Feb. 9, 1965 H. J. CHAFER 3,169,180

HOT WIRE THERMAL TRIP OVERLOAD ELECTRIC DEVICE

Filed Sept. 12, 1961

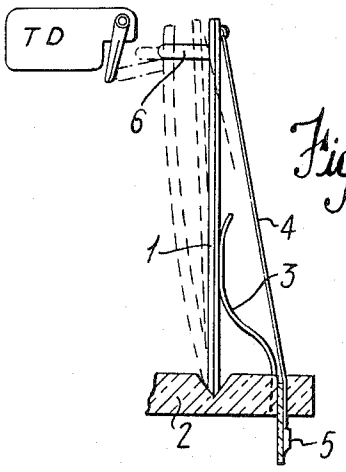


Fig. 1.

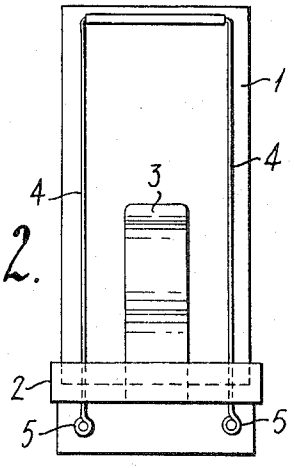


Fig. 2.

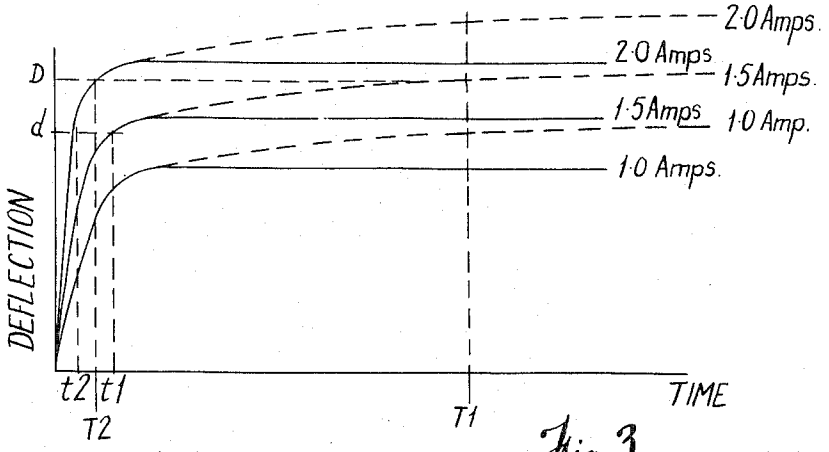


Fig. 3.

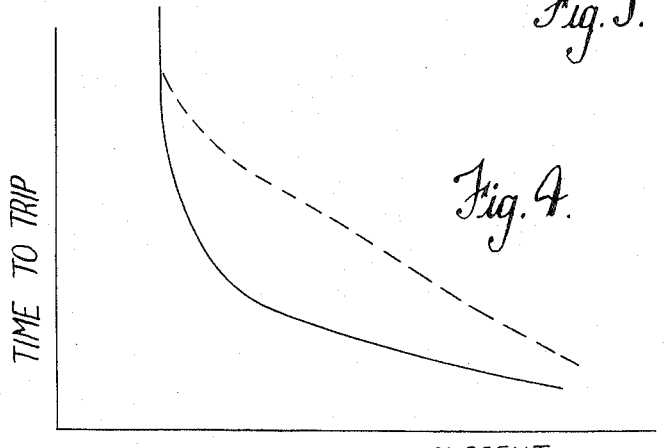


Fig. 4.

INVENTOR
HENRY J. CHAFER

ATTORNEY

United States Patent Office 3,169,180 Patented Feb. 9, 1965

3,169,180

HOT WIRE THERMAL TRIP OVERLOAD ELECTRIC DEVICE

Henry James Chafer, Rugby, England, assignor to Associated Electrical Industries Limited, London, England, a British company

Filed Sept. 12, 1961, Ser. No. 137,644
Claims priority, application Great Britain, Sept. 13, 1960, 31,517/60
5 Claims. (Cl. 200—116)

Thermal overload relays normally employ a bimetal strip through which the current is passed, the strip actuating the tripping mechanism of the relay when the distortion of the strip, due to the heating effect of the current, reaches a magnitude corresponding to the overload current value at which the relay is set to operate. Such relays require a relatively heavy current for this operation.

When a relay is required to operate on small current values, in order to obtain sufficient resistance to raise the temperature of the strip to that which provides the required deflection, it would be necessary to reduce the cross-sectional area of the strip to such an extent that it would be incapable of producing the force required to actuate the tripping mechanism. The present invention aims at solving this difficulty.

A thermal overload relay, according to the present invention, comprises an angularly movable member provided with resilient means biasing the member for angular movement in a direction to cause the tripping device to be actuated, said member being normally restrained in a non-actuating position by at least one electric conductor of small thermal mass through which the relay current is passed, elongation of the conductor(s), as the result of the heating effect of the current passed therethrough, permitting angular movement of the member under the influence of the bias in a direction to actuate the tripping device.

In order to obtain a relatively large angular movement of said member as a result of the elongation of the conductor(s) the conductor(s) and the member are preferably arranged to form an acute angle with one another, the conductor(s) being attached to the member at the apex of the acute angle, and the member being angularly movable about its end opposite the acute angle.

Biasing means is conveniently in the form of a spring bearing upon said member and secured to an insulating base member, which also constitutes the base of the acute-angled triangle and serves to insulate the conductor(s) from the member apart from its, or their, connection to the member at the apex of the triangle.

Under the influence of the heat generated in the conductor by the passage of current therethrough, the metallic strip accordingly distorts and in so doing shortens the length of the linear path between its ends. This permits the angular movement of the end of the member located at the apex of the acute angle to occur to a greater extent under the influence of a prolonged overload, than would be the case when the member is of uniform material; this enables the setting of the relay to be adjusted so that for short current pulses, or surges, the deflection of the member is insufficient to cause actuation of the tripping device. The relay is thus capable of being rendered immune to short overloads. Since such bimetal members are normally constituted from one strip having substantially no thermal expansion, the elongation of the bimetal member as a whole, under the influence of the heating effect of the current passing through the conductor(s) can be neglected.

The insulating member forming the base of the triangle, constituted by the conductor and the member,

may provide a pivotal point about which the angular movement of the member takes place, biasing of the strip in the direction to actuate the tripping device being provided by a spring located on the insulating member between the ends of the conductor(s) and the strip.

In order that the invention may be more readily understood, reference is directed to the accompanying drawing, in which:

FIGS. 1 and 2 show in side elevation and end view, respectively, the operative portion of a thermal overload relay constructed in accordance with the invention.

FIG. 3 is a family of curves illustrating the operation of the relay, and

FIG. 4 a typical characteristic for a thermal overload relay of the invention illustrating the improvement obtained thereby.

Referring to the drawing, and particularly to FIGS. 1 and 2 thereof, there is illustrated a thermal overload responsive mechanism of the invention. It comprises a bimetallic member in the form of a strip **1**, mounted for angular rotation upon a base member **2** of insulating material, the strip being urged in an anti-clockwise, or tripping, direction by means of a spring **3**, and restrained by means of resistive conductors **4** anchored at their lower end to the base member **2**, and secured at their upper ends, as by welding, to the strip **1**. The strip and conductors **4** can be seen to be arranged to form an acute angle with one another, the connection between the strip **1** and the conductors **4** being located at the apex of the acute angle. In order to locate the lower end of the strip **1** on the base member **2**, the latter is notched, as indicated. Conductors **4** are provided with terminals **5** carried by the base member **2**, so as to be insulated from one another. The current to which the device is to be made responsive is carried by the conductors **4** in series, so that terminals **5** represent the connections for the relay. Conveniently, the upper end of the strip is provided with a projection **6** of insulating material which forms the means for operating the tripping device, which may be in the form of a microswitch, rigidly mounted relative to the base memmber **2**. Alternatively the projection **6** may be omitted and the strip **1** caused to actuate a mechanical latch forming part of the tripping device.

On passage of current through the conductors **4**, which are conveniently in the form of thin wires, the wires become heated and elongate. If the strip **1** were of uniform material it would tend to move angularly in the tripping direction. The degree of angular movement would depend on the elongation of the conductors **4** which, in turn, depend on the current flow therethrough. Owing to the small thermal capacity of the conductors **4**, a short pulse of current of greater magnitude than the normal current would tend to effect a tripping operation, which is undesirable, since only a prolonged overload is required to cause operation of the tripping mechanism. The conductors **4** are in heat-exchange relation with the strip **1**, and the heating of the strip by radiation, conduction and convection, is utilised in accordance with the invention to render the relay unresponsive to such pulses of current.

This is effected by making the strip **1** of bimetal. When the heating of the strip occurs, the strip distorts as a result of the unequal expansions of the material at the two faces of the strip. This distortion shortens the linear distance between the ends of the strip located respectively at the apex and base of the triangle. This effective shortening of the strip and the elongation of the conductors **4** permits the strip to deflect to a greater distance than is the case when the strip is of uniform material. Consequently, the motion of the upper end of the strip,

under the influence of a prolonged overload, is thereby caused to be greater, and the setting of the relay can be made less sensitive, so that the deflection obtained for a short current pulse can be made insufficient to produce actuation of the tripping device. The low expansion side of the strip is located next to the conductors 4 so as to introduce the maximum delay in the operation of the relay. The operation may be explained by the operating characteristics shown in FIG. 3 of the drawings, where for a given tripping deflection the time of tripping is plotted against time.

The curves for a relay, having a non-bimetal strip, are shown in full. Let it be assumed that the normal relay current is 1.0 amp, and that *d* represents the deflection at which the relay will operate. It will be seen that if the current increases to 1.5 amps the relay will trip at time t_1, and if it increases to 2.0 amps at time t_2. Both of these are very short periods of time. If we now consider the curves shown in interrupted lines which correspond to a relay having a bimetal strip, the effect of the latter can be seen. Again it will be assumed that 1.0 amp is the normal relay current, but because of the additional deflection due to the shortening of the bimetal strip arising from its distortion, the critical deflection is now greater, say D. If the current now increases to 1.5 amps it will be seen that the relay does not trip until time T_1, although for a greater increase in current say to 2.0 amps it trips at time T_2, which is of the same order as t_2.

In FIG. 4 the time taken for a normal relay, i. e. one having a single metal strip, to trip for various values of current is shown by the full line, and the broken line indicates the effect of providing the relay with a bimetallic strip in accordance with the invention.

It may thus be appreciated that the relay with a bi-metal strip is less sensitive to an increase in current for a short period, provided the increase is not greater than a predetermined value.

To ensure that the bi-metal strip will start shortening as soon as its temperature begins to rise, it is preferably given an initial slight curvature in the direction in which it is due to bend.

In this specification, the term bimetallic strip is intended to include a strip formed from more than two separate metals which do not possess the same thermal characteristics.

What I claim is:

1. A thermal overload relay including a base, a member supported on said base for rotational movement relative thereto which is constituted over at least part of its length by at least two separate metallic portions having different thermal expansion characteristics, a tripping device adapted to be actuated by said member, resilient means to bias the member for angular movement in a direction such as to cause said tripping device to be actuated, at least one electrical conductor of small thermal mass secured to said member adjacent the free end thereof and serving normally to restrain said member in a non-actuating position, and terminal means for enabling current for actuating said relay to be passed through said conductor.

2. A thermal overload relay including a base and angularly a member supported on said base member for rotational movement relative thereto which is constituted over at least part of its length by at least two separate metallic portions having different thermal expansion characteristics, a tripping device adapted to be actuated by said

member, resilient means to bias the member for angular movement in a direction such as to cause said tripping device to be actuated, at least one electrical conductor of small thermal mass secured to said member adjacent the free end thereof and located adjacent to the metallic portion thereof having the lowest expansion characteristic, said conductor serving normally to restrain said member in a non-actuating position, and terminal means for enabling current for actuating said relay to be passed through said conductor.

3. A thermal overload relay including an insulating base member, a bi-metal strip supported on said base member for rotational movement relative thereto, a tripping device adapted to be actuated by said strip, a spring secured at one end to said base member and bearing against said bi-metal strip to bias said bi-metal strip for angular movement in a direction such as to cause said tripping device to be actuated, at least one electrical conductor of small thermal mass extending betwen the bi-metal strip adjacent the free end thereof and the bias member and serving normally to restrain said bi-metal strip in a non-actuating position, and terminal means for enabling current for actuating said relay to be passed through said conductor.

4. A thermal overload relay including an insulating base member, a bimetallic strip supported on said base member for rotational movement relative thereto, a tripping device adapted to be actuated by said strip, a spring secured at one end to said base member and bearing against said strip to bias said strip for angular movement in a direction such as to cause said tripping device to be actuated, at least one electrical conductor in the form of a wire extending between the strip adjacent the free end thereof and the base member and serving normally to restrain said strip in a non-actuating position, and terminal means for enabling current for actuating said relay to be passed through said conductor.

5. A thermal overload relay including an insulating base member, a bimetallic strip supported on said base member for rotational movement relative thereto, a tripping device adapted to be actuated by said bimetallic strip, a spring secured at one end to said base member and bearing against said bimetallic strip to bias said bimetallic strip for angular movement in a direction such as to cause said tripping device to be actuated, at least one electrical conductor extending between the bimetallic strip adjacent the free end thereof and the base member adjacent to the portion of said bimetallic strip having the lower coefficient of expansion and which serves normally to restrain said bimetallic strip in a non-actuating position, and terminal means for enabling current for actuating said relay to be passed through said conductor.

References Cited by the Examiner

UNITED STATES PATENTS

2,130,368	9/38	Sachs	200—116
2,681,394	6/54	Hollins	200—113
2,943,172	6/60	Ingwersen	200—116

FOREIGN PATENTS

853,625	11/60	Great Britain.

BERNARD A. GILHEANY, *Primary Examiner.*

ROBERT K. SCHAEFER, *Examiner.*