The present invention relates to electric circuit breakers and particularly to circuit breakers incorporating auxiliary switch means for providing remote indication of the automatically opened or "tripped" condition of the circuit breaker.

Electric circuit breakers of the type referred to commonly include a generally rectangular insulating casing enclosing at least one pair of relatively movable contacts, operating mechanism for operating the contacts, and current responsive releasing means for causing automatic opening of the contacts upon the occurrence of predetermined current conditions. In accordance with the prior art, means has also been provided for giving a remote indication of the tripped condition of the circuit breaker. One such means commonly used comprises a miniature auxiliary switch, supported in the insulating casing adjacent the main operating mechanism, and adapted to be operated on by an actuator connected to the contact operating mechanism.

Such auxiliary switches must be carefully mounted in proper position with respect to the operating mechanism in order to insure proper operation. The difficulty attendant upon proper installation of such auxiliary devices has, in the past, added to the expense of the manufacture of circuit breakers incorporating such devices. In addition, the need for such accurate mounting with respect to the operating mechanism has greatly increased the difficulty of installing such devices "in the field," that is, by the user himself.

It is an object of the present invention to provide a circuit breaker including means for remotely indicating the automatically tripped condition of the circuit breaker which can easily be assembled in accurate and proper position in the circuit breaker.

It is a further object of the invention to provide an electric circuit breaker including remote trip-indicating means which can be readily installed by the user.

It is a further object of the invention to provide a circuit breaker including such remote indicating means the operation of which can be easily tested before complete assembly of the circuit breaker.

In accordance with the invention in one form, an electric circuit breaker is provided comprising a generally rectangular insulating enclosure which serves to support a plurality of pairs of relatively movable contacts, and operating mechanism for operating the contacts between open and closed circuit position. Current responsive means is provided for initiating automatic opening operation of the mechanism comprising a separately enclosed "trip unit" which is adapted to be removable mounted in the main circuit breaker enclosure. Remote trip-indicating means is also provided comprising an auxiliary switch which is mounted on the trip unit casing, and a switch actuator which is actuated by the trip unit to operate to cause release of the main operating mechanism.

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 incorporating the invention;
FIGURE 2 is a perspective view of a current responsive mechanism or "trip unit" of the circuit breaker of FIGURE 1;
FIGURE 3 is an elevation view of a portion of the latch mechanism of the trip unit of FIGURE 2;
FIGURE 4 is a view similar to FIGURE 3 but showing the parts in a released or "tripped" condition;
FIGURE 5 is a perspective view of a portion of the latch mechanism of the trip unit of FIGURE 2, and
FIGURE 6 is a fragmentary elevation view of the latch mechanism of the trip unit of FIGURE 2.

In the drawing, the invention is shown as incorporated in a three-pole electric circuit breaker comprising a generally rectangular insulating casing including a base and a cover. Three pairs of relatively movable contacts (12 and 13) (only one pair shown) are provided in the base. Each stationary contact 15 is mounted on a corresponding line terminal strap 14 supported in the base 10, and each terminal strap 14 carries a line terminal connector 15A at its outer end. Each movable contact 12 is carried by a contact arm 15, which in turn is supported on a contact cross-arm 15A, serving to gang together for common movement all three contact arms of the circuit breaker. The contact arm 15 together with the contact cross-arm 15A, is adapted to be operated between open and closed circuit positions by means of an operating mechanism including a releasable member or "cradle" 16, which is pivotally supported by suitable means on a stationary pivot pin 17 supported in the base 10. A pair of interconnected toggle links 18 and 19 are also provided, having a common pivot pin 20. The toggle link 18 is pivotally connected by means of a pin 21 to the contact arm 15. The toggle link 19 is connected by means of a pivot pin 22 to the releasable member or cradle 16. The toggle links 18 and 19 are adapted to be moved between straightened and collapsed conditions by an over-center type tension spring 23 having one end thereof connected to the knee pivot pin 20 of the toggle links 18 and 19, and having its other end connected to a pin 24 adapted to be operated by manually engageable operating handle member 25. The releasable member or cradle 16 is normally releasably held in a manner to be described, and upon release, is rotated about the pivot pin 17, causing the pivot pin 22 to move upwardly and to the right, thereby moving the toggle linkage 18-19, upwardly, and at the same time causing it to assume a collapsed condition, whereby to move the movable contact arms 15 to open circuit position regardless of whether the manual handle 25 is retained in the "on" position.

As will be more readily apparent hereinafter, any suitable operating mechanism may be used of the type including a normally restrained member which is releasable to cause automatic opening movement of the movable contacts. A mechanism of the type disclosed herein is more fully shown and described in co-pending application Serial No. 212,432, filed July 25, 1962, and assigned to the same assignee as the present invention.

For the purpose of releasably holding the releasable member 16 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 28.

The trip unit 28 comprises a pair of cooperating insulating casing parts 29, 30 which cooperate to provide a closed box-like enclosure. The trip unit 28 includes a first set of terminal straps 31 projecting into the trip unit cover member 30 and a second set of terminal straps 32 extending outwardly of the trip unit casing member 29. The members of each pair of corresponding terminal members 31-32 are interconnected by a partly U-shaped connecting strap or heater 33 which has its ends brazed, respectively, to the terminal members 31-32.
nal members 31 are rigidly attached to the base 10 by suitable means such as by bolts or screws 33, see FIGURE 1.

The intermediate portion of the beater member 33 is U-shaped and serves to support a current responsive bimetallic strip 34, which is rigidly attached thereto by suitable means such as by brazing. The bimetallic strip 34 carries an adjustable actuating screw 35, which is disposed and arranged to engage a common trip bar 36 pivotally supported in the trip unit cover 30 by pivot pin 37. The trip bar 36 carries at its central portion a latch portion 38, for a purpose to be described.

In operation, upon the occurrence of excess current through the circuit breaker, the beater member 33 becomes heated and transmits such heat to the bimetallic strip 34. The bimetallic strip 34 is disposed and arranged to warp or deflect so as to move the calibrating screw 35 toward the right as viewed in FIGURE 1, and into engagement with the common trip bar 36. This action rotates the trip bar 36 about its pivotal support 37, thereby moving the latch surface 38 to a retracted position.

For the purpose of releasably holding the releasable member 16, a primary latching member 40 is provided, pivotally supported on a pivot pin 41 carried by a generally U-shaped frame member 42, see FIGURE 2. The latch member 40 is biased toward latching position as shown in FIGURES 1 and 3 by means of a coil type spring 43, see FIGURE 6.

The latch member 40 is biased against a stop lug 40A struck inwardly from one of the sides of the frame 42. In this position the latch portion 40' of the member 40 is in position to releasably restrain the releasable member 16 of the mechanism, as shown particularly in FIGURES 1 and 3.

The frame member 42 also supports a generally U-shaped actuator 44, which is pivotally carried by an extended pivot pin 45 to be described more fully. The actuator member 44 is generally U-shaped, and includes an arm terminating in a latch projection 44', which is normally releasably held by the latch surface 38 of the trip bar 36. The actuator 44 also includes an upwardly extending finger or projection 46, which, when the actuator 44 is released by the latch 38, is moved into engagement with the latch member 40 to move it to released position as shown in FIGURE 2. The actuator 44 is normally biased toward releasing position by a coil type spring 47, see FIGURE 6.

In operation, therefore, the latch parts just described are normally in the position shown in FIGURE 3, in which the actuator member 44 is releasably held by the latch surface 38 of the trip bar 36. Upon movement of the trip bar 36 in a clockwise direction, as viewed in FIGURE 1, the latch surface 38 is moved away from the latch portion 44' of the actuator 44. This allows counterclockwise rotation of the actuator 44, which causes the projection 46 of the actuator 44 to engage a portion of the latch member 40, rotating the latch member 40 clockwise about its pivot 41 and withdrawing the latch portion 40', normally biased toward releasable member 16, and permitting automatic opening of the circuit breaker mechanism.

It will be observed in connection with the foregoing, that the actuator 44 is held in latched relation by the latch surface 38 with no mechanical dependence upon the latch member 40 or the releasable member 16.

In invention, for the purpose of providing a remote indication of the tripped condition of the circuit breaker, there is provided an auxiliary miniature switch indicated generally at 50. The auxiliary switch 50 is provided with terminals 51, 52, 53 such that when the switch is in a "normal" or unactuated condition, the terminal 52 is electrically connected to the terminal 53 but is electrically isolated from the terminal 51, and when the switch is in an actuated condition, the terminal 52 is connected electrically to the terminal 51 and is electrically disconnected from the terminal 53. The switch therefore comprises a switch which is normally biased toward closed position in one direction. The switch 50 is rigidly attached directly to the cover 30 of the casing of the trip unit 28 by suitable means such as by screws 56.

For the purpose of non-rotatably holding the shaft 45 with respect to the actuator 44, the shaft 45 is provided with a flattened portion 45A. A flat sheet metal retaining clip 58 is also provided, having a notch 59 therein and having a tang 60 struck therefrom at an intermediate portion. Referring to FIGURE 6, the retaining clip 58 is assembled by inserting it through an opening in the bight portion of the actuator 44 so that the notch 59 embraces the flattened portion 45A of the shaft 45, and so that the tang 60 becomes engaged under the inner surface of the bight portion of the actuator 44. The retaining clip 58 therefore serves not only to prevent relative rotational movement between the shaft 45 and the actuator 44, but also to prevent axial movement of the shaft 45 with respect to the remaining parts. For this reason, engaging and operating the resilient actuator 54, the shaft 45 is also provided with an actuating arm 55 rigidly attached thereto by suitable means such as by welding.

In operation, when the parts are in the normal condition, as shown for example in FIGURES 1 and 3, the extension arm 55 of the shaft 45 engages the resilient actuator 54 of the switch 50 and holds it in an actuated condition. Upon release of the actuator 44 from the latch surface 38 due to overload current conditions, the actuator 44 is rotated by the spring 47 into engagement with the latch member 40, causing the latch member 40 to release the releasable member 16 and at the same time moving the arm 55 out of engagement with the actuator 54, thereby allowing the switch 50 to assume its normal or unactuated condition and thereby closing the circuit to a remotely located indicating device, such as a bell or light or both, not shown.

It will be observed that there is provided, in accordance with the invention as described, an electric circuit breaker having a removable trip unit 28 which includes a releasable actuator 44 and an auxiliary switch mounted on the trip unit and disposed and arranged to be actuated from a non-indicating to an indicating condition upon release of the releasable member 16 and the trip unit can therefore be assembled, and provided with an auxiliary trip indicating switch before the trip unit is inserted in the circuit breaker. This makes it easier to properly position the auxiliary switch with respect to the releasable member. Also, testing of the assembly, including operation of the auxiliary switch unit, can readily be accomplished with this construction much more readily than if the auxiliary switch were required to be supported on the circuit breaker casing proper and to be actuated in response to releasing movement of a portion of the circuit breaker operating mechanism, such as cradle 16.

It will also be observed that it is desirable to add auxiliary trip indicating means to circuit breakers which are already in use, this can readily be accomplished by removing the trip unit and making the necessary modifications to add the auxiliary switch and its associated actuating device. Such installation can be carried out much more readily by a field person, than if it were necessary to install such a switch within the circuit breaker proper and adjust it with respect to the operating mechanism of the circuit breaker.

While the invention has been disclosed in only one particular embodiment, it will be readily apparent that many modifications thereof may be made, and it is therefore intended by the appended claims to cover all such modifications as fall within the true scope and spirit 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 enclosure,
   (b) at least one pair of relatively separable contacts mounted in said insulating enclosure,
   (c) manually operable operating mechanism in said enclosure for operating said movable contacts between open and closed circuit positions, said operating mechanism including a releasable member releasable to cause automatic opening of said contacts,
   (d) a removable trip unit removably mounted in said enclosure,
   (e) said removable trip unit including an actuator means biasing said actuator in a predetermined direction, a trip bar carried by said trip unit normally latching said actuator against movement in said predetermined direction, and current responsive means carried by said trip unit for causing releasing movement of said trip bar,
   (f) said actuator when released by said trip bar causing release of said releasable member of said operating mechanism,
   (g) auxiliary switch means carried by said trip unit,
   (h) operating means for operating said auxiliary switch, and
   (i) means connecting said operating means to said actuator for actuation thereby when said actuator is released by said trip bar.
2. An electric circuit breaker comprising:
   (a) a generally rectangular insulating enclosure,
   (b) at least two relatively moveable contacts mounted in said enclosure,
   (c) operating mechanism for operating said relatively moveable contacts between open and closed circuit positions, said operating mechanism including a releasable member releasable to cause automatic opening of said contacts,
   (d) a current responsive trip unit removably mounted in said enclosure,
   (e) a primary latch member carried by said trip unit and releasably engaging said releasable member of said operating mechanism when said trip unit is mounted in said casing,
   (f) an actuator member carried by said trip unit,
   (g) biasing means biasing said actuator for movement in a direction to engage said primary latch member,
   (h) a trip bar carried by said trip unit normally engaging and holding said actuator,
   (i) current responsive means carried by said trip unit and operable upon the occurrence of predetermined current conditions through said contacts to move said trip bar to allow said actuator to move into engagement with said primary latch member,
   (j) auxiliary switch means carried by said trip unit,
   (k) switch actuating means carried by said actuator and causing actuation of said auxiliary switch upon movement of said actuator into engagement with said primary latch member, whereby said auxiliary switch may be utilized to generate a remote indication of the tripping operation of said circuit breaker.
3. An electric circuit breaker comprising:
   (a) a generally rectangular insulating enclosure,
   (b) at least two relatively moveable contacts supported in said enclosure,
   (c) operating mechanism in said enclosure for operating said relatively moveable contacts between open and closed circuit positions, said operating mechanism including a releasable member releasable to cause automatic opening of said contacts,
   (d) primary latch means releasably engaging and holding said releasable member,
   (e) a trip unit removably mounted in said insulating enclosure,
   (f) said trip unit comprising a self-contained insulating enclosure within said main circuit breaker enclosure,
   (g) an actuator member carried by said trip unit and moveable in a predetermined direction to engage said primary latch means to cause releasing movement of said primary latch means,
   (h) biasing means biasing said actuator member for movement in said predetermined direction,
   (i) a trip bar carried by said trip unit normally restraining said actuator member from movement in said predetermined direction,
   (j) current responsive means carried by said trip unit within said trip unit enclosure and disposed and arranged to cause movement of said trip bar upon the occurrence of predetermined current conditions through said contacts to release said actuator member,
   (k) an auxiliary switch mounted on said trip unit enclosure adjacent said actuator member,
   (l) an operating shaft supporting said actuator member, said operating shaft including a radially extending arm engaging and operating said auxiliary switch upon movement of said actuator member in said predetermined direction.

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