Aug. 30, 1955 W. H. MIDDENDORF 2,716,679

CIRCUIT BREAKER

Filed May 11, 1954

2 Sheets-Sheet 1

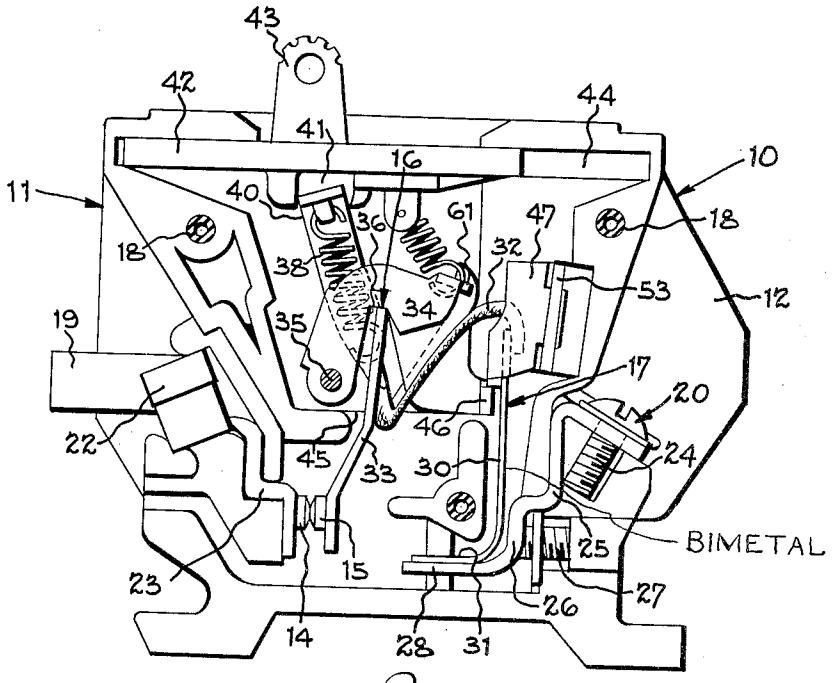


Fig. 1

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2 Sheets-Sheet 2

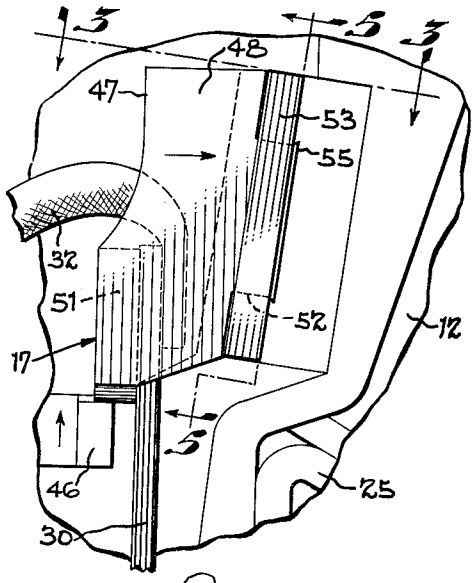


Fig. 2

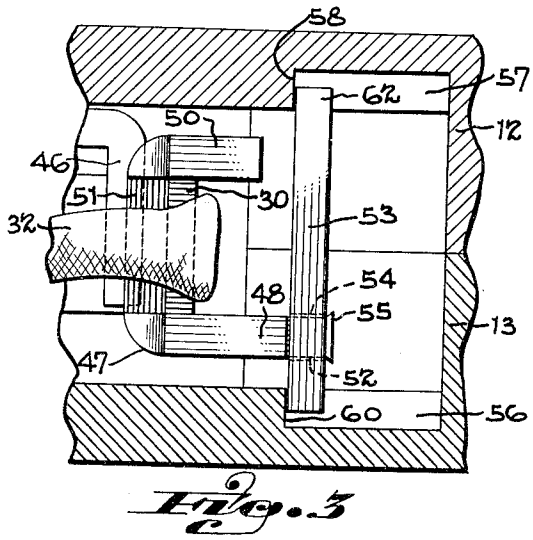


Fig. 3

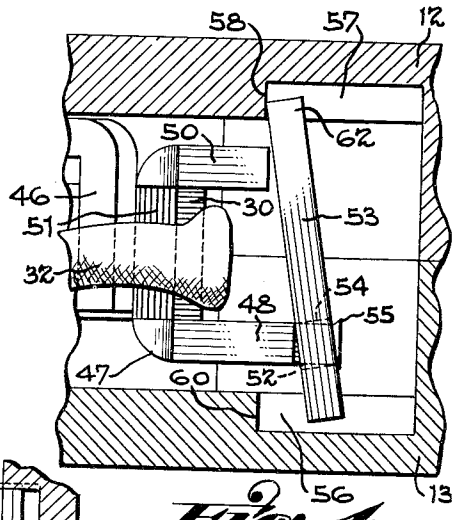


Fig. 4

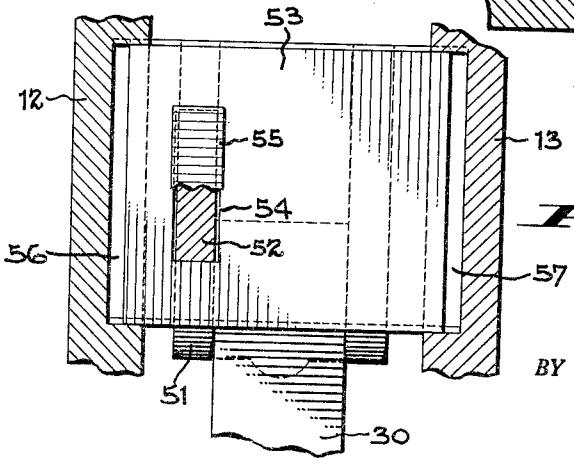


Fig. 5

BY

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2,716,679

# CIRCUIT BREAKER

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Application May 11, 1954, Serial No. 429,094

6 Claims. (Cl. 200—88)

This invention relates to circuit breakers and is more particularly directed to circuit breakers of the type embodying a magnetically and thermally responsive tripping mechanism.

Circuit breakers of the type with which the present invention is concerned are frequently used to protect household and similar circuits against overload or short circuit conditions. Basically, such a circuit breaker comprises a stationary and a movable contact, an operating mechanism for effecting the separation of the contacts, and a trip device for actuating the operating mechanism, immediately upon the occurrence of a heavy overload or after a predetermined interval in response to a continuing moderate overload condition. One form of trip device includes a thermal element in the form of an elongated bimetallic strip, which is heated by any excessive current flow and bends to release the spring actuated contact operating mechanism. The tripping means also includes a magnetically responsive core carried by the bimetallic strip and adapted to release the operating mechanism upon being drawn to a core by the high magnetic field force resulting from a very large current flow through the circuit breaker.

It has been determined that even after the contacts have been separated, arcing occurs and current continues to pass between the contacts and flow through the bimetallic element for a substantial portion of a cycle after the initial contact opening. Under some overload conditions, this current flow, after the contacts have opened, causes the thermally responsive element to deflect many times the amount deflected prior to the contact opening. One of the principal difficulties with previously proposed circuit breakers is that in order to obtain a large tripping force between the magnetic armature and core these elements have been arranged so that once the contacts have been tripped the bimetallic element is restrained by the core and armature against further deformation and consequently when it is heated by the arcing current it is stressed beyond its elastic limit, becoming permanently set.

The principal object of the present invention is to provide a magnetic armature and core construction which provides a maximum magnetic force for tripping the contacts; but nevertheless, permits free movement of the thermally responsive element, after tripping to prevent that element from taking a permanent set. More specifically, the present invention is predicated upon the concept of providing a magnetically responsive tripping means, carried entirely by the thermally responsive strip and including an armature which is restrained by the housing from movement toward the bimetallic strip, but is free to move away from it.

In the preferred embodiment, the magnetically responsive means comprises a core mounted adjacent the end of the bimetallic strip and an armature member hingedly secured to one portion of the core, normally in spaced relationship with a second portion thereof. The circuit breaker housing is configurated to constrain the armature from movement toward the bimetallic strip and core, but to permit it to move freely in the opposite direction. When the circuit including the breaker is heavily overloaded, or short circuited through the breaker, it causes a strong magnetic field to be established between the core and armature. Since the armature is restrained against movement toward the core, the magnetic force causes the core to be drawn to the armature, flexing the bimetallic element to release the operating mechanism and open the switch contacts.



The principal advantage of the present construction is that even though the bimetallic element continues to flex, due to the arcing current, it is not restrained by either the core or armature, which are both carried by the bimetallic strip and are free to move in the direction of travel of the hot bimetallic strip. Consequently, the bimetallic strip does not take on a permanent set and the circuit breaker continues to give dependable service even though it is subjected to all sorts of overload conditions.

Another important advantage of the present construction is that it provides a maximum magnetic force for a given size armature and core. There is only a single air gap of minimum width between the armature and core; and in fact it has been found that the gap need not be appreciably greater than the distance the armature must move to release the contact operating mechanism. As a result, the magnetic field built up in the core by a heavy overload current causes the core to be drawn rapidly toward the armature, effecting an almost instantaneous opening of the contacts.

Another advantage of the present construction is that it is extremely simple, requiring a minimum number of parts. The entire magnetic tripping device includes only two readily stamped and assembled members, namely, a core mounted upon the bimetallic strip and an armature pivotally secured to the core.

These and other advantages of the present invention will be more readily apparent from a further consideration of the following detailed description of the drawings illustrating a preferred form of the invention.

In the drawings:

Figure 1 is a longitudinal view of a circuit breaker embodying the principles of the present invention, one of the housing plates being removed to show the mechanism in detail.

Figure 2 is an enlarged elevational view, showing the trip mechanism in the latched position.

Figure 3 is a cross sectional view of the trip mechanism taken along line 3—3 of Figure 2.

Figure 4 is a cross sectional view similar to Figure 3 showing the trip means in a tripped position.

Figure 5 is a cross sectional view taken along line 5—5 of Figure 2.

As shown in Figure 1, a circuit breaker 10 comprises a housing 11 formed of two mating sections 12 and 13 fabricated from a suitable molded insulating material such as Bakelite. A stationary contact 14 and a cooperating movable contact 15 are mounted within the housing together with a contact operating mechanism indicated generally at 16 and a tripping mechanism indicated generally at 17.

The two sections of housing 11 function as supporting members for the various components of the breaker mechanism and are configurated to form various recesses and projections for removably receiving and retaining the various breaker elements. The breaker parts such as the contacts and operating mechanism components are fitted into their proper places in one section of the breaker housing before the two housing sections are brought together; the parts are thereafter retained in their proper position by the configuration of the two

housing members which are joined together as by means of rivets 18.

Electrical connection to the breaker is made by means of contact jaws 19 and a threaded terminal 20. Contact jaws 19 extend outwardly from the housing and are urged toward one another by a generally U-shaped spring clip 22. The jaws and clip are sufficiently resilient however, to permit the ready insertion of a contact blade or other conductive member between the jaws. The inner ends of the jaws are joined to connector strip 23, which fits within suitably configurated slots within the housing members and carries stationary contact 14, which is rigidly secured adjacent to the end of the strip.

Terminal 20 includes a screw 24 threadably engaging a terminal strip 25 which extends through an opening in the housing into the interior of the breaker. Terminal strip 25 is bent in an irregular shape and includes a segment 26 adapted for abutment with adjusting screw 27 and a segment 28 adapted to support the tripping mechanism. Within the circuit breaker, the electrical circuit is completed through an elongated bimetallic strip 30 having a mounted foot 31 welded to segment 28 of connector 25, a flexible conductor 32 secured to the free end of the bimetallic strip and to switch arm 33 which carries movable contact 15. In addition, the circuit includes stationary contact 14, connector strip 23, and contact jaws 19.

The operating mechanism 16, by means of which the movable contact is shifted between its open and closed positions, includes in addition to switch arm 33, a carrier member 34 pivotally mounted within the housing by means of pin 35 engaging suitable journal openings formed in the housing sections. The end of switch arm 33 remote from contact 15 is pivotally cradled in a recess 36 formed in the carrier member, and is held in position by an over-center spring 38, secured to switch arm 33 and to an operating lever 40. The end of the operating lever, to which the spring is attached, resides in a recess 41 provided in plate 42 which is formed integral with operating handle 43 and is slidably mounted in guideway 44 formed in the housing sections. The opposite end of operating lever 40 is inserted between one wall of the housing and carrier member 34 and abuts a projecting wall 45 of the housing.

Carrier member 34 is provided with a release arm 46 adapted for cooperative engagement with the core of the tripping mechanism to latch the operating mechanism with the contacts in their closed position and to release the operating mechanism so that the over-center spring can rotate the carrier and switch arm to open the contacts.

The tripping device comprises bimetallic element 30 mounted upon segment 28 of connector 26 and having flexible conductor 32 looped over its free end and welded in place. The free end of the bimetallic element carries a generally U-shaped ferro-magnetic core member 47 which is welded or otherwise secured in place and includes support arm 48, a second arm 50 shorter than the first, and a connecting segment 51. Support arm 48 terminates in a tang 52 which loosely carries an armature 53. The armature is preferably in the form of a substantially rectangular plate of ferro-magnetic material and is provided with an elongated slot 54 for receiving tang 52. The tang passes through the slot and is peened over at its end 55 to hold the armature in place.

As shown particularly in Figures 3 and 4, the ends of armature 53 reside in recesses 56 and 57 formed in the opposite housing sections. When the arm 33 is latched and the contacts are in the closed position, the free end of the armature is spaced from arm 50 of the core and is prevented from moving toward the core by shoulder 58 of the housing. The end of armature 53, secured to arm 48 is held in abutment with shoulder 60 by the spring action of the bimetallic strip 30. Since the peened portion 55 of tang 52 is effective to urge the free end of the arm against shoulder 58, the air gap, or spacing between arm 50 and the armature, is determined by the difference in length of the two core arms. This air gap is preferably of minimum length, that is not appreciably greater than the distance which the core must move to release arm 46. Both the armature and core are free to move within recesses 56 and 57 in the direction of movement of the hot bimetallic strip, to the right in Figures 3 and 4. The depth of these recesses is preferably sufficient to permit movement of the core and armature for a distance several times greater than the distance moved to effect release of arm 46. Thus the bimetallic strip is free to flex a substantial distance after the operating mechanism has been tripped.

In operation, the contacts are manually shifted from the opened to the closed position by means of operating handle 43. In order to close the contacts following a tripping of the breaker, the operating handle is shifted from its left hand position shown in Figure 1, to its position at the right hand end of the slot. During its movement, handle 43 causes operating lever 40, and in turn spring 38, to pivot clockwise. The operating lever during its pivotal movement engages a projecting lug 61 formed on the carrier member and thereby forces the carrier member to rotate clockwise about pin 35. Near the end of its clockwise movement, the release arm 46 of the carrier member engages segment 51 of the core, slightly flexing the bimetallic strip to permit passage of the release arm under the core. At its extreme position, the release arm passes beyond the end of the core and the bimetallic strip returns to its original position in which the segment 51 of the core locks the release arm in place.

The operating handle is then returned to its left hand position, as shown in Figure 1, to effect manual closing of the contacts 14 and 15. Movement of the handle in this direction causes counter-clockwise pivotal movement of operating lever 40 and causes counter-clockwise movement of the spring 38 carried by the lever. As the operating handle approaches its extreme left hand position, the spring is moved beyond its over-center position whereupon the spring urges contact arm 33 in a clockwise movement to bring movable contact 15 into engagement with stationary contact 14.

Upon the occurrence of a short circuit or heavy overload condition, causing a current flow of more than predetermined magnitude, the current flowing through the flexible conductor 32 and the bimetallic strip 30 energizes core member 47, causing the establishment of a magnetic field around the core. The effect of this magnetic field is to cause the attraction of the free end 62 of the armature and arm 50 of the core; since the gap between these two elements is minimized the magnetic force between the two is a maximum. The armature is restrained from movement toward the core by its engagement with shoulder 58 of recess 56, so that the core is forced to move toward the armature. In the strong magnetic field, the core moves rapidly toward the armature and becomes disengaged from release arm 46. Upon tripping of the release arm carrier member 34 is urged counter-clockwise by the main operating spring 38. Movement of the carrier member in this direction causes counter-clockwise rotation of switch arm 33 and rapid opening of the contacts.

Despite the rapid opening of the contacts however, some arcing occurs between the contacts or arc quenching elements, if they are provided; so that current continues to flow through the bimetallic strip for a short period after tripping. This current causes the bimetal element to become heated and to continue to flex away from the release arm, to the right in Figures 1–4. Since the movement of the strip is not restrained in this direction, the bimetallic element cannot become permanently deformed.

When an overload current of moderate magnitude flows through the circuit breaker, it causes the bimetallic

strip 30 to become heated, and since the high expansion side of the element is disposed toward the releasable arm, the bimetal element deflects away from the arm, to the right in Figures 1–4. If the moderate overload continues, the free end of the bimetallic element is shifted sufficiently far to the right to disengage the core from the release arm, tripping the operating mechanism to open the contacts as explained above. Again, if the bimetallic element continues to flex due to additional current flow caused by arcing, its movement is not impeded and the element is not permanently deformed.

Having described my invention I claim:

1. In a circuit breaker having a spring actuated release arm, means for normally restraining said release arm, said means comprising a bimetallic strip, a magnetic core mounted on the free end of said bimetallic strip, an armature pivotally secured to one portion of said core and having a free end normally in spaced relationship with another portion of said core, means restricting the movement of the free end of said armature toward said bimetallic strip but permitting the movement of said armature away from said bimetallic strip, said core being adapted for cooperative engagement with said release arm, said bimetallic strip being flexed in response to a continued moderate current overload away from said arm, and the portion of said core spaced from said armature being drawn to said armature upon an excessive current overload, whereby said core is disengaged from said arm to effect the release thereof.

2. In a circuit breaker having a spring actuated release arm, means for normally restraining said release arm, said means comprising a bimetallic strip, a magnetic core mounted on the free end of said bimetallic strip and having two spaced arms, an armature pivotally secured to one arm of said core and having a free end normally in spaced relationship with the other arm of said core, means restricting the movement of the free end of said armature toward said bimetallic strip but permitting the movement of said armature away from said bimetallic strip, said core being adapted for cooperative engagement with said release arm, said bimetallic strip being flexed in response to a continued current moderate overload away from said arm, and the portion of said core spaced from said armature being drawn to said armature upon an excessive current overload, whereby said core is disengaged from said arm to effect the release thereof.

3. In a circuit breaker having a spring actuated release arm, means for normally restraining said release arm, said means comprising a bimetallic strip, a magnetic U-shaped core mounted on the free end of said bimetallic strip and including two arms of unequal length, an armature pivotally secured to the longer arm of said core and having a free end normally in spaced relationship with the other arm of said core, means restricting the movement of opposite ends of said armature toward said bimetallic strip but permitting the movement of said armature away from said bimetallic strip, said core being adapted for cooperative engagement with said release arm, said bimetallic strip being flexed in response to a continued moderate current overload away from said arm, and the portion of said core spaced from said armature being drawn to said armature upon an excessive current overload, whereby said core is disengaged from said arm to effect the release thereof.

4. A circuit breaker having a housing, relatively moveable contact means and spring urged operating means for effecting opening of said contact means, current responsive trip means effective to normally restrain said operating means and to release said operating means in response to an overload current in the circuit through said breaker, said trip means comprising a dimetallic strip mounted at one end, a magnetic core mounted adjacent to the free end of said bimetallic strip, an armature pivotally secured to one portion of said core and normally in spaced relationship with another portion of said core, said housing being configurated to form a recess, said armature being disposed within said recess and being restricted by said housing from movement toward said bimetallic strip but being free to move within said recess in a direction away from said bimetallic strip, said bimetallic strip being flexed in response to a moderate current overload in a direction away from said spring urged operating means, and the arm of said core spaced from said armature being drawn to said armature upon an excessive current overload, whereby said core is disengaged from said spring urged operating means to effect the release thereof.

5. A circuit breaker having a housing, relatively moveable contact means and spring urged operating means for effecting opening of said contact means, current responsive trip means effective to normally restrict said operating means and to release said operating means in response to an overload current in the circuit through said breaker, said trip means comprising a bimetallic strip mounted at one end, a magnetic core mounted adjacent to the free end of said bimetallic strip, said core including two spaced arms, an armature pivotally secured to one of said arms and normally in spaced relationship with the other of said arms, said housing being configurated to form a recess, said armature being disposed within said recess, each end of said armature being positioned for engagement with a wall of the housing defining said recess, whereby said armature is restricted by said housing from movement toward said bimetallic strip but is free to move within said recess in a direction away from said bimetallic strip, said bimetallic strip being flexed in response to a moderate current overload in a direction away from said spring urged operating means, and the arm of said core spaced from said armature being drawn to said armature upon an excessive current overload, whereby said core is disengaged from said spring urged operating means to effect the release thereof.

6. A circuit breaker having a housing, relatively moveable contact means and spring urged operating means for effecting opening of said contact means, current responsive trip means effective to normally restrict said operating means and to release said operating means in response to an overload current in the circuit through said breaker, said trip means comprising a bimetallic strip mounted at one end, a magnetic core mounted adjacent to the free end of said bimetallic strip, said core including two spaced arms, one of said arms having a tang formed on the end thereof, an armature configurated to form a slot for receiving said tang, the end of said tang bent to pivotally support said armature, the free end of said armature being normally in spaced relationship with the other arm of said core, said housing being configurated to form a recess, said armature being disposed within said recess and being free to move within said recess in a direction away from said bimetallic strip, and means restricting said armature from movement toward said bimetallic strip, said bimetallic strip being flexed in response to a moderate current overload in a direction away from said spring urged operating means, and the arm of said core spaced from said armature being drawn to said armature upon an excessive current overload, whereby said core is disengaged from said spring urged operating means to effect the release thereof.

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