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CIRCUIT BREAKER WITH AMBIENT COMPENSATING MEANS

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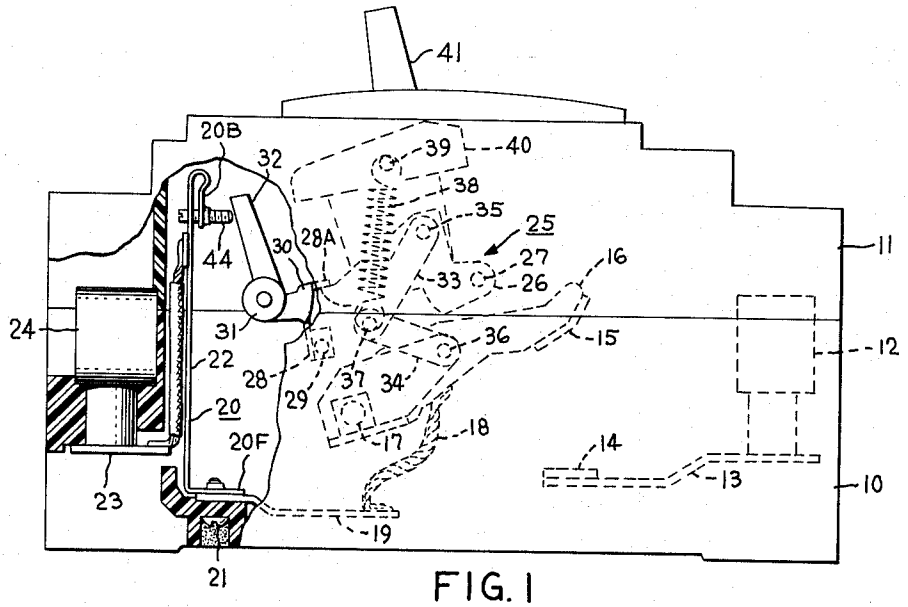


FIG. 1

FIG. 2

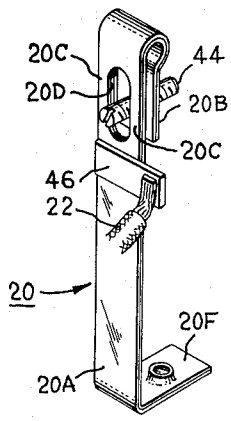


FIG. 3

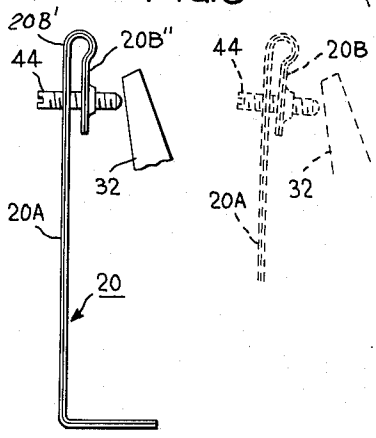
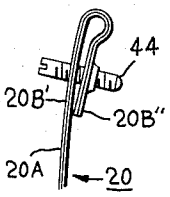


FIG. 4



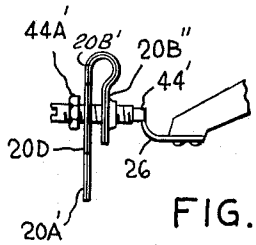


FIG. 5

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CIRCUIT BREAKER WITH AMBIENT COMPENSATING MEANS

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Our invention relates to electric circuit breakers, and more particularly to electric circuit breakers incorporating current responsive means of the thermal acting type, together with means for compensating the response of the current responsive means in accordance with the temperature of the medium in which the circuit breaker is located, such as the ambient atmosphere.

While various arrangements have been devised to provide a compensating action in accordance with ambient temperature, such arrangements have ordinarily added significantly to the cost and complication of the basic device.

It is an object of the present invention to provide an electric circuit breaker including thermally acting current responsive means including means providing ambient temperature compensation, which is extremely simple and inexpensive, and yet effective and dependable.

It is another object of the invention to provide an electric circuit breaker including current responsive means providing ambient compensation which is of limited extent. Thus ambient compensation is provided through a predetermined range of elevated ambient temperatures, but such compensating action is discontinued upon reaching a certain predetermined elevated temperature. This provides a safety factor, since it is desirable that tripping occur at extremely elevated temperatures of the device even if such temperatures are due exclusively to high ambient temperature rather than high current.

It is another object of the invention to provide a circuit breaker including a tripping element having a first portion which is responsive to heat generated by electric current passing through the circuit breaker, and a second portion which is responsive to ambient temperature, and thermal barrier means between the first and second portions for obstructing the flow of heat from the first portion to the second portion.

In accordance with the invention in one form, an electric circuit breaker is provided of the molded case type including at least one pair of relatively separable contacts and mechanism for operating the contacts including a releasable trip member which, when released, causes automatic opening of the contacts. Means is provided for causing release of the releasable trip member comprising a thermally acting current responsive member in the form of an elongated bimetallic strip. The bimetallic strip is arranged to deflect under certain conditions and to move a latch member to cause release of the releasable member and automatic opening of the contacts. In accordance with the invention the bimetallic strip comprises a first portion connected electrically in series with the contacts, and a second integral portion which does not carry current. The second portion is return-bent, and the end thereof remote from the current-carrying portion acts to cause release of the releasable means.

The first or current-carrying portion comprises a portion adjacent a fixedly-mounted end of the bimetallic strip, and the second or compensating portion comprises a return-bent portion at the movable end of the strip. Because of this arrangement, deflection of the current-carrying portion tends to move the actuating portion in a first direction, and deflection of the return-bent portion, i.e., opening or closing of the bend, tends to move it in the opposite direction.

In accordance with the invention, means is provided for limiting the effect of the return-bent portion and hence the temperature range over which compensation occurs. Thus in a first form, the configuration is dimensioned so that deflection over a first range of temperature causes the return-bend portion to completely close up on itself, after which no further compensation can take place.

In a second form, the return-bent portion carries a calibrating screw which passes through an opening in the opposite portion of the strip and carries an adjustable stop-nut which acts to limit opening of the return-bend.

In accordance with another aspect of the invention, the second portion is thermally isolated by greatly reducing the cross-section of the bimetallic strip between the return-bent portion and the first or current-carrying portion.

In accordance with the invention in a particular form, the thermal isolation referred to is provided by an elongated opening through the bimetallic strip, providing a pair of relatively long, narrow sections between the two portions which acts as an effective thermal barrier. In addition, the opening permits passage of a calibrating screw carried by the free end of the ambient compensating portion.

In accordance with a further aspect of the invention, a "heat sink," comprising a metallic body, is attached to the thermal strip adjacent the reduced section portion but on the current-responsive side thereof, to further aid the thermal barrier action.

The invention will be more fully understood from the following detailed description, and its scope will be pointed out in the appended claims.

In the drawing,

FIGURE 1 is a side elevation view of an electric circuit breaker embodying the invention;

FIGURE 2 is a perspective view of the bimetallic strip assembly of FIGURE 1;

FIGURE 3 is a side elevation view of the tripping element of the breaker of FIGURE 1, showing the ambient compensating action;

FIGURE 4 is a view of a portion of the tripping element showing the compensation-limiting action; and

FIGURE 5 is a fragmentary view of another embodiment of the invention.

In the drawing, the invention is shown in FIGURE 1 as incorporated in an electric circuit breaker comprising a molded insulating casing including a base **10** and a cover **11**. An incoming or line terminal **12**, which may be of any suitable design, is supported in the base **10** and electrically connected to a conductive strap **13** at one end, which strap supports a stationary contact **14** at its other end.

A movable contact **15** is carried by a contact arm **16** which is pivotally supported for rotation about the pivot **17**, and is electrically connected by means of a flexible conductive braid **18** to a conductive strap **19**. The conductive strap **19** is connected to the bent-over foot portion **20F** of an elongated bimetallic strip **20** by suitable means, such as by a screw **21**. The bimetallic strip **20** is connected by a second flexible conductive braid **22** to a conductive plate **23** to which is connected an outgoing or load terminal **24**.

For the purpose of manually moving the movable contact **15** into and out of engagement with the stationary contact **14**, and for permitting automatic movement of the contact **15** from closed position to open position upon the occurrence of predetermined current conditions, operating mechanism is provided which is indicated generally at **25**. The operating mechanism **25** includes a releasable cradle member **26** which is pivotally supported upon a pivot **27**, which is fixedly supported by suitable means, not shown, with respect to the base **12**. The releasable

member 26 is normally latched, as shown in FIGURE 1, by means of a first latch member 28 which is pivotally supported on a fixed pivot 29 in the base 10. The first latch member 28 has a bent-over portion 28A which normally restrains the end of the releasable member 26. The first latch member 28 is normally maintained in its latching position by means of a second latch member 30, carried by a trip bar 31 having an integral extension 32.

The contact member 16 is disposed and arranged to be operated between the open circuit position as shown in FIGURE 1 and a closed circuit position, by means of a pair of toggle links 33, 34 which are connected to the releasable member 26 and to the contact arm 16 by pivot pins 35, 36, respectively. The toggle links 33, 34 are interconnected by a knee pin 37. The toggle links 33, 34 are operated between collapsed position as shown in FIGURE 1 and a straightened position, by means of a pair of tension type operating springs 38 each having one end connected to the knee pivot pin 37 of the toggle links 33, 34, and the other end connected to a pin 39 which is carried by a manually operable member 40, disposed and arranged to operate reciprocally on an arc about a fixed pivot, not shown, mounted in the base 10. The manually operable member 40 includes a manually engageable handle portion 41 projecting outwardly through an opening in the top wall of the casing cover 11. When the handle member 41 is moved from the position shown in FIGURE 1 to the right, it carries the upper end of the operating springs 38 to the right as viewed, until the line of action of the springs (extending between the pins 37 and 39) passes across the pivot pin 35 of the upper toggle links 33. When this occurs, the toggle links move to straightened position with a snap action, moving the movable contact to closed circuit position. Reverse movement of the handle 41 produces reverse action of the toggle links returning them to collapsed position and returning the movable contact to open circuit position.

Upon release of the releasable member 26 from the latch member 28, when the parts are in the closed-circuit position, the force of the operating springs 38 causes clockwise rotation of the releasable member 26. Clockwise rotation of the releasable member 26 carries the upper end of the toggle links 33, 34 upwardly and to the right, causing opening movement of the contact 15 from the stationary conduit 14. This action is followed by collapsing of the toggle linkage and movement of the contact arm to full open position, the handle returning partway toward open circuit position to a mid or trip-indicating position, at which time the pin 42 carried by the manually operable member 40 engages a portion of the releasable member 26. Resetting is accomplished by manually moving the handle member 41 to the full left position as shown. This causes the pin 42 to move the releasable member 26 counterclockwise until it again becomes in latched engagement with the latch member 28.

The operating mechanism just described is shown and described in fuller detail in Patent No. 3,005,066, D. B. Powell, issued October 17, 1961, and assigned to the same assignee as the present invention. It will be understood that this mechanism is shown for illustration purposes only, and that the invention may be used with a great many different mechanisms which include releasable opening means.

For the purpose of causing automatic opening of the contacts upon the occurrence of predetermined current conditions, a thermally acting current-responsive element is provided, comprising bimetallic strip 20.

Referring particularly to FIGURE 2, the bimetallic strip 20 includes a first portion 20A, comprising the portion between the terminal strap 19 and the braid 22, which is connected electrically in series with the contacts 14, 15. The bimetallic strip 20 also includes a second portion 20B which may be described as generally U-shaped, and includes a first section 20B' extending in substantially straight-line alignment with the portion 20A, and a second portion 20B'' extending in parallel spaced relation to the first section, and a bend joining the first and second sections.

The portions 20A and 20B are interconnected by a thermal barrier portion comprising two spaced apart relatively long, narrow side portions 20C defining an elongated opening 20D.

For the purpose of adjusting the action of the element 20, a calibrating screw 44 is provided which is threadedly engaged in the portion 20B and which extends through the opening 20D.

Referring now to FIGURE 1, it will be observed that deflection or warping of the bimetallic strip 20 in a sense such as to move the upper end thereof to the right, will cause the calibrating screw 44 to move to the right to engage the extension 32 of the trip 31, rotating the trip bar 31 clockwise. Rotation of the trip bar 31 clockwise carries with it the second latch member 30, disengaging the latch member 30 from the first latch member 28. This permits the first latch member 28 to rotate slightly counterclockwise, releasing the releasable member 26, and opening the circuit breaker. Upon resetting of the releasable member 26, the end of the releasable member 26 strikes the base portion of the first latch member 28, rotating it again slightly clockwise and permitting the parts to reset by action of a spring (not shown) acting on the trip bar 31.

The ambient temperature compensating action of the bimetallic strip of the present invention is illustrated particularly in FIGURES 3 and 4. FIGURE 3 illustrates, in dotted lines, the type of deflection which occurs when the bimetallic strip assembly experiences a rise in temperature due to an increase in the temperature of the ambient atmosphere only. In this case, the bimetallic strip is uniformly heated throughout. The high-expansion side of the bimetallic strip is at the left of the first portion 20A as viewed. Thus the portion 20A warps so as to move the upper end to the right as viewed. This would ordinarily move the end of the calibrating screw 44 to the right as viewed, operating the trip bar extension 32. At the same time, however, the compensating portion 20B is also heated, thus causing the loop portion to close up, thereby moving the calibrating screw to the left as viewed, and correcting for the movement caused by the first portion. As a consequence, the end of the calibrating screw 44 remains substantially unmoved.

When the first portion 20A of the bimetallic strip is heated by the action of current passing therethrough, however, the return-bent portion 20B is not significantly heated by such current due to the fact that the current does not pass through this portion, and also to the fact that this portion is thermally isolated by means of the strips 20C. The temperature of the portion 20A will therefore be higher than the temperature of the portion 20B. The flow of heat by conduction from the portion 20A to the portion 20B is further inhibited by the action of a "heat sink" member comprising metallic piece 46, which is attached to the bimetallic strip 20 adjacent the reduced section portions 20C, and which is extended sidewise to support the braid 22. The block of metal 46 acts as a substantial "heat sink" at this point, and further decreases the flow of heat from the portion 20A toward the portion 20B especially as regards short-time heat rises.

In accordance with the invention, means is also provided for limiting the compensating action provided. In accordance with this aspect of the invention, the initial spacing of the section 20B' of the portion 20B from the section 20B'', is such that after an increase of temperature of the portion 20B to a predetermined extent, the bend of the portion 20B closes up on itself, as illustrated in FIGURE 4 until section 20B'' of the portion 20B engages section 20B'. It will be obvious that when this occurs, further increase of ambient temperature cannot produce

further compensating action. This is desirable for safety reasons, since it is ordinarily desirable to have the circuit breaker trip whenever the temperature within or around the device exceeds a predetermined point, from any cause whatever. We have found that a desirable limiting action is obtained when the spacing of the portion **20B** from the corresponding portions **20C** is not greater than 2 times the thickness of the bimetallic strip used, and preferably *less than* such thickness. Thus in a particular example, a bimetallic strip of .050" is used with a gap or spacing of .031".

In the form of the invention shown in FIGURE 5, the calibrating screw **44'** is of the latch-retaining type, and serves to hold a releasable member such as **26'** directly. In the form of the invention illustrated in FIGURES 1–4, the high expansion side of the main portion of the bimetallic strip is on the *left* as viewed. In the form of the invention shown in FIGURE 5, the high expansion side of the main portion of the bimetallic strip is on the *right* as viewed. Thus the action of the return bent portion **20B'** is to open when heated, and thus to move the latch-screw **44'** to the right, in opposition to the tendency of the main portion **20A'** which is to move it to the left.

The calibrating screw **44'** carries an enlargement at the opposite side of the portion **20A'** comprising an adjustable stop nut **44A'** which is disposed and arranged to engage the portions of the strip adjacent the opening **20D'** to limit the amount of opening of the return-bent portion **20B'**. Since the nut **44A'** is adjustable, its position can be varied to vary the temperature beyond which the compensating action is ineffective. The nut **44A'** is preferably fixed in position after adjustment by suitable means, such as by soldering.

While the invention has been described in connection with only two specific embodiments, it will be readily apparent that many modifications thereof may readily be made by those skilled in the art, and it is therefore intended by the appended claims to cover all such modifications as fall within the true spirit and scope of the invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. An electric circuit breaker comprising:

(a) an insulating casing;

(b) at least one pair of relatively movable contacts in said insulating casing;

(c) operating mechanism in said casing for said relatively movable contacts comprising a trip member releasable to cause automatic opening of said contacts;

(d) a current responsive element comprising an elongated strip of bimetallic material rigidly mounted at one end thereof in said insulating casing;

(e) said bimetallic strip having a first, substantially straight, portion adjacent said rigidly mounted end;

(f) said bimetallic strip having a second, generally U-shaped, portion remote from said rigidly mounted end, said U-shaped portion including a first section extending in substantially straight-line alignment with said first portion and a second section extending in parallel spaced relation to said first section;

(g) means for heating said first portion only of said bimetallic strip in accordance with current passing through said contacts;

(h) tripping means carried by said second section of said bimetallic strip, said tripping means being moved in a first direction by said first portion of said bimetallic strip upon deflection thereof in accordance with

current through said contacts to cause release of said trip member and opening of said contacts;

(i) said tripping means being moved in a direction opposite to said first direction upon movement of said second section of said U-shaped portion of said bimetallic strip with respect to said first portion in response to an increase in ambient temperature to provide an ambient-temperature compensating action, and

(j) means limiting movement of said second section with respect to said first section to limit said ambient temperature compensating action.

2. An electric circuit breaker as set forth in claim **1** wherein said U-shaped portion of said bimetallic strip closes on itself upon an increase in ambient temperature and said first section is spaced from said second section not substantially more than twice the thickness of said bimetallic strip, whereby said second section engages said first section to limit said embient compensating action.

3. An electric circuit breaker as set forth in claim **1** wherein said U-shaped portion of said bimetallic strip opens up upon an increase in ambient temperature, and means carried by one of said sections for engaging the other of said sections upon predetermined separation of said sections to limit said ambient compensating action.

4. An electric circuit breaker as set forth in claim **3** wherein said means carried by one of said sections comprises a screw threadedly engaged in said one section and extending through an opening in the other of said sections and having an abutment thereon at the side of said other section opposite to said one section larger than said opening.

5. An electric circuit breaker as set forth in claim **1**, wherein said current responsive element also comprises:

(a) an opening in said first section of said U-shaped portion adjacent said first portion of said bimetallic strip;

(b) a rigid metallic heat sink member attached to said bimetallic strip between said first portion and said U-shaped portion and having a portion extending to one side of said strip;

(c) said means for heating said first portion in response to current through said contacts comprising means connecting said first portion electrically in series with said contacts, said connecting means comprising a flexible conductor having one end connected to said extending portion of said heat sink member and a second conductor connected to said rigidly mounted end of said bimetallic strip, and

(d) a calibrating screw threadedly engaged in said second section of said U-shaped portion and including a portion extending through said opening in said first section whereby said calibrating screw is accessible for adjustment from the side of said bimetallic strip opposite from said second section.

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