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THERMAL RELAY

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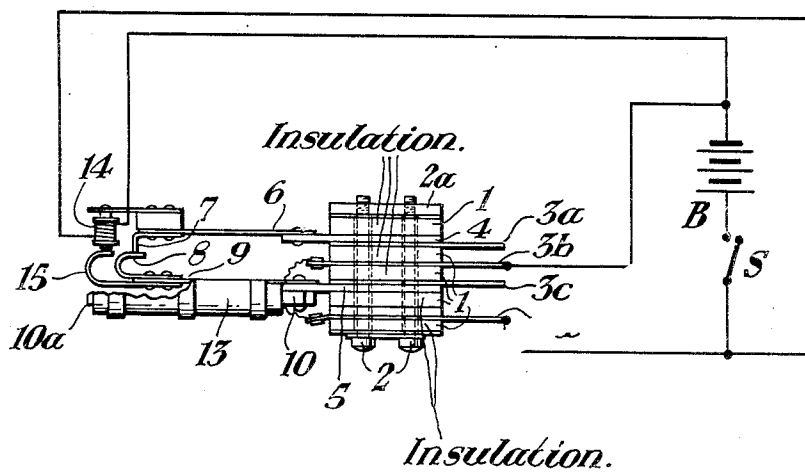


Fig. 1.

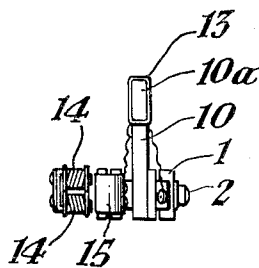


Fig. 3.

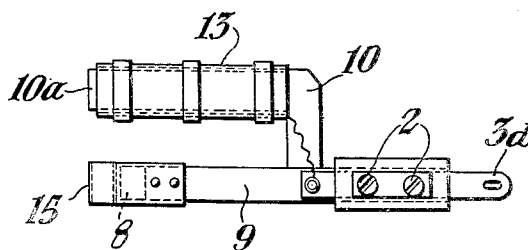


Fig. 2.

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THERMAL RELAY

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1

My invention relates to relays, and particularly to relays which employ a thermally responsive element heated by an energy transfer means for operating electrical contacts at the expiration of a predetermined time interval after the application of operating energy to the relay.

In relays of this type, the operating energy is supplied to the heater element from a source which is sometimes subject to voltage variations. For example, the relay might be energized from a storage battery which at times would be fully charged, and at other times would be in a partially discharged condition thus causing the voltage applied to the relay to be lower at some times than others. This variation in the applied voltage of the operating energy causes the heater element to heat more slowly at some times than others, and the time required for the heated thermally responsive element to operate the relay contacts therefore varies inversely with the applied voltage. This is obviously undesirable, and one object of my invention is to provide more nearly uniform performance of such relays at various voltages.

Another object of my invention is to provide novel means for operating the electrical contacts in a thermal relay with a snap action.

Still another object of my invention is to maintain the relay operation substantially independent of the ambient temperature to which the relay is exposed.

In the preferred form of my invention, I accomplish these objects by providing the relay with electrical contacts secured to two thermally responsive members. An energy transfer means such as a heating element heats the first thermally responsive member and thereby causes it to deflect. Also an electromagnetic means is provided for applying to the first member a force which opposes the deflection caused by the energy transfer means. This force is proportioned to compensate for variations in the operating time of the relay caused by variations in the applied voltage. That is to say, the energy transfer means and the electromagnetic means are energized by the same source so that when the relay is energized, the magnetic force due to the energization of the electromagnetic means acts on the first thermally responsive member at the same time the energy transfer means begins heating the member causing it to deflect. The magnetic force prevents the deflection of the member from actuating the electrical contacts until the deflection force becomes great enough to overcome the magnetic force. When this occurs, the con-

2

tacts open with a snap action. However, the electromagnetic means is supported by the second thermally responsive member in such manner that ambient temperature variations causes the deflection of both of the thermally responsive members to maintain the electrical contacts in a substantially constant relationship. The time interval for operating the contacts of the relay is thereby made essentially independent of voltage variations and ambient temperature.

Other objects and characteristic features of my invention will become apparent as the description proceeds.

I shall describe one form of relay embodying my invention, and shall then point out the novel features thereof in claims.

In the accompanying drawings, Fig. 1 is a view, partly in side elevation and partly diagrammatic, showing one form of thermal relay embodying my invention. Fig. 2 is a bottom view of the relay shown in Fig. 1. Fig. 3 is a view of the left side of the relay as seen in Fig. 2.

Like reference characters refer to similar parts in each of the views.

Referring to the drawings, the thermal relay here shown consists of a plurality of insulating blocks 1 held together by two insulated screws 2 screwed into a mounting member 2a. Clamped between the blocks 1 in parallel spaced relations are four terminal fingers 3a, 3b, 3c and 3d. Also clamped between the blocks 1 are a first support 4 disposed adjacent finger 3a, and a second support 5 disposed below the support 4 and adjacent finger 3c. A first thermally responsive member, here shown as a bimetallic strip 6, is secured at one end to the support 4. Secured to the strip 6 at its free end is an electrical contact element 7 which cooperates with an electrical contact element 8, secured to one end of a second bimetallic strip 9, to form a contact 7-8. The strip 9 is disposed below and substantially parallel to strip 6 and is secured at its other end to the support 5. The contact formed by the contact elements 7 and 8 is adapted to be opened and closed in order to open and close an electrical circuit including this contact, the supports 4 and 5, and the terminal fingers 3a and 3c. To compensate for the effects on the contact 7-8 of variations in ambient temperature, the bimetallic strips 6 and 9 are disposed so that the unsecured end of each strip deflects downwardly as a result of increases in ambient temperature.

Secured to the support 5, in addition to the bimetallic strip 9, is an L-shaped member 10, disposed with one leg 10a substantially parallel to

3

the bimetallic strip 9. Mounted on the leg 10a is a heating element 13 which is electrically connected to the terminal fingers 3b and 3d and which is adapted to heat the strip 9 by conduction along the member 10 when the heating element is energized. The heating element 13 is arranged to be energized from a suitable source, here shown as a battery B, over a circuit which includes a switch S.

It will be apparent from the drawings that when the switch S is closed the heating element 13 is energized and begins to heat the strip 9. After a predetermined time the strip 9 is sufficiently heated to deflect downwardly and open the contact 7-8.

Relays of the type thus far described are well known in the art. In relays of this type, when the voltage decreases at the source B the element 13 heats more slowly than normally, and when the voltage increases at the source B the element 13 heats faster than normally. As a result, the time required for the heated bimetallic strip 9 to actuate the contact 7-8 varies with the voltage. Moreover relays of the type thus far described are subject to contact difficulties due to the arcing which occurs when the contact 7-8 opens gradually in response to the heating of the strip 9.

According to my invention, I overcome these difficulties by providing the relay with an electromagnetic means disposed to oppose the operation of the electrical contacts in response to heating of the heating element 13. As here shown, this means comprises an electromagnet 14 attached to the unsecured end of the bimetallic strip 6, and provided with salient poles which cooperate with an armature 15 attached to the unsecured end of the bimetallic strip 9. The electromagnet 14 is intended to be energized by the same source B as the heating element 13, and the switch S controls the energy supplied to the electromagnet 14 as shown in Fig. 1. When the switch S is closed, the source B in addition to energizing the heating element 13, energizes the electromagnet 14. The electromagnet 14 exerts a magnetic force pulling armature 15 and the unsecured end of strip 9 toward the unsecured end of strip 6, and resisting the deflection force pulling the contact elements 7-8 apart. The magnetic force prevents the deflection of strip 9 from pulling the contact elements 7 and 8 apart until the strip 9 is sufficiently heated to overcome the magnetic force. When this occurs the contact 7-8 opens with a sudden snap action.

It will be readily understood that since the electromagnet 14 and the heater element 13 are energized by the same source, the voltage variations at the source will result in voltage variations at the electromagnet 14 proportional to the voltage variations at the heater element 13. When the applied voltage is lower than normal the magnetic force of the electromagnet 14 on the armature 15 is less than normal. The required deflection force of the bimetallic strip 9 necessary to overcome the magnetic force is also less than normal. But the strip 9 is heated more slowly when the voltage at the heater element 13 is lower than normal. Therefore the time required for the strip 9 to actuate the contact 7-8 is substantially the same as at normal voltage. Similarly, when the applied voltage is higher than normal the magnetic force of the electromagnet 14 on the armature 15 is greater than normal. The required deflection force of the bimetallic strip 9 necessary to overcome the magnetic force is also greater than

4

normal. But the strip 9 is heated faster when the voltage at the heater element 13 is higher than normal. It follows therefore, that by properly proportioning the parts, the time required for the strip 2 to actuate the contact 7-8 can be made to be substantially independent of voltage variations.

One advantage of a relay constructed in accordance with my invention is that since the thermally responsive members are arranged to deflect in the same directions in response to ambient temperature changes in the manner previously described, and since the electromagnet of the electromagnetic means for compensating for variations in voltage is secured to one of these members and its cooperating armature to the other of these members, it follows that changes in ambient temperature will not change the relative position of the electromagnet and its cooperating armature, and therefore will not affect the voltage compensation provided by my invention.

It should be particularly pointed out that while in describing my invention I have shown it applied to a thermal relay of the type employing bimetallic strips as the thermally responsive members, it may be applied to many other types of thermal relays.

Although I have herein shown and described only one form of thermal relay embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In a thermal relay, in combination, two cooperating thermally responsive members provided with electrical contacts, one of said thermally responsive members being provided with an energy transfer means that causes said one member to be deflected and thereby operate said contacts in a given predetermined time interval in response to energization of said energy transfer means, said one member also being provided with an armature and the other thermally responsive member being provided with an electromagnet having salient poles which cooperate with said armature so as to oppose the operation of said electrical contacts in response to energization of said electromagnet, the parts of said thermal relay being so proportioned that when said electromagnet and said energy transfer means are energized from the same source of current the forces set up by said electromagnet and said energy transfer means will cause said contacts to become operated in said given predetermined time interval irrespective of voltage variations of said current source, and said thermally responsive members being so disposed and having their parts so proportioned that the deflection of said members due to variations in ambient temperature will cause said electrical contacts as well as said electromagnet and cooperating armature to remain in a substantially constant relationship.

2. In a thermal relay, in combination, two essentially identical bimetallic members provided with electrical contacts that are normally closed, one of said members being provided with a heating means that causes said one member to be deflected and thereby operate said contacts in a given predetermined time interval in response to energization of said heating means, said one member also being provided with an armature, the other member being provided with an electromagnet having salient poles which cooperate

5

with said armature so as to oppose the operation of said electrical contacts in response to energization of the electromagnet, the parts of said thermal relay being so proportioned that when said electromagnet and said heating means are energized from the same source of current the forces set up by the electromagnet and heating means will cause said relay to open its contacts in said given predetermined time interval irrespective of voltage variations of said current source, and said bimetallic members being disposed in substantially parallel spaced relation and having their parts so proportioned that the deflection of said members due to variations in ambient temperature will cause said electrical contacts as well as said electromagnet and cooperating armature to remain in a substantially constant relationship.

3. In a thermal relay of the type comprising two bimetallic strips disposed in substantially parallel spaced relation and having their parts proportioned so that the deflection of one of said strips due to variations in ambient temperature will be in the same direction and essentially of the same magnitude as the deflection of the other of said strips, said strips being provided with electrical contacts that are normally closed, said one strip also being provided with electrical heating means for deflecting said one strip to open said contacts in a given predetermined time interval in response to heating of said strip, said

6

one strip also being provided with an armature, said other bimetallic strip being provided with electromagnetic means having salient poles which cooperate with said armature so as to oppose the opening of said contacts in response to energization of said electromagnetic means, the parts of said thermal relay being so proportioned that when said electromagnetic means and said heating means are energized from the same source of current, the forces set up by the electromagnetic and heating means will cause said relay to open its contacts with a snap action in said given predetermined time interval irrespective of voltage variations of said current source.

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