Nov. 1, 1949 H. E. SCHLEICHER 2,486,888

CURRENT RESPONSIVE RELAY WITH SHOCK AND AMBIENT TEMPERATURE COMPENSATING MEANS

Filed Feb. 5, 1945 2 Sheets-Sheet 1

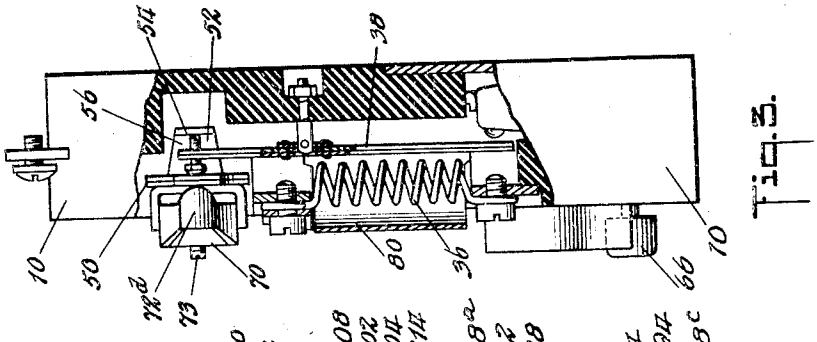


Fig. 5.

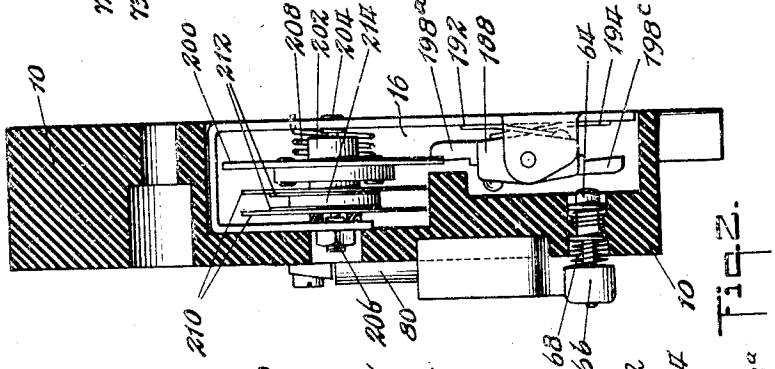


Fig. 2.

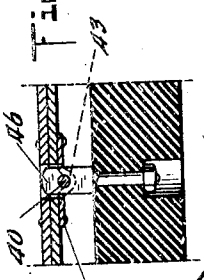


Fig. 4.

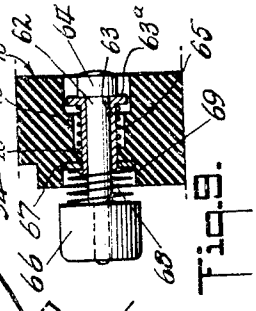


Fig. 9.

Fig. 1.

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CURRENT RESPONSIVE RELAY WITH SHOCK AND AMBIENT TEMPERATURE COMPENSATING MEANS

Filed Feb. 5, 1945 2 Sheets-Sheet 2

Fig. 2.

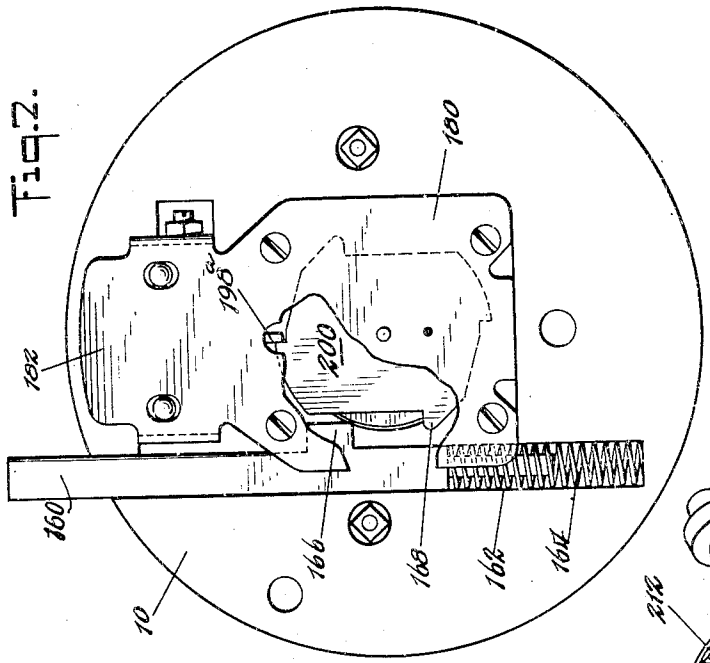


Fig. 4.

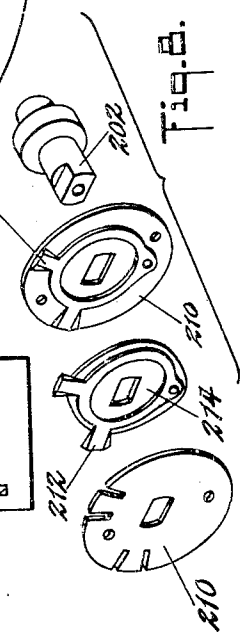


Fig. 6.

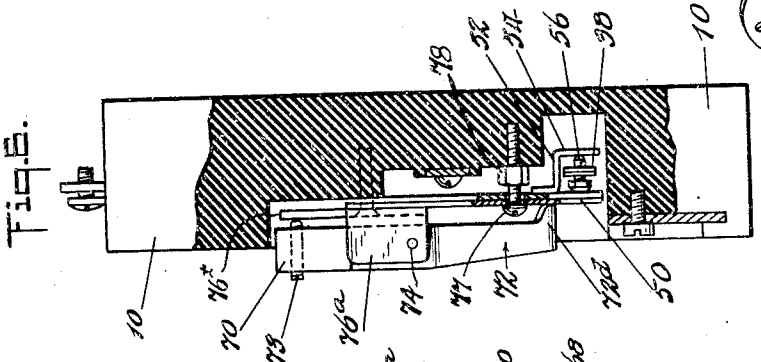
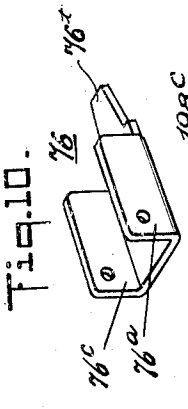


Fig. 10.



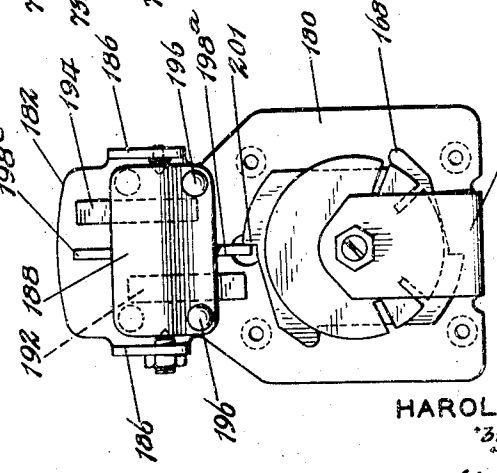


Fig. 5.

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UNITED STATES PATENT OFFICE

2,486,888

CURRENT RESPONSIVE RELAY WITH SHOCK AND AMBIENT TEMPERATURE COMPENSATING MEANS

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Application February 5, 1945, Serial No. 576,228

26 Claims. (Cl. 200—122)

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This invention relates to electric relay switches responsive to current variations. More particularly it relates to a current responsive relay of the bi-metallic type which is provided with means to automatically compensate for variations in ambient temperature and with means to neutralize or compensate for sudden and severe shocks, or vibrations of any sort, to which the relay may be subjected.

It is an object of the invention to provide an improved structure for a sensitive relay of the foregoing type which will be practically unaffected by sudden shocks or vibrations. Another object of the invention is to provide a relay of the foregoing type with automatic ambient temperature compensation. Another object is to provide a relay of the foregoing type with automatic ambient temperature compensation and at the same time to provide means to compensate for or neutralize sudden shocks and vibration so that insofar as concerns operation, the relay will be practically unaffected by such shocks or vibrations. Another object of the invention is to provide a relay of the foregoing type which will be more accurate, sensitive and reliable in operation at all settings or adjustments and under conditions of rough and varied usage, such as are encountered in military and naval installations. Other objects include provision of a balanced mounting for the current responsive bi-metal permitting greater deflection than heretofore; provision for confining and directing the heat generated in the bi-metal heater coils to insure maximum bi-metal deflection per watt of heat generated; and provision for adjustment of the novel structure features to enable maximum utility and best operating conditions.

Further objects and advantages of the invention will become apparent as it is described in connection with the accompanying drawings.

In the drawings—

Fig. 1 is a plan view of the relay embodying the principles of the invention. Fig. 2 is a transverse section view taken along line 2—2 of Fig. 1. Fig. 3 is a section view taken along line 3—3 of Fig. 1. Fig. 4 is a fragmentary sectional detail view of the pivotal mounting for the current responsive bi-metal. Fig. 5 is a detailed view of the switch mechanism used in the structure of Figs. 1–3. Fig. 6 is a section view taken along line 6—6 of Fig. 1. Fig. 7 is a plan view partly broken away of the opposite side of the structure illustrated in Fig. 1. Fig. 8 is an exploded view of the movable contact unit. Fig. 9 is a fragmentary detail view in section of the inertia plunger and its mounting; while Fig. 10 is a perspective view of the mounting bracket for the compensating bi-metal.

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Referring to the drawings, the parts of the invention are mounted upon a circular or disc-shaped molded insulation base 10, in order that the invention may be conveniently incorporated as a unit in and used with rotary electromagnetic switches, particularly those of the type disclosed in my prior co-pending application entitled "Rotary magnetic switch," filed November 26, 1943, S. N. 511,855. The base 10 is recessed and apertured at various points and places to receive the operating parts of the invention as will be hereinafter more fully explained.

The contact making and breaking mechanism comprises a pair of fixed contacts 12 and 14 stamped from sheet metal in strip form and located in radial recesses formed in the base 10 with the inner ends forming contacting portions and extending into a circular central recess 16 of the base 10. The outer ends of the members 12 and 14 may extend beyond the periphery of the base and conventionally may be provided with terminal screws for wire connections. For bridging the inner ends of the members 12 and 14 a rotary movable contact assembly is provided comprising a pair of insulating discs 210 against the inner faces of which lie a pair of identical thin resilient stamped sheet metal contact blades 212 which are separated by an insulating washer 214. All of said parts are secured together by rivets in permanent fixed relation. The central aperture through the discs 210 and spacing washer 214 is preferably non-circular and fits over a similarly shaped end of a molded insulation shaft 202 so as to turn therewith. Also mounted on, and turning with the shaft 202 is a latch plate 200 stamped from sheet metal and provided with a shoulder 201 on its periphery to be engaged by a latch finger 180a in a manner and for the purpose to be hereinafter more fully described. To urge the shaft and parts carried thereon constantly in one direction, a spring 208 is coiled about the end of the shaft 202 beneath the latch plate 200 and with one end of the spring engaged with said latch plate, and the other end anchored to a frame 180.

The mounting for the shaft 202 and parts carried thereon is the frame 180 which is stamped from sheet metal into the shape illustrated in Fig. 5. From opposite sides of the central portions of frame 180 are extensions 182 and 184.

To afford support for the bearings of the shaft 202, the frame 180 has its extension 184 reversely bent so that its end portion lies parallel to the body of the frame. Conical bearings holes are

formed in the end of the stud shaft 202 to receive the conical bearing member 204 located in the central portion of the frame 180 and to receive the conical end of a journal pin 206 which is screw threaded into an aperture in the end of extension 184 co-axial with the conical bearing member 204. The journal pin 206 may be adjusted to remove all excess play and to prevent movement under impact.

The extension 182 has lateral arms or lugs 186 bent up at right angles thereto. Between it is located a diametrically and statically balanced pivoted trigger member 188 which is preferably formed from molded insulating material into hexagonal prismatic form. In order to resiliently maintain the trigger in a neutral position, obliquely angled leaf spring members 192 and 194 each have one arm lying upon and secured to the face of the frame 180 while the other arm extends obliquely upward to engage converging adjacent faces of the trigger member 188. At the opposite side of the trigger member from said converging faces, semi-spherical buttons or nubs 196 are located near the ends of the trigger in position to be engaged by the ends of one or the other of two bi-metallic members, hereinafter to be described, which are responsive to current conditions in the circuit to be controlled.

In the central portion of the trigger member 188 is molded a balanced tripping member which is balanced by having similar fingers such as 198a, 198c extend in opposite directions. The finger 198a extends radially of the pivot axis beyond the surface of the tripping member in position to be engaged by the radial shoulder 201 on the balanced rotary latch disc 200. Thus when the trigger member 188 is caused to pivot by the action of the bi-metallic members pressing against either of the nubs or heads 196, the finger 198a of the latch member 188 releases or disengages the latch disc 200 permitting the shaft and contacts carried thereby to pivot under the action of spring 208 causing breaking of the circuit between fixed contacts 12 and 14.

For resetting the bridging contacts 212, a depressible insulating bar 160 slides in a rectilinear tangential passage 162 in the base 10. A coil compression spring 164 in the bottom of the passage 162 urges the bar outwardly of the passage; and a laterally extending lug 166 near the inner end of the bar is positioned to be engaged by an extension 168 from the periphery of the latch disc 200 when the latch disc has been released by disengagement of the trigger finger 198 from the shoulder 201 of the disc. This limits the rotary motion of the latch disc also, and thereby limits the rotary motion of the bridging contacts 212 in the circuit opening direction.

When the resetting bar is depressed, the engagement of its lug 166 with the extension 168 causes rotation of the latch disc 200 against the urge of the spring 208 until the latch finger 198 falls back of the shoulder 201 of the latch disc to hold said disc latched with the bridging contacts 212 engaged with the fixed contacts 12 and 14.

In order that the relay switch mechanism may be used on a three wire line, and may be tripped in response to an overload current in either of the outside lines, current responsive tripping means is made in duplicate and arranged symmetrically in the base 10 on each side of the vertical axis (line 2—2), as the device is viewed in Fig. 1. Since the two-current responsive tripping mechanisms and all compensating means used in connection with each mechanism are identical, only one end need be described.

Referring to Figs. 1 and 3 particularly, wire terminals 30 and 34 stamped from sheet metal are located in spaced recesses in the base 10 to overlie at spaced points a deeper recess 35 extending tangentially of the base. Between the two terminals 30, 34, a coiled resistance element or heater 36 extends, being secured by screws at either end to said terminals.

Beneath said heater coil 36 and lying in the deep tangential recess 35 is a strip of bi-metal 38 which responds to the heat generated in said heater. To dynamically and statically balance bi-metal 38, it is pivotally mounted at its mid portion about a pivot pin 40 which is held between the lower surface of the bi-metal 38 and a bearing plate 42, secured against said bottom surface and having a semi-spherical indentation or rib 43 for the reception of said pin 40. The ends of said pin 40 extend beyond the sides of the bi-metal and are seated within the co-axial bearing recesses 44 molded into the side walls of the deep tangential recess. To hold the pin and bi-metal from movement outwardly of the bearing recesses 44, a bearing pin post 46 is bolted to the floor of said tangential recess and projects upwardly through an aperture in the center of said bearing plate 42 and a registering aperture in the bi-metallic strip 38. The top end of post 46 is flattened and apertured to receive the bearing pin 40 which is thus held at its center by post 46 with its ends in the bearing recesses 44.

One end of said bi-metal 38 extends over the tripping member 188 in position to cause tilting thereof as said bi-metal flexes when heated by coil 36. The opposite end of the bi-metal is connected with an ambient temperature compensating bi-metal strip 50 in order that the device shall always operate at the same overload setting regardless of variations in ambient temperature conditions. The compensating bi-metal 50 is located tangentially in a recess in the base 10 at substantially right angles to the current responsive bi-metal 38 with the end of the compensating bi-metal 50 overlying the end of the current responsive bi-metal 38. A permanent, but adjustable connection between the compensating bi-metal and the current responsive bi-metal is formed by a Z angle bracket 52 affixed to the compensating bi-metal adjacent its flexing end with a portion 54 of said bracket underlying the current responsive bi-metal in parallel relation thereto and to the tip of the compensating bi-metal. A bolt 56 is screw threaded into a threaded aperture in the end of the current responsive bi-metal and the head as well as the opposite end of the bolt are preferably made spherically curvilinear about the mid point of the bolt so as to permit flexing of the current responsive bi-metal with a minimum frictional retardation. The compensating bi-metal is anchored at its opposite end to the base 10 by means of screw bolts or in any suitable fashion.

The mass of the current responsive bi-metal and of the adjustment bolt carried thereby determine the point of balance at which the pivot pin 40 should be located in order to achieve the desired dynamic and static balance. This mounting, while achieving balance, also gives greater deflection of the bi-metal from the fulcrum point than in prior structures wherein the fulcrum and fixed end or hinge were usually coincident. The reason for this is that, in the present structure, bending of the bi-metal can take place on both sides of the fulcrum, the bending between

the pivot pin 40 and bolt 56 causing a deflection of the free end of the bi-metal 38 which is augmented by the additional curvature of the bi-metal between its free end and the pivot pin. Thus the bi-metal is not only balanced but a multiplied deflection resulting from its curvature is utilized.

When the invention is used in connection with military or naval installations, the device is likely often to be subjected to sudden and extremely severe shocks or vibration. Under such circumstances the current responsive bi-metal is likely to flex or vibrate and cause movement of trigger member 188. Various conditions may be the cause of the movement of the bi-metal, such as shocks and vibrations of various amplitudes and frequencies, which may set up peculiar transient oscillations in the bi-metal.

In order to compensate for these unusual conditions, an inertia plunger acting on the finger 198c of the tripping member 188 is provided, with a compound sleeve mounting. The plunger has a cylindrical shank or mid-portion 62 sliding within a flanged sleeve 63 which itself slides within a circular aperture 10a through the casing 10. The sleeve is resiliently mounted in said aperture by a coiled spring 65 around one end of the shank pressing upon the sleeve flange 63a at one end and at its other end pressing against the bottom of a counter-sink 10c around said aperture 10a. A washer 67 secured to the opposite end of the sleeve stops the motion of the sleeve outwardly of the aperture and is the seat for one end of the spring 68.

A small head 64 at one end of the plunger is adapted to engage the trigger 198c. On the opposite end of the plunger is screw-threaded a metallic larger head 66, beneath which is the coiled compression spring 68 which seats on the bottom of a well or counterbore 69 coaxial with the aperture 10a. The spring 65 is somewhat stronger than spring 68. The plunger is adjusted as closely as possible, at maximum throw, to the latch finger 198c when the latter is in latching position. Impacts in a direction that will cause the bi-metal to move in the direction of trip, will also cause the plunger to move in the same direction but at the opposite side of the trip member 188. The operation of the plunger in cooperation with its sleeve mounting is such as to give a rapid series of impulses to damp out oscillations of the bi-metal, preventing the occurrence of a condition of resonance, so that the damping or compensating means is effective under all conditions of shocks and vibrations to which the device is subjected. Understanding of the foregoing may perhaps be enhanced by comparison with a simple form of inertia plunger (i. e., omitting sleeve 63 and spring 65 and their functions) which would be most effective when giving singular impulses in sequence with but opposite to the device and would become less effective as a condition of possible resonance occurred. But for conditions where simple shock of considerable magnitude is all that need be guarded against, and in certain other conditions, such simplified form might be sufficient for the needs.

When the shock is in the opposite direction to the action of the plunger, there is a tendency of the compensating bi-metal to move the current responsive bi-metal counterclockwise about its pivotal mounting and, thereby, to cause operation of the trigger member 188 and tripping of the mechanism. To avoid this action and counteract this tendency, secondary compensating means

in the form of an inertia hammer are provided acting on the compensating bi-metal. The inertia hammer comprises a rectangular block of metal 70 partly inserted between the end of the arms 72a, 72c of a U-bent strip of metal.

For pivotally mounting the block 70 and the U-shaped member 72, a pin 74 passes through said members and has its ends supported within the parallel side arms or plates 76a, 76c of a stamped sheet metal U-shaped bracket 76 whose transverse portion is seated upon and secured over the upper surface of the compensating bi-metal adjacent its end. To adjust the amount of pivotal movement which the compensating member may have, a screw 73 is threaded through the metal block 70 adjacent its end and is engageable with a tapering tail portion or extension 76t of the supporting bracket 72. Ordinarily this screw will be adjusted to a point where a rounded lateral extension 72d at the juncture of the arms 72a, 72c will just touch the compensating bi-metal. Thus when a sudden shock or vibration causes a severe motion of the device to the right, as viewed in Fig. 3, and the compensating bi-metal tends to move oppositely relative to the base 10, a compensatory movement of the inertia hammer will simultaneously occur due to the tendency of the metallic block 70 to move about its pivot in a direction away from the base 10 as viewed in Fig. 5, with the result that the opposite end or hammer head 72d will strike against the free end of the compensating bi-metal to counteract the tendency of that end to move oppositely. Although the tail 76t is relatively stiff it possesses some resilience so that slight deflection (perhaps only some thousandths of an inch) is permitted. As a result, the striking of the inertia hammer against it causes high frequency impulses of the hammer to damp and smooth out tendencies toward resonance between the co-acting members.

The compensating bi-metal 50 is backed up by a screw 77 near its free end, threaded into base 10 and held by a check nut 78, to prevent reverse movement under shock that might move the bi-metal to trip. The screw is adjusted for the lowest desired ambient temperature correction of the compensating bi-metal.

It may thus be observed that the inertia hammer compensates for, neutralizes and overcomes the effort of the compensating bi-metal to move under sudden shock when the device is suddenly moved to the right, as viewed in Fig. 5. A sudden shock in the opposite direction and a concomitant tendency or movement of the current responsive bi-metal to trip the device will be compensated for to overcome and neutralize by movement of the dome-shaped compensating device 66. The utilization of more than one damping means plus the differential elasticities and inertia moments throughout the system tend to effect static equilibrium under all possible combinations of vibrations and shocks, and, particularly, to prevent amplitudes of motion occurring in the tripping bi-metal of sufficient magnitude to cause tripping.

In order that the heat generated in the heater coil elements shall be directed against the current responsive bi-metallic member and shall be sensibly constant in amount regardless of external temperature conditions, there is provided a bright metallic plate reflector 80 preferably stamped from sheet metal into a substantially parabolic form as viewed in cross section. This reflector is located and maintained over the heater element, by frictional engagement be-

tween its side edges and the side walls of the recess in which the heater is located.

From the foregoing it may be observed that I have provided a current responsive sensitive relay which may be calibrated and adjusted at any temperature so as to trip at any desired current value; and the structure embodies ambient temperature compensation to compensate for all normally encountered variations in ambient or atmospheric temperatures. At the same time the device embodies devices to compensate for normally expected movement of the parts when the device is subjected to sudden severe shocks and vibrations.

Many modifications and variations within the scope of the invention will occur to those skilled in the art. Thus the invention is not limited to the specific embodiments illustrated.

What I claim is:

1. In an electric switch, relatively movable contact means, a thermally responsive bi-metallic element for causing movement of said contact means, a fulcrum support for said bi-metallic element between its ends, means at one end of said element having arcuate surfaces and acting as a ball joint to position said end of said element fixedly, the other end being free to deflect, and means activated by deflection of said bi-metallic element causing movement of said contact means.

2. In an electric switch, relatively movable contact means, a thermally responsive bi-metallic element for causing movement of said contact means, a fulcrum support for said bi-metallic element between its ends, means at one end of said element to hold said end fixedly adjustable means to position said end of said element with relation to said holding means, said adjustment means having arcuate surfaces acting as a ball joint connection between it and said holding means, the other end of said element being free to deflect, and means activated by deflection of said bi-metallic element causing movement of said contact means.

3. In an electric switch, relatively movable contact means, a thermally responsive bi-metallic element for causing movement of said contact means, a fulcrum support for said bi-metallic element between its ends, means holding one end of said element fixedly, the other end being free to deflect, and means activated by deflection of said bi-metallic element causing movement of said contact means, said holding means including a bi-metallic means compensating for the effect of ambient temperature variations of said thermally responsive bi-metallic element, and means forming a ball joint between said compensating means and said thermally responsive element, the points of engagement of said ball joint means with said compensating means being in a line perpendicular to the plane of said thermally responsive bimetal element.

4. In an electric switch, relatively movable contact means, a thermally responsive bi-metallic element for causing movement of said contact means, a fulcrum support for said bi-metallic element between its ends, means holding one end of said element fixedly, the other end being free to deflect, and means activated by deflection of said bi-metallic element causing movement of said contact means, said holding means including a bi-metallic means compensating for the effect of ambient temperature variations of said thermally responsive bi-metallic element, and an adjustable member movable to vary the position of said thermally responsive bimetal element relative to said compensating means having arcuate surfaces acting as a ball joint between said compensating means and said thermally responsive element.

5. In an electric switch, relatively movable contact means, a thermally responsive bi-metallic element for causing movement of said contact means, a fulcrum support for said bi-metallic element between its ends, means holding one end of said element fixedly, the other end being free to deflect, and means activated by deflection of said bi-metallic element causing movement of said contact means, said holding means including a bi-metallic means compensating for the effect of ambient temperature variations of said thermally responsive bi-metallic element, and an adjustable bolt for varying the setting of said thermally responsive element relative to said compensating means, said bolt having arcuate surfaces forming a ball joint between said compensating means and said thermally responsive element.

6. A thermally responsive bi-metallic member, an electric current carrying helically spiralled heater element located adjacent thereto, and a parabolic metallic reflector plate extending in an axial direction over said element reflecting and directing the heat generated by said element onto said bi-metallic member, an insulating base having a channel receiving said bi-metallic member, said reflector plate being resilient and compressible for insertion into said channel with its sides expanding into frictional holding engagement with the walls of said channel.

7. In an electric switch, relatively movable contact means, an electro thermally responsive bi-metallic member pivoltally supported between its ends for operating said contact means, an ambient temperature responsive bi-metallic member supporting one end of said electro responsive member compensating for ambient temperature variations, an inertia hammer means acting on said compensating bi-metallic member to move the latter in a non-contact operating direction.

8. In an electric switch, relatively movable contact means, an electro thermally responsive bi-metallic member pivotally supported between its ends for operating said contact means, an ambient temperature responsive bi-metallic member supporting one end of said electro-responsive member compensating for ambient temperature variations, inertia responsive means comprising a weight and striking member moving with said weight pivotally mounted adjacent said compensating member to act thereon in non-contact operating direction,

9. In an electric switch, relatively movable contact means, pivoted tripping means for releasing said contact means, electro-responsive bi-metallic means acting on said tripping means, and inertia plunger means acting on said tripping means in a direction to counteract movement in tripping direction when said bi-metallic means is subjected to shocks.

10. In an electric switch, relatively movable contact means, pivoted tripping means for releasing said contact means, electro-responsive bi-metallic means and inertia plunger means acting on said tripping means in a direction to counteract movement in tripping direction when said bi-metallic means is subjected to shocks, the mass of the inertia plunger means being such as to equal shock force of said bi-metallic means.

11. In an electric switch, relatively movable contact means, balanced pivotally mounted trip-

ping means for releasing said contact means, electro-responsive bi-metallic means acting on said tripping means, inertia plunger means acting on said tripping means in the same direction as said bi-metallic means but on the opposite side of its pivot to counteract movement of said bi-metallic means in a tripping direction when subjected to shock.

12. In an electric switch, relatively movable contact means, balanced pivotally mounted tripping means for releasing said contact means, electro-responsive bi-metallic means acting on said tripping means, inertia plunger means acting on said tripping means in the same direction as said bi-metallic means but on the opposite side of its pivot to counteract movement of said bi-metallic means in a tripping direction when subjected to shock, the mass of said inertia means being such as to equal the shock force of said bi-metallic means to prevent excess motion to release said tripping means.

13. In an electric switch, relatively movable contact means, pivoted tripping means for releasing said contact means, electro-responsive bi-metallic means acting on said tripping means, and inertia plunger means acting on said tripping means in a direction to counteract movement in tripping direction when said bi-metallic means is subjected to shocks, in combination with ambient temperature compensating means including a bi-metallic member acting on said electro-responsive bi-metallic member, and inertia hammer means acting on said compensating bi-metallic member to prevent trip when the direction of a shock is opposite to the action of said plunger means.

14. In an electric switch, relatively movable contact means, pivoted tripping means for releasing said contact means, electro-responsive bi-metallic means acting on said tripping means, and inertia plunger means acting on said tripping means in a direction to counteract movement in tripping direction when said bi-metallic means is subjected to shocks, in combination with ambient temperature compensating means including a bi-metallic member acting on said electro-responsive bi-metallic member, and inertia hammer means acting on said compensating bi-metallic member to prevent trip when the direction of a shock is opposite to the action of said plunger means, said hammer means being fulcrummed and balanced to move said compensating bi-metallic member away from trip direction when a shock occurs in direction opposite to the action of said plunger means.

15. In an electric switch, relatively movable contact means, pivoted tripping means for releasing said contact means, electro-responsive bi-metallic means acting on said tripping means, and inertia plunger means acting on said tripping means in a direction to counteract movement in tripping direction when said bi-metallic means is subjected to shocks, and means returning the plunger to inactive position and acting with dampening effect during shocks and disturbances.

16. In an electric switch, relatively movable contact means, pivoted tripping means for releasing said contact means, electro-responsive bi-metallic means acting on said tripping means, and inertia plunger means acting on said tripping means in a direction to counteract movement in tripping direction when said bi-metallic means is subjected to shocks, in combination with ambient temperature compensating means including a bi-metallic member acting on said electro-responsive bi-metallic member, and inertia hammer means acting on said compensating bi-metallic member to prevent trip when the direction of a shock is opposite to the action of said plunger means, said hammer means having a different vibrating frequency than said plunger means to give a split phase dampening effect tending to statistically balance said electro-responsive bi-metallic means during shock impacts.

17. In an electric switch, relatively movable contacts, electro-responsive bi-metallic means having a cantilever mounting, ambient temperature compensating means including a bi-metallic member, a spherical adjustable coupling between said electro-responsive bi-metallic means and said compensating means enabling calibration adjustments without impairing the spherical nature and action of said coupling.

18. In an electric switch, relatively movable contact means, tripping means for releasing said contact means, electro-responsive bi-metallic means acting on said tripping means, and inertia plunger means acting to counteract and damp out vibratory and other movement of said electro-responsive means resulting from shock and vibratory conditions to which the switch may be subjected.

19. In an electric switch, relatively movable contact means, tripping means for releasing said contact means, electro-responsive bi-metallic means acting on said tripping means, inertia plunger means, a resilient sleeve mounting for said plunger means to create a rapid vibratory action of said plunger acting to counteract and damp out vibratory and other movement of said electro-responsive means resulting from shock and vibratory conditions to which the switch may be subjected.

20. In an electric switch, relatively movable contact means, tripping means for releasing said contact means, electro-responsive bi-metallic means acting on said tripping means, inertia plunger means, resilient means acting in opposite directions on said plunger means and acting to counteract and damp out vibratory and other movement of said electro-responsive means resulting from shock and vibratory conditions to which the switch may be subjected.

21. In an electric switch, relatively movable contact means, tripping means for releasing said contact means, electro-responsive bi-metallic means acting on said tripping means, an inertia plunger, spring means urging said plunger into retracted position, other spring means urging said plunger in a direction to actuate said tripping means, both said spring means cooperating with said plunger to counteract and damp out vibratory and other movement of said electro-responsive means resulting from shock and vibratory conditions to which the switch may be subjected.

22. In an electric switch, relatively movable contact means, tripping means for releasing said contact means, electro-responsive bi-metallic means acting on said tripping means, an inertia plunger, spring means urging said plunger into retracted position, other spring means exerting an urge on said plunger in a direction to actuate said tripping means, and a sleeve cooperating with said plunger and both spring means to counteract and damp out vibratory and other movement of said electro-responsive means resulting from shock and vibratory conditions to which the switch may be subjected.

23. In an electric switch, relatively movable

contact means, electro-responsive means for causing actuation of said contact means, ambient temperature compensating means cooperating with said electro-responsive means, inertia hammer means acting on said compensating means to move it in non-contact-operating direction and a mounting bracket having an extension engaged by said inertia hammer means and imparting dampening impulses to overcome vibratory and shock-induced motion of said compensating means and to overcome tendencies toward resonance in the aforesaid co-acting parts.

24. In an electric switch, relatively movable contact means, electro-responsive means for causing actuation of said contact means, ambient temperature compensating means cooperating with said electro-responsive means, inertia hammer means acting on said compensating means to move it in non-contact-operating direction and semi-rigid means possessing limited resilience engageable by said inertia hammer means to impart dampening impulses to overcome vibratory and shock-induced motion of said compensating means and to overcome tendencies toward resonance in the aforesaid co-acting parts.

25. In an electric switch, relatively movable contact means, tripping means for releasing said contact means, electro-responsive bi-metallic means acting on said tripping means, inertia plunger means, resilient means acting in opposite directions on said plunger means and acting to counteract and damp out vibratory and other movement of said electro-responsive means resulting from shock and vibratory conditions to which the switch may be subjected, ambient temperature compensating means cooperating with said electro-responsive means, inertia hammer

means acting on said compensating means to move it in non-contact-operating direction.

26. In an electric switch, relatively movable contact means, a thermally responsive bimetallic element for causing movement of said contact means, a fulcrum support for said bimetallic element between its ends, means holding one end of said element fixedly, the other end being free to deflect, said holding means including a bimetallic means compensating for the effect of ambient temperature variations of said thermally responsive bimetallic element, and an adjustable member movable to vary the position of said thermally responsive bimetal element relative to said compensating means.

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