March 14, 1967 C. L. JENCKS 3,309,637

CIRCUIT BREAKER WITH IMPROVED TRIP ADJUSTMENT

Filed March 29, 1965 2 Sheets-Sheet 1

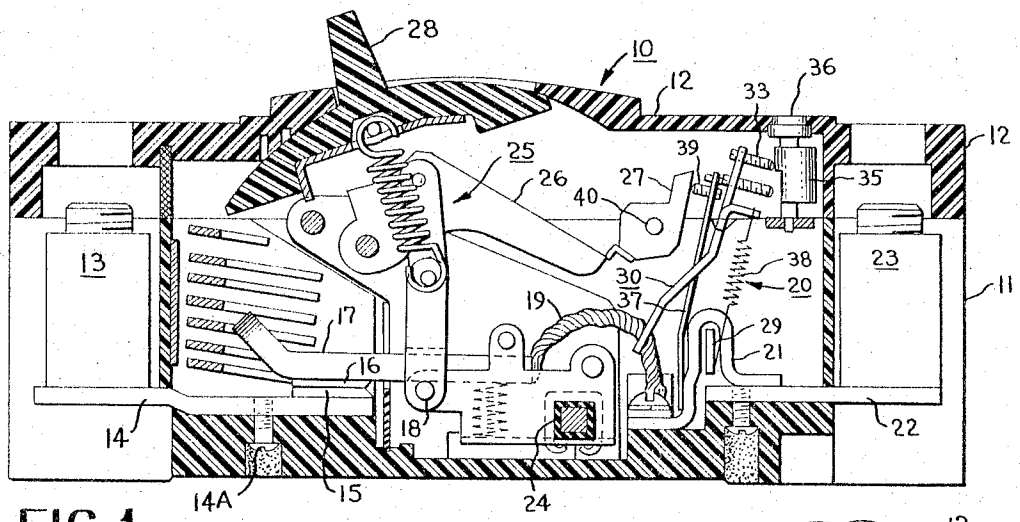

FIG. 1

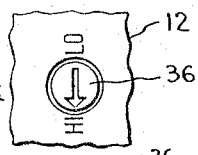

FIG. 2a

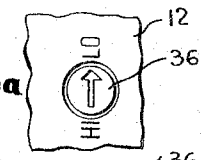

FIG. 3a

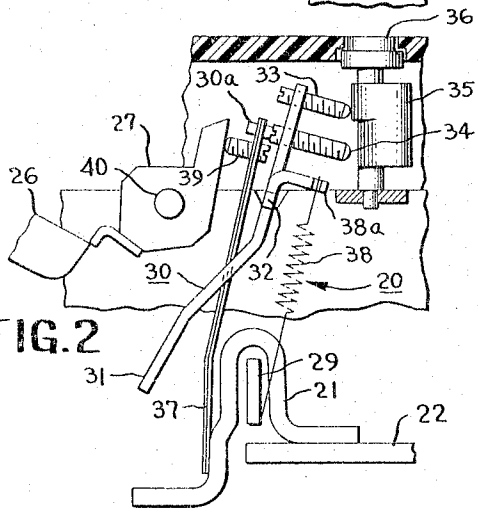

FIG. 2

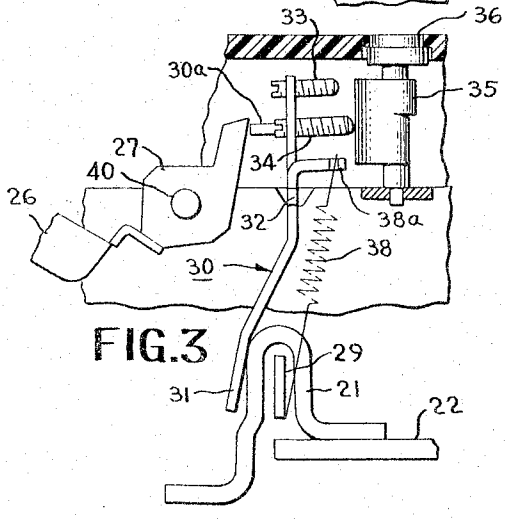

FIG. 3

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March 14, 1967 C. L. JENCKS 3,309,637

CIRCUIT BREAKER WITH IMPROVED TRIP ADJUSTMENT

Filed March 29, 1965 2 Sheets-Sheet 2

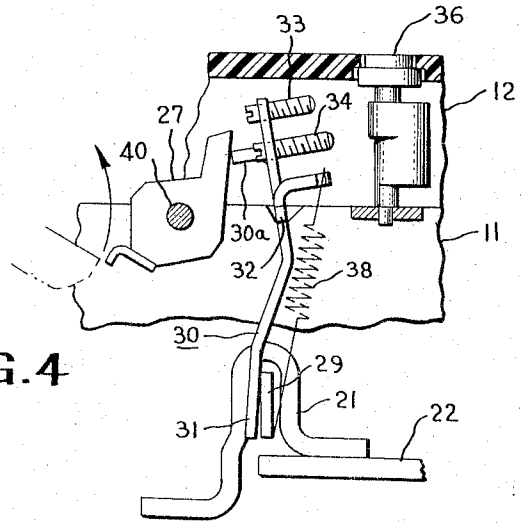


FIG. 4

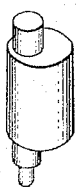
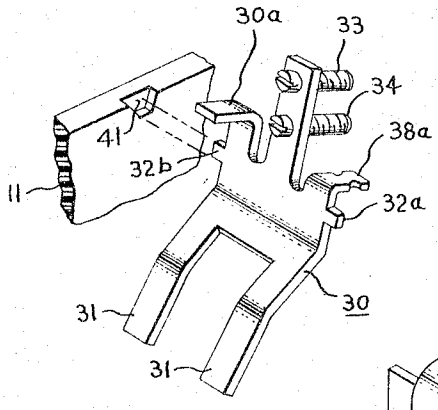
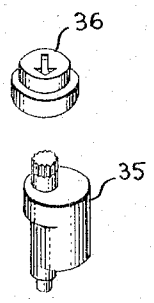


FIG. 5a





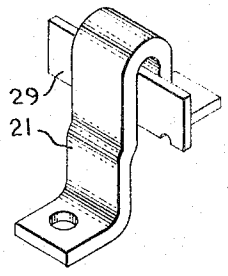


FIG. 5

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CIRCUIT BREAKER WITH IMPROVED TRIP ADJUSTMENT

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Filed Mar. 29, 1965, Ser. No. 443,462
5 Claims. (Cl. 335—176)

This invention relates to electric circuit breakers and particularly to electric circuit breakers of the type usually enclosed in a molded insulating casing and provided with adjustable current responsive means for causing automatic opening of the circuit breaker upon the occurrence of predetermined electrical conditions.

Electric circuit breakers of the type referred to may include means accessible externally of the main insulating casing for permitting limited adjustment of the amount of current flow which will cause automatic opening of the circuit breaker. Such external adjustment by the user is preferably confined within predetermined high and low limits. Typically such circuit breakers are of the multipole variety such as three pole circuit breakers and an external adjusting means operatively connected through a wall of the insulating casing is provided for selective, independent adjustment of the internal automatic trip mechanism of each pole by the user within the previously mentioned predetermined limits. Preferably such circuit breakers are so conceived and designed that the manufacturer can selectively provide any one of a number of ranges of adjustment desired by the user. Additionally, it is highly desirable that the manufacturer be able to independently preset both the high and low limits of the range of adjustment permitted the user by the externally accessible means. Such adjustment means are required to be simple and compact, have excellent repeatability characteristics, impervious to ambient conditions such as temperature and provide reliable maintenance-free service over extended periods of continuous use.

Typically such circuit breakers may include a magnetic tripping means which comprises a pivotally supported armature positioned adjacent means for developing a magnetic field having a strength which is a function of the current flow through the circuit breaker. Accordingly, the proximity of the armature to the magnetic field is determinative of the electrical conditions i.e., current conduction through the circuit breaker at which the automatic tripping means will be actuated.

Accordingly, it is an object of the present invention to provide means for independently presetting the maximum and minimum adjustable excursions of a movable member such as the armature of a magnetically actuated tripping mechanism of a circuit breaker.

It is another object of the present invention to provide means for independently setting the high and low points at which an electric circuit breaker is actuated in response to electric conditions.

Yet another object of the present invention is to provide means for selective external adjustment of the operating point of an electric circuit breaker over a predetermined range which is simple, reliable and conservative of space.

In accordance with the invention in one form there is provided an electric circuit breaker which includes a pair of contacts, one of which is movable and supported by a movable contact arm and the other of which is stationary. When the circuit breaker is in its "on" condition, the spring-biased, movable contact arm is positioned to hold the movable contact in engagement with the stationary contact by suitable restraining means. The restraining means is operatively responsive to the actuation of a pivoted magnetic tripping device for automatic operation of the circuit breaker and interruption of the current flow

therethrough. The pivoted member of the magnetic tripping device is spring biased and comprises an armature on one side of its pivot point and two adjustably positionable cam follower means on the other side of its pivot point. An adjustably positionable cam surface is supported in the pivotal path of the pivoted member for engagement with either of the adjustable cam follower means in accordance with the disposition of the cam surface. A magnetic field piece is positioned adjacent a loop formed by the main conductor of the circuit breaker and is disposed in general alignment with the pivotal path of the armature on the lower extremity of the pivoted member. Thus the maximum distance and the closest proximity of the armature with respect to the magnetic field piece may be determined by adjustment of the upper cam follower with respect to the low point of the cam surface and adjustment of the lower cam follower with respect to the high point of the cam surface, respectively.

The invention will be more fully understood from the following detailed description when 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, cross-sectional view of a circuit breaker embodying the present invention;

FIGURE 2 is a side elevation view of the present invention illustrating one of the extremities of its adjustment;

FIGURE 2*a* is a top elevation view of the external adjustment member of FIGURE 2;

FIGURE 3 is a side elevation view illustrating another of the extremities of adjustment possible with the present invention;

FIGURE 3*a* is a top elevation view of the external adjustment member of FIGURE 3;

FIGURE 4 is a side elevational, partial view of a circuit breaker embodying the present invention illustrating actuation of the magnetic trip mechanism;

FIGURE 5 is an exploded perspective view of elements comprising portions of the present invention illustrating their cooperative configurations;

FIGURE 5*a* is in a perspective view of a cam element in accordance with another embodiment of the invention.

In FIGURE 1 the invention is shown as embodied in an electric circuit breaker **10** having a molded insulating casing comprising a base **11** and a cover **12**. The base **11** and the cover **12** are each provided with integral barrier portions forming three elongated pole chambers extending from end to end of the casing and FIGURE 1 is taken generally on a plane through a pole chamber. A plurality of line terminals **13**, one for each pole chamber, are supported on line terminal straps **14** at one end of the base **11**. Each of the line terminal straps **14** is attached to the base by suitable means such as the screw **14***a*. On each of the line terminal straps **14** there is carried a stationary line contact **15**. A movable contact **16**, aligned for engagement with the stationary contact **15**, is carried on a movable contact arm **17** which is pivotally supported by a pivot pin **18**. The movable contact arm **17** is electrically connected by means of a flexible, multi-stranded electrical conductor **19** to a current responsive magnetic tripping assembly indicated generally at **20** and to be described more fully hereinafter. The magnetic tripping assembly **20** includes a main conductor **21** which is electrically connected to complete a current path to a load terminal strap **22** which supports a load terminal connector **23**. The current carrying parts just described have substantially identical counter parts arranged in like connection in each of the three pole chambers of the circuit breaker.

For the purpose of providing simultaneous operation

of the contact member of each of the pole chambers, the movable contact arms 17 are each fixedly attached to a contact cross arm 24. An appropriate operating mechanism shown generally at 25 is provided for the purpose of operating the movable contact 16 between open and closed circuit position and for releasably restraining the movable contact 16 in closed circuit position with the stationary contact 15 to permit automatic opening of the contacts upon the occurrence of predetermined current conditions in a manner to be described. The operating mechanism 25 is engaged through member 26 with a latch member 27 shown restraining the operating mechanism 25 in its closed, "on" or latched position. A manually engageable handle member 28 extends through the cover portion of the insulating casing of the circuit breaker for external manual operation. The main current conductor portion 21 of the magnetic trip assembly 20 is looped about a magnetic field piece 29. A pivoted member, shown generally at 30, supports an armature 31 at its lower extremity which is aligned to be engageable with the magnetic field piece 29 when pivoted about the pivot point 32. The upper end of the pivoted member 30 supports two adjustable cam followers 33 and 34 which it may be seen are engageable with a cam surface 35 positioned in the pivotal path of the pivoted member 30. The cam surface 35 is shown as being rotatable about an axis aligned generally vertically in the illustration of FIGURE 1 and is accessible for rotational adjustment by means of the external knob member 36. Also affixed to the main current conductor 21 is a thermally responsive means 37 the operation of which will be described more fully hereinafter together with the description of the operation of the magnetic tripping device of the present invention in the several extremities of its adjustable range.

FIGURES 2 and 3 are enlarged illustrations of a portion of the circuit breaker 10 of FIGURE 1 and more particularly illustrate the operation of the present invention in two extreme adjustments of high and low current carrying conditions. In FIGURES 2 and 3 like members bear the same numerical designation as in FIGURE 1. As may be seen from FIGURE 2 the main current conductor 21 supports a thermally responsive device 37 and upon the occurrence of overload conditions of current flow through the circuit breaker, the main current conductor 21 becomes heated and through thermal contact with the thermally responsive means 37 transmits its heat thereto causing it to respond by tending to rotate in a counterclockwise direction with its threaded adjustable calibration means 39 bearing upon the latch member 27. The latch member 27 therefore tends to rotate about its pivot 40, releasing member 26 and allowing the operating mechanism 25 to operate so that the movable contact 16 and the stationary contact 15 spring apart in snap action interrupting the flow of current through the circuit breaker.

The magnetic tripping assembly 20 also operates to release the operating mechanism 25 from its closed or latched position in a manner which will now be described. The flow of current through the main current conductor 21 creates a magnetic field in the magnetic field piece 29. The pivoted armature 30 which pivots about the pivot axis 32, is spring-biased by the spring 38 in a clockwise direction. Upon the occurrence of overload current flow conditions through the main current connector 21, a magnetic pull is exerted by magnetic field piece 29 upon the armature 31, rotating the pivoted member 30 counterclockwise about its pivot point 32. The pivot arm extension 30*a* thereupon comes into contact with latch member 27 urging it in a counterclockwise direction in the manner previously described in connection with the description of the operation of the thermally responsive means 37 of the trip mechanism. In a manner similar to that previously described, the operating mechanism 25 is unlatched and the movable contact 16 and stationary contact 15 of the circuit breaker are disengaged with a snap action interrupting the flow of current through the circuit breaker.

It will be noted that FIGURE 2 shows the magnetic trip mechanism of the present invention in its latched position. Further, it will be noted that the upper arm of the pivoted member 30 supporting two cam follower means in the form of threaded screws 33 and 34, illustrates the upper cam follower 33 in contact with a portion of the cam surface 35. In this position the armature 31 is disposed at or near its furthest disposition from the magnetic field piece 29 and accordingly a considerable magnetic pull must be developed by the flow of relatively high currents through the main current conductor 21 before the magnetic trip assembly will be actuated by reason of the armature 31 being drawn by magnetic pull into engagement with the magnetic field piece 29. Thusly, the adjustment knob 36 in the partial view of FIGURE 2*a* is shown as indicating a "high" adjustment.

Contrasted with this adjustment, FIGURE 3 shows the cam surface 35 disposed so that the lower cam follower 34 on the pivoted member 30 is in engagement with a portion of the cam surface 35, the armature 31, it will be noted, is disposed much closer to the magnetic field piece 29 and accordingly, considerably less current flow through the main current conductor 21 will be required to develop the magnetic pull in the magnetic field piece 29 to attract and engage armature 31 thereby urging latch member 27 in a counterclockwise direction about its rotational pivot point 40, releasing member 26 to actuate the operating mechanism 25 and disengage the movable contact 16 from the stationary contact 15 as previously described. Accordingly, in FIGURE 3*a* the externally accessible adjusting knob 36 is shown as indicating a "low" adjustment.

FIGURE 4 is an illustration showing the cooperative action of the magnetic trip assembly in causing unlatching and release of the operating mechanism 25 to disengage the main contact members 15 and 16 of the circuit breaker. In FIGURE 4 identical members bear the same numerical designation as in FIGURES 1, 2 and 3 and it can be seen that current flow through the main current conductor 21 has acted upon the magnetic field piece 29 to create a magnetic field exerting a pull upon the armature 31 at the lower extremity of the pivot member 30, rotating the pivoted member 30 about its pivotal axis 32 to draw the armature 31 into engagement with the magnetic field piece 29. On the upper extremity of the pivoted member 30, the arm extension 30*a* has engaged latch member 27, rotating it in a counterclockwise direction about its pivot point 40, disengaging the member 26 and allowing release and actuation of the operating mechanism 25 to disengage the main contacts of the circuit breaker 15 and 16.

FIGURE 5 is an exploded perspective view of the principal members of the present invention illustrating their particular configuration in the preferred embodiment of the invention. As is shown in FIGURE 5, the pivoted member 30 of the present invention comprises a unitary stamped metal member which includes two legs comprising the armature 31 and two ears 32*a* and 32*b* extending from the sides and adapted to be received in a pair of appropriate recesses such as that shown at 41 in the bottom portion 11 of the insulating casing of the circuit breaker to support the pivoted member 30 for pivotal movement. A portion of the pivoted member 30 is bent over to form an arm extension 30*a* which is disposed as has been previously described, for engagement with the latch member 27 upon displacement of the pivoted member 30 by reason of attraction of the armature 31 into engagement with the magnetic field piece 29. The magnetic field piece 29 is shown in FIGURE 5 as being disposed within the loop of the main conductor 21, but electrically isolated therefrom.

Accordingly, current flow through the main current conductor 21 creates a magnetic field in the magnetic field

piece **29**, which magnetic field exerts sufficient pull upon the armature **31** under overload current flow conditions through the main current conductor **21** so as to attract the armature **31** in rotational movement of the pivot member **30** for engagement of the armature **31** with the magnetic field piece **29**. The pivoted member **30** also includes at its upper extremities an arm extension **38***a* which is notched to receive and retain a spring member such as shown at **38** in FIGURES 1, 2, 3 and 4 to bias the pivoted member **30** so as to urge its movement in a clockwise direction about its pivot point. Thus the adjustably positionable cam follower **33** or **34** is brought into engagement with a cam surface disposed in the pivotal path of the pivoted member **30** either the cam follower **33** or the cam follower **34** being engaged with the cam surface **35** in accordance with the disposition of the cam surface **35**.

As was previously explained in connection with FIGURES 2 and 3 when the cam surface **35** is disposed away from the pivoted member **30** the upper cam follower **33** comes into engagement with the upper portion of the cam surface **35**. When the cam surface **35** is disposed and positioned in its closest proximity to the pivoted member **30** the lower cam follower **34** comes into contact with the cam surface **35**. As shown in FIGURE 5 the cam surface **35** has two portions, an upper portion and a lower portion to accommodate the particular requirements of the preferred embodiment of the circuit breaker embodying the present invention.

As will be appreciated by those knowledgeable in the art, the cam surface employed in conjunction with the present invention need not be of two diversely planar surfaces, but may be a single plane surface such as that illustrated in FIGURE *5a*. Moreover, it will be evident that the concept of the present invention is not limited to the use of a rotational cam surface but may also be affected by a cam surface which is slidably positionable so as to engage the upper cam follower means **33** in one position and engage the lower cam follower **34** in a second position.

The cam followers are rendered adjustable by reason of being threaded so that they can be independently extended or retracted with respect to the cam surface. While the cam surface itself primarily determines the range of adjustability, the adjustable cam followers afford independent presetting of the maximum and minimum excursions of the pivoted member in the course of selective external adjustment by the user by means of the externally positionable cam surface.

Moreover, as will be evident to those skilled in the art, the present invention does not depend on critical spring adjustment or other means subject to deviation from factory calibration because of ambient temperature and similar conditions encountered in actual operational use.

The present invention therefore embodies in a simple mechanism, a concept which lends itself to inexpensive manufacture having a minimum of movable, frictionally engaged parts which can be compactly embodied in circuit breakers of modern design and affords excellent repeatability of performance without the requirement for readjustment of its factory calibration as well as insuring reliable operation over extended periods of continuous use.

While there has been shown and described the preferred embodiment of the invention, it will be readily apparent that many modifications thereof may be made and I therefore intend by the appended claims to cover all such modifications as fall within the true spirit and scope of the invention.

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

1. Control apparatus comprising:
(a) a support;
(b) a cam member having first and second cam surfaces fixed relative to each other;
(c) means supporting said cam member on said support for movement along a predetermined path between predetermined limits;
(d) first and second cam follower members;
(e) a movable output member supported on said support;
(f) common support means supporting said first and second cam follower members in fixed relation to each other for simultaneous movement;
(g) means connecting said common support means to said output member for movement of said output member in response to movement of said cam member;
(h) said first cam follower member engaging said first cam surface during a first portion of said movement of said cam member, and said second cam follower member engaging said second cam surface during a second portion of said movement of said cam member; and
(i) means for adjusting at least one of said cam follower members independently of the other of said cam follower members.

2. Electrical control apparatus comprising:
(a) a support;
(b) a cam member having a first cam surface and a second cam surface in fixed relation to said first cam surface;
(c) means supporting said cam member on said support for movement along a predetermined path between predetermined limits;
(d) a magnetic field piece supported on said support and having an electrical winding;
(e) a magnetic armature;
(f) means supporting said magnetic armature on said support for movement toward and away from magnetic field piece;
(g) first and second cam follower members;
(h) common support means carrying said first and second cam follower members in fixed relation to each other;
(i) means connecting said common support means to said magnetic armature whereby movement of said common support means causes corresponding movement of said armature;
(j) said first cam follower engaging said first cam surface during a first portion of said movement of said cam member and said second cam follower member engaging said second cam surface during a second portion of said movement of said cam member, and
(k) means for adjusting at least one of said cam follower members independently of the other of said cam follower members.

3. Electrical control apparatus comprising:
(a) a support;
(b) a generally cylindrical cam member supported on said support for rotation about a longitudinal axis;
(c) said cam member having first and second cam surface portions fixed relative to each other and displaced axially along said cylindrical cam member;
(d) first and second cam follower members;
(e) common support means carrying said first and second cam follower members in fixed relation to each other;
(f) means pivotally supporting said common support means on said support adjacent said cam member;
(g) a movable member on said support;
(h) means connecting said movable member to said common support means for adjustably positioning said movable member in response to movement of said common support means;
(i) said first cam follower member engaging said first cam surface portion of said cam member during a first portion of the rotation of said cam member

and said second cam follower member engaging said second cam surface portion during a second portion of said rotation of said cam member; and

(j) means for independently adjusting at least one of said first and second cam follower members independently of the other of said cam follower members.

4. An electrical control apparatus comprising:

(a) a support;

(b) a generally cylindrical cam member supported on said support for rotation about a longitudinal axis;

(c) said cam member having first and second cam surfaces fixed relative to each other and displaced longitudinally thereof;

(d) a movable member pivotally supported on said support;

(e) said movable member carrying said first and second cam follower members in fixed relation to each other;

(f) said first cam follower member being positioned further from the pivotal support of said pivotally supported member than said second cam follower member whereby said first cam follower member engages said first cam surface portion of said cam member during a first portion of rotation of said cam member and said second cam follower member engaging said second cam surface of said cam member during a second portion of rotation of said cam member;

(g) means for adjusting at least one of said cam follower members independently of the other of said cam follower members;

(h) current responsive means supported on said support and including a sensitivity adjusting member movable to adjust the sensitivity of said current responsive means, and

(i) means connecting said movable member carrying said cam follower members to said sensitivity adjusting member to adjust the sensitivity of said current responsive means in response to movement of said cam member.

5. An electrical control apparatus as set forth in claim 4, wherein said first and second cam follower members are each adjustable independently of each other.

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