Aug. 16, 1960 M. I. NYSTUEN 2,949,518

THERMOSTATIC TIME DELAY RELAY

Filed April 24, 1959

FIG. 1

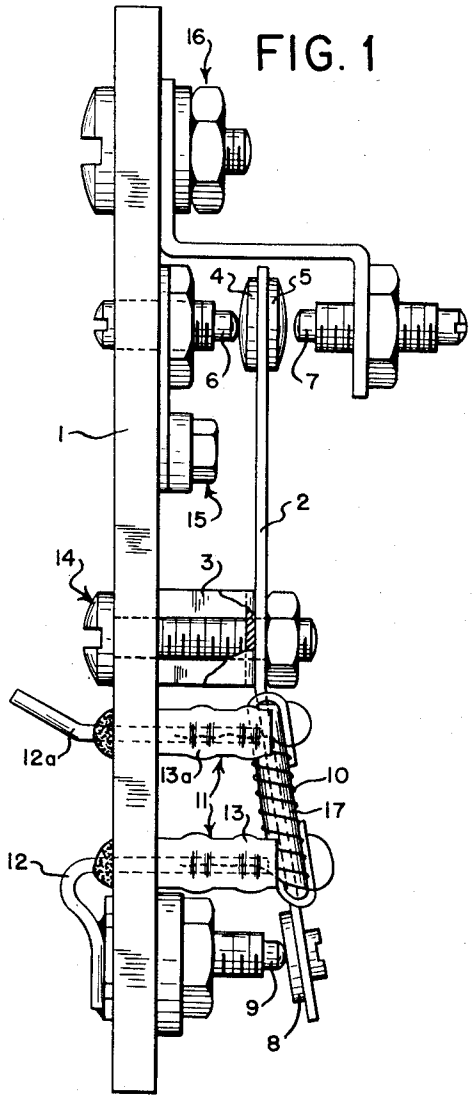


FIG. 2

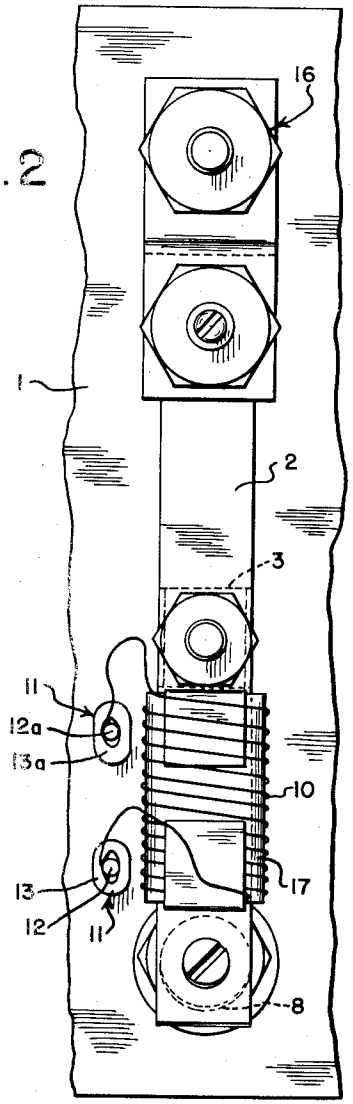
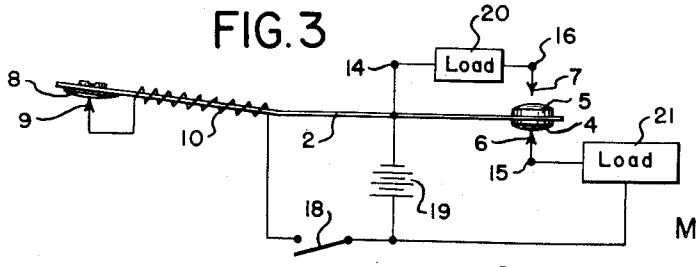


FIG. 3



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THERMOSTATIC TIME DELAY RELAY

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This invention relates to electric relay devices, especially of the thermostatic time delay type.

The relay in accordance with the invention is simple in construction, reliable in operation, and inexpensive to manufacture. The nature of the invention and its several advantages will be understood from the following description considered in connection with the accompanying drawing, in which:

Fig. 1 is a side view in elevation of the relay according to the invention;

Fig. 2 is a plan view of the relay; and

Fig. 3 is a circuit diagram of connections by which the relay is operable in the manner below described.

Referring to Figs. 1 and 2, the relay according to the invention comprises a suitable base **1** of insulating material to which the component parts are secured. A bi-metal, thermostatic strip **2** is affixed at its mid-section to a bracket **3** of U-shaped metal, and this bracket is fastened by a screw, or otherwise, to the base **1**. Thus, the respective ends of the strip are free to flex independently. As shown, the bracket is oriented so that the channel thereof is in alignment with the longitudinal axis of the strip **2**. This permits circulation of heated air by convection from the lower end to the upper end of the strip, especially when the device is mounted vertically as illustrated in the drawing. If the bracket is of different configuration, it can be perforated or otherwise arranged to permit the circulation of air.

The upper end of the bi-metal strip **2** carries two opposed contacts **4**, **5** for the purpose of opening or closing one or more external or load circuits. Movable contact **4** is in contacting alignment with fixed contact **6**, and is here shown to be normally closed. Fixed contact **7** is in contacting alignment with movable contact **5** and is normally open. Hence, these contacts open and close, respectively, upon actuation of the relay after a predetermined delay period. The movement of the upper end of strip **2** with its contacts **4**, **5** occurs in response to the respective heating and cooling thereof.

The lower section of strip **2** carries at its end a movable contact **8** which is normally closed against fixed contact **9**. When this lower section becomes heated these contacts open, and close again upon its cooling. The lower section is heated by an electric heating coil **10**. Obviously, the required characteristics of this coil will depend upon several variables, including the desired rapidity of operation, the physical size of the component parts, the thermal characteristics of the bi-metal strip, and the voltage of the current to be applied. In the embodiment here illustrated "Nichrome" resistance wire of 2.5 mils diameter, having a total resistance of approximately 110 ohms, was wound with spaced turns around the strip as shown. A suitable insulating layer **17** is wrapped around the strip before the wire is wound thereon.

A covering of similar or equivalent material may advantageously be applied outside the wire to protect it

and to conserve the heat, although none is shown in the drawing.

To terminate the ends of the resistance wire of coil **10** and to provide means for connecting the wire in an appropriate circuit, terminal members **11** are employed. These comprise two short lengths of solid copper wire **12** and **12***a* which pass through the base **1** and extend near the heater coil. A metal sleeve **13**, **13***a* is dropped over the top of each of the wires **12**, **12***a*, respectively, and one end of the resistance wire is placed in the space between the inside of the sleeve and the solid terminal wire which it encloses. Then each sleeve is crimped with a crimping tool, thus mechanically and electrically attaching the resistance wire to the terminal wire. Terminal wire **12** is here shown to be electrically connected to fixed contact **9** so that the circuit to the heater is normally closed. If the heater is to be controlled externally of the relay, terminal wires **12** and **12***a* would both be connected to the external circuit. Connections can be made at terminals **14**, **15**, and **16**, for controlling external load circuits.

Fig. 3 is a circuit diagram illustrating the connections by which the time delay relay of the invention can be operated to control one or more external load circuits. As shown diagrammatically, the heating coil **10** is wrapped around the lower (left-hand) section of strip **2**. One end, **12**, of the coil is connected to fixed contact **9**, and the other end to a control switch **18**. This switch, which may comprise a relay, or equivalent, is connected through a source **19** of electric voltage, here represented as a battery, which, in turn, is connected to strip **2** to complete the circuit. Since contacts **8**, **9** are normally closed, the coil **10** will become heated when switch **18** is closed. If a D.C. voltage source such as a battery is used, it would be desirable to connect a large condenser across contacts **8**, **9** to prevent arcing, as is well known in the art. However, for many reasons it is advantageous to employ alternating current, in which case the condenser would not be necessary. Alternating current at a convenient voltage, such as 24 volts, is readily obtainable from a suitable step-down transformer.

Load circuit **20** is, as shown, connected between terminals **15** and **16** and, therefore, will be closed upon actuation of the relay. Load circuit **21** is connected between terminal **15** and battery **19**, and its circuit is opened when the relay is actuated. In this arrangement the voltage source **19** is available to energize load circuit **21**. Load circuit **20** would, of course, also be provided with actuating voltage if required.

The delayed operation of the relay according to the invention is an important aspect and, therefore, requires further description. The lower section of bi-metal strip **2**, which is directly heated by coil **10**, will flex shortly after the circuit is closed by switch **18**. This opens contacts **8**, **9** and de-energizes the heating circuit, whereupon that section of the strip will cool, and contacts **8** and **9** will close again, resuming the heating. This cyclic operation will continue indefinitely and will assume a uniform rate, once the strip has reached its operating temperature. The rate of cycling can be adjusted by adjusting the height of contact **9** and by varying the current through the heating coil.

Although the re-establishment of connection between contacts **8** and **9** involves cooling of the hotter end of the bi-metal strip, some of the heat generated during the successive heating periods will travel along strip **2** by conduction in the metal and thus will heat the upper section of strip **2**, which in Fig. 3 is to the right. Additionally, when the relay is positioned vertically, as shown in Figs. 1 and 2, the air in the neighborhood of coil **10** which is heated thereby will flow upwardly and supplement the heat carried through the bimetal strip itself,

As a result of this heating, the upper section of the strip will flex upwardly breaking contacts **4**, **6** and closing contacts **5**, **7**. This change in connections constitutes actuation of the relay.

From the foregoing, it will be understood that the period of time required to actuate the relay depends upon several factors. One controlling factor is the effect of bracket **3**. This bracket, being of metal as described, has a certain degree of thermal capacity, viz., it absorbs heat from the strip and to this extent effectively comprises a heat barrier between the heated and unheated ends of the strip. Furthermore, the heat-radiating surfaces of bracket **3** tend to dissipate the heat which it absorbs and thus prevent such heat from passing to the upper end of the bi-metal strip. Hence, the thermal characteristics of bracket **3** have an important bearing on the time delay in actuation of the relay. It has been found that the heated air from coil **10** tends to bypass the barrier effect of the bracket, especially if the bracket is constructed, as shown, so as to permit free flow of the heated air through its channel. Thus, by changing the angular position of bracket **3** with respect to the axis of strip **2**, it is possible to adjust, to some extent, the delay in the time of actuation of the relay after the heating circuit has been initially closed.

Other expedients can also be employed to control the rate of actuation of the relay. For example, the actuation time will be shorter if more heat is retained within the structure by enclosing the sides of the strip. This is especially effective if the relay is mounted horizontally. Introducing thermal insulation between the strip **2** and bracket **3** will also increase the actuating rate.

The bi-metal strip **2** is usually a continuous piece. However, two strips can be clamped together at the bracket **3**, either abutting or overlapping. The rate of heat conduction between the extreme ends of the strip can be adjusted by changing the separation or overlapping of the sections at the joint or by interposing therein materials of different heat conductivity. The delay in actuation will be increased by thus decreasing the rate of heat transfer between the two strips, and conversely.

In a practical embodiment of the relay herein illustrated and described but of dimensions smaller than those in the drawing, it was found that an optimum operating temperature for the bi-metal strip **2** was approximately 275° F. This is high enough to make changes in ambient temperature unimportant in their effect on the thermostatic strip. Such a temperature was reached after approximately 60 seconds of heating of the coil; and with the described adjustments the delay before cycling commences could be adjusted between approximately 5 seconds and 1½ minutes. This range can be extended in either direction by appropriate changes in the above-mentioned variables.

The adjustments herein described make it possible with the structure as shown to cause actuation of the relay, viz., movement of contacts **4**, **5**, after a delay of between approximately 20 seconds and 2½ minutes. These limits apply to the particular embodiment herein described by way of example, but either or both can be extended in either direction by changing the rate of heating of the upper section of strip **2** by means of the expedients previously discussed.

For many applications the effective of ambient or surrounding temperatures is unimportant. However, if the relay is to be subjected to large changes in ambient temperature, the effect can be compensated for by known expedients, one of which is to employ bi-metallic material in the bracket which supports the strip, or in the bracket on which the fixed contact is mounted.

I claim:

1. A time delay relay of the thermostatic type comprising a base, a mounting bracket secured to said base, a longitudinal bi-metal strip mounted at its midsection on said bracket so that its two ends can flex independently with respect thereto, a first movable contact carried on a first end of said strip, a first fixed contact positioned on the base in contacting alignment with said first movable contact, a heating coil secured to said strip between said first movable contact and said bracket, means connecting one end of said coil to one of said contacts and means adapted to connect the other end of said coil to an electric source, a second movable contact carried on the second end of said strip, and a second fixed contact positioned on said base in contacting alignment with said second movable contact, said bracket being of heat-conductive material and being in heat-conductive contact with said strip, whereby to delay the transfer of heat from said coil into the second end of said strip.

2. A time delay relay according to claim 1 in which said bracket is shaped and disposed so as to be open to the flow of air along said strip between the first and second ends thereof.

3. A time delay relay according to claim 1 in which said bracket is of U-shaped metal and is positioned so that its channel is in alignment with the longitudinal axis of said strip.

4. A time delay relay comprising thermostatically deformable strip means, heat-conductive means rigidly supporting said strip means intermediate its extreme ends, and in heat-conductive contact with said strip means, said ends being independently flexible, a movable contact carried by a first one of said ends, a first fixed contact disposed to make connection with said movable contact when said strip means is unflexed, an electric heating element disposed to heat said first end more than said second end, electric connections including said contacts for energizing said element, a second movable contact carried by the second end of said strip means and a second fixed contact disposed in contacting alignment with said second movable contact, whereby said second contacts are closed or opened in response to heating of said strip means after a time delay in part predetermined by the heat conductivity characteristic of said heat conductive means.

5. A time delay relay comprising a thermostatically deformable strip, a heat-conducting bracket supporting said strip intermediate its ends, the ends of said strip being independently flexible, said bracket having a predetermined thermal capacity and a heat-radiating surface, a first movable contact carried by a first end of said strip, a first fixed contact disposed in contacting alignment with said movable contact, means for connecting an external circuit to said contacts, a second movable contact carried by the second end of said strip, a second fixed contact in contacting alignment with said second movable contact, said second contacts being adjusted to be closed when the second end of said strip is unflexed, an electric heater element disposed to heat the second end of said strip and thereby open said second contacts, and circuit means including said second contacts for energizing said element when said second contacts are closed, the heat-conductive path from the second end of said strip through said bracket to the first end of said strip being such as to delay the movement of said first movable contact for a predetermined time interval after the commencement of heating by said element.

6. A time delay relay comprising a thermostatically deformable strip, a heat-conducting bracket supporting said strip intermediate its ends, said bracket having a heat-radiating surface and said ends being independently flexible, a first movable contact carried by a first end of said strip, a first fixed contact disposed in contacting alignment with said movable contact, means for connecting an external circuit to said contacts, a second movable contact carried by the second end of said strip, a second fixed contact in contacting alignment with said second movable contact, said second contacts being adjusted to be closed when the second end of said strip is unflexed, an electric heater element disposed to heat the

second end of said strip and thereby open said second contacts, and circuit means including said second contacts for energizing said element when said second contacts are closed, whereby the heating and cooling of said second end occurs cyclically, the heat-conductive path from the second end of said strip through said bracket to the first end of said strip being such as to delay the movement of said first movable contact for a time interval measured by a predetermined number of heating and cooling cycles of said heating element.

References Cited in the file of this patent

UNITED STATES PATENTS

2,108,964	Freudenberg et al.	Feb. 22, 1938
2,317,830	Vaughan	Apr. 27, 1943

FOREIGN PATENTS

33,729	France (Addition to No. 638,663)	July 31, 1928
601,932	Germany	Sept. 5, 1934