June 5, 1956 J. R. WALTON ET AL 2,749,407

SINGLE PHASING PREVENTOR

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FIG. 1

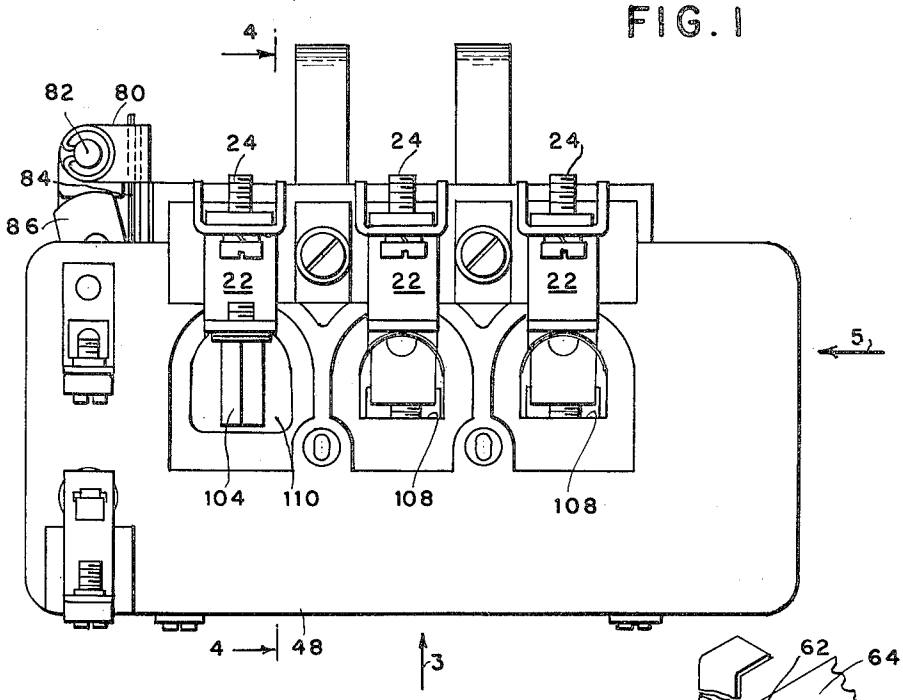


FIG. 6

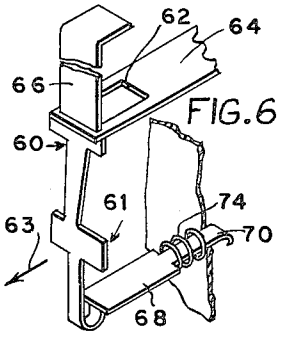
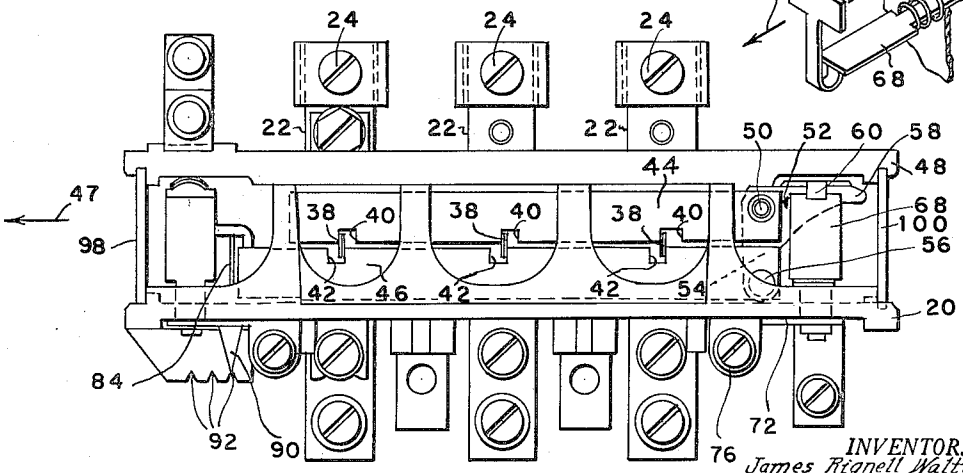


FIG. 3



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FIG. 2

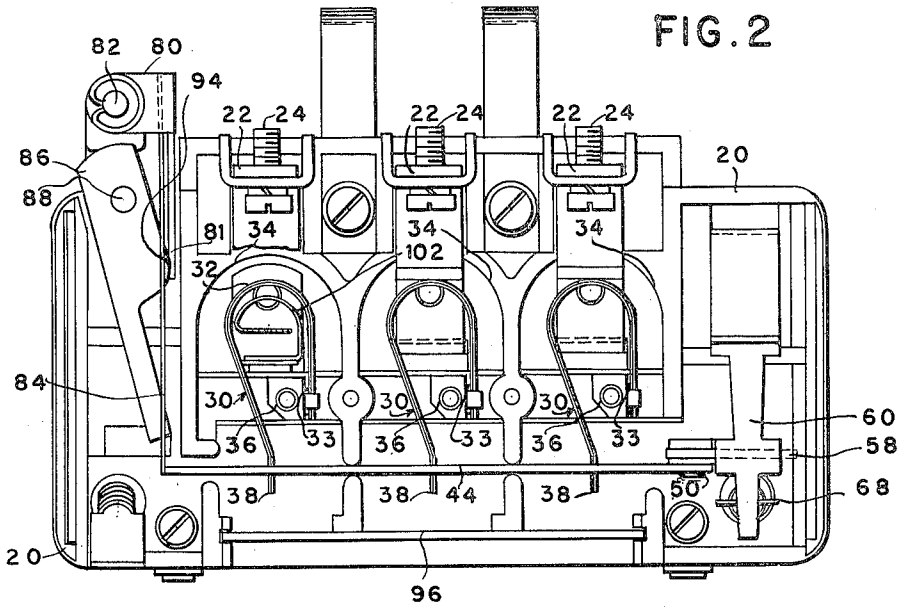


FIG. 4

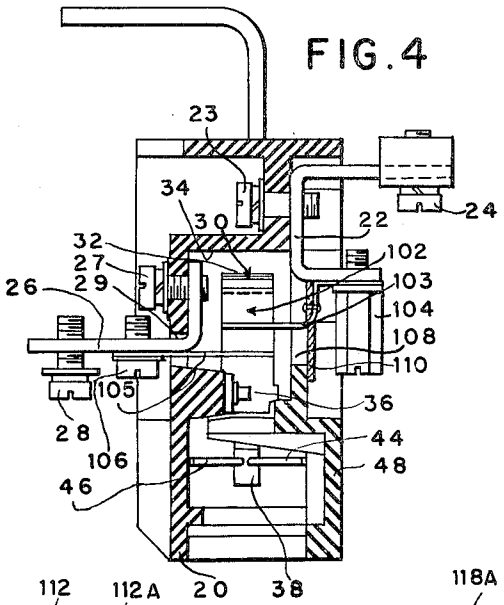
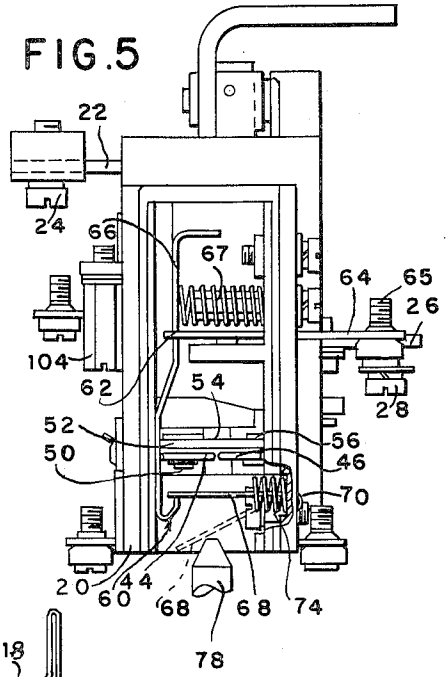


FIG. 5



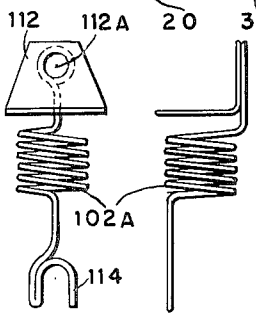


FIG. 7 FIG. 8

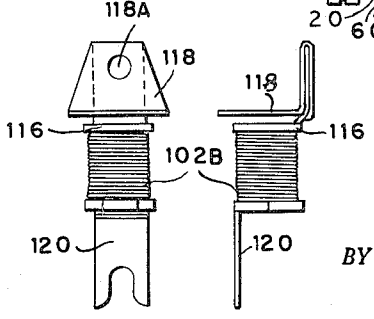


FIG. 9 FIG. 10

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United States Patent Office 2,749,407 Patented June 5, 1956

2,749,407

SINGLE PHASING PREVENTOR

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Application October 15, 1953, Serial No. 386,352

8 Claims. (Cl. 200—116)

This invention relates generally to devices for protecting polyphase circuits.

Devices of the subject type are especially useful for protecting polyphase alternating current electrical apparatus, and particularly polyphase electric motors, and comprise a plurality of current-sensitive members each of which can respond to one of the currents between which unbalance is to be avoided, a switch, and a operative connection between the current-sensitive members and the switch for operating the latter to disconnect the apparatus by non-uniform movement of the member in the event of unbalance. Since the device is particularly useful in protecting polyphase motors against single phasing, it is described hereinafter as a "single phasing preventor" or more briefly, as a "preventor." According to the practice of the prior art, a number of bimetal strips was employed to operate the "preventor," these being heated in accordance with the currents in the respective phases of the circuit being protected, either by passing current through the bimetal itself or through a resistance element mounted with it. In either case, if it was desired to renew the heating elements, or to exchange them for others of different value, it was necessary to reassemble the bimetal strips, if not to exchange them for others, which involved re-adjusting the mechanism.

Therefore, it is the primary object of the present invention to provide for the replacement of the heating elements without interference with any mechanically operated parts, whereby to obviate the necessity for re-adjustment when the heating elements are replaced. In accordance with said object, it is a more specific object to provide for the replacement of the heating elements without disturbing the bimetal strips. Another object of the present invention is to make the means of attaching in place the heaters, or carriers, therefor such that positive location is obtained on interchange.

A further object is to provide a more efficient improved and generally simplified single phasing preventor.

The above and other objects, features and advantages of the present invention will be more fully understood from the following description considered in connection with the accompanying illustrative drawings.

In the drawings:

Fig. 1 is a top plan view of a preventor, pursuant to the present invention, for protecting a three phase electric circuit against unbalance, two of the heaters being removed for purposes of illustration;

Fig. 2 is a view similar to Fig. 1, with the cover of the device removed, two of the heaters being removed as in Fig. 1;

Fig. 3 is a front elevation taken in the direction of arrow 3 in Fig. 1;

Fig. 4 is a sectional view taken on the line 4—4 of Fig. 1;

Fig. 5 is an end view in the direction of the arrow 5 in Fig. 1;

Fig. 6 is a fragmentary perspective view of a switch provided in the preventor device;

Figs. 7 and 8 illustrate one form of heater for the preventor; and

Figs. 9 and 10 illustrate another form of heater therefor.

Referring now to the drawings in detail, the protector device of the present invention is provided with an insulating base 20 on which the various component parts thereof are mounted. Provision is made for three laterally spaced conducting brackets or terminal elements 22, each provided with a terminal 24 for the incoming current, said brackets being suitably secured to the base 20, as by the securing elements 23 (Fig. 4). Three conducting brackets or terminal elements 26 are also secured to the base 20 as by the securing elements 27, said brackets extending through apertured portions 29 of the base and being each provided with a terminal 28 for the outgoing current. Consequently, it will be understood that there is an input terminal 24 and an output terminal 28 for each current phase. The base 20 has defined therein three laterally spaced chambers 34 in each of which there is mounted a bimetal strip 30. More specifically, each strip is provided with a looped portion 32, an end portion 33 which is secured to the insulated base in the companion chamber, as by means of a clip 36, and with a free end 38 which extends from the chamber and engages in slots 40 and 42 provided in the longitudinally extending slide members or plates 44 and 46, respectively. The plates are disposed between the base 20 and a cover 48 which is fixed thereto, said base and cover defining a housing for the protector. Said plates are mounted for slidable movement in the direction of their longitudinal axis under the control of the bimetal strips. Adjacent one end thereof, the upper plate 44 carries a pivot 50 on which there is pivotally mounted a bell crank lever 52. A pin 56 carried at one end of the lower plate 46 extends into and is connected with one arm 54 of the bell crank lever. The other arm 58 of the bell crank lever engages a hook contact 60, which constitutes one of the contacts of a switch 61, best illustrated in Fig. 6, the other switch contact being indicated at 68.

Switch 61 is of similar construction and operation to the switch illustrated and described in the British patent specification No. 553,154 and in No. 628,220. As illustrated and described therein, and as shown herein, the aforementioned hook contact 60 of the switch extends through an opening 62 provided in a fixed conducting bracket 64, which is provided with a terminal screw 65 (Fig. 5). One end of the companion contact 68 is hooked, as at 70, into a contact bar 72 (Fig. 3) which is fixed to the device in a suitable manner and which is provided with a terminal 76. A spring 74 operates to move the contact 68 downwardly from the full line, to the broken line position thereof, as illustrated in Fig. 5, when the companion contact 60 is rocked in a clockwise direction, viewing said figure. In this connection it will be noted that the hook contact 60 has an extension portion 66 upwardly of the bracket 62, which extension is biased by a spring 67 in a direction to effect engagement of the opposite end of the hook contact 60 with the companion contact 68. It will be understood that the switch contacts 60 and 68 are connected in well known manner to control the supply of current to a suitable load, for example, and not by way of limitation, to a motor, and, when the switch is opened, protects the motor by cutting off the current supply thereof. In this connection, the switch may be connected in series with the operating coil of a suitable contactor (not illustrated) for controlling the supply of current to the apparatus, for example, a motor, which is being protected.

The aforementioned spring 67 serves to press the hook contact 60 against the bell crank lever 52, as best illustrated in Figs. 3 and 5. When the bell crank lever is in the posi-

tion thereof illustrated in Fig. 3, the hook at the lower end of the hook contact 60 is in contact with and holds the companion switch contact or arm 68 of the switch 61. The pressure exerted by the spring 67 through the hook contact 60 on the bell crank 52 makes the latter thrust the plate 46 in the direction of the arrow 47 in Fig. 3, and relative to the companion plate 44, so far as such movement is permitted by the engagement of the bimetal ends 38 in the slots of these plates. The relative position of the various parts being, as illustrated in Fig. 3. Uniform heating of the bimetal strips 30 will cause their free ends 38 to move in the direction of the arrow 47 by equal amounts, and it will be apparent that the plates 44 and 46 and the bell crank lever 52 will move in the direction of said arrow 47 with said free ends of the heaters. The upper arm 58 of the bell crank lever, against which the hook contact 60 presses, will slide under the latter without affecting the closed condition of the switch 61. However, should unequal heating of the bimetal strips occur, so that one of them moves less than the others, this one will limit the movement of the plate 46 in the direction of the arrow 47, but the plate 44 will continue to move in said direction under pressure from the other strips which are moving further than said one strip. Consequently, the plate 44 will move in the direction of the arrow 47 over the plate 46, carrying with it the pivot 50 of the bell crank lever 52, while the pin 56 which is fixed to the plate 46 and which engages in the lower arm 54 of the bell crank lever will prevent that lower arm from moving in the direction of the arrow 47. Consequently, the bell crank lever will pivot in a counter-clockwise direction, viewing Fig. 3, so that the arm 58 thereof moves upwardly from the position thereof illustrated in said figure. This arm forces the hook contact 60 upwardly, viewing Fig. 3, until it disengages the companion switch contact 68, permitting the latter to be moved to the open position thereof by spring 74, as illustrated in broken line in Fig. 5. Since, as previously indicated, the switch is connected to control the supply of current to a motor, it will be apparent that when opened the switch protects the motor by cutting off the supply of current thereto. As previously indicated, the contact arm 68 being pivoted at the hook portion 70 and being biased by the spring 74 to press firmly against the hook end of hook contact 70 in the engaged condition thereof, when the lower portion of the hook contact 60 is moved in the direction of the arrow 63 (Fig. 6) to disengage the hooked end thereof from the companion contact 68, as previously explained, the latter is moved downwardly by the spring 74 until it abuts an insulating nose 78, as illustrated in Fig. 5.

Once the switch 61 is opened in the described manner, it remains open even though the hook contact 60 moves back in the direction opposite the arrow 63. However, after the hook contact has returned to the position thereof illustrated in Fig. 5 or 6, the companion switch contact 68 may be re-engaged therewith by moving upwardly upon the nose 78, as illustrated in Fig. 5, to move the contact 68 back into engagement with the hook contact 60 to reset the switch.

Provision is made for a bracket 80 which is pivoted at 82 and which carries a bimetal strip 84. Provision is also made for a lever 86 which is pivotally mounted, as at 88, and which is provided with a pointer 90 (Fig. 3), which pointer moves relative to notches 92 provided on the base 20 as the lever 86 is rotated on its pivot. As best seen in Fig. 2, the lever 86 is provided with a projection 94 which limits the rotation of the bracket 80, it being noted that the latter is provided with a part 81 which is adapted to engage the projection 94, said projection being disposed in the path of movement of the part 81. As best seen in Fig. 3, the bimetal strip 84 extends from the bracket 80 into the path of movement of the lower plate 46 in the direction of the arrow 47 to limit the movement of said plate in said direction.

In view of the foregoing, it will be apparent that the extent of the movement of the plate 46 in the direction of the arrow 47 may be predetermined by the setting of the pointer 90 at a particular notch 92, the setting of said pointer determining the position of the lever 86 and thereby limiting the clockwise rotation of the bracket 80, viewing Fig. 2, which in turn determines the setting of the bimetal 84 which, as indicated, predetermines the extent of the movement of the plate 46 in the direction of the arrow 47. Under conditions of uniform heating of the various bimetal strips 30, the plates 44 and 46 move in the direction of the arrow 47, viewing Fig. 3, as previously described, until movement of the plate 46 is stopped by its engagement with the bimetal strip 84. Further heating of the strips 30 will cause the companion plate 44 to move in the direction of the arrow 47, relative to the plate 46, to result in the pivotal movement of the bell crank lever 52 in a direction to open the switch 61, as previously described, and thereby discontinue the supply of current to the apparatus, for example a three phase motor which is being protected. Therefore, it will be apparent that the preventor device herein described provides protection against ordinary overload of the apparatus as well as protection against unbalance in the various current phases thereof. By a suitable design or construction of the bimetal strip 84, so that for a given change of ambient temperature its deflection is the same as that of the bimetal strips 30, the uniform overload which will trip the switch 61 is caused to be made independent of ambient temperature.

The base 20 and the cover 48, which constitute the housing, are extended to overlap the free ends 38 of the bimetal strips 30 and to hold a transparent front window plate 96 (Fig. 2). The base and the cover may also be extended at each side of the device to overlap the strip 84 and associated parts, and to hold transparent side window plates 98 and 100. Consequently, the various operating parts are clearly visible and yet they are protected. In this connection, it will be understood that it is particularly useful to be able to observe the movement of the free ends 38 of the various strips 30 in order to see if they are moving together, as when the three leads of the circuit being protected are equally loaded, or if one or more of the ends is lagging, as when unbalance exists between the three leads of the circuit being protected.

Cover 48, when mounted on the base 20, closes the top of the various chambers 34. The heaters 102 are disposed in each of the chambers 34 when the protector device is in use. Pursuant to the present invention, as best shown in Fig. 4, each heater 102 is fixed to a companion incoming terminal bracket 22 by a securing portion 103 which extends transversely of the bimetal loop outwardly of the associated chamber, through the medium of the screw 104 and is fixed to a companion outgoing terminal bracket 26 by a securing portion 105 which extends transversely of said loop outwardly of the associated chamber, through the medium of a screw 106. Consequently, it will be apparent that at both ends thereof, the heater is secured outwardly of the housing. It will be noted from the left hand chamber, viewing Fig. 2, that the heater lies within and adjacent to the loop 32 of the associated bimetal strip 30 in close spaced thermal relation therewith to obtain maximum heat transfer. Referring now to Fig. 4, it will be noted that the housing cover 48 is cut away, as at 108, to permit the heater to be readily removed or replaced through the cover, without the necessity of removing the latter, by merely removing the screw 104 and by backing up or slackening the screw 106. Each heater 102 has attached to itself, or made a part thereof, a plate 110 which serves to close the opening 108 provided in the cover 48 when the heater is in position in the device. Fig. 2 illustrates only one of the heaters in position, the heater in the left hand chamber, viewing said figure, being shown in section at the level of the companion bimetal strip 30, the heaters in the center and the right hand chambers having been removed for purposes of illustration. The center and

right hand heaters have also been removed from Fig. 1 and in addition the screws **104** which hold the heaters to the brackets **22** have also been removed so as to reveal the openings **108** in the top cover **48**.

The heater **102** shown in position in the protector device is formed of sheet metal and is suitably shaped for disposition within the loop **32** of the associated bimetal strip and to provide the terminal connecting portions **103** and **105** thereof. Thicker or thinner sheet metal is employed for larger or smaller currents respectively, provided however that the heater is not made of such thin material as to be readily liable to accidental deformation.

For smaller currents, a heater **102A**, as illustrated in Figs. 7 and 8 may be used. Said heater is made of spirally wound wire, being provided with the apertured end portion **112**, apertured as at **112A**, for connection by screw **104** to the terminal brackets **22** and with the U-shaped end or peripherally interrupted portion **114** for connection by screw **106** to the terminal bracket **26**. For still smaller currents, a heater **102B**, as illustrated in Figs. 9 and 10 may be used. Said heater is formed of a relatively thin or fine wire which is spirally wound on an insulating former or mounting member **116**. The heater **102B** is provided with an apertured end **118**, apertured as at **118A**, for connection by screw **104** with the terminal bracket **22** and with a slotted end **120** for connection by screw **106** to the terminal bracket **26**. It will be understood that the heater **102** is also apertured in the connecting portion **103** thereof, and is slotted in the connecting portion **105** thereof in the same manner, as at **120** in Fig. 9. It will be noted in addition, that the U-shaped opening **114** in Fig. 7, is substantially in the form of an open ended slot as in Fig. 9. Therefore, in view of the slotted ends of each of the heaters, in removing or replacing a heater, the screw **106** which engages in said slotted ends needs to be slackened back only. However, the screw **104** must be entirely removed, but being at the top of the device, as will be apparent from Fig. 1, this is readily effected, and, in order to facilitate the removal of the screw **104**, the latter is provided with a long hexagon head to provide a suitable finger grip. Once the screw **104** is entirely withdrawn, and the screw **106** is partially withdrawn, the heater may be readily removed through the opening **108** in the cover **48** without the necessity of removing the cover. If the heaters are not inherently sufficiently rigid, strict interchangeability may be secured by mounting the heater on a carrier which may be of ceramic or other heat resisting material; moreover all the heaters may be mounted on one carrier, or the carriers of different phases mounted together to form one unit. In any event, the attaching means for the heaters, or carriers if used, as previously described, provide for positive location of the various heaters upon interchange or replacement thereof.

In view of the foregoing, it will be readily apparent that there is no direct mechanical connection, nor any electrical connection whatsoever, between the heaters and the adjacent bimetal strips **30**. On removing only one screw, namely the screw **104**, and on slackening or backing up another screw, namely the screw **106**, a heater may be removed and may be replaced by another heater without disturbing any of the operating mechanism of the device or the associated bimetal strip.

While we have shown and described the preferred embodiments of our invention, it will be understood that various changes may be made in the idea or principles of the invention within the scope of the appended claims.

Having thus described our invention, what we claim and desire to secure by Letters Patent is:

1. In a protective device for electric circuits, operating mechanism for said device including a circuit controlling switch, a plurality of thermally responsive elements and means for operating said switch in response to the condition of said elements; heaters for said elements, respectively, energized by the currents in said circuits, respectively, and means for removably mounting said heaters in said device independently of said operating mechanism, whereby said heaters are replaceable without interference with said operating mechanism, said thermally responsive elements being flexible bimetal members, and said heaters each being mounted in spaced thermal relation with an associated bimetal member and independently thereof, said bimetal members each having a loop defined therein and each heater being mounted within the loop of its associated bimetal member.

2. In a protective device for electric circuits, operating mechanism for said device including a circuit controlling switch, a plurality of thermally responsive elements and means for operating said switch in response to the condition of said elements; heaters for said elements, respectively, energized by the currents in said circuits, respectively, and means for removably mounting said heaters in said device independently of said operating mechanism, whereby said heaters are replaceable without interference with said operating mechanism, said thermally responsive elements being flexible bimetal members, and said heaters each being mounted in spaced thermal relation with an associated bimetal member and independently thereof, said bimetal members each having a loop defined therein and each heater being mounted within the loop of its associated bimetal member, said mounting means including spaced terminal elements for each circuit and each heater having securing portions extending outwardly of its associated loop for removable securement to the associated terminal elements.

3. In a protective device for electric circuits, operating mechanism for said device including a circuit controlling switch, a plurality of thermally responsive elements and means for operating said switch in response to the condition of said elements; heaters for said elements, respectively, energized by the currents in said circuits, respectively, and means for removably mounting said heaters in said device independently of said operating mechanism, whereby said heaters are replaceable without interference with said operating mechanism, said thermally responsive elements being flexible bimetal members, and said heaters each being mounted in spaced thermal relation with an associated bimetal member and independently thereof, said bimetal members each having a loop defined therein and each heater being mounted within the loop of its associated bimetal member, said mounting means including spaced terminal elements for each circuit and each heater having securing portions extending outwardly of its associated loop for removable securement to the associated terminal elements, and securing members threadedly engageable in said terminal elements for releasably securing said heater portions thereto, respectively, one of said heater portions being peripherally interrupted, whereby said one heater portion can be disconnected from its associated terminal element without disengaging the associated securing member from said latter terminal element.

4. A protective device for electric circuits comprising a housing for said device, a plurality of chambers defined in said housing, operating mechanism in said housing responsive to unbalance in said circuits and including thermally responsive elements for said circuits, respectively, said elements being mounted in said chambers, respectively, and heaters for said elements disposed within said chambers, respectively, in spaced thermal relation therewith and being removably mounted in operative disposition outwardly of said chambers, and means for mounting said heaters externally of said housing, said means comprising spaced terminal elements for each circuit provided with portions disposed outwardly of said housing, said heaters interconnecting the associated terminal elements by releasable securement to said portions thereof, said device being further characterized in that the heaters are sheet metal members provided with secur-

ing portions extending outwardly of said housing, and securing elements interconnecting associated terminal and heater portions, one of said portions in each heater being peripherally interrupted, whereby to facilitate the disconnection of said one heater portion from its associated terminal portion without removing the securing element from the latter.

5. A protective device for electric circuits comprising a housing for said device, a plurality of chambers defined in said housing, operating mechanism in said housing responsive to unbalance in said circuits and including thermally responsive elements for said circuits, respectively, said elements being mounted in said chambers, respectively, and heaters for said elements disposed within said chambers, respectively, in spaced thermal relation therewith and being removably mounted in operative disposition outwardly of said chambers, and means for mounting said heaters externally of said housing, said means comprising spaced terminal elements for each circuit provided with portions disposed outwardly of said housing, said heaters interconnecting the associated terminal elements by releasable securement to said portions thereof, said device being further characterized in that the heaters are spirally wound elements provided with securing portions extending outwardly of said housing, and securing elements interconnecting associated terminal and heater portions, one of said portions in each heater being U-shaped, whereby to facilitate the disconnection of said one heater portion from its associated terminal portion without removing the securing element from the latter.

6. A protective device for electric circuits comprising a housing for said device, a plurality of chambers defined in said housing, operating mechanism in said housing responsive to unbalance in said circuits and including thermally responsive elements for said circuits, respectively, said elements being mounted in said chambers, respectively, and heaters for said elements disposed within said chambers, respectively, in spaced thermal relation therewith and being removably mounted in operative disposition outwardly of said chambers, and means for mounting said heaters externally of said housing, said means comprising spaced terminal elements for each circuit provided with portions disposed outwardly of said housing, said heaters interconnecting the associated terminal elements by releaseable securement to said portions thereof, said device being further characterized in that the heaters are spirally wound elements provided with securing portions extending outwardly of said housing and securing elements interconnecting associated terminal and heater portions, one of said portions in each heater being an open ended slot defined therein, whereby to facilitate the disconnection of said one heater portion from its associated terminal portion without removing the securing element from the latter.

7. A protective device for electric circuits comprising a housing for said device, a plurality of chambers defined in said housing, operating mechanism in said housing responsive to unbalance in said circuits and including a circuit controlling switch, a plurality of bimetal strips for said circuits, respectively, and means for operating said switch in response to the condition of said strips, said means including a pair of members mounted for relative movement, said members having slots defined therein, said strips being disposed in said chambers and having free end portions extending therefrom and through said slots for effecting movement of said members upon flexing of said strips respectively, and heaters for said strips, disposed within said chambers, respectively, in spaced thermal relation with said strips, said heaters extending from the respective chambers and being removably mounted outwardly of said chambers.

8. A protective device for electric circuits comprising a housing for said device, a plurality of chambers defined in said housing, operating mechanism in said housing responsive to unbalance in said circuits and including a circuit controlling switch, a plurality of bimetal strips for said circuits, respectively, and means for operating said switch in response to the condition of said strips, said means including a pair of members mounted for relative movement, said members having slots defined therein, said strips being disposed in said chambers and having free end portions extending therefrom and through said slots for effecting movement of said members upon flexing of said strips respectively, and heaters for said strips, disposed within said chambers, respectively, in spaced thermal relation with said strips, said heaters extending from the respective chambers and being removably mounted outwardly of said chambers, and a transparent window provided in said housing through which the free ends of said bimetal strips are visible.

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