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K. W. KLEIN ET AL  
CIRCUIT BREAKER WITH REMOVABLE TRIP UNIT HAVING  
IMPROVED MOUNTING MEANS FOR TERMINAL STRAP  
AND THERMAL RESPONSIVE MEANS

3,264,435

Original Filed June 25, 1962

3 Sheets-Sheet 1

FIG. 1.

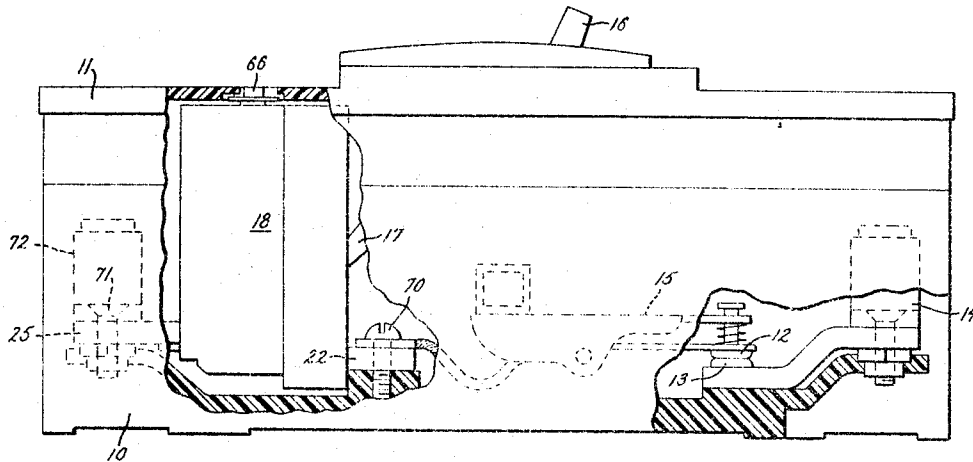


FIG. 3.

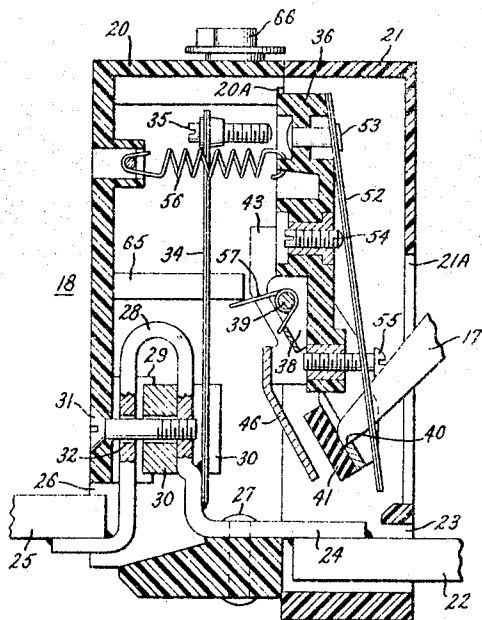
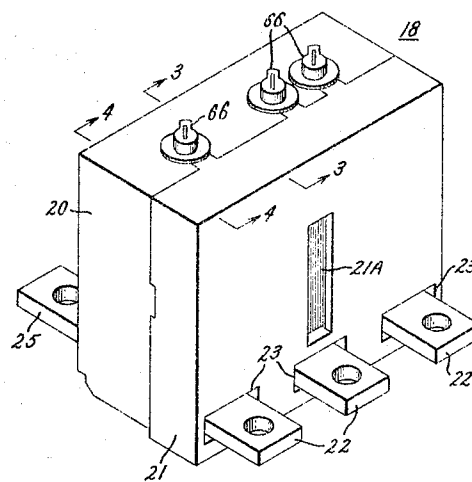


FIG. 2.



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FIG. 4.

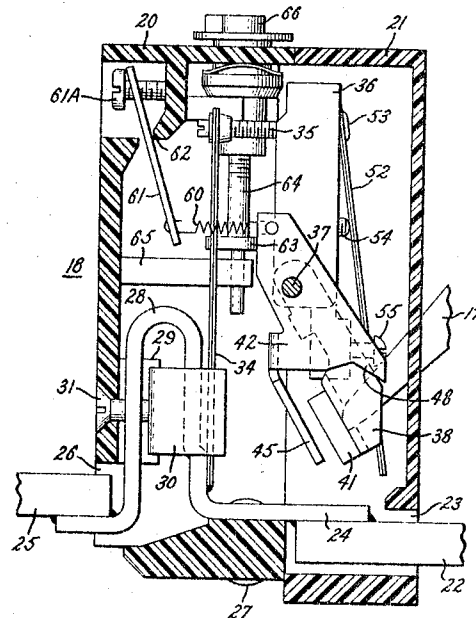


FIG. 5.

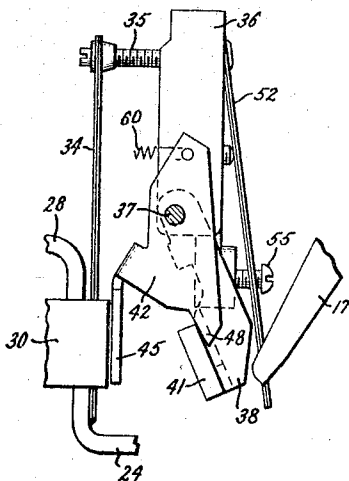
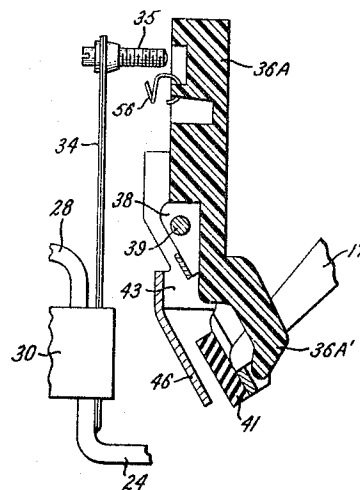


FIG. 6.



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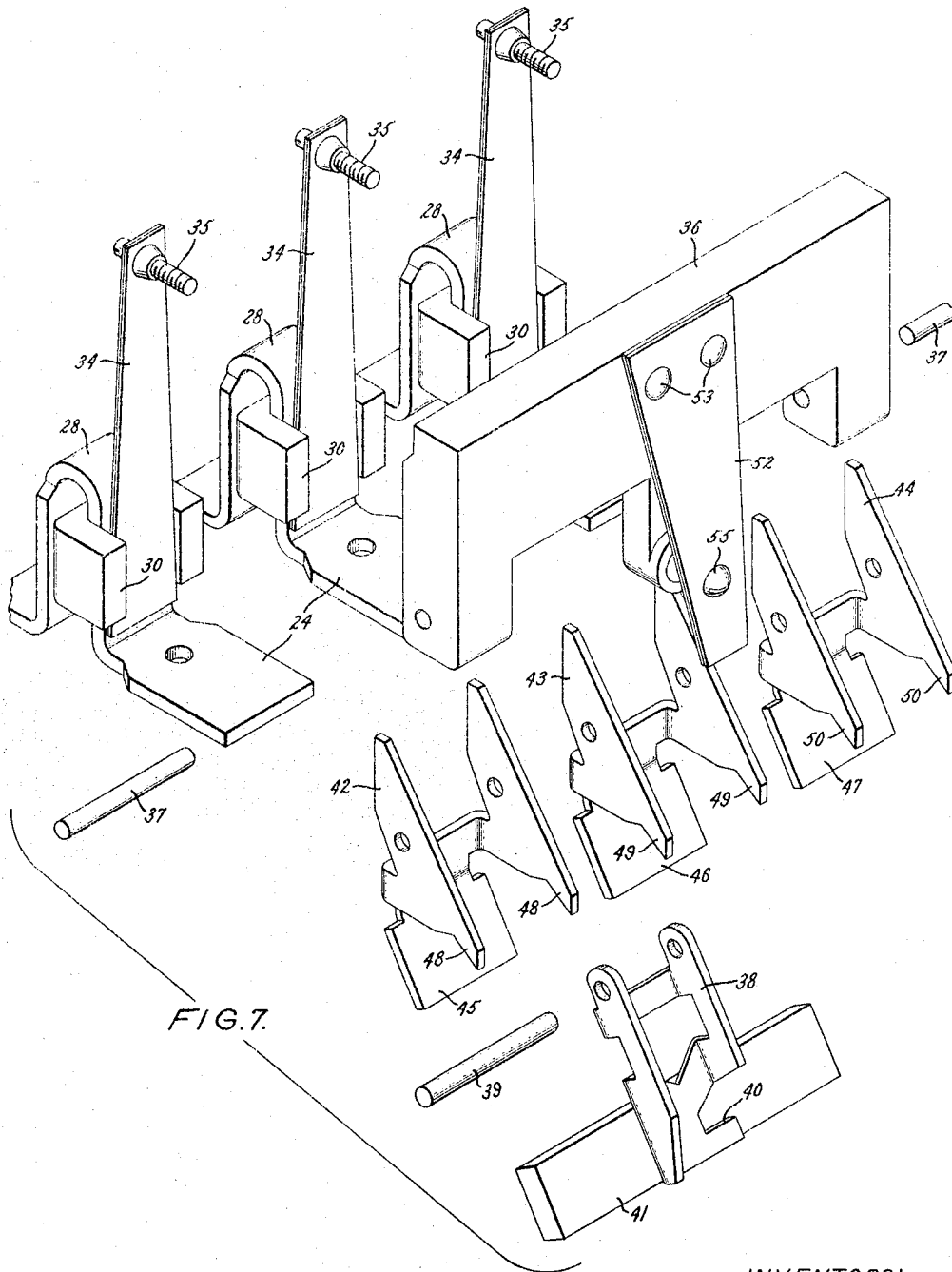
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3,264,435

**CIRCUIT BREAKER WITH REMOVABLE TRIP UNIT HAVING IMPROVED MOUNTING MEANS FOR TERMINAL STRAP AND THERMAL RESPONSIVE MEANS**

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Original application June 25, 1962, Ser. No. 204,730, now Patent No. 3,162,739, dated Dec. 22, 1964. Divided and this application July 6, 1964, Ser. No. 381,016  
4 Claims. (Cl. 200—116)

This application is a division of application Serial No. 204,730 filed June 25, 1962, now Patent 3,162,739, assigned to the same assignee as the present invention.

The present invention relates to electric circuit breakers, and particularly to electric circuit breakers incorporating thermal and magnetic tripping means.

One of the most difficult problems in the electric circuit breaker art is the provision of a device which can be readily adjusted or "calibrated" to open automatically and precisely, within certain defined limits, upon the occurrence of any of a number of predetermined current conditions therethrough. This is especially true of circuit breakers incorporating both thermal and magnetic tripping means, which means must be adjusted or calibrated separately.

Circuit breakers of conventional prior art construction are often difficult to adjust or calibrate because of certain practically unavoidable variations in construction or assembly of parts. Similar difficulties are caused by undesirable inter-effects of the thermal and magnetic tripping means. Also, calibration of such breakers is often affected by mounting of the trip device in the breaker proper, and also by stresses created in such mounting means by the attachment of heavy conducting cables to the circuit breaker terminals.

It is an object of the invention to provide an electric circuit breaker of the type described in which the mounting of the trip device in the breaker proper does not adversely affect the calibration of the trip device, and in which the connection of heavy current conducting cables does not adversely affect the calibration of the trip device.

In accordance with the invention, an electric circuit breaker is provided comprising thermal and magnetic tripping means contained in a separate, removable housing or "trip unit." The trip unit has terminal straps projecting therefrom on the incoming and outgoing sides, by means of which it may be bolted in place in the circuit breaker. The terminal strap mounting and construction, and the thermal current responsive means mounting and construction, are such that even through the terminal members may be partially distorted when the trip unit is mounted in a circuit breaker, because of unevenness in the breaker casing or other causes, the relationship of the thermal current tripping means to the remainder of the trip unit mechanism is not disturbed, and therefore the calibration of the trip unit will not be adversely affected by the mounting of the unit in the circuit breaker.

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

In the drawings,

FIGURE 1 is a side elevation view, with portions broken away, of an electric circuit breaker incorporating the invention;

FIGURE 2 is a perspective view of the tripping assembly or trip unit of the circuit breaker of FIGURE 1;

FIGURE 3 is a sectional view of the trip unit of FIGURE 2, taken generally on the line 3—3 of FIGURE 2;

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FIGURE 4 is a sectional view of the trip unit of FIGURE 2, taken generally on the line 4—4 of FIGURE 2; FIGURE 5 is an elevation view of a portion of the trip mechanism of FIGURE 2;

FIGURE 6 is a view similar to FIGURE 5 but showing a modified form of the invention, and

FIGURE 7 is an exploded perspective view of the trip mechanism of FIGURE 2.

In the drawings, the invention is shown as incorporated in an electric circuit breaker comprising a generally rectangular insulating casing including a base 10 and a cover 11. Three pairs of relatively movable contacts 12, 13 (only one pair shown), are provided in the base 10. Each stationary contact 13 is connected to a corresponding line terminal 14. Each movable contact 13 is carried by a contact arm 15. The movable contact arms 15 are adapted to be operated in unison between open and closed positions by means of an operating mechanism, not shown, which is capable of being operated by a manually engageable handle 16, projecting through an opening, not shown, in the casing cover 11.

The operating mechanism may be of any suitable type, such, for instance, as shown in Patent No. 2,921,169, E. B. Judd et al., issued January 12, 1960, and assigned to the same assignee as the present invention, including a releasable member 17 arranged to cause automatic opening movement of the movable contacts 12 when released.

For the purpose of holding the member 17, and releasing it upon the occurrence of predetermined current conditions through any of the three pairs of contacts 12, 13, tripping mechanism is provided comprising a trip unit designated generally as 18.

The trip unit 18 comprises a first insulating casing part 20, and a cooperating second insulating casing part 21. The casing parts 20, 21 cooperate to form a closed box-like enclosure for the tripping mechanism. The releasable member 17 projects into the casing of the trip unit 18 through an opening 21A in the casing part 21, and is held by a means to be described.

A set of three first terminal members 22 is provided, projecting through openings 23 in the casing part 21. Each of the terminal members 22 is rigidly attached, such as by brazing, to one end of a corresponding strap-like conductor 24, to be more fully described.

A set of three second terminal members 25 is also provided, projecting through openings 26 in the casing part 20. Each of the terminal members 25 is rigidly attached, such as by brazing, to the other end of a corresponding conductor 24.

Each conductor 24 is rigidly attached to the casing part 20 by suitable fastening means such as rivet 27. Each conductor 24 includes a generally U-shaped intermediate portion 28, of smaller cross-section than the said end portions, for a purpose to be described.

The casing part 20 includes, adjacent each of the conductors 24, a pair of abutments or bosses 29, only one shown, positioned respectively, at opposite sides of said conductor 24.

A generally U-shaped magnet 30 is supported adjacent each strap 24, in such a way that its bight portion rests against the two corresponding abutments 29. The side portions of each magnet 30 extend on opposite sides of a corresponding conductor 24.

The leg of the intermediate U-shaped portion of the conductor 24 which passes through the magnet 30 is rigidly anchored with respect to the casing part 20 by means of a screw 31. The screw 31 passes through an opening in the casing part 20, through an enlarged clearance hole 32 in one leg of the intermediate portion 28 of the conductor 24, through a clearance hole in the bight portion of the magnet 30, and into threaded engagement with the other leg of the intermediate portion 28.

Thus the screw 31 serves to press one leg of the portion 28 of the conductor 24 against the bight portion of the magnet 30, and this in turn against the abutments 29 of the casing part 20. It will be noted, however, that the other leg of the portion 28 extends freely and with ample clearance through the space provided between the magnet 30 and the outer wall of the casing part 20.

Thermal current-responsive means is provided comprising a bimetallic strip 34, rigidly attached at one end to each of the conductors 24 by suitable means such as by welding or brazing. Each bimetallic strip 34 carries an adjusting or calibrating screw 35 in threaded engagement therewith at its free end, for a purpose to be described.

A thermal trip bar 36 is also provided, pivotally supported within the trip unit enclosure on a pair of pivot pins 37 which are trapped between the casing parts 20 and 21 (see FIGURE 7). The thermal trip bar 36, as shown particularly in FIGURE 7, extends across the full width of the trip unit 18, and is adapted to be engaged by the calibrating screws 35 of each of the bimetallic strips 34.

A latch member 38 is also pivotally supported on the trip unit 18, on a pivot pin 39, also trapped between the casing parts 20, 21. The pivot pin 39 extends in coaxial alignment with the pins 37.

The latch member 38 is generally U-shaped or channel-shaped, as shown in FIGURE 7, and includes a latching portion 40, adapted to releasably engage the releasable latch member 17 of the circuit breaker operating member. The latch member 38 constitutes a primary trip member since it is acted on by other trip members to cause tripping. While the member 38 has an integral portion (40) serving as a latch, and will therefore be referred to as a "latch member" herein, it will be appreciated that the latch 40 may, if desired, be supported separately.

An extension member 41, of insulating material, is rigidly attached to the latch member 38 by suitable means, such as by cementing or riveting, for a purpose to be described.

Magnetic tripping members 42, 43, 44, are also provided in the trip unit 18. Members 42 and 44 are pivotally supported on the pivot pins 37, respectively. Member 43 is pivotally supported on the pivot pin 39.

Each of the magnetic tripping members 42, 43, 44 is generally U-shaped, and the bight portion of each includes an armature portion 45, 46, 47, respectively.

The side portions of each of the magnetic tripping members include actuating extensions 48, 49, 50 respectively, see FIGURES 4 and 7.

The thermal trip bar 36 includes an "ambient-compensating" bimetallic strip 52, rigidly attached thereto at one end by suitable means, such as by rivets 53.

The bimetallic strip 52 is adapted to be maintained in predetermined angular relation to the trip bar 36 by means of adjusting screws 54 and 55. The screw 54 engages the side of the strip 52 adjacent the bar 36, and establishes the minimum spacing of the corresponding portion of the strip 52 therefrom. Alternatively, this screw may be omitted, and the mounting of the strip 52 by means of the rivet 53 used to position the strip, without such adjustment. The screw 55 passes through the strip 52 and includes a headed portion overlying the side of the strip 52 facing away from the bar 36. The screw 55 therefore serves to establish the maximum spacing of this portion of the strip 52 from the bar 36.

The thermal trip bar 36 is biased counterclockwise, as viewed, at all times by means of a tension spring 56, see FIGURE 3, having one end attached to the bar 36 and the other end attached to the casing part 20. When not in engagement with a calibrating screw 35 of a bimetallic strip 34, the movement of the bar 36 in counterclockwise direction is limited by a stop portion 20A of the casing part 20.

The latch member 38 is biased counterclockwise, as

viewed, at all times by means of spring 57, see FIGURE 3. The travel of the latch member 38 in counterclockwise direction is normally limited by its engagement with the end of releasable member 17, as shown in FIGURES 3 and 4.

Each of the members 42, 43, 44, is likewise constantly biased in counterclockwise direction. For this purpose, a tension spring 60 is provided for each such member. Each tension spring 60 is attached at one end to a corresponding member 42, 43, 44, and at the other end to one end of an arm 61, pivotally supported on a fulcrum portion 62 of the casing part 20. The other end of each arm 61 is adjustably positioned by means of a calibrating screw 61A, threadedly engaged in the casing part 20. Thus adjustment of each screw 61A serves to adjust the tension of the corresponding spring 60.

The counterclockwise position of each of the members 42, 43, 44, is adjustably determined by a cam member 63, carried by a vertically extending shaft 64. The shaft 64 has its lower end rotatably journaled in a hole, not shown, in a portion 65 of the casing part 20. The shaft 64 is also provided with an externally accessible adjusting knob 66.

The construction and operation of the adjusting means for the members 42, 43, 44, is more fully described in our Patent No. 3,084,236, issued April 2, 1963.

#### *Thermal tripping operation*

In operation, passage of current through the conductor 24 causes the intermediate portion 28 to become heated, due to its reduced cross-section. Heat generated in the portion 28 is transmitted, primarily by conduction, to the bimetallic strip 34, which is disposed and arranged to deflect to the right, as viewed, upon heating.

Deflection of the strip 34 causes the calibrating screw 35 to engage the thermal trip bar 36, rotating the trip bar 36 clockwise as viewed. Such rotation of the trip bar 36 causes the ambient compensating bimetallic strip 52 to engage the latch member 38, rotating the latch member 38 clockwise as viewed to release the releasable member 17.

It will be observed that in order to rotate the trip bar 36, the bimetallic strip 34 must overcome the bias of the trip bar biasing spring 56 as well as the static and sliding friction of the latch engagement.

In accordance with the invention, the force of the bias spring 56 is made substantially greater than the friction resistance of the latch arrangement. The latch friction thus constitutes only a relatively small part of the force which must be overcome by the bimetallic strip 34. Because of this, relatively wide variations can occur in the latch friction without substantially affecting the total force which must be overcome by the bimetallic strip. Such variations in the force tending to move the releasable member 17, by variations in the smoothness of the inter-engaging latch surfaces, and by variations in the inter-relation of the latch member 38 and the releasable member 17 caused by variations in the mounting of the trip unit 18 in the main circuit breaker casing.

The ambient compensating bimetallic strip is disposed and arranged so that its movable end deflects away from the trip bar 36 upon heating. Thus if the temperature of the ambient air increases, it will cause the bimetallic strip 34 and the bimetallic strip 52 to deflect. The strip 34, as previously described, will deflect in such a way as to cause clockwise rotation of the bar 36. Such rotation of bar 36 would normally cause the free end of strip 52 to engage and move the latch member 38 to the left as viewed. The increase of ambient temperature, however, also causes the strip 52 to deflect so as to move its free end to the right. Thus the net result is that the latch member 38 is not moved upon such equal heating of the strips 34 and 52.

Such compensating action of the bimetal 52, however, is limited by the head of screw 55. Thus only a "limited"

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ambient-compensating action is provided, and, above a certain point, equal heating of the strips 34 and 52 produces a net movement of the latch member 38 toward tripping or releasing position.

In FIGURE 6 there is shown a modified form of the invention in which the ambient-compensating bimetallic strip 52 of FIGURES 3 and 4 is replaced by an integral extension 36A' of the trip bar 36A. The construction is otherwise similar to that of the form of FIGURES 3 and 4. In operation, this form exhibits no ambient-compensated action, and increase of ambient temperature contributes to tripping movement of the latch 38.

#### *Magnetic tripping operation*

Upon the occurrence of short-circuit magnitude currents in any one of the conductors 24, the corresponding armature 45 is attracted to its magnet 30, rotating the member 42 about its pivot 37. When this occurs, the extension 48 engages the bar 41, moving the latch 38 to releasing position.

The member 42, when rotating in this manner, works against the tension spring 60, which normally holds the member 42 against the cam 63. A similar spring and cam member, not shown, is also provided for each of the members 43 and 44.

It will be observed that the members 42, 43, 44 are pivotally supported independently of each other and also independently of the thermal trip bar 36. Thus each of these members is free to rotate against only the force of its own bias spring.

This arrangement simplifies the adjusting or calibrating procedure since changes in the force of the thermal trip bar bias spring can have no effect on the magnetic tripping operation, and vice versa.

Perhaps more importantly, the strength of the thermal trip bar bias spring can be chosen to best suit the needs of the thermal trip mechanism as described above. Conversely, the strength of the armature bias spring 60 can be chosen to best suit the needs of these devices.

As previously mentioned, it is desirable, in accordance with the invention, to provide bias means against which the bimetallic strips 34 must work to deflect the bar 36 which is substantially stronger than the force necessary to overcome the latch friction alone. Since the latch friction, which is subject to change or variation, is only a small portion of the total force against which the bimetallic strips work, such variation is correspondingly small compared to the total force.

In a particular embodiment of the invention, for example, comprising a circuit breaker rated at 225 amperes, the force required to move the latch 38 was about two ounces, while the return spring 56 was ten ounces.

Also, it is desirable that the bias spring 60 for the members 42, 43, 44 be relatively light, so that the breaker can trip magnetically at sufficiently low values. In this case, the tripping action takes place suddenly and the extension 48 strikes the latch bar 41 with impact, as compared to the slow-moving action of the thermal trip, and a strong bias spring is neither needed nor desired.

In the same embodiment of the invention referred to above, for example, armature return-springs were utilized such as to exert a force of about one and one-half ounces when the armature is in maximum open position.

#### *Trip unit mounting provisions*

As shown particularly in FIGURE 1, the trip unit 18 is mounted in the base 10 by means of screws 70 and 71, passing through the terminal members 22 and 25, respectively and into threaded engagement with inserts in the base 10. The screws 71 also serve to retain clamp-type cable connectors or lugs 72 in place.

It sometimes occurs that because of unavoidable variation in parts, etc., the mounting of the terminals 22 and 25 securely to the inserts in the base produces bending stresses on the conductors 24. In accordance with the

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present invention, any tendency of such bending stresses to affect the predetermined setting of the bimetallic strip 34 is minimized. For this purpose, the conductor 24 is mounted to the casing part 20 at two closely spaced points as shown in FIGURE 3, by screw 31 and rivet 27. The bimetallic strip 34 is mounted on the conductor 24, as shown, at a point between the aforesaid closely spaced mounting points.

In addition, the leg of the U-shaped intermediate portion 28 which is opposite the leg engaging the screw 31, is permitted ample clearance by the bosses 29 and magnet 30, as previously described. Thus this portion of conductor 24 can flex fairly easily, allowing the terminals 25 to conform to their corresponding supporting surfaces, without bending the portion of conductor 24 which supports the bimetallic strip 34.

This flexibility also avoids the placing of any unduly great stresses on the molded material of the trip unit housing such as might cause breakage.

While the invention has been shown in only one particular embodiment it will be readily appreciated that many modifications thereof may readily be made. 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) a generally rectangular insulating casing, at least two line terminals carried by said casing in side-by-side relation at one end thereof, at least two load terminals carried by said insulating casing in side-by-side relation adjacent the other end thereof and substantially in alignment with the corresponding line terminals,

(b) at least one pair of relatively movable contacts within said casing between each pair of corresponding line and load terminals and disposed and arranged to control electrical continuity therebetween,

(c) operating mechanism within said insulating casing for operating said relatively movable contacts between open and closed circuit conditions, said operating mechanism including a manually engageable handle member projecting through an aperture in said insulating casing, and a member releasable to cause automatic opening of said contacts,

(d) a separately enclosed trip unit mounted within said insulating casing and including a member movable to cause release of said releasable member, said trip unit comprising a generally rectangular insulating casing having pairs of line and load terminals disposed and arranged to be connected in series relation between corresponding pairs of line and load terminals of said circuit breaker,

(e) a plurality of electrical conductors within said trip unit, each of said conductors interconnecting the members of a pair of line and load terminals of said trip unit, each of said conductors including a first portion fixedly attached to the bottom wall of said trip unit, and a second generally U-shaped portion extending substantially perpendicular to said bottom wall of said trip unit, and

(f) a pair of supporting abutments at either side of said conductor adjacent said U-shaped portion, a bridging member supported on said abutments and extending across said conductor, a clearance hole in one of the legs of said U-shaped portion, a clearance hole in said bridging member, and fastening means passing through said trip unit casing and through both of said clearance holes and into engagement with the other of said leg portions, whereby to compress said other leg portion of said U-shaped portion against said bridging member and into fixedly mounted relation with said trip unit casing.

## 2. An electric circuit breaker comprising:

- (a) a generally rectangular insulating casing, at least two line terminals carried by said casing in side-by-side relation at one end thereof, at least two load terminals carried by said insulating casing in side-by-side relation adjacent the other end thereof and substantially in alignment with the corresponding line terminals, 5
- (b) at least one pair of relatively movable contacts within said casing between each pair of corresponding line and load terminals and disposed and arranged to control electrical continuity therebetween, 10
- (c) operating mechanism within said insulating casing for operating said relatively movable contacts between open and closed circuit conditions, said operating mechanism including a manually engageable handle member projecting through an aperture in said insulating casing, and a member releasable to cause automatic opening of said contacts, 15
- (d) a separately enclosed trip unit mounted within said insulating casing and including a member movable to cause release of said releasable member, said trip unit comprising a generally rectangular insulating casing having pairs of line and load terminals disposed and arranged to be connected in series relation between corresponding pairs of line and load terminals of said circuit breaker, 20
- (e) a plurality of electrical conductors within said trip unit, each of said conductors interconnecting the members of a pair of line and load terminals of said trip unit, each of said conductors including a first portion fixedly attached to the bottom wall of said trip unit, and a second generally U-shaped portion extending substantially perpendicular to said bottom wall of said trip unit, and 25
- (f) a pair of supporting abutments at either side of said conductor adjacent said U-shaped portion; a generally U-shaped magnetic field piece embracing one leg of said U-shaped portion, the bight portion of said field piece extending across said abutments between the legs of said U-shaped portion, a clearance hole in the other leg of said U-shaped portion, a clearance hole in said bight portion of said field piece, and fastening means passing through said trip unit and through both of said clearance holes and into engagement with said one leg of said U-shaped portion, whereby to compress said one leg portion against said field piece and into fixedly mounted relation with said casing. 30

3. An electric circuit breaker as set forth in claim 2, wherein the spacing of said bight portion of said field piece from said casing is sufficient to permit substantial flexing movement of said other leg. 35

## 4. An electric circuit breaker comprising:

- (a) a generally rectangular insulating casing, at least two line terminals carried by said casing in side-by-side relation at one end thereof, at least two load terminals carried by said insulating casing in side-by-side relation adjacent the other end thereof and 40

substantially in alignment with the corresponding line terminals,

- (b) at least one pair of relatively movable contacts within said casing between each pair of corresponding line and load terminals and disposed and arranged to control electrical continuity therebetween, 45
- (c) operating mechanism within said insulating casing for operating said relatively movable contacts between open and closed circuit conditions, said operating mechanism including a manually engageable handle member projecting through an aperture in said insulating casing, and a member releasable to cause automatic opening of said contacts, 50
- (d) a separately enclosed trip unit mounted within said insulating casing, and including a member movable to cause release of said releasable member, said trip unit comprising a generally rectangular insulating casing having pairs of line and load terminals disposed and arranged to be connected in series relation between corresponding pairs of line and load terminals of said circuit breaker, 55
- (e) said trip unit comprising a generally rectangular insulating casing having a back wall and upstanding side walls and front and back walls, 60
- (f) a plurality of electrical conductors within said trip unit, each of said conductors including an end portion projecting out of said trip unit casing, said projecting end portions of said conductors serving to support and connect the members of a pair of line and load terminals of said trip unit,
- (g) each of said conductors being rigidly mounted to said bottom wall of said trip unit at one point, each of said conductors including a generally U-shaped portion within said trip unit between said mounted point and one of said projecting ends, said U-shaped portion having a first leg portion adjacent said projecting end portion and a second leg portion adjacent said mounted point, and
- (h) means spaced from said one rigid mounted point of each of said conductors fixedly attaching said second leg portion of said U-shaped portion fixedly with respect to said trip unit casing, said first leg portion being freely movable with no restraint except its own resilience, and an elongated bimetallic strip rigidly mounted on said second leg portion of said U-shaped portion, at a point thereof which is between said fixedly mounted points.

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