May 23, 1933. G. W. O'KEEFFE 1,910,494

THERMAL RELAY

Filed June 11, 1931 2 Sheets-Sheet 1

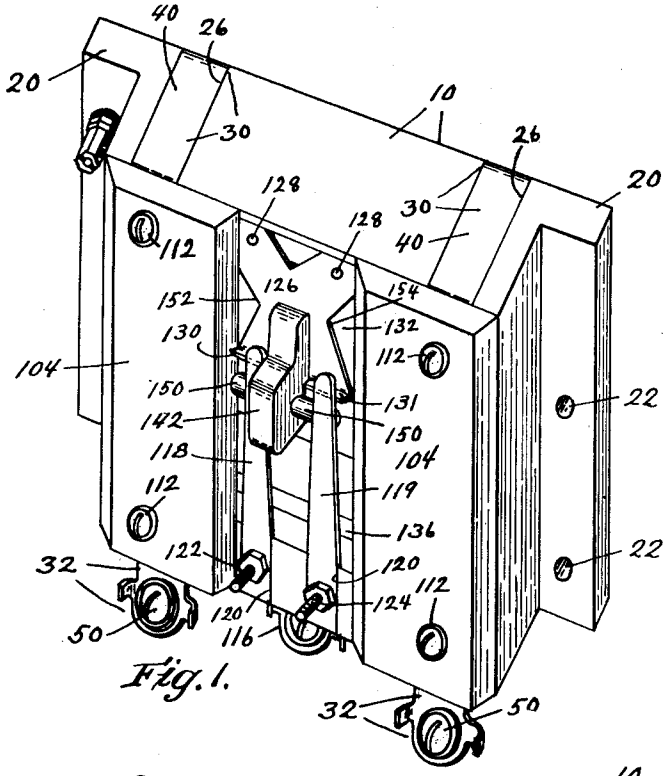


Fig. 1.

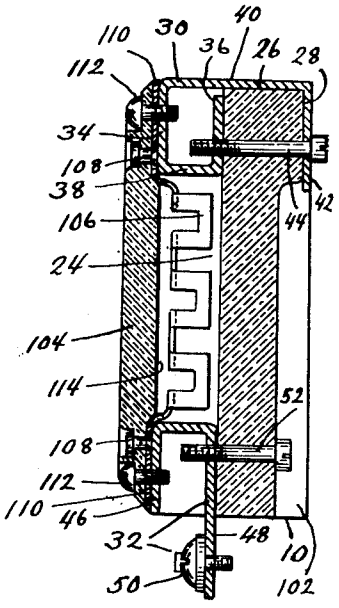


Fig. 3.

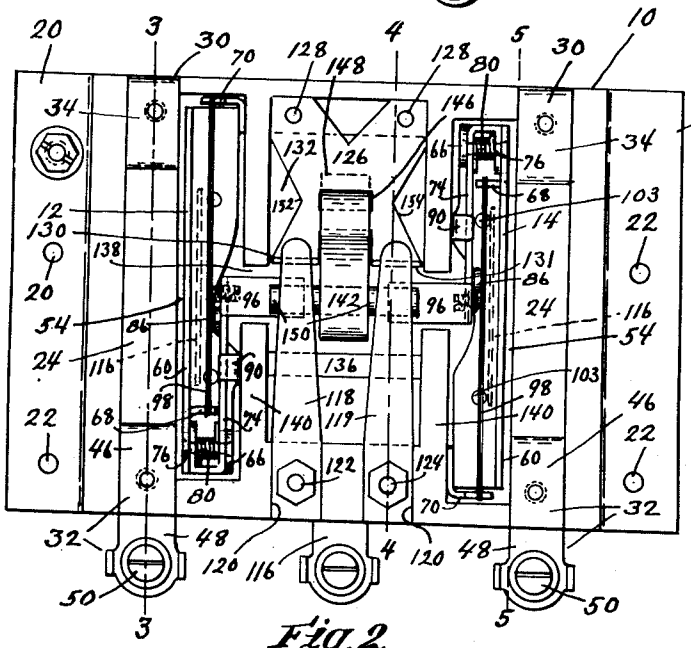


Fig. 2.

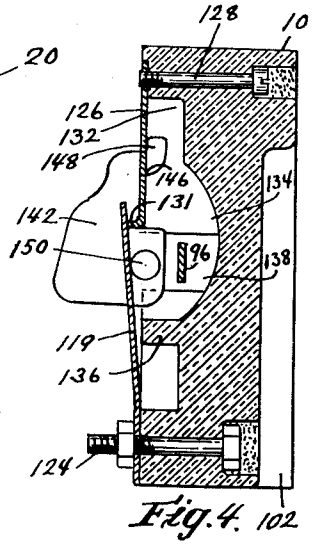


Fig. 4.

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1,910,494

THERMAL RELAY

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2 Sheets-Sheet 2

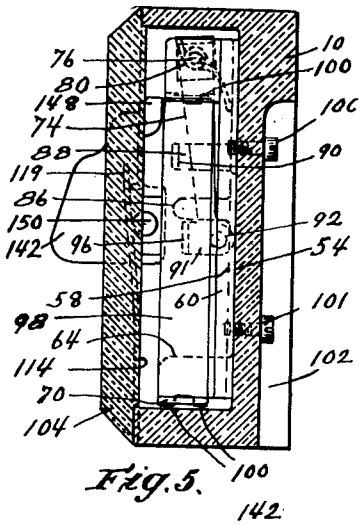


Fig. 5.

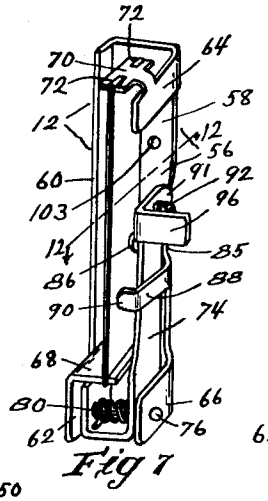


Fig 7

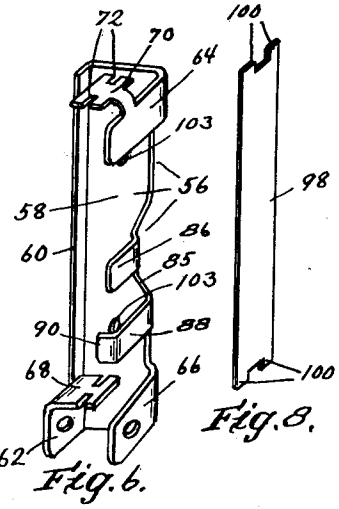


Fig. 6.

Fig. 8.

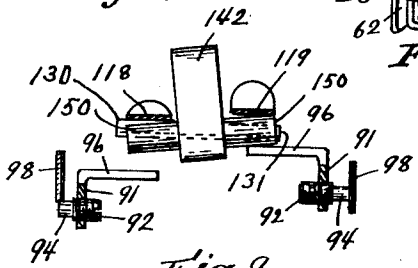


Fig. 9

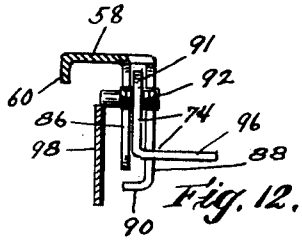


Fig. 12.

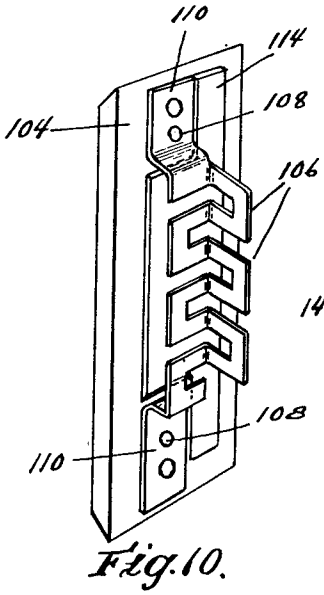


Fig. 10.

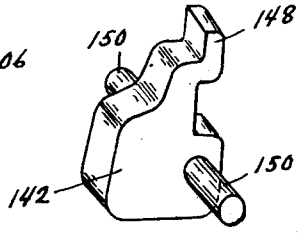


Fig. 11.

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by Thurmond

atty

Patented May 23, 1933 1,910,494

UNITED STATES PATENT OFFICE

GEORGE W. O'KEEFFE, OF MILTON, MASSACHUSETTS, ASSIGNOR TO CONDIT ELECTRICAL MANUFACTURING CORPORATION, OF SOUTH BOSTON, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS

THERMAL RELAY

Application filed June 11, 1931. Serial No. 543,593.

This invention relates to overload protective thermal relays of the type having a thermally-expansible element which is responsive to and is heated by current in a power circuit and which operates to control contact members included in a control circuit of a switch for the power circuit, as the circuit of an electric motor. The relay, however, is not limited to such use.

One of the objects of the present invention is the provision of an improved thermal relay of this type having means for effecting a positive and rapid separation of its contact members and specifically to provide a thermally responsive relay having a normally stressed operating member and a thermally expansible element for normally holding said member in an inoperative position and for releasing said member suddenly upon a predetermined heated condition of the expansible element to actuate the relay contacts with a snap action.

In thermal relays employing the usual bimetal expansible strip, the strip is frequently under an initial stress or, if free from such stress, is bent between its ends, either into U-shape, spiral or other configuration. The temperature of the strip modifies its stress and its configuration. The temperatures of the room in which the relays are constructed vary from day to day. Thus, while all relays may be adapted to operate at the same current rating, those adjusted under a certain factory room temperature will, in fact, be different in adjustment from those regulated under a different room temperature, and will perform differently when in service. Hence a further object of the invention is the provision of a relay that is practically free from the above objection.

In carrying out this object I provide a bimetal strip that is straight and free from any reflexed condition and is normally under no initial stress between rigid end abutments so that, upon being heated, it is caused to bend or buckle in the middle, thereby to release, like a detent, a spring actuated circuit controlling member. Such a construction constitutes a further object of the invention.

Another object is the provision of improved means by which a common circuit-controller is operated separately by a plurality of such thermal relays and wherein an operated relay can be reset by a part of the circuit-controller without modifying the condition of the circuit as determined by the operation of the relay.

A yet further object of the invention is the provision of an improved thermal relay having an electric heating element and a thermally-expansible element which is located alongside and closely adjacent said heating element and is arranged when heated to flex in the direction of said heating element.

A yet further object of the invention is the provision of an improved form of thermal relay having a base portion which supports a thermally-expansible element and a detachable cover portion which carries the heating element.

Another object of the invention is the provision of a heater element for a thermal relay having a grid-shaped heating portion which is designed to prevent warping or sagging of the element when it is heated.

A still further object of the invention is generally to improve the construction and operation of thermal relays.

Fig. 1 is a front perspective view of the thermal relay embodying the present invention.

Fig. 2 is a front elevation of the relay of Fig. 1 with the covers removed, the position of the heating elements being indicated by dotted lines.

Fig. 3 is a section on line 3—3 of Fig. 2.

Fig. 4 is a section on line 4—4 of Fig. 2.

Fig. 5 is a section on line 5—5 of Fig. 2.

Fig. 6 is a perspective view of the supporting frame for a thermal element.

Fig. 7 is a view similar to Fig. 6 with the spring pressed operating member in place.

Fig. 8 is a detail perspective view showing a thermally-expansible element.

Fig. 9 is a sectional view illustrating the position of the relay parts after one thermally responsive unit has operated on overload.

Fig. 10 is a rear perspective view of a cover showing the heating element carried thereby.

Fig. 11 is a perspective view of the manual resetting member.

Fig. 12 is a section on line 12—12 of Fig. 7.

As here shown the relay embodying the invention is adapted to be associated with and provide overload protection for a three phase power circuit and includes a generally rectangular base or block 10 of insulating material, preferably a material that can be molded, which constitutes an insulating support for the main and auxiliary terminals of the relay, together with two separate and identical thermally-responsive relay units 12 and 14, and the cooperating stationary and movable contact members of the relay (Fig. 2). The base plate 10 is formed with rear oppositely outstanding side flanges 20 having passages 22 therethrough to receive bolts by which the relay is adapted to be secured to any desired apparatus. The relay herein shown is especially designed to be secured to the frame of an enclosed electromagnetically operated switch of the type commonly employed for controlling small power circuits, although it is not limited to such use. The base 10 is provided with relatively deep transverse grooves 24 (Figs. 2 and 3) which are located adjacent the flanged ends thereof and which extend from top to bottom of the base. The base is further provided with shallow conductor receiving channels 26 and 28 in the top and upper rear faces thereof respectively which are extensions of and are in alignment with said grooves 24.

Each of said grooves 24 contains an upper and a lower main terminal member 30 and 32 for a separate phase conductor of the power line with which the relay is associated. Said upper terminal member 30, as shown most clearly in Fig. 3, comprises a flat bar or strip of conducting material of generally U-shape comprising the spaced upstanding arms 34 and 36 and the lower connecting portion 38. The arm 36 is adapted to lie in the bottom of the groove 24 and the connecting portion 38 is of such length that the arm 34 is located flush with the front face of the base. The foremost arm 34 of said terminal is provided with an integral portion 40 which extends rearwardly in the channel 26 and with a downwardly extended integral portion 42 which lies in the conductor receiving channel 28 on the rear face of the base. The strips comprising said terminal members, as shown most clearly in Fig. 2, have a width commensurate with the width of the grooves 24 and the conductor passages 26 and 28, whereby to completely occupy the ends of the grooves. Bolts 44 extend through the rear portions 42 and are screw-threaded into the arms 36 of said terminal members whereby to secure them fixedly to the base. Said terminal portions 42 and bolts 44 constitute the upper main line terminals of the relay. Said lower contact members 32 comprise inverted U-shaped straps comprising the spaced parallel arms 46 and 48, the former of which is disposed flush with the front face of the base and the latter of which lies in the bottom of grooves 24 and extends downwardly below the lower edge of the base and is provided with a terminal attaching screw 50. Said lower contact members are secured rigidly to the base by means of screw-threaded bolts 52.

The base 10 is also provided with deep transverse rectangular wells 54 which are disposed between and adjacent the grooves 24 and each of which is in communication throughout its length with one of said grooves. Each of said wells 54 contains a thermally-responsive unit which is adapted to be influenced by the current flowing in the phase conductor located in the groove adjacent thereto. Said thermally-responsive units are identical and interchangeable. Each unit consists of a stamped rigid frame 56, Fig. 6, consisting of a back plate 58 which is disposed in the bottom of the well, a left hand upstanding reflexed plate-stiffening flange 60 provided with an enlarged ear 62 at the lower end thereof, and a pair of upper and lower right hand side ears 64 and 66 all of which ears are reflexed into a position normal to the base plate 58. The diagonally opposite ears 62 and 64 are provided with mutually inwardly-directed reflexed wings 68 and 70 each of which is provided with a pair of aligned marginal notches 72 which are disposed in a common vertical plane and which are adapted to support a thermally-expansible strip hereinafter to be described.

Said frame also carries a pivotally supported operating or circuit-controlling arm 74, Fig. 7, which lies alongside the right hand side of the frame. Said operating arm 74 is pivotally supported at one end on a pin 76, which extends between and is fixed in the parallel ears 62 and 66 of the frame, and has its other and free end located intermediate the ends of the frame. Said arm is provided with a U-shaped bent end portion the parallel arms of which are closely received between the ears 62 and 66 and thus prevent lateral displacement of the arm on its pivot pin 76. A coil spring 80 is provided on said pin between the U-shaped arms of said member and has oppositely extended ends which engage the base plate 58 and the U-shaped end of the arm 74 respectively whereby to bias the arm constantly for movement at its free end in a direction away from the base plate 58. The base plate 58 of said frame is provided with a cutaway portion 85 from the margin of which a reflexed ear 86 upstands which is disposed closely adjacent the left hand side of the member 74 and constitutes means to support the free end thereof against lateral displacement in one direction. A second upstanding ear 88 is provided closely adjacent

the arm 74 on the opposite side thereof which constitutes means to prevent displacement of the free end of the arm 74 in the opposite direction. Said ear 88 is further provided with a reflexed end 90 which overlies said member 74 and constitutes a stop to limit the movement of the arm under the action of the spring 80. Said member 74 has an enlarged end portion 91 into which a stud 92 is adjustably screw-threaded, the stud having a thread-free end portion which is adapted to be normally disposed beneath the vertical plane including the notches 72 in which the thermal element is located. Said operating member 74 is further provided with an outstanding arm 96 at the free end thereof which extends a substantial distance beyond the right hand end of ears 64 and 66 of the frame and constitutes a circuit-interrupting and relay-resetting member.

A composite thermal strip 98, Fig. 8, is adapted to be supported between the wings 68 and 70 of the frame and in the notches 72 and comprises a flat strip composed of two metals having different characteristics of thermal expansion secured back to back. Said strip is provided with longitudinally extended pairs of projections 100 at its opposite ends which are located in the notches 72 of the frame, whereby to support the expansible element at its opposite ends against lateral displacement in all directions while permitting longitudinal movement of the ends thereof due to changes in length of the strip during expansion and contraction. The projections 100 are intended to be long enough so that they will not come out of the notches 72 on any usual flexing of the straight thermal element. The projections 100 and notches 72 are also such as to permit the strip to bow freely, when heated, without imposing restraint on the ends of the termal element. The thermal element thus, in effect, floats between the wings 68 and 70, which support the thermal element against undue longitudinal movement with respect to the latch pin 92, of the circuit-controlling arm 74.

With this construction the thermal element need have no reflexed sections and is free from restraint against bowing due to temperature changes, so that the variations in room temperatures at which various thermal elements are constructed, assembled and tested have negligible effect in their ultimate operating characteristics. The floating thermal element also obviates the necessity for extreme accuracy in manufacture of the length of the element, or the distance between the wings 68 and 70.

The frames 56 of the thermal units are secured rigidly in the wells 54 by means of attaching screws 101, the heads of which are located in a broad recess 102 in the rear face of the base plate and two of which extend through the base 10 and are screw-threaded into passages 103 in the base plate 58 of each frame. The thermally-responsive units are located in the wells 54 in longitudinally transposed position so that the laterally extended arms 96 of the operating members 74 thereof are mutually inwardly directed toward the center of the base. By thus reversing the position of the units they can be identical in construction.

Means are provided separately to connect electrically each pair of upper and lower terminals 30 and 32, which means also constitutes the heater element for the adjacent thermally-responsive unit. As shown in Figs. 3 and 10, a cover 104 is provided for each of the adjacent intercommunicating grooves and wells 24 and 54, on the back face of which cover is carried a heater element 106. Said element 106 is secured permanently to the cover by means of rivets 108 located adjacent the ends thereof and is formed from a flat strip of resistance material having oppositely directed, deep marginal slots which are located on alternate sides of the strip and in longitudinally staggered relation whereby to provide a heating grid having a relatively long sinuous path of current travel from end to end of the strip. The strip is provided with upwardly offset flat end portions 110 which are located at one side of the longitudinal median line through the strip and which when the cover is disposed in covering relation with the channel and well of the base, are disposed over and in contact with the terminal portions 34 and 46 of the upper and lower terminals 30 and 32 and consequently connect said terminals electrically through the heater element. Attaching screws 112 extend through the cover and the terminals 110 of the heater element and are screw-threaded into the foremost arms 34 and 46 of the upper and lower terminals respectively, the screws thus serving not only to hold the cover in place but also to maintain the heater element in good electrical contact with the terminal members. As shown most clearly in Fig. 10, the grid portion of the heater element is composed of two angularly-related sections one of which is parallel and the other of which is normal to the cover and is adapted to lie in the base well closely adjacent the thermal element, when the cover is in position over the well. The angularly-related grid sections serve to strengthen the grid mechanically and to make it sufficiently rigid to avoid sagging or deflecting laterally when hot. The covers are provided at one side of the heater element and beneath the heating portion thereof with a raised portion or boss 114 which is adapted to be received within and to conform closely with the margins of the wells 54 and that portion of the grooves 24 which is enclosed by the terminals 30 and 32 thus to assist in aligning the screws

112 with the threaded passages in the contact members. The raised portion 114 also prevents the attachment of the cover in an inverted position.

An intermediate terminal 116 is provided at the lower edge of the base between and spaced back from the line terminals 32 and has a conducting portion which extends upwardly in the recess 102 at the back of the base and terminates in an upper main contact member, not shown.

The stationary and movable contact members of the circuit-controller are supported on the face of said base plate between the thermally-responsive devices above described. As shown in Figs. 2 and 4, said movable contact members comprise a pair of parallel spaced resilient fingers 118 and 119 which are fixed at their lower ends in rectangular channels 120 in the face of the base by means of bolts 122 and 124 which constitute the auxiliary circuit terminals for the relay.

The stationary contact member comprises a resilient bifurcated plate 126 which is secured rigidly at its upper margin to the base 10 by means of attaching means 128. Said plate has the bifurcations thereof extended beneath the ends of the contact fingers 118, 119, and provided with upturned contact flanges 130 and 131 respectively at their lower edges which normally are engaged by the contact fingers 118, 119. The base plate 10 is provided with a central recess 132 Fig. 4, located beneath the stationary and movable contact members which is further provided with a deeper central arcuate recess 134 in the vicinity of the mutually inwardly directed operating arms 96 of the thermal units. A transverse barrier 136 extends across the recess 132 beneath the movable contact fingers 118, 119 and limits the downward movement of said contact members upon the depression of the stationary contact member 126. A transverse slot 138 is provided in the dividing walls 140 which separate the recess 132 from the wells 54, thus to permit vertical movement of the extensions 96 of the operating members 74. The terminals 122 and 124 of the relay are intended to be connected in series in the pilot circuit of an electromagnetically operated switch, or the like, and consequently the elevation of either movable contact finger 118 or 119 from engagement with the stationary contact member 126 will effect the opening of the pilot circuit.

As shown most clearly in Figs. 4 and 11, an insulating member 142 is carried by the stationary contact member 126 between the bifurcations thereof. Said insulating member has an angularly-related rearwardly directed extension which projects through a rectangular passage 146 in said contact member located in the median line thereof and an upwardly extended angularly-related toe portion 148 which lies parallel with and is disposed beneath the contact plate 126. Said insulating member is also provided with oppositely extended trunnions 150, also of insulating material, which overlie and are spaced above the operating arms 96 and are directly beneath and in contact with the movable contact fingers 118, 119, as shown most clearly in Fig. 4. It will thus be evident that the insulating member 142 will be held in the above described position by the contact fingers 118, 119 and the toe portion 148. Said member constitutes means by which the flexible plate 126 can be flexed manually out of engagement with the contact fingers 118, 119 whereby to break the auxiliary circuit independently of the thermal devices; and also to reset the devices after an operation thereof.

The operation of the relay is as follows:

If an overload condition occurs in the main circuit to be protected which includes in series therewith the heater elements 106, sufficient heat will be generated in one or more of said heater elements to cause the bimetallic strip 98 adjacent thereto to flex out of its normally straight condition and to assume an arcuate position in which its middle point is displaced laterally and passes from beneath the stud 94 of the actuating member 74, thus releasing the actuating member which under the bias of the spring 80 flies upwardly into engagement with the abutment 90. In this position of the operating arm the extension 96 thereof has engaged a trunnion 150 of the insulating member 142 and has raised the member and the contact finger above it into an elevated position in which it is free from its cooperating stationary contact flange, thereby breaking the auxiliary circuit. It will be noted that the extension 96 of the operating arm strikes the insulating member 142 a hammer blow due to its normally spaced relation therewith and consequently effects a rapid separation of the contacts. In Fig. 9 the insulating member 142 is shown in the position it occupies after one of the thermally-responsive units has operated.

It will be evident that the operation of either thermally-responsive unit, since they control contacts which are in series, will effect the opening of the pilot, or auxiliary, circuit.

The resetting of the relay is accomplished by depressing the insulating member 142 upon which the stationary contact plate 126 is adapted to be flexed downwardly sufficiently to permit the trunnions 150 to depress the extensions 96 of the operating arm 74 which has operated into a position in which its stud 94 is beneath the thermal element. In order to increase the flexibility of the stationary contact plate 129, V-shaped marginal notches

152 and 154 are provided in the side and top edges of said contact member.

During the resetting operation the plate 126 is moved away from the contact fingers 118, 119 so that the auxiliary circuit is not completed until after the relay has been reset and the plate allowed to return to its normal position. Thus the main circuit is always protected by a relay whenever the auxiliary circuit is complete, which is a desirable feature.

It will be noted that the thermal element 98 has edgewise engagement with the pin 92. Thus the spring pressure on the pin is resisted in the most rigid plane of the thermal element and does not offer appreciable restraint to its free flexing under heat.

As herein shown the invention has been illustrated in connection with a relay having normally closed contacts but it is obvious that the relay might equally well have normally open contacts or that in place of the contact members any of the usual mechanical tripping devices might be employed.

Various changes in the construction and arrangement of the parts may be made without departing from the scope of the invention.

I claim:

1. A thermal relay comprising an insulating supporting base, pairs of insulated main and auxiliary terminal members carried by said base, cooperating stationary and movable contact members normally electrically connecting said auxiliary terminal members, an operating member having means which constantly biases it into a position to separate said contact members, thermlly-actuated means controlling the release of said operating member, a heater element located in heat imparting relation to said thermally-actuated member which is electrically connected between said main terminal members, and manual means for resetting said operating member first and thereafter effecting the reengagement of said contact members.

2. A thermal relay comprising an insulating supporting base, two pairs of main line terminals carried by and spaced apart on said base, auxiliary terminals carried by said base, cooperating stationary and movable contact members normally electrically connecting said auxiliary terminals, heater elements electrically connecting the pairs of main line terminals, a thermally-responsive member located adjacent each of said heater elements, operating members associated with each of said thermally-expansible members having means normally biasing them into a position to separate said contact members, means associated with said thermally-expansible members arranged to govern the release of said operating members, and manually operative means for conjointly resetting said operating members and thereafter completing the electrical connection between said auxiliary terminals at said contact members.

3. A thermal relay having an insulating supporting base, spaced main and auxiliary terminal members carried by said base, cooperating stationary and movable contact members mounted on said base and electrically connected with said auxiliary terminal members, a thermally-responsive unit located adjacent said contact members comprising a spring pressed operating member which is biased into a position to control said contact members, a thermally-actuated latch member for withholding said operating member from operation, and a cover member having a heater element carried thereby, said heater element having terminals that are spaced apart the same distance as said main terminal members, said cover member having provision for securing it to said base with the terminals of said heater element electrically connecting a pair of said main line terminal members and also with said heater element disposed in operative relation with said thermally-responsive unit.

4. In a thermal relay, a frame having opposed reflexed end portions, a flat normally straight bimetallic strip extended between and having its ends loosely connected with said end portions so that said strip is free to flex throughout its length between its ends, a pivoted operating arm carried by said frame, means normally biasing said operating arm into an operating position, said arm having an abutment which is located under and normally engages a narrow face of said bimetallic strip whereby to hold said operating member releasably against operation, and heating means for said bimetallic strip.

5. In a thermal relay, a frame including a back portion having upstanding end portions, a flat bimetallic strip extended between and loosely supported by said end portions, an operating arm disposed alongside said bimetallic strip between its ends and having a pivoted support at one end on an end portion of said frame, means constantly biasing said arm into an operated position, said arm having a latch portion thereof normally disposed beneath and engaged with a narrow face of said bimetallic strip by which said arm is held from operation, and means for heating said strip to move the narrow face thereof out of engagement with said latch portion.

6. In a thermal relay, a frame having a back portion, and reflexed upstanding end portions, a normally straight flat bimetallic strip carried by said frame in a plane normal to the base having its opposite ends loosely connected with said end portions to permit lateral movement of said strip intermediate its ends, an operating arm pivoted at one end

to said frame and disposed in a plane parallel with and closely adjacent said strip, means normally biasing said arm into an operated position, said arm having a lateral extension which is normally disposed beneath the narrow edge of said strip intermediate the ends thereof whereby said strip normally holds said arm in an inoperative position against its bias, and a heater element disposed alongside said strip.

7. A thermally-responsive unit for a thermal relay comprising a frame having a back supporting portion and upstanding reflexed end portions, a normally straight flat bimetallic strip carried by said frame having its ends loosely connected with said end portions whereby to permit said strip to flex laterally intermediate its ends while maintaining its ends fixed against deleterious lateral displacement, an operating arm having a pivotal connection at one end of said frame extended alongside said strip and having its free end located intermediate the length of said strip, means constantly biasing said arm into an operating position, a latch portion carried by the free end of said arm arranged normally to engage said strip whereby to hold said arm releasably by said strip in its unoperated position, and upstanding projections carried by said frame on opposite sides of said arm constituting means to restrain said arm from lateral movement in either direction.

8. A thermal-responsive unit for a thermal relay comprising a supporting frame having a back attaching portion and having reflexed upstanding end portions, an operating arm having a pivoted support at one end on said frame and having means which constantly biases it toward an operated position, means for restraining the free end of said arm from lateral movement in both directions comprising upstanding projections of said frame located on opposite sides of and closely adjacent said arm, and means for releasably holding said arm in an unoperated position comprising a normally straight bimetallic strip having its opposite ends loosely supported in the end portions of said frame and normally overlying an extended portion of said operating member.

9. A thermally-responsive unit for a thermal relay comprising a frame having a back supporting portion and spaced upstanding and confronting end portions, an operating member carried by said frame which is normally biased into an operated position, and means normally holding said arm in an unoperated position comprising a normally straight bimetallic strip having its ends loosely supported in the end portions of said frame.

10. A thermally-responsive unit for a thermal relay comprising a frame having a back supporting portion and having opposed upstanding ears at one end thereof, an operating arm carried by said frame having a U-shaped end which is closely received between the ears of said frame and is pivotally supported therebetween, means to guide the free end of said arm against lateral displacement in both directions comprising upstanding ears of said frame which engage the free end of said arm on opposite sides thereof, a spring constantly biasing said arm into an operated position, an adjustable latch projection carried by the free end of said arm, and means normally engaging said projection whereby to hold said arm in an unoperated position comprising a normally straight bimetallic strip which is supported at its ends on said frame and is extended alongside said arm.

11. A thermally-responsive unit for a thermal relay comprising a frame having a back supporting portion and having upstanding reflexed and confronting ears at its opposite ends, an operating arm having one end thereof pivotally supported on said frame and having its free end located intermediate the ends of said frame, an adjustable latch portion carried by the free end of said arm, means normally biasing said arm into an operated position, and means for holding said arm releasably in an unoperated position comprising a normally straight strip of bimetallic material having the opposite ends thereof loosely supported in the confronting ears of said frame, the ends of said strip having angular projections which are received in corresponding angular passages in said ears whereby to permit free longitudinal movement of the strip upon expansion thereof while maintaining the ends thereof fixed against lateral movement relative to the ears.

12. A thermal relay having an insulating supporting base provided with a pair of spaced wells and having a transverse channel connecting said wells, a stationary contact member located on one side of said channel between said wells, a pair of movable contact members fixed to said base on the other side of said channel and extended thereacross into a position to engage said stationary contact member, said stationary contact member constituting a bridging member for said movable contact members, a thermally-responsive unit located in each of said wells comprising a frame having a spring pressed operating member and a thermally-expansible member which normally holds said operating member releasably in an unoperated position, said operating members having mutually inwardly directed extensions located in said channel each beneath a movable contact member, and heater elements disposed in said wells alongside said members.

13. A thermal relay having an insulating supporting base provided with a pair of spaced wells and having a transverse channel connecting said wells, a stationary con-

tact member located on one side of said channel between said wells, a pair of movable contact members fixed to said base on the other side of said channel and extended thereacross into a position to engage said stationary contact member, said stationary contact member constituting a bridging member for said movable contact members, a thermally-responsive unit located in each of said wells comprising a frame having a spring pressed operating member and a thermally-expansible member which normally holds said operating member releasably in an unoperated position, said operating members having mutually inwardly directed extensions located in said channel each beneath a movable contact member, and cover members for said wells having heater elements carried thereby, and means to secure said cover members to said base with the heater elements thereof located in said wells.

14. A thermal relay having an insulating supporting base provided with a pair of spaced wells and having a transverse channel connecting said wells, a stationary contact member located on one side of said channel between said wells, a pair of movable contact members fixed to said base on the other side of said channel and extended thereacross into a position to engage said stationary contact member, said stationary contact member constituting a bridging member for said movable contact members, a thermally-responsive unit located in each of said wells comprising a frame having a spring pressed operating member and a thermally-expansible member which normally holds said operating member releasably in an unoperated position, said operating members having mutually inwardly directed extensions located in said channel each beneath a movable contact member, heating means for said thermally-expansible members, and manually operative means arranged to engage the extensions of said operating members to reset said members to an unoperated position.

15. A thermal relay having an insulating supporting base provided with spaced wells therein and having a transverse channel connecting said wells, a stationary contact member located on said base between said wells at one side of said channel, a pair of movable contact members secured to said base on the opposite side of said channel and extended across said channel into a position to engage said stationary contact member, a thermally-responsive unit located in each of said wells, comprising a support for a spring pressed operating member and having a thermally-expansive strip which constitutes means for normally holding said operating member in an unoperated position, said operating members having mutually inwardly directed extensions which are disposed in said channel each beneath and in position to control a movable contact member, a manual resetting member supported above said base which overlies the extensions of said operating members whereby said members can be manually reset, and cover means forming closures for the wells in said base having heater elements supported on the rear face thereof, and means to secure said covers releasably to the base, said heater elements having rearwardly extended projections thereof which enter into said wells and are disposed alongside said thermally-expansible elements.

16. A thermal relay comprising a supporting structure, a bimetal element having a loose connection with said structure by which it can float in said structure and bow freely in the middle when heated, means for heating said element so that it can bow, and means controlled by the bowing of said element.

17. A thermal relay comprising a bimetal strip, a supporting structure therefor having means which supports both ends of the strip loosely against lateral displacement but permits longitudinal movement, so that the strip can bow freely in the middle when heated, means for heating the strip, and means controlled by the bowing of the strip.

18. A thermal relay comprising a straight bimetal strip that is free from intentional initial stress, a supporting structure therefor having end members that engage the ends of the strip loosely so that the strip can move lengthwise therein and bow therebetween when heated while restraining the ends of the strip against undue sidewise movement, means for heating the strip, and means controlled by the bowing of the strip.

19. A thermal relay comprising a straight bimetal strip that is free from intentional initial stress, a supporting structure therefor having end members that engage the ends of the strip to hold it located but without subjecting the strip to longitudinal pressure, means for heating the strip so that it can bow between its ends, and means controlled by the bowing of the strip.

20. A thermal relay comprising a flat straight bimetal strip that is free from intentional initial stress and is adapted to bow when heated, a supporting structure therefor having end-supports which loosely engage opposite flat faces of the strip at the ends thereof to restrain the strip against lateral displacement while permitting it to bow freely in the middle when heated without exerting longitudinal thrust on the strip, and means controlled by the bowing of the strip.

21. A thermal relay comprising a flat straight bimetal strip that is free from intentional initial stress and is adapted to bow when heated, a supporting structure therefor

having end-supports which loosely engage opposite flat faces of the strip at the ends thereof to restrain the strip against lateral displacement while permitting it to bow freely in the middle when heated without exerting longitudinal thrust on the strip, a pivoted arm having an extension which engages an edge of the cool strip at the middle thereof, the strip moving away from engagement with said extension when bowed, and spring means urging said arm for movement when said extension is released.

22. A thermal relay comprising a flat straight bimetal strip, a supporting structure therefor having slotted end supports in the slots of which the ends of said strip are loosely received, means which restrains said strip against longitudinal displacement from said end supports, and a pivotally-supported, spring-urged tripping arm disposed alongside said strip having an extension which underlies and engages a side edge of said cool strip and is released from such engagement by the bowing of the heated strip.

In testimony whereof, I have signed my name to this specification.

GEORGE W. O'KEEFFE.