BIMETALLIC STRIP THERMALLY RESPONSIVE DEVICE

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INVENTOR.

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HIS ATTORNEY
My invention relates to thermally responsive bimetallic devices and particularly to such devices which are adapted to be used in electric circuit breakers and to be heated by current carried by such circuit breakers to constitute a current-responsive control therefor, such as to trigger an automatic opening operation on the occurrence of certain predetermined current conditions.

In such circuit breaker applications, it is desirable that the current-responsive device be very sensitive to changes in current and capable of being accurately pre-set or "calibrated" to cause automatic opening or "tripping" at certain closely predictable times. It is also desirable however that such device not be subject to being falsely actuated by outside physical forces such as by sudden shocks or by vibration. This is especially important in circuit breakers used in airplanes and on shipsboard and is of critical importance in circuit breakers used by the armed forces.

Prior art devices in which attempts have been made to add rigidity and shock resistance to current-responsive bimetallic devices are subject to various deficiencies. In some cases, such devices suffer a loss of sensitivity; in other cases, such devices develop high stresses internally or at their mounting points, with resultant loss in accuracy of calibration and decrease in their ability to do useful work.

The use of conventional or non-shock-resistant bimetallic strip devices for current-responsive devices in circuit breakers has also been limited in the low-current ranges in the past because the amount of working force available with conventional structures when energized by such low currents is too small.

It is an object of my invention to provide a current-responsive bimetallic device which is highly shock resistant and is also very sensitive.

It is a further object of my invention to provide such a current-responsive device which develops high working force and which may be accurately calibrated or pre-set.

In accordance with my invention in one form, I provide a current-responsive bimetallic strip device including a first straight strip portion having one end supported on a circuit breaker casing and having its other end arranged to engage a trip member of the circuit breaker, and a second, reinforcing strip portion having one end essentially connected to the working end of the first bimetal and having its other end supported on the breaker casing at a point spaced from the supporting point of the first portion, so as to brace the first portion, at least one of the supported ends of the assembly being supported on the casing by means providing for pivotal movement of the bimetallic strip portion thereof.

In accordance with another aspect of my invention, I support the bracing bimetallic strip at a point approximately half-way between the ends of the main portion of the bimetallic strip, whereby the bracing portion is made much more rigid than it otherwise would be.

In accordance with still another embodiment of my invention, I provide a structure as outlined above in which both of the supported ends of the bimetallic assembly are supported by pivotal means, whereby substantially all stresses in the bimetallic strip, such as would prevent it from deflecting freely when not loaded, are relieved.

My invention will be more fully understood from the following detailed description and its scope will be pointed out in the appended claims:

Figure 1 is a side elevation view and longitudinal section of a circuit breaker incorporating a bimetallic tripping device in accordance with my invention, and shown in normal or unheated condition;

Figure 2 is a detached perspective view showing parts of the bimetallic current-responsive device of Figure 1 and its mounting in exploded relation;

Figure 3 is a fragmentary sectional view of the circuit breaker of Figure 1, the bimetallic current-responsive device being shown in the position which it assumes on the occurrence of moderate heating;

Figure 4 is a view similar to Figure 3 but showing a second embodiment of the invention, the parts being shown in normal or unheated condition;

Figure 5 is a fragmentary end view of the circuit breaker of Figure 1, the cover being omitted;

Figure 6 is a perspective view of the terminal portion of the device of Figure 4, the parts being shown in exploded relation;

Figure 7 is a view similar to Figure 3 but showing a third embodiment of the invention, the parts being shown in the normal or unheated condition.

My invention is shown in a circuit breaker including an insulating housing comprising a base 10 and a cover 11, and provided with a line terminal 12 and a load terminal 13.

The circuit breaker operating mechanism may be of any suitable type. I have shown my invention as used with an operating mechanism as shown and described in Patent #2,455,753 issued December 7, 1948, to B. E. Getchell and assigned to the same assignee as the present invention. The operating mechanism includes a movable contact arm 14 rigidly attached to a cross arm 15 pivotally supported at its ends by suitable supporting brackets (not shown) mounted in the casing base 10. The contact arm 14 is adapted to be manually moved between "open" and "closed" position by mechanism including a pair of toggle links 16 and 17. The toggle links 16 and 17 are adapted to be moved to a collapsed condition to move the movable contact arm upwardly to "open" position, and conversely to be moved to a straightened condition to move the contact arm downwardly to "closed" position. The toggle linkage is adapted to be operated between such collapsed and straightened positions in this manner by means of a hand handle member 18 which is pivotally supported in lugs 19 of a U-shaped frame member 20, and is connected to the knee of the toggle linkage by tension springs 21.

A releasable holding member 22, pivoted on a pin 23 journaled in the frame 29 supports the upper end of the upper toggle link 16. The releasable holding member 22 has a latch portion 24 adapted to be releasably held by a generally L-shaped intermediate latch member 25, also pivotally supported on the frame member 20. The intermediate latch member 25 in turn is releasably held by a latch surface 26 carried by a rotatable trip member 27. The intermediate latch member 25 is also provided with an aperture into which the latch surface 26 is adapted to move upon a predetermined amount of clockwise rotation of the trip member 27, to permit the intermediate latch member 25 to rotate slightly counterclockwise,
thereby releasing the holding member 22 and permitting automatic opening of the contacts. The resetting of the trip member 23 after an automatic opening operation is accomplished by moving the handle member 18 counterclockwise to the extreme "off" position, during which movement a portion of the handle 18 engages the trip member 23 and rotates it in counterclockwise direction until the latch surface 24 once again engages and is held by the intermediate latch member 25.

In an improved shock-resistant bimetallic current-responsive device 40 for the purpose of rotating the trip bar 27 to cause tripping upon the occurrence of predetermined current conditions, as shown particularly in Figures 2 and 3. The current-responsive device 40 comprises an elongated substantially straight strip of bimetallic material 28 having a generally U-shaped mounting bracket 29 rigidly attached to one end thereof by suitable means as by welding. The U-shaped bracket 29 has a projecting lug portion 29' which provides a seat for connecting a flexible conductor 30 thereto by suitable means such as by brazing. The U-shaped bracket 29 is pivotally supported on the base 10 by a relatively stationary U-shaped supporting bracket 31 to which it is connected by a pivot pin 32 passing through corresponding holes in both members. The U-shaped bracket 31 is fixedly attached to the base 10 by means of an anchoring screw 33 which is threadedly engaged in a molded insert bushing 34 carried by the base 10. The bimetallic strip 28 has rigidly attached to its upper end, one end of a generally L-shaped bimetallic bracing member 35. The bracing member 35 has its opposite end rigidly attached to the terminal member 13 by suitable means such as by welding, and the terminal 13 is in turn fixedly anchored to the base 10 by means of an insert 36 which has its upper end 37 spun over the terminal 13, and which has a central bore through which receive the terminal screw 38.

The junction of the strips 28 and 35 has a tapped hole therein to receive a calibration screw 39 which may be adjusted during assembly of the device and then fixed in position by suitable means such as by soldering. The bimetallic strip 28 has its high expansion side on the left as viewed in Figures 3 and 4, and the bimetallic strip 35 likewise has its high expansion side on the left as viewed in Figures 3 and 4. Because of this arrangement the movable ends of both strips 28 and 35 deflect to the right as viewed in these figures when heated by current passing therethrough. It will be observed that in the heated condition shown in Figure 3, the bimetallic strip 28 assumes a generally arcuate condition and the bimetallic strip 35 tends to straighten slightly. It will also be observed that the mounting bracket 29 fixedly carried by the end of the strip 28 has rotated slightly counterclockwise about the pin 32. It has been confirmed by test that with the configuration shown there is no inherent tendency for any part of this configuration to move otherwise than as shown in the figures. Since the bracket 29 is free to rotate on the pin 32, there is no restraining force other than the work required to move the trip member 27. Hence, no incidental stresses are set up in the bimetallic configuration or in the mounting base. This has been clearly demonstrated by experiments in which the pin 32 is removed with the parts in the condition indicated in Figure 4 and then expanded through the assembly, the parts heating and deflecting to the condition shown in Figure 3. During this deflection it has been observed that the apertures in the U-shaped bracket 29 and the mounting bracket 31 remain in perfect alignment, showing that the only relative motion between the bracket 29 and the support 31 is a motion of rotation about the center of the pins 32.

In Figure 4 I have shown another embodiment of my invention in which the lower end of the straight strip 28' is fixedly attached to the base 10', and the end of the bracing portion 35' is attached to the base 10' by a pivotal supporting means. In this construction the end of the bimetallic strip 35' has attached thereto a right-angle bracket 41 adapted to be mounted in juxtaposed relation to a right-angle shaped terminal 13'. It is attached to the base 10' by means of the insert 36'. The bracket 41 is pivotally joined to the terminal 13' by means of a suitable pivot pin such as shouldered screw 42 adapted to pass through the aligned holes in the members 41 and 13' and to hold these members together with a predetermined force, as determined by spring washer 43 retained by nut 44.

In this form, as the bimetallic strip 28' deflects to the right, the bracing member 35' straightens slightly and the bracket 41 rotates slightly counterclockwise about the pivot 42.

In Figure 7 I have shown another embodiment of my invention in which both mounted ends of the assembly are pivotally supported on the base 10. It has been found that when both ends are pivotally supported in this manner, the working force available is still further increased beyond that provided by pivoting either end individually.

It has also been observed by test that the working force available at the movable end of the assembly by contact with calibrating screw 39 is substantially greater than the force developed by a single cantilever-mounted type bimetal.

Bimetallic strip current-responsive devices made in accordance with my invention are rigid in all conditions of deflection and substantially unaffected by sudden jarring forces exerted on the circuit breaker as well as by vibration.

Comparative tests were conducted for the purpose of determining the amount of usable work available by bimetallic strip assemblies in accordance with my invention as compared (a) to a simple straight cantilever-mounted bimetal, and (b) to a simple cantilever-mounted bimetal braced by a L-shaped bracing member but with both mounted ends of the assembly fixedly attached to the circuit breaker casing. For this purpose an equal force of .57 pound was applied to the working end of each bimetallic strip assembly in a direction to restrain deflection, an equal current (20 amperes) was passed through each assembly, and the maximum amount of deflection against this force in the steady state was noted as follows:

<table>
<thead>
<tr>
<th>Work, lb. in.</th>
<th>Percent of simple bimetal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Simple bimetal</td>
<td>100</td>
</tr>
<tr>
<td>2. Bimetal with flat ends</td>
<td>.985</td>
</tr>
<tr>
<td>3. Applicant's embodiment as in Figure 1</td>
<td>.985</td>
</tr>
<tr>
<td>4. Applicant's embodiment Figure 4</td>
<td>.978</td>
</tr>
<tr>
<td>5. Applicant's embodiment Figure 5</td>
<td>.975</td>
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</tbody>
</table>

While only three specific embodiments of my invention have been shown, it will be apparent that many modifications thereof may be made without departing from the scope of my invention and I therefore intend by the appended claims to cover all such modifications as fall within the true spirit and scope of my invention.

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

1. A thermally responsive device comprising a support, a first bimetallic strip portion having one end thereof pivotally mounted on said support and having its other end spaced away from said support, a second bimetallic strip portion having one end thereof pivotally mounted on said support and having its other end connected directly to the said other end of said first bimetallic strip portion, said first and second strip portions extending in the same general direction from the point of connection of said connected ends, and means for passing electric current through both of said strip portions in series.
2. A thermally responsive device comprising a support, a substantially straight bimetallic strip portion having one end fixedly and non-rotatably mounted on said support and having its other end spaced away from said support, a second bimetallic strip portion having one end thereof pivotally mounted on said support and including a generally L-shaped operative intermediate portion and having its other end connected directly to said other end of said first bimetallic strip portion, and means for passing an electric current through said strip portions in series.

3. A thermally responsive device comprising a support, a substantially straight bimetallic strip portion having one end pivotally mounted on said support and having its other end spaced away from said support, a second bimetallic strip portion having one end fixedly and non-rotatably mounted on said support and having a generally L-shaped operative intermediate portion and having its other end connected directly to said other end of said straight bimetallic strip portion, said first and second strip portions extending in the same general direction from the point of connection of said connected ends, and means for passing an electric current through both of said strip portions in series.

4. A thermally responsive device, comprising a support, a first substantially straight bimetallic strip portion having one end thereof pivotally mounted on said support and having its other end spaced away from said support, a second bimetallic strip portion having one end thereof pivotally mounted on said support and having a generally L-shaped operative intermediate portion and having its other end connected directly to said other end of said first bimetallic strip portion, said first and second strip portions extending in the same general direction from the point of connection of said connected ends, and means for passing an electric current through both of said strip portions in series.

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