ELECTRIC CIRCUIT BREAKER WITH IMPROVED TRIP MEANS

FIG. 1.

FIG. 2.

FIG. 3.

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FIG. 4.

FIG. 5.

FIG. 6.

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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 therefrom. 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-contacts 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 present invention to provide a circuit breaker which can be more readily adjusted or calibrated than prior circuit breakers of comparable capacity. It is another object of the invention to provide an electric circuit breaker of medium to high current capacity, such as 400 amperes, in which the thermal tripping means does not undesirably affect the magnetic tripping means, and vice versa.

It is a further object of the invention to provide an electric circuit breaker of the type described in which the tripping mean in 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 in one form, an electric circuit breaker is provided including a latch member movable to cause automatic opening of the breaker. A movable member is also provided, for engaging and moving the latch member to releasing or tripped position. Thermally-responsive means, such as a bimetallic strip, is provided, arranged to engage and move the storehouse movable member. Separate biasing means are provided comprising first biasing means for biasing the latch member to latched position and second biasing means for biasing the movable member away from releasing position. The said second biasing means is, moreover, chosen so that the force necessary to overcome it is substantially greater than the force required to move the primary latch member against its static and dynamic friction and against the said first biasing means.

In accordance with another aspect of the invention, magnetic tripping means is also provided, including an armature biased to unattracted position, and adapted when attracted, to engage and move the said latch member, without moving said first movable member, and therefore without having to work against the bias acting on said first movable member.

In accordance with a still further aspect of the invention, the magnetic and thermal tripping means and the latch member are mounted on or carried by a common support, and the current conductors associated therewith are constructed to permit flexing thereof without affecting the pre-set positioning of the magnetic and thermal tripping means and the latch member.

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;

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 21. 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 each 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 bell-cast 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 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 coaxially 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 sup-
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5 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 latch friction may be caused, for instance, by 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 the bar 36 will 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” 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 36, 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 two 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 19 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 18. 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 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.

Certain aspects of the invention disclosed herein are disclosed and claimed in our divisional application Serial Number 381,016, filed July 6, 1964, and assigned to the same assignee as the invention claimed herein.

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) an insulating casing,
   (b) at least two relatively movable contacts in said casing
   (c) operating mechanism in said casing for operating said relatively movable contacts between open and closed circuit condition, said operating mechanism including a member releasable to cause automatic opening of said contacts,
   (d) a primary trip member in said casing movable to cause release of said releasable member,
(e) a first trip member disposed and arranged to be moved into engagement with said primary trip member,

(f) thermal current responsive means in said casing responsive to thermal effects of current through said circuit, said thermal current responsive means causing tripping movement of said first trip member upon the occurrence of predetermined current conditions,

(g) biasing means biasing said first trip member against movement in said tripping direction,

(h) a second trip member in said casing disposed and arranged to be moved into engagement with said primary trip member independently of said first trip member,

(i) magnetically operable current responsive means in said casing responsive to current conditions through said contacts for causing tripping movement of said second trip member,

(j) biasing means biasing said second trip member against movement in said tripping direction,

(k) said first trip member biasing means being substantially stronger than said second trip member biasing means.

2. An electric circuit breaker comprising:

(a) a generally rectangular insulating casing having opposition sides and end walls and opposed top and bottom walls,

(b) at least two line terminal members supported on said insulating casing in side-by-side relation at one end thereof,

(c) at least two load terminal members supported in side-by-side relation on said insulating casing at the other end thereof at locations corresponding laterally to those of said line terminals,

(d) the portions of said insulating casing between said corresponding line and load terminals comprising "pole chambers" whereby said circuit breaker comprises a multi-pole circuit breaker having a number of poles corresponding to the number of load terminals,

(e) at least two relatively movable contacts in each of said pole chambers,

(f) manually operable operating mechanism within said insulating casing for operating all of said relatively movable contacts between open and closed circuit condition in unison, said operating mechanism including a manually operable handle member projecting through an opening in said top wall of said insulating casing, and a member releasable to cause automatic opening of said relatively movable contacts,

(g) latch means in said insulating casing normally engaging and restraining said releasable latched position,

(h) a primary trip member supported in said insulating casing and movable to cause release of said releasable member,

(i) a thermal trip bar supported in said insulating casing and extending across all of said pole chambers, said thermal trip bar being movable to engage said primary trip member to move said primary trip member to tripping position,

(j) thermally operable current responsive means in each of said pole chambers operable in response to current conditions existing between said relatively movable contacts in each of said pole chambers to engage said thermal trip bar to move said thermal trip bar in tripping direction,

(k) magnetically operable current responsive means supported in said casing at each of said pole chambers, said magnetically operable means being operable to act on said primary trip member independently of said thermal current responsive means in response to current condition through the corresponding pair of relatively movable contacts,

(l) means biasing said thermal trip bar against operation in said tripping direction, and

(m) said magnetically operable current responsive means acting on primary trip member to move said primary trip member in a tripping direction without opposition by said biasing means of said thermal trip bar.

3. An electric circuit breaker comprising:

(n) a generally rectangular insulating casing having opposed side and end walls and opposed top and bottom walls, at least two line terminals in side-by-side relation carried by said casing adjacent one of said end walls, at least two load terminals carried by said insulating casing adjacent the other of said end walls, each of said load terminals being substantially in alignment with a corresponding line terminal, the portion of said insulating casing between two such corresponding line and load terminals comprising a "pole" of said circuit breaker,

(o) at least two relatively movable contacts in each of said pole portions of said circuit breaker,

(p) operating mechanism within said circuit breaker for operating all of said relatively movable contacts between open and closed circuit condition in unison, said operating mechanism including a manually operable handle member projecting through an aperture in said top wall and a member releasable to cause automatic opening of said contacts,

(q) a primary trip member movable to cause release of said releasable member,

(r) spring means biasing said primary trip member against movement in said tripping direction,

(s) a thermal trip bar pivotally supported in said insulating casing and extending across all of said pole portions,

(t) means carried by said thermal trip bar for engaging said primary latch member to cause movement of said latch member in said tripping direction upon rotation of said thermal trip bar in a predetermined condition,

(u) spring means biasing said thermal trip bar against movement in said predetermined direction,

(v) thermal current responsive means in each of said pole portions of said circuit breaker and including means responsive to thermal effects of current passing through said pair of relatively movable contacts in said pole portions respectively, and a portion engageable with said thermal trip bar to cause movement thereof in tripping direction against the bias of said biasing means,

(w) magnetic current responsive means in each of said pole portions of said circuit breaker and including means responsive to magnetic effects of current passing through said pair of relatively movable contacts in said pole portions respectively, and

(x) means operable by each of said magnetic current responsive means for engaging and moving said primary trip member in a tripping direction independently of each of the other magnetic current responsive means in the other of said pole portions of said circuit breaker and without causing rotation of said thermal trip bar.

4. An electric circuit breaker comprising:

(y) a generally rectangular insulating casing having opposed side and end walls and opposed top and bottom walls,

(z) at least two line terminals carried by said insulating casing in side-by-side relation adjacent one of said end walls,

(1) at least two load terminals carried by said insulating casing in side-by-side relation adjacent the other of said end walls,

(m) each of said load terminals being in substantial alignment with a corresponding one of said line terminals, the portion of said circuit breaker between
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5 each of said corresponding line and load terminals comprising a pole portion of said circuit breaker. (e) at least two relatively movable contacts in each of said pole portions of said circuit breaker and movable between open and closed circuit conditions for controlling circuit continuity between said corresponding line and load terminals respectively, (f) operating mechanism carried by said insulating casing for operating said relatively movable contacts in unison between open and closed circuit conditions, said operating mechanism including a manually operable handle member projecting through an aperture in said top wall of said insulating casing and a member releasable to cause automatic opening of said contacts, (g) a primary trip member movable to cause release of said releasable member, (h) spring means biasing said primary trip member against movement in releasing direction, (i) thermal current responsive means in each of said pole portions of said circuit breaker and including means responsive to thermal effects of current through said corresponding relatively movable contact in said pole portion of said circuit breaker, (j) magnetic current responsive means in each of said pole portions of said circuit breaker and including means responsive to magnetic effects of current passing through said relatively movable contacts in said pole portion of said circuit breaker, (k) a thermal trip bar pivotally supported in said insulating casing and extending across all of said pole portions of said circuit breaker and disposed and arranged to be engaged by each of said thermal responsive means in each of said pole portions, said thermal trip bar also including means for engaging said primary trip member to cause movement of said primary trip member in releasing direction upon rotation of said thermal trip bar in a predetermined direction by said thermal responsive means, (l) second spring means biasing said thermal trip bar against rotation in said predetermined condition, and (m) a magnetic trip bar extending at least partially across all of said pole portions of said circuit breaker and disposed and arranged to be engaged by each of said magnetically operable current responsive means in each of said pole portions, and means connecting said magnetic trip bar to said primary trip member to cause releasing movement of said primary trip member upon movement of said magnetic trip bar by said magnetically operable current responsive means.

5. An electric circuit breaker comprising: (a) at least two relatively movable contacts, (b) operating mechanism for operating said relatively movable contacts between open and closed circuit condition, said operating mechanism including a member releasable to cause automatic opening of said contacts, (c) a primary trip member movable to cause release of said releasable member, (d) bias spring means biasing said primary trip member against movement in said releasing direction, (e) first current responsive means responsive to current passing through said relatively movable contacts and including a first trip member disposed and arranged to engage said primary trip member to move said primary trip member to releasing position, (f) bias spring means for said first trip member biasing said first trip member against movement in said tripping direction, (g) second current responsive means responsive to current passing through said relatively movable contacts and including a second trip member disposed and arranged to engage said primary trip member independently of said first trip member to move said primary trip member to releasing position, (h) bias spring means biasing said second trip member against movement in said tripping direction, and (i) each of said bias spring means being independent of each other bias spring means.

6. An electric circuit breaker as set forth in claim 5 wherein the force exerted by said bias spring means for said first trip member in its normal condition is at least twice as strong as the force exerted by said bias spring means for said second trip member in its normal condition.

7. An electric circuit breaker comprising: (a) at least two relatively movable contacts, (b) operating mechanism for operating said relatively movable contacts between open and closed circuit condition, said operating mechanism including a member releasable to cause automatic opening of said contact, (c) a primary latch member engaging said releasable member to normally restrain said releasable member against movement in automatic opening direction, said primary latch member being movable in a predetermined direction to release said releasable means, (d) said primary latch member being movable toward said releasing position upon the application thereto of a predetermined force sufficient to just overcome the latch friction forces resisting such movement by reason of the latch engagement between said primary latch member and said releasable member, (e) thermal current responsive means responsive to thermal effects of current passing through said relatively movable contacts and including a member movable in response to said thermal current effects, (f) means connecting said movable member of said thermally responsive means to said primary latch member to cause movement of said primary latch member toward said releasing position upon movement of said movable member, and (g) spring biasing means opposing movement of said movable and therefore of said thermally responsive means in said tripping direction with a force which is at least four times as great as said frictional latch forces, whereby said latch friction forces comprise only a small portion of the force against which said thermally responsive means operates and whereby variations in said latch friction forces can therefore constitute not more than a relatively small portion of the total force against which said thermally responsive means operates.

8. An electric circuit breaker comprising: (a) at least two relatively movable contacts, (b) operating mechanism for operating said relatively movable contacts between open and closed circuit condition, said operating mechanism including a member releasable to cause automatic opening of said contacts, (c) a primary trip member movable against predetermined latch friction forces to cause release of said releasable member, (d) first spring means biasing said primary trip member against movement in said releasing direction, (e) a first trip member disposed and arranged to be moved into engagement with said primary trip member to cause movement thereof in said releasing direction, (f) second spring means biasing said first trip member against movement in said tripping direction, (g) thermal current responsive means responsive to thermal effects of current through said relatively movable contacts and including a portion disposed and arranged to engage said first trip member to move said first trip member in tripping direction, (h) a second trip member disposed and arranged to be moved into engagement with said primary trip member,
(i) third spring bias means biasing said second trip member against movement in said tripping direction,

(j) magnetic current responsive means responsive to magnetic effects of current passing through said relatively movable contacts and including a portion disposed and arranged to cause movement of said second trip member in tripping direction, and

(l) said second spring means biasing said first trip member being at least four times as great as said latch friction forces, and said second trip member being movable in tripping direction to release said primary trip member without overcoming the bias of said second bias means.