Feb. 9, 1943. C. W. KUHN ET AL 2,310,531

PROTECTIVE DEVICE

Filed June 7, 1941 2 Sheets-Sheet 1

Fig. 1

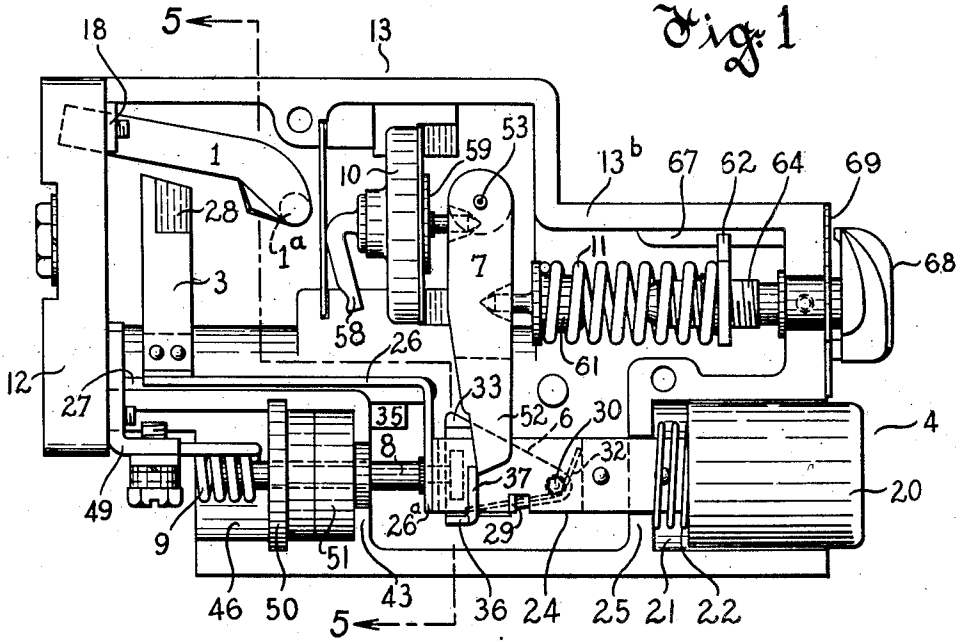

Fig. 2

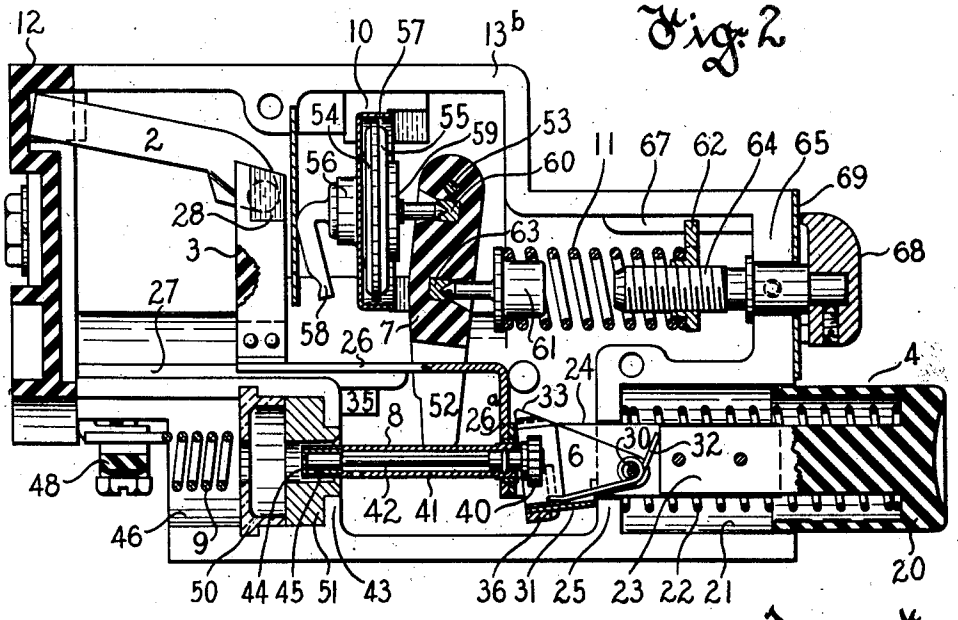

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Fig. 3

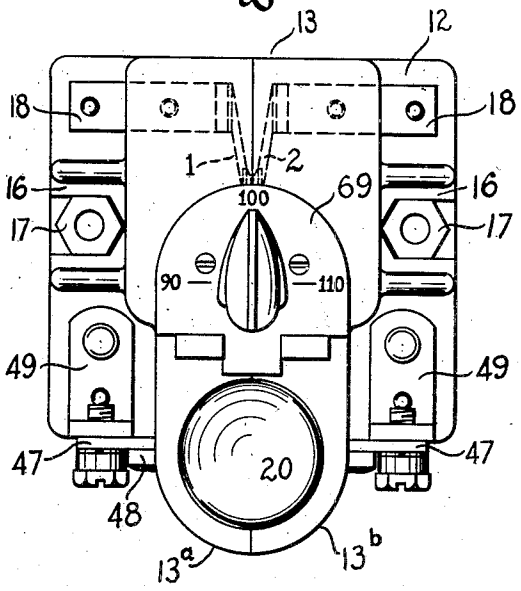


Fig. 4

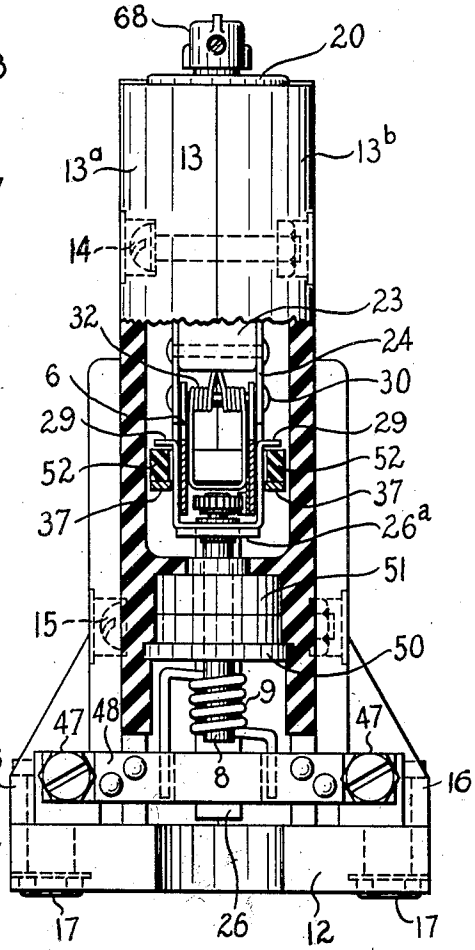
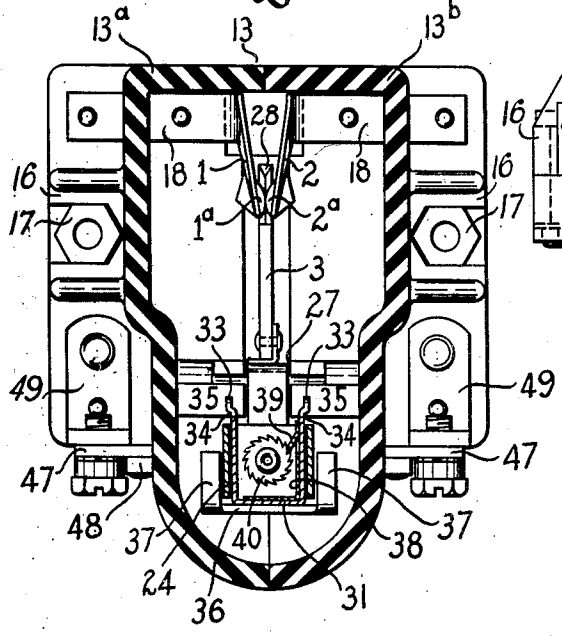


Fig. 5



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Patented Feb. 9, 1943

2,310,531

UNITED STATES PATENT OFFICE

2,310,531

PROTECTIVE DEVICE

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Application June 7, 1941, Serial No. 396,999

13 Claims. (Cl. 200—124)

This invention relates to protective devices for electric circuits, and is particularly applicable to electro-thermal overload relays of the fusible alloy type.

Overload relays of the aforesaid type usually include a switch biased toward open position and adapted to be held in closed position by a trip mechanism including parts which are normally held against relative movement by a fusible alloy connection. An electric heater associated with said parts and connected in the circuit to be protected acts upon given overload conditions in such circuit to effect fusion of the alloy connection for opening of the switch. Upon opening of the switch the protected circuit is interrupted and the alloy connection then cools and becomes solid to render the trip mechanism effective to hold the switch in closed position upon manual resetting thereof.

Overload relays of the aforesaid type, as heretofore constructed did not compensate for ambient temperature changes and as a result the sensitivity of such relays to overload current conditions in the heater was increased upon a rise in ambient temperature and decreased upon a drop in ambient temperature.

The present invention has among its objects to provide an improved overload responsive relay of the aforesaid type having automatic compensating means associated therewith for insuring response of the relay upon a predetermined overload current value in the heater regardless of variations in ambient temperature.

Another object is to provide an overload relay of the aforesaid type including means for effecting rapid cooling of the solder connection upon response of the relay to thereby enable resetting of the relay after a relatively short interval following response thereof.

Another object is to provide an overload relay of the aforesaid character including a user's adjustment which is operable to vary the overload current value at which the relay responds.

Another object is to provide an ambient temperature compensated overload relay of the aforesaid character which is exceedingly simple in construction and positive and reliable in operation.

Various other objects and advantages of the invention will hereinafter appear.

The accompanying drawings illustrate an embodiment of the invention which will now be described, it being understood that various modifications may be made in the embodiment illustrated without departing from the spirit and scope of the appended claims.

In the drawings,

Figure 1 is a side elevational view of a relay embodying the invention, the relay being shown in normal position and half of the enclosing casing therefor being removed;

Fig. 2 is a view similar to that shown in Fig. 1 illustrating the relay in tripped position and also illustrating certain of the parts thereof in section;

Fig. 3 is a front elevational view of the relay shown in Fig. 1;

Fig. 4 is a bottom view of said relay, with portions thereof broken away and shown in section, and

Fig. 5 is a sectional view on line 5—5 of Fig. 1.

Referring to the accompanying drawings, the same illustrate an overload responsive relay including a pair of resilient contact fingers 1 and 2 which normally engage to establish a control circuit and are separable by an insulating finger 3 associated with a reciprocable push button element 4. Push button element 4 is biased to move insulating finger 3 into engagement with contact fingers 1 and 2, and said element has a latching mechanism associated therewith for normally maintaining the same in a position to hold said insulating finger 3 out of engagement with said contact fingers.

The latching mechanism associated with element 4 includes a pivoted latch 6 carried by said element and a pivoted lever 7 to be engaged by said latch. Latch 6 is normally held in engagement with lever 7 by a thermal responsive element 8 to maintain insulating finger 3 out of engagement with contact fingers 1 and 2. As hereinafter set forth thermal element 8 is responsive under the action of an electric heater coil 9 to release latch 6 from lever 7 for separation of contact fingers 1 and 2 by insulating finger 3 upon a predetermined overload current condition in said coil. Also as hereinafter set forth lever 7 is operable by a temperature responsive diaphragm device 10 against the action of a loading spring 11 to automatically adjust thermal element 8 with respect to its associated heater coil 9 so that overload operation of the relay is substantially uninfluenced by ambient temperature changes.

The relay is provided with a vertically disposed molded insulating base 12 of rectangular form which carries a vertically divided insulating casing 13 comprising two similarly shaped complementary half sections 13a and 13b formed to pro-

vide an enclosure for the above described mechanism. Sections 13a and 13b are secured together by bolts 14 and 15 shown in dotted lines in Fig. 4. and the side faces of said sections are provided with projections 16 which are secured to the front face of base 12 by bolts 17 shown in Figs 3 and 4.

More specifically the contact fingers 1 and 2 are secured to horizontally spaced terminal plates 18—18 mounted upon the front face of insulating base 12. As shown in Fig. 5 terminal plates 18 are located adjacent the upper edge of insulating base 12 and project outwardly beyond opposite sides of casing 13. Also as shown in Fig. 5, fingers 1 and 2 project forwardly and downwardly in converging relation from their associated terminal plates 18 into casing 13 and the front ends of said fingers are provided with silver contact tips 1a and 2a which are normally held in engagement to establish circuit between said terminal plates.

Element 4 is provided with a cylindrical push button 20 which is slidably supported within a recess 21 formed in the front end of casing sections 13a and 13b. Push button 20 is biased to move forwardly under the action of a coil spring 22 located within recess 21 and said push button is provided with a rearwardly extending projection 23 which carries a horizontally disposed U-shaped bracket 24. The casing sections 13a and 13b are formed to provide a wall 25 having an opening for receiving bracket 24, and as shown in Fig. 4 the yoke portion of said bracket is spaced rearwardly with respect to the inner end of projection 23 and has a horizontally disposed elongated bar 26 fixed thereto. Bar 26 is guided within a slot 27 formed on the interior of casing sections 13a and 13b, and the front end of said bar is provided with a downwardly extending portion 26a which is secured by welding to the yoke portion of bracket 24. Insulating finger 3 is secured to the rear end of bar 26 and the same extends upwardly from said bar and has a knife edge portion 28 formed on the upper end thereof for engagement with contact tips 1a and 2a of contact fingers 1 and 2. Inward movement of element 4 is limited by engagement of the inner end of push button 20 with wall 25 and outward movement thereof is limited by engagement of stop projections 29 formed on bracket 24 with the inner face of said wall.

The latch 6 associated with push button element 4 is pivotally mounted between the side arms of bracket 24 upon a pin 30, and said latch is provided with spaced side walls which extend rearwardly from said pin and are connected on their under side as shown in Fig. 5 by a yoke portion 31. The free end of latch 6 is biased to move downwardly under the action of a spring 32 carried by pivot pin 30 and the side walls of said latch are provided with upwardly extending toe projections 33—33. As shown in Fig. 5 toe projections 33 are bent outwardly to provide stop surfaces 34 for engaging the upper side of bracket 24 to limit downward movement of latch 6 under the action of spring 32. Also upon movement of push button element 4 into its inner extreme position the toe projections 33 on latch 6 engage stop projections 35—35 formed on the interior of casing sections 13a and 13b to move said latch upwardly into the position shown in Fig. 1 against the action of spring 32. As shown in Fig. 5, a member 36 fixed to the yoke portion 31 of latch 6 is provided with upwardly extending latch projections 37, 37 which are located on opposite sides of bracket 24 for engagement with lever 7. Also as shown in Fig. 5, latch 6 has a spring member 38 fixed thereto which is provided with a pawl 39 for engaging a ratchet wheel 40 associated with thermal element 8.

Thermal element 8 is provided with an elongated sleeve 41 which contains a pin 42. Sleeve 41 has one end secured within an openiig in the yoke portion of bracket 24, and said sleeve extends rearwardly from said bracket through an opening in a vertical wall 43 formed within casing sections 13a and 13b. The rear end of sleeve 41 has a cup member 44 fixed therein and the rear end of pin 42 is secured within said cup member by a fusible alloy connection 45. Ratchet wheel 40 is fixed to the front end of pin 42 and is thus normally held against rotation by the alloy connection 45 to render pawl 39 effective to hold latch 6 in the position shown in Fig. 1 against the action of spring 32.

The electric heater 9 associated with thermal element 8 is mounted within a cylindrical recess 46 which is formed on the under side of casing sections 13a and 13b and extends rearwardly from the wall 43. The terminal portions of heater coil 9 are secured to terminal plates 47—47 fixed to an insulating bar 48 and said terminal plates are secured to terminal brackets 49—49 mounted upon the front face of insulating base 12. An insulating disk 50 and a metal disk 51 are mounted within recess 46, said disks being provided with a center opening for receiving thermal element 8. Insulating disk 50 is formed of heat resisting material and is located adjacent the front end of heater coil 9, and the metal disk 51 is interposed between said insulating disk and the wall 43 of casing 13.

Lever 7 is arranged vertically within casing 13 and its lower end is bifurcated to provide prongs 52—52 which are located on opposite sides of bracket 24 to be engaged by the latch projections 37—37 associated with latch 6. The upper end of lever 7 is provided with a pivot pin 53 which is journaled on opposite sides of said lever within suitable bearing projections formed on the opposing faces of casing sections 13a and 13b.

The ambient temperature responsive device 10 is located to the rear of lever 7 and comprises two flexible metal disks or diaphragms 54 and 55 which are sealed together at their peripheries in any suitable manner as by a solder connection. Disk 54 is sealed to a nipple 56 which is secured within an opening in a cup member 57. Nipple 56 is provided with a closed pipe extension 53 and said pipe extension and the space between diaphragms 54 and 55 contains an expansible fluid, such as ethyl chloride. Device 10 is held in assembled position between casing sections 13a and 13b by an outwardly extending flange on cup member 57 which engages within suitable notches formed on the opposing faces of said casing sections. Diaphragm 55 is engaged by the thrust disk 59 having a pointed pin extension fixed thereto which engages within a cone shaped opening in a bearing insert 60 supported within a recess in the rear face of lever 7.

Loading spring 11 is held under compression between a thrust member 61 which engages the rear end of said spring and a nut 62 which engages the front end thereof. Thrust member 61 is provided with a pointed pin projection which engages within a cone shaped recess in a bearing insert 63 supported within a recess in the front face of lever 7, and nut 62 is carried by a screw 64 which is journaled within an opening in a wall

65 on the front end of casing sections 13a and 13b. Nut 62 is provided with a tongue projection which extends upwardly into a slot 67 formed between casing sections 13a and 13b, and as is apparent upon rotation of screw 64 said nut is moved axially upon said screw to vary the loading effect of spring 11. The front end of screw 64 has a lever 68 secured thereto which cooperates with a dial plate 69 mounted upon the front wall 65 of casing sections 13a and 13b.

The function and operation of the aforedescribed relay will now be more fully described. The latching projections 37—37 on latch 6 are normally held in engagement with the rear side of the prong projections 52—52 on lever 7 against the action of spring 32 by engagement of pawl 39 with the ratchet wheel 40 of thermal reponsive device 8. Loading spring 11 is so adjusted that when the adjusting lever 68 is in an intermediate positon marked "100" on the dial 69 (Fig. 3) the loading effect of such spring is such that device 10 acts, when subjected to a predetermined ambient temperature, as for example 40 deg. C., to maintain lever 7 and push button element 4 in the position shown in Fig. 1. Insulating finger 3 is thus normally held out of engagement with contact fingers 1 and 2 and the inner end of thermal element 8 is normally located midway between the ends of heater coil 9. Heater coil 9 is so designed that when the ambient temperature is of normal value said heater coil is adapted to effect fusion of the alloy connection 45 upon a predetermined overload current condition in the circuit in which said heater coil is connected.

An increase in ambient temperature tends to lower the overload current value at which heater coil 9 effects fusion of the alloy connection 45, while a decrease in ambient temperature has an opposite effect. However, if the ambient temperature rises above normal value device 10 acts to move lever 7 and the push button element 4 forwardly out of the position shown in Fig. 1 against the action of loading spring 11, to adjust thermal element 8 forwardly with respect to heater coil 9. On the other hand, if the ambient temperature drops below normal value device 10 permits inward movement of lever 7 and push button element 4 out of the position shown in Fig. 1 under the action of loading spring 11 to thereby adjust thermal element 8 inwardly with respect to heater coil 9. The portion on the inner end of thermal element 8 which is surrounded by heater coil 9 is thus increased or reduced in accordance with ambient temperature changes to provide for fusion of the alloy connection 45 of said thermal element by a predetermined overload current condition in said heater coil regardless of ambient temperature variations.

Upon fusion of the alloy connection 45 of thermal element 8, pin 42 and its associated ratchet wheel 40 are free to rotate, thus permitting the latch 6 to move downwardly out of the position shown in Fig. 1 under the action of spring 32. Upon downward movement of latch 6 out of the position shown in Fig. 1 the latch projections 37—37 associated therewith are disengaged from the prongs 52—52 on lever 7 to permit movement of push button element 4 from the position shown in Fig. 1 into the position shown in Fig. 2 under the action of spring 22. Upon movement of push button element 4 into the position shown in Fig. 2 the insulating finger 3 associated therewith is moved into position between the contact tips 1a and 2a of contact fingers 1 and 2 to interrupt circuit between said contact fingers. Contact fingers 1 and 2 are usually arranged to control a main switch which acts upon interruption of circuit between said contact fingers to open the protected circuit in which heater coil 9 is connected. Upon deenergization of heater coil 9 the alloy connection 45 of thermal element 8 cools and becomes solid, and the relay may then be reset in the position shown in Fig. 1 by depression of push button 20.

Upon movement of push button element 4 into the position shown in Fig. 1 the inner end of thermal element 8 is surrounded by the metal disk 51. Disk 51 provides for rapid cooling of the fusible alloy connection 45 of thermal element 8 to thereby enable resetting of the relay after a relatively short interval following response thereof. Upon depression of push button 20 the toe projections 33 on latch 6 engage the stop projections 35 on the interior of casing sections 13a and 13b to move said latch upwardly into the position shown in Fig. 1 against the action of spring 32. If sufficient time has elapsed to permit cooling of the alloy connection 45, latch 6 is retained in the position shown in Fig. 1 by engagement of pawl 39 with ratchet wheel 40. Upon resetting of latch 6 latch projections 37 are positioned to engage prongs 52 on lever 7 to thereby hold push button element 4 in circuit opening position upon release of push button 20.

In connection with the foregoing it should be noted that the degree of compression of loading spring 11 determines the overload current value at which the relay is adapted to be tripped. By moving adjusting lever 68 from the position marked "100" on dial plate 69 to the position marked "110" the loading effect of spring 11 is decreased to permit forward movement of thermal element 8 with respect to heater coil 9 for an increase in the overload current value at which the relay is adapted to respond. Movement of adjusting lever 68 from the position marked "100" on dial plate 69 to the position marked "90" increases the loading effect of spring 11 to thereby reduce the current value at which the relay is adapted to respond.

In connection with the foregoing it should also be noted that the relay may be modified to provide for tripping thereof by varying current conditions in heater coil 9 under varying ambient temperature conditions. Thus thermal element 8 may be of such length that the inner end thereof is located to the rear of heater coil 9 when device 10 is subjected to a normal ambient temperature. Temperature responsive device 10 will then act to adjust thermal element 8 with respect to heater coil 9 to provide for tripping of the relay at a substantially reduced current value upon a rise in ambient temperature and at a substantially increased current value upon a drop in ambient temperature.

Also the relay may be so adjusted that the inner end of thermal element 8 is located to the front of heater coil 9 when device 10 is subjected to a normal ambient temperature. Thermal element 8 will then be automatically adjusted with respect to heater coil 9 to provide for tripping of the relay at an increased current value upon a rise in ambient temperature, and at a reduced current value upon a drop in ambient temperature.

What we claim as new and desire to secure by Letters Patent is:

1. In a protective device for an electric circuit, in combination, a switch element biased toward

circuit opening position, a current responsive latching mechanism for normally holding said switch element against movement into circuit opening position, said latching mechanism including a heater element to be connected in the circuit to be protected, and a fusibly mounted member releasable under the action of said heater element to trip said latching mechanism for movement of said switch element into circuit opening position, and a condition responsive device for effecting relative adjustment of said fusibly mounted member and said heater element for regulation of the current value at which said latching mechanism is tripped.

2. In a protective device for an electric circuit, in combination, a switch element biased toward circuit opening position, a current responsive latching mechanism for normally holding said switch element against movement into circuit opening position, said latching mechanism including a heater element to be connected in the circuit to be protected, and a fusibly mounted member releasable under the action of said heater element to trip said latching mechanism for movement of said switch element into circuit opening position, and means responsive to variations in ambient temperature for adjusting said fusibly mounted member with respect to said heater element to provide for tripping of said latching mechanism by a given current value in said heater element under varying ambient temperature conditions.

3. In a protective device for an electric circuit, in combination, a movable switch member biased toward circuit opening position, a current responsive latching mechanism associated with said member and settable upon movement of said switch member into circuit closing position to maintain the same in such position, said latching mechanism including a stationary electric heater element to be connected in the circuit to be protected, and a thermal element responsive under the action of said heater to trip said latching mechanism, said thermal element being located adjacent said heater element when said latching mechanism is in set position and said thermal element upon response to trip said latching mechanism being moved to a position remote from said heater to provide for quick cooling thereof upon tripping of said latching mechanism.

4. In a protective device for an electric circuit, in combination, a switch including a push button element biased toward circuit opening position, a current responsive latching mechanism associated with said push button element settable upon movement of said operating push button element into circuit opening position to maintain the same in such position, said latching mechanism including a stationary electric heater to be connected in the circuit to be protected and a fusibly mounted member carried by said push button element and releasable under the action of said heater to trip said latching mechanism, said fusibly mounted member being located adjacent said heater upon setting of said push button element in circuit closing position and being moved away from said heater to provide for quick cooling thereof upon movement of said push button element into circuit opening position.

5. In a protective device for an electric circuit, in combination, a movable switch member biased toward circuit opening position, a current responsive latching mechanism associated with said member and settable upon movement of said switch member into circuit closing position to maintain the same in such position, said latching mechanism including a stationary electric heater element to be connected in the circuit to be protected, and a thermal element responsive under the action of said heater to trip said latching mechanism, said thermal element being located adjacent said heater element upon setting of said latching mechanism, and said thermal element upon response to trip said latching mechanism being moved to a position remote from said heater to provide for quick cooling thereof, and means associated with said latching mechanism and effective upon setting thereof for effecting relative adjustment of said thermal element and said heater element in response to ambient temperature variations.

6. In a protective device for an electric circuit, in combination, a pair of resilient contact fingers normally held in engagement to establish circuit therebetween, a push button element biased to move into a position to effect separation of said contact fingers, a current responsive latching mechanism for maintaining said push button element in position to permit engagement of said contact fingers, said latching mechanism including an electric heater to be connected in the circuit to be protected, and a fusibly mounted member carried by said push button element and releasable under the action of said heater to trip said latching mechanism, said fusibly mounted element being located adjacent said heater upon setting of said latching mechanism and being movable away from said heater for quick cooling thereof upon tripping of said latching mechanism, and an ambient temperature compensating device associated with said latching mechanism for adjusting said fusibly mounted member with respect to said heater upon setting of said latching mechanism.

7. In a protective device for an electric circuit, in combination, a movable switch member biased toward circuit opening position and an electrothermally controlled latching mechanism settable upon movement of said switch member into circuit closing position to maintain the same in such position, said latching mechanism including an electric heater to be connected in the circuit to be protected, and an associated device responsive upon a predetermined current condition in said heater to trip said latching mechanism for movement of said switch member into circuit opening position, said device being normally maintained adjacent said heater and upon response to trip said latching mechanism being removed with respect to said heater to provide for quick cooling thereof.

8. In an overload protective device for an electric circuit, in combination, a movable switch member biased toward circuit opening position and an electrothermally controlled latching mechanism settable upon movement of said switch member into circuit closing position to maintain the same in such position, said latching mechanism including a stationary heater to be connected in the circuit to be protected, and an associated thermal device carried by said switch member and normally responsive to a predetermined current condition in said heater to trip said latching mechanism for movement of said switch member into circuit opening position, said thermal device being normally located adjacent said heater, and upon response to trip said

latching mechanism being moved away from said heater to provide for quick cooling thereof.

9. In an overload protective device for an electric circuit, in combination, a movable switch member biased toward circuit opening position, an electrothermally controlled latching mechanism settable upon movement of said switch member into circuit closing position to maintain the same in such position, said latching mechanism including an electric heater to be connected in the circuit to be protected, and a thermal device responsive upon a predetermined current condition in said heater to trip said latching mechanism for movement of said switch member into circuit opening position, said thermal device being normally maintained adjacent said heater and upon response to trip said latching mechanism being removed with respect to said heater for quick cooling thereof, and means associated with said latching mechanism for effecting relative adjustment of said thermal device and said heater in response to ambient temperature changes.

10. In a protective device for an electric circuit, in combination, a movable switch member biased toward circuit opening position, an electrothermally controlled latching mechanism settable upon movement of said switch member into circuit closing position to maintain the same in such position, said latching mechanism including an electric heater to be connected in the circuit to be protected, and a thermal device responsive upon a predetermined current condition in said heater to trip said latching mechanism for movement of said switch member into circuit opening position, said thermal device being normally maintained adjacent said heater and upon response to trip said latching mechanism being removed with respect to said heater to provide for quick cooling thereof, and manual means for effecting relative adjustment of said thermal device and said heater to provide for response of said device at selected current values in said heater.

11. In an overload protective device for an electric circuit, in combination, a movable switch member biased toward circuit opening position, an electrothermally controlled latching mechanism settable upon movement of said switch member into circuit closing position to maintain the same in such position, said latching mechanism including an electric heater to be connected in the circuit to be protected and a thermal device responsive upon a predetermined current condition in said heater to trip said latching mechanism for movement of said switch member into circuit opening position, said thermal device being normally maintained adjacent said heater and upon response to trip said latching mechanism being removed with respect to said heater to provide for quick cooling thereof, and a condition responsive device associated with said latching mechanism and operable upon setting of said latching mechanism to effect automatic adjustment of said thermal device with respect to said heater.

12. In an overload protective device for an electric circuit, in combination, a movable switch member biased toward circuit opening position, an electrothermally controlled latching mechanism settable upon movement of said switch member into circuit closing position to maintain the same in such position, said latching mechanism including a stationary heater to be connected in the circuit to be protected, and an associated thermal device carried by said switch member and normally responsive to a predetermined current condition in said heater to trip said latching mechanism for movement of said switch member into circuit opening position and a cooling element for said thermal device located at a point removed from said heater, said thermal device being located adjacent said heater element upon setting of said latching mechanism and upon response to trip said latching mechanism being moved away from said heater into the vicinity of said cooling element.

13. In an overload protective device for an electric circuit, in combination, a movable switch member biased toward circuit opening position, an electrothermally controlled latching mechanism settable upon movement of said switch member into circuit closing position to maintain the same in such position, said latching mechanism including a heater to be connected in the circuit to be protected, and a thermal device responsive upon a predetermined current condition in said heater to trip said latching mechanism for movement of said switch member into circuit opening position, said thermal device being normally maintained adjacent said heater and upon response to trip said latching mechanism being removed with respect to said heater for quick cooling thereof, and means associated with said latching mechanism for effecting relative adjustment of said thermal device and said heater in response to ambient temperature changes, said means comprising a temperature responsive diaphragm having a manually adjustable loading spring associated therewith.

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