ELECTRIC CIRCUIT BREAKER WITH MAGNETIC TRIPPING MEANS

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5 Claims

ABSTRACT OF THE DISCLOSURE

A latch-trip type electric circuit breaker, including a thermal-magnetic current responsive tripping device; the tripping device includes a generally channel-shaped field piece, a confronting generally channel-shaped armature, a cylindrical core member carried by the field piece between the two members, and an energizing coil surrounding the core; a bimetallic strip extends between the end of the core member and armature and is located with respect to the air gaps between the field piece and the armature that although some leakage flux goes through the magnetic armature, all the flux, including such leakage flux, goes across the working air gaps of the magnetic assembly, whereby to provide a compact and sensitive thermal-magnetic trip assembly.

Background of the invention

Field of the invention.—The present invention relates to latch-trip type electric circuit breakers, and more particularly, to electric circuit breakers of the type including combined thermal and magnetic current responsive means for causing releasing of the latch and automatic opening of the circuit breaker upon the occurrence of predetermined current conditions therethrough.

Description of the prior art.—An electric circuit breaker of the general type referred to is shown in prior Patent 3,162,739, K. W. Klein et al., issued Dec. 22, 1964 (Class 200—88) and assigned to the same assignee as the present invention. In circuit breakers of the latch-trip type, thermal means comprising an elongated bimetallic strip is provided for causing unlatching or “tripping” of the circuit breaker upon the occurrence of current conditions above the nominal rating of the circuit breaker which persist for a predetermined length of time such as to cause sufficient heating and warping of the bimetallic strip to cause it to engage and actuate a trip member. In addition, magnetic actuated means is provided for causing substantially instantaneous latch release upon the occurrence of high excess currents such as short-circuit currents if they are in the range of about 6 to 12 times the nominal rating of the circuit breaker.

In circuit breakers of medium and high capacity, the magnetic tripping structures can be extremely simplified, such as, for example, as comprising a generally U-shaped magnetic field piece and a generally flat plate type armature with a single current carrying conductor passing therebetween, in effect, a single turn winding. The current carrying conductor may be a bimetallic strip, or a conductor acting as a heater for the bimetallic strip, as in the above-mentioned patent. Such simplified structure is possible because in these current ranges, the amount of current in the 6 to 12 times range at which the devices are required to operate is sufficiently high (400 amperes or more) to provide substantial force even with such simplified magnetic structures. In lower amperage ratings, however, such, for example, as 15 through 50 amperes, more sensitive devices are required, such as devices capable of operating as low as 90 amperes. Such sensitive magnetic tripping devices require multi-turn rather than single-turn windings. If the turns on the windings are of substantial number, a conflict arises with the space requirements, since such devices are also required to be extremely compact.

Summary of the invention

It is an object of the present invention to provide an electric circuit breaker of the latch-trip type including combined thermal and magnetic tripping means which is both sensitive and extremely compact.

It is a further object of the invention to provide a circuit breaker of the type described including a combined thermal-magnetic trip device in which the bimetallic strip is directly heated and is also used to form a portion of a turn of the magnetic device winding without detracting from the magnetic efficiency of the magnetic trip device.

In accordance with the invention in one form, an electric circuit breaker of the latch-trip type includes an armature provided with a set of multi-turns, each winding being electrically, magnetically, and thermally isolated from the others. The winding is arranged in such a manner that it is substantially entirely surrounded by a magnetic core. In accordance with the invention in another form, an electric circuit breaker of the latch-trip type includes a trip bar, the trip bar being actuated by tripping means located in each of three poles of the circuit breaker. A tripping mechanism in each pole of the circuit breaker includes a stationary magnetic field piece having a back wall which supports a generally cylindrical core member extending at right angles thereto and carrying a multi-turn energizing winding. A movable armature is included of generally U-shaped cross-section and includes side portions extending on either side of the coil and core assembly so that current through the coil sets up magnetic lines of force which emanate from one end of the cylindrical core member, pass through the armature member, and thence back through the sides of the armature member across the pair of air gaps between the ends of the side wall and the stationary field piece. A bimetallic strip is mounted in cantilever fashion adjacent the magnetic assembly and passes between the armature and field piece. The side walls of the armature accordingly extend substantially beyond the bimetallic strip before terminating to form air-gaps with relation to the field piece. Because of this arrangement, although some leakage flux passes transversely through the bimetallic strips, this does not detract from the sensitivity of the assembly since all flux including such leakage flux goes across the air gaps to cause actuation.

Brief description of the drawings

FIGURE 1 is a side elevation view of an electric circuit breaker incorporating the invention, a portion of the side wall of the casing being broken away to show the internal parts and particularly the trip unit assembly; FIGURE 2 is a side elevation view of the trip unit assembly of the circuit breaker of FIGURE 1, the side of the enclosing casing of the trip unit nearest the observer being removed to show the internal parts; FIGURE 3 is an exploded perspective view of a portion of the trip unit device of FIGURE 2; FIGURE 4 is a sectional view of the parts of the assembly shown in FIGURE 3 but illustrated in assembled relation, and FIGURES 5 and 6 are illustrations of other alternate possible arrangements, shown for purposes of discussion.

Description of one embodiment

The invention is shown as incorporated in an electric circuit breaker including a generally rectangular insulating casing 10. (For purposes of simplification, only a single pole chamber is illustrated. It should be appreciated, however, that the embodiment disclosed is a three-pole circuit breaker and that each pole thereof includes a current path and current tripping parts similar to those to be described in connection with the selected pole.) The pole chamber illustrated includes a power incoming terminal 11 supported in the insulating casing 10 by suitable means,
The current flows from the incoming power terminal 11 through separable contacts (not shown) to the incoming terminal strip 12 of the trip unit 13, and from the outgoing terminal strip 14 of the trip unit 13 to an outgoing or load terminal 15. The circuit breaker contacts (not shown) are operated by a suitable operating mechanism (not shown) which may be actuated by an actuating handle member 16 projecting from the top wall of the circuit breaker casing 10. The operating mechanism includes a releasable trip member 17 which is normally held from tripping action by latch means included in the trip unit 13 to be described. The trip unit 13 includes an insulating casing comprising two generally cup-shaped parts 13A and 13B. A rigid conducting strap 18 is mounted on the insulating base portion 13A by suitable means such as by rivet 19 and is connected to the terminal member 12 at one end and supports a rigidly upstanding bimetallic member 20 at the other end. The upper or movable end of the bimetallic strip 20 carries a "calibrating" or actuating screw 21, and has connected thereto a flexible conductor member 22 which extends to and is connected to an energizing coil 23, which in turn is connected to the outgoing terminal 14. The releasable trip member 17 is normally held by a latch member 25 which is pivotally supported at 26 in the insulating casing part 13B. The latch member 25 is biased counterclockwise to the position shown by suitable biasing means, not shown, and includes a latch projection 25A which engages and restrains the tip of the trip member 17. The latch member 25 also includes a "magnetic" common trip bar portion 25B which permits actuation of the latch member 25 by the magnetic tripping means of any of the poles of the breaker in a manner to be described. A "thermal" common trip bar 27 is also provided and is pivotally supported on the same pivot axis as the latch member 25. The "thermal" trip bar 27 extends across all the poles of the circuit breaker to permit actuation by any of the thermal trip members of any of the poles. The "thermal" trip bar 27 includes a projection 27A which engages the latch member 25 to cause rotation of the latch member 25 in clockwise direction upon clockwise rotation of the trip bar 27. For the purpose of causing movement of the latch member 25 in releasing direction by the magnetic actuating means to be described, a generally H-shaped intermediate actuating member 28 is provided (see FIGURE 5) which is also pivotally supported on the same pivot pin 26 as the latch member 25. The actuating member 28 includes a pair of projecting portions 28A which overlay portions of the magnetic trip bar 25B. The actuating member 28 is biased counterclockwise at all times by the adjustable tension spring member 29. The tension spring member 29 is adapted to be adjusted by rocking movement of an adjusting lever 30 which is retained in desired position by an adjusting screw 311 threadedly engaged in the insulating casing part 13A. The actuating member 28 is biased by the spring 29 against a cam member 32 as a stop. The cam members 32 forms a part of a rotatable adjusting assembly which is adapted to be rotated by an externally accessible adjusting knob 33. The actuating member 28 has attached thereto a generally channel-shaped magnetic armature member 35, which is adapted to be moved thereby toward and away from a generally channel-shaped stationary magnetic field piece 36. (As used in this application, the term "magnetic" is used while the term material having a permeability substantially better than that of air.) The member 36 has its side portions 36A bent up to provide pole portions 35A of the armature 35. A cylindrical core member 38 of material of high magnetic permeability, is mounted on the field piece 36 by means of the screw 37 which passes through the casing wall 13A and through the field piece 36, threading into the core member 38. The energizing coil 23 surrounds the core member 38, as shown in FIGURE 2. The core member 38 is preferably covered with a thin insulating covering not shown. Likewise, the conductor forming the coil 23 also is coated with an insulating coating.

Operation of the thermal tripping means

Upon the occurrence of excess currents in the range of 125% to 200% of the nominal rating of the circuit breaker, the bimetallic strip 20 bends and warps so as to move the upper end thereof to the right as viewed in FIGURE 2, causing the calibrating screw 21 to engage the "thermal" trip bar 27, rotating it clockwise as viewed and causing the projection 27A to engage the latch member 25. This engagement rotates the latch member 25 also in clockwise direction to disengage the retaining portion 25A from the trip member 17 to cause tripping.

Operation of the magnetic tripping means

Upon the occurrence of excess currents in the range of 6 to 12 times the nominal rating of the circuit breaker, the coil 23 is energized so as to draw the armature 35 toward the field piece 36, rotating the actuating member 28 clockwise as viewed and causing the projections 28A to engage the magnetic trip bar 25B, thereby rotating the latch member 25 in clockwise direction to disengage the latch projection 25A from the trip member 17. Referring to FIGURE 4, a diagram is shown illustrating what is believed to be the magnetic flux flow in the invention. Assuming the current conditions to be in a direction to cause flux in the direction illustrated through the core member 38, it will be observed that the flux divides and passes through the field piece 36 in opposite directions and thence across the working air gaps 40 to the side wall portions of the armature 35, and thence from the central portion of the back wall of the armature 35 through the bimetallic strip 20 returning to the core member 38. Also, it is believed that a portion 41 of the magnetic flux which may be designated "leakage" flux, flows from the side wall portions of the armature 35 edgewise through the bimetallic strip 20 returning to the core member 38. It will be observed, nevertheless, that all of the flux, including the leakage flux 41 is required to pass across the working air gaps 40, thus providing a very highly efficient assembly, and minimizing the number of turns required in the coil 23.

This arrangement may be contrasted to other possible arrangements, such, for example as illustrating in FIGURES 5 and 6. Thus, in FIGURE 5, it will be observed that flux flowing upwardly through the core member 38' divides and passes through the side wall portions of the stationary magnetic field piece 36', and that while a portion thereof passes across the working air gaps 40', a second portion 41' passes through the bimetallic strip 20' without having first bridged the working gaps 41'. In accordance with the invention, however, by positioning the portion of the bimetallic strip which extends between the magnetic members 35, 36, entirely within the space defined by the back wall and side walls of the magnetic member 35, it is assured that virtually all the flux which passes laterally through the bimetallic strip will also be required to pass across the working gaps 40'. In the space intermediate the stationary field piece 36" and the armature 35", it will be observed that in this form also, the leakage flux 41" is free to pass through the bimetallic strip 20" without having first bridged the working gaps 41". In accordance with the invention, however, by positioning the portion of the bimetallic strip which extends between the magnetic members 35, 36, entirely within the space defined by the back wall and side walls of the magnetic member 35, it is assured that virtually all the flux which passes laterally through the bimetallic strip will also be required to pass across the working gaps 40...
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 insulating casing;
   (c) operating means in said insulating casing for moving said contacts between open and closed circuit positions, said operating means including a releasable member releasable to cause automatic opening of said contacts and a trip member movable to cause release of said releasable member;
   (d) trip means in said insulating casing for causing tripping movement of said trip member upon the occurrence of predetermined current conditions through said circuit breaker, said trip means including magnetic tripping means and thermal tripping means;
   (e) said magnetic tripping means comprising a pair of magnetic members supported in spaced apart relation;
   (f) a generally cylindrical magnetic core member having one end thereof mounted on a first one of said magnetic members and having its free end spaced from the second of said magnetic members;
   (g) a winding on said core connected electrically in series with said contacts;
   (h) an elongated bimetallic strip extending between said free end of said core and said second magnetic member;
   (i) said second magnetic member being generally channel-shaped and including a back wall and side wall portions extending therefrom;
   (j) the portion of said bimetallic strip which extends between said magnetic members being positioned within the space defined by said back wall and said side walls of said second magnetic member.

2. An electric circuit breaker as set forth in claim 1 wherein said circuit breaker also includes means connecting said bimetallic strip electrically in series with said winding.

3. An electric circuit breaker as set forth in claim 1 wherein said portion of said bimetallic strip which extends between said magnetic members is spaced from a line interconnected the end portions of said side wall portions of said second magnetic member.

4. An electric circuit breaker as set forth in claim 1 wherein said circuit breaker also comprises means fixedly mounting one end of said bimetallic strip in said casing closely adjacent said magnetic trip assembly.

5. An electric circuit interrupter as set forth in claim 1 wherein said circuit breaker comprises a plurality of pole chambers, each of said pole chambers containing current responsive means similar to said trip means for causing tripping movement of said trip member.

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