deflect before contact **23** engages contact **24** and thus compensates for the increased deflection rate of bimetal strip **11**. Since the increased rate of deflection of strip **11** and the increased distance strip **11** has to deflect to cause engagement of contacts **23** and **24** are both proportional to the increase in heater coil voltage, the time required for contacts **23** and **24** to engage can be made to be substantially independent of voltage variations over a wide range. Thus the thermal time delay switch according to the present invention is useful to control a variety of equipment such as air conditioning equipment, which may operate under varying voltage conditions.

In FIG. 3 there is shown a normally closed contact switch which is generally similar to that illustrated in FIGS. 1 and 2 and corresponding parts are designated by like reference numerals. In the embodiment of FIG. 3, however, the bimetal strips **11** and **13** are supported with their sides reversed from that previously described, so that their directions of deflection with temperature change are reversed. The bimetal strips **11** and **13** are stressed toward each other and it will be apparent that the effect

of temperature upon strips **11** and **13** will be similar to that previously described except that the temperature change initially changes the pressure exerted upon contacts **23** and **24** by the strips **11** and **13** instead of causing their movement. When the strips have been heated sufficiently to overcome the initial biasing forces, they will act to separate contacts **23** and **24**.

While the invention has been illustrated and described in its preferred embodiments and has included certain details, 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. A voltage-compensated thermal time delay switch comprising in combination: a first bimetal member having a substantially uniform deflection-temperature curve; a second bimetal member having a deflection-temperature curve that reverses at a predetermined temperature; electric heating means mounted in heat transfer relation with said members to cause said members to move upon being heated; switch contacts mechanically connected with said members and operated thereby in a given predetermined time interval in response to energization of said heating means; said first and second members being disposed to deflect in opposite directions with an increase in temperature of said members when the temperature of said second member is below said predetermined value; said first and second members being disposed to deflect in the same direction with an increase in temperature when the temperature of said second member is above said predetermined value; said heating means being effective to heat said second member to a temperature above said predetermined value in said given time interval when a voltage is applied to said heating means having a magnitude greater than a first selected value; said first and second members being effective to operate said contacts only when said second member is heated to a temperature exceeding said predetermined value; and said members being responsive to variations in the heating rate of said heating means to maintain substantially constant the time interval in which said operation of said switch contacts occurs during variations in the magnitude of the voltage applied to said heating means between said first selected value and a second selected value greater than said first selected value.

2. A thermal time delay switch as specified in claim 1 wherein said bimetal members comprise two strips arranged so as to extend generally in the same direction in spaced relation to each other, said first member being supported at one end in fixed relation to the adjacent end of said second member, said switch contacts comprising first and second electrical contacts mounted respectively on said first and second members and arranged to move into and out of contact with each other in response to relative movement between said members, and said electrical heating means comprising an electrical heating element associated with said second member.

3. A thermal time delay switch as specified in claim 2 wherein said contacts are normally separated, and said bimetal members being so disposed in relation to each other that when heated by said heating means they deflect toward each other until the temperature of said second member reaches said predetermined temperature.

4. A thermal time delay switch as specified in claim 2 wherein said bimetal members are stressed to normally urge said contacts in engagement with each other, and said bimetal members being so disposed in relation to each other that when heated by said heating means they both act to decrease the pressure exerted on said contacts by said members until the temperature of said second member reaches said predetermined temperature.

References Cited in the file of this patent

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