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TEMPERATURE COMPENSATED TIME DELAY RELAY

Filed Aug. 16, 1963

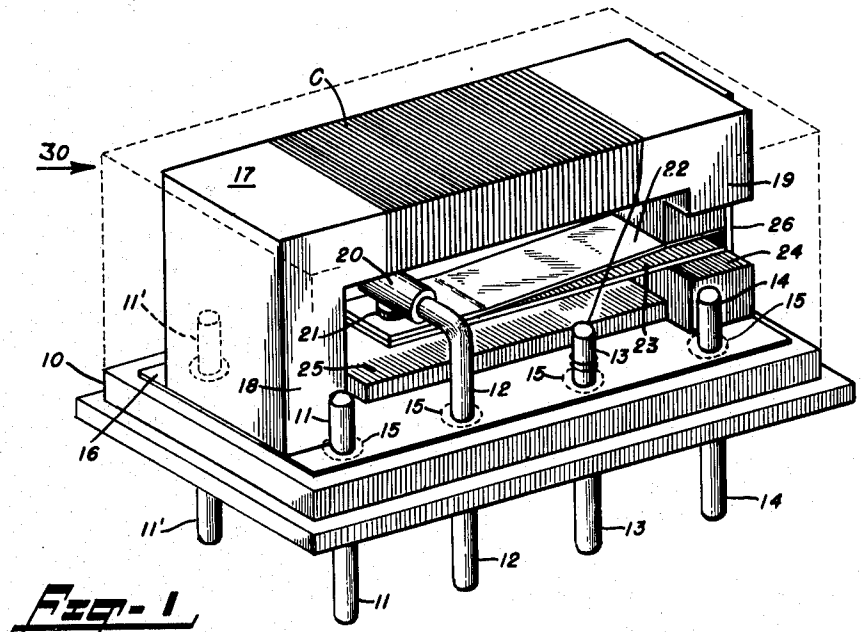


Fig-1

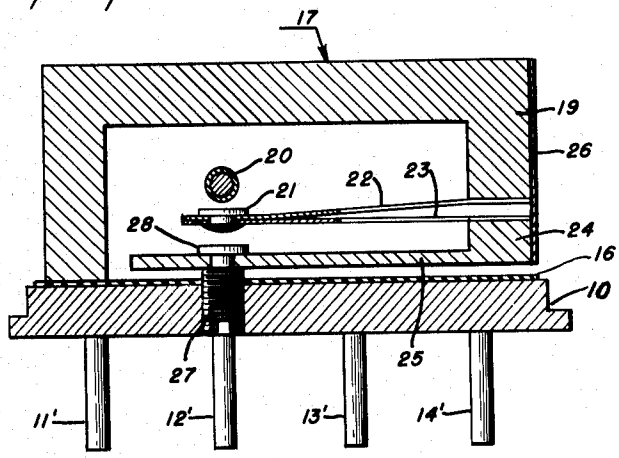


Fig-3

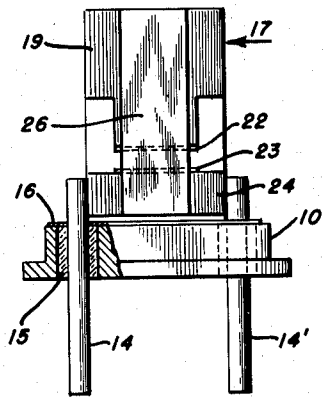


Fig-2

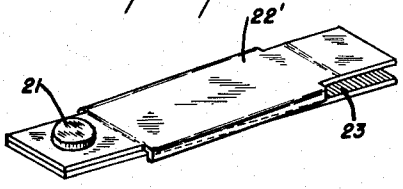


Fig-4

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TEMPERATURE COMPENSATED TIME DELAY RELAY

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This invention relates to time-delay relays and more particularly to an electrical time-delay relay of improved construction.

Time-delay relays of the class to which this invention is directed operate on the principle of the thermal expansion of an actuating member to effect the actuation of electrical contacts, thereby to provide an alarm or control function. The actuation of the electrical contacts takes place a predetermined time interval after heat has been applied to, or removed from, the actuating member through the medium of an electrical heating means associated therewith. Essentially, such relays are compensated for changes in ambient temperature in order to provide the same time-delay action over the entire ambient temperature range within which the relay is expected to operate. Generally, this is accomplished by incorporating, within the relay, a compensating member having the same temperature coefficient of expansion as the contact-actuating member but thermally isolated therefrom, whereby the relative spacing between the cooperating electrical contacts remains constant throughout the normal range of ambient temperature changes.

An object of this invention is the provision of an electrical time-delay relay of simple, economical construction and which lends itself to miniaturization.

An object of this invention is the provision of an electrical time-delay relay of small size and having a high degree of thermal isolation between the contact-actuating mechanism and the ambient temperature compensator, thereby increasing the operating efficiency.

An object of this invention is the provision of a time-delay relay wherein the ambient temperature compensating means constitutes a part of the relay housing whereby the entire inner volume of the housing is available for other components, thus increasing the volumetric efficiency of the design and aiding in miniaturization of the relay.

An object of this invention is the provision of a time-delay relay having a set of cooperating electrical contacts, one contact being fixed and the other contact being carried by a cantilevered mechanism, an actuating member having an electrical heater associated therewith, and means effecting a flexing of the cantilever mechanism in response to the thermal expansion of the actuating member.

These and other objects and advantages of the invention will become apparent from the following description when taken with the accompanying drawings. It will be understood, however, that the drawings are for purposes of illustration and are not to be construed as defining the scope or limits of the invention, reference being had for the latter purpose to the claims appended hereto.

In the drawings wherein like reference characters denote like parts in the several views:

FIGURE 1 is an isometric view showing a time-delay relay made in accordance with this invention;

FIGURE 2 is an end view showing the front of the relay;

FIGURE 3 is a central, longitudinal, cross-sectional view of the relay, with the heater coil omitted; and

FIGURE 4 is an isometric view showing another construction of the movable contact assembly.

Reference, now, is made to FIGURES 1 and 2 wherein

there is shown a base **10** made of a suitable metal and having a plurality of pins extending therethrough, the front row pins **11–14** being visible in this view of FIGURE 1 and one of the rear pins **11'** being shown in dotted lines. Each pin is electrically insulated from the base by means of associated glass inserts **15** thereby forming a header. Positioned on the upper surface of the base is a thin sheet **16** of insulation, preferably mica, which sheet is punched to provide clearance holes for the pins.

The actuator **17**, comprising a generally C-shaped block of suitable metal, has its long leg **18** resting upon the mica sheet and welded to the transversely-aligned set of pins **11**, **11'**. A heater coil C, here shown wound around the base portion of the actuator, has one lead soldered to the pin **13** and the other lead soldered to the transversely-aligned rear pin which is not visible in the drawing. The other end **19**, of the actuator, has a reduced-width portion spaced a predetermined distance from the upper surface of the base **10**. It is here pointed out that the actuator **17** and the base **10** are made of a metal having a high temperature coefficient of expansion, such as stainless steel, and the physical proportions of these members are matched so that their axial expansion and contraction will be equal over a fairly wide range of ambient temperature variations. Consequently, the base **10** serves not only as a support for the various components but also functions as a temperature compensator. Also, although the actuator **17** is supported directly on the base, it is electrically insulated therefrom by the mica sheet and the glass inserts. Because of the low thermal conductivity of the mica and glass, the actuator effectively is thermally insulated from the base. This is an important consideration in devices of this type since the difference in temperature between the actuator and the compensator (base **10**), brought about by current flowing in the heater coil, effects the actuation of the electrical contacts, as will be described hereinbelow.

The pin **12** is relatively long, is offset inwardly and has a cylinder **20** secured thereto, said cylinder being made of a material having good electrical contact characteristics, such as silver or platinum-iridium. This constitutes the stationary contact of the relay. The movable contact comprises a button **21**, of similar material, and riveted to the ends of the leafs, or fingers **22**, **23**. These fingers are made of a material having a very low temperature coefficient of expansion, such as, for example, Invar. The end portions of the fingers, which carry the contact **21**, are coplanar and welded together, whereas the other end portions are spaced apart. The end of the upper finger **22** is welded to the face of the short leg **19**, of the actuator, and the corresponding end of the lower finger **23** is welded to the surface of a cross bar **24** having an integral adjustment lever **25** extending therefrom.

The opposed ends of the cross bar **24** are provided with semi-circular vertical channels accommodating the transversely-aligned set of pins **14** and **14'** (see FIGURE 2). The cross bar is welded to such fingers but its lower surface is spaced somewhat from the mica sheet **16** for purposes which will be explained hereinbelow. A thin, flat spring **26** is welded to the cross bar and to the actuator leg **19**, thereby providing a predetermined, accurate spacing between these members. This flat spring essentially is rigid to vertical and transverse loading lying in the plane of the spring but is flexible to longitudinal motion of either of the attached members in a direction normal to the plane of the spring. It will be apparent, therefore, that the flat spring maintains the spacing between the actuator end **19** and the cross bar **24** without resistance to the axial, thermal expansion of the actuator **17** relative to the cross bar **14**.

In the illustrated construction, the stationary contact **20** normally is spaced from the movable contact **21**. The initial, preset spacing between these contacts is maintained throughout a wide range of ambient temperature variations, since both the actuator **17** and the base **10** expanded equally. When the heater coil is energized, the rapid transfer of heat to the actuator causes the latter to expand thereby applying tension to the cantilever mechanism comprising the anchored fingers **22, 23**. This causes the fingers to flex thereby moving the movable contact **21** toward the fixed contact **22**. The time delay between the moment of application of heat to the actuator and the closure of the contacts depends upon the design parameters of the particular relay. Electrical connection of the contacts to an external circuit is made by means of the pin **12** (carrying the stationary contact) and either of the two pins connected to the cross bar.

As stated hereinabove, the adjustment lever **25** is integral with the cross bar **24**, which cross bar is welded to the transversely aligned pins but spaced from the mica sheet. Such pins effectively serve as fulcrum points for the lever. With specific reference to FIGURE 1, it will be seen that raising the free end of the relatively thick lever **25** will forcefully bend the two supporting pins to the right thereby applying tension to the lower finger **23** and causing the movable contact **21** to move further away from the fixed contact. Thus, the lever **25** provides a means for adjusting the initial spacing between the two electrical contacts.

Reference is now made to FIGURE 3, which is a longitudinal, cross-sectional view of the relay shown in FIGURE 1 but with the heater coil omitted. This view shows the integral adjustment lever **25** and the cross bar **24**, the latter being spaced from the mica sheet **16**. An adjusting screw **27** is threaded into a hole provided in the base **10** and extends through a clearance hole formed in the mica sheet. A rivet **28** has a shank passing through a clearance hole provided in the lever **25** and force-fitted into an axial bore provided in the screw. A slight clearance is provided between the end of the screw and the lever whereby the screw may be rotated to effect an upward or downward displacement of the lever. An upward lever displacement results in an increase in the spacing between the contacts **20, 21**, whereas a downward lever displacement results in a decrease in such spacing. Since the two pins to which the cross bar **24** is attached (pins **14** and **14'** visible in FIGURE 2) are relatively heavy, the lever **25** will remain in the adjusted position under conditions of high shock.

When the relay is intended for service under conditions of high vibration, the cantilever mechanism can be modified as shown in FIGURE 4. Here, the upper finger **22'** includes a wider central portion which is bent along longitudinal lines to form depending side edges, which edges are spaced from the proximate sides of the lower finger **23**.

A time-delay relay, made in accordance with this invention, can be made in a very small overall size and can be hermetically sealed. A simple, rectangular, cup-like case (as shown by the dotted lines **30** in FIGURE 1) can be positioned with its open end resting upon the peripheral ledge formed in the base and the case and base made integral by soldering.

The relay shown in FIGURE 1 is of the normally-open type, that is, the two contacts are spaced apart at ambient temperatures and becomes engaged a predetermined time interval after the heater is energized. With the fixed contact **20** positioned beneath the fingers **22, 23** and in normal engagement with the lower surface of the movable contact **21**, a normally-closed contact arrangement is provided. Both such arrangements can be utilized to provide a relay of the single-pole, double-throw class.

Various other changes and modifications can be made in the illustrated and described construction. The heater element may take the form of a resistor positioned within

a recess provided in the actuator. The actuator can have a variety of shapes and can be perforated with holes to reduce the operating time constant of the relay. Also, the base and the actuator can be made of different metals and unequal axial lengths, provided the temperature coefficients of expansion are chosen to provide the desired ambient temperature compensation. The cantilever mechanism can be spring-biased in one or the other directions to effectuate a desired operating characteristic. These and other changes and modifications may be made without departing from the scope and spirit of the invention as recited in the following claims.

I claim:

1. An electrical time-delay relay comprising,

(a) a base made of a metal having a relatively high coefficient of thermal expansion,

(b) a generally C-shaped actuator made of a metal having a relatively high temperature coefficient of expansion and carried by said base, said actuator having an elongated base portion joined to legs of unequal length,

(c) a pair of diverging fingers made of a metal having a negligible temperature coefficient of expansion, one end of the one finger being secured to the shorter leg of the actuator, the corresponding end of the other finger being secured to said base, and the free ends of the fingers being joined together,

(d) a movable contact secured to the joined ends of the fingers,

(e) a cooperating stationary contact carried by the base and insulated therefrom, and

(f) a heater in heat-transfer relation to the base portion of the actuator.

2. The invention as recited in claim **1**, including thermal insulation means disposed between the longer leg of the actuator and the base.

3. The invention as recited in claim **1**, wherein one of said fingers includes side walls offset in the direction of the other finger and spaced from the side edges thereof.

4. A time-delay relay comprising,

(a) a base made of a metal having a relatively high coefficient of thermal expansion,

(b) a plurality of sets of contact pins extending through the base and electrically insulated therefrom,

(c) a generally C-shaped actuator made of a metal having a relatively high coefficient of thermal expansion one leg of said actuator being secured to a set of pins at one end of the base and the other leg being spaced from the base,

(d) a cross-bar member secured to a set of pins at the other end of the base, said member having a lower surface spaced from the base and an upper surface spaced from said other leg of the actuator,

(e) a pair of fingers in the form of flat strips of metal having a substantially zero coefficient of thermal expansion, one end of the one strip being secured to the said other leg of the actuator, one end of the other strip being secured to the said cross-bar member, and the free ends of the strip being joined together,

(f) a movable contact carried by the joined ends of the said strips,

(g) a cooperating stationary contact carried by a pin intermediate of said end sets of pins, and

(h) a heater element in heat-transfer relation with said actuator, said heater element being connected to a third set of pins.

5. The invention as recited in claim **4**, including an adjustment lever integral with said cross-bar member and extending in spaced-relation to the said fingers and the base, and adjustable means for deflecting the said adjustment lever relative to said base, thereby to bend the pins secured to the cross-bar member for the purpose of adjusting the relative spacing between the movable and fixed contacts.

6. The invention as recited in claim 4, including a flat leaf spring secured to the said cross-bar member and the said other leg of the actuator, said spring maintaining the spacing between the cross-bar member and the said leg of the actuator while permitting longitudinal expansion of the actuator relative to the base.

7. The invention as recited in claim 5, wherein the base is rectangular and has the same coefficient of thermal expansion as the said actuator.

8. The invention as recited in claim 5, wherein the said base is provided with a peripheral ledge, in combination with a cup-like case supported by the said ledge.

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