

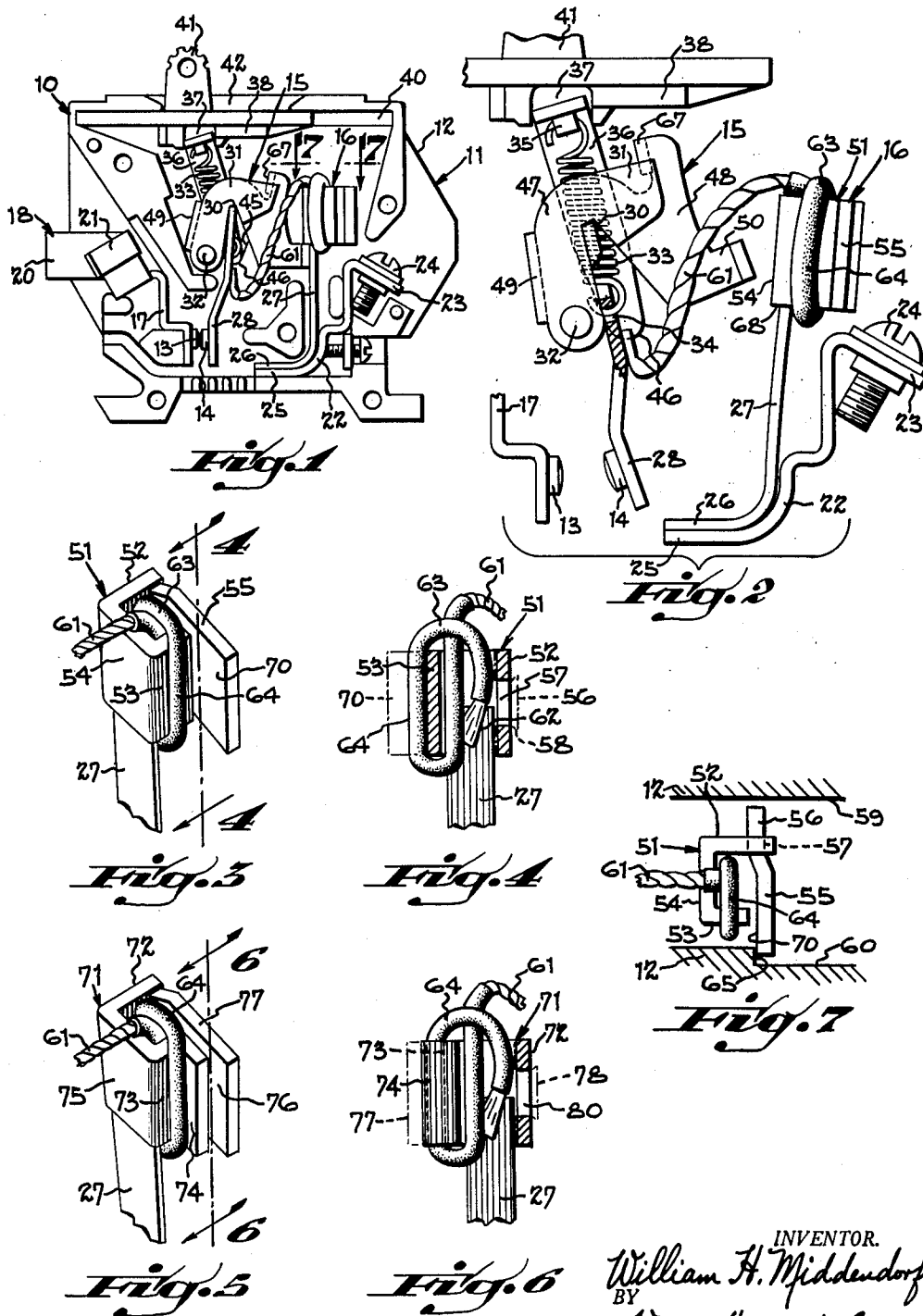
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W. H. MIDDENDORF

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CIRCUIT BREAKER WITH IMPROVED ELECTROMAGNETIC TRIPPING DEVICE

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INVENTOR.
 William H. Middendorf.
 BY
 Work, Herrn & Evans.
 ATTORNEYS.

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3,179,767 CIRCUIT BREAKER WITH IMPROVED ELECTROMAGNETIC TRIPPING DEVICE

William H. Middendorf, Covington, Ky., assignor to The Wadsworth Electric Manufacturing Company, Inc., Covington, Ky., a corporation of Kentucky
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The present invention relates to circuit breakers and is more particularly directed to the current responsive tripping mechanism of a circuit breaker for automatically opening the breaker upon a current overload.

A circuit breaker incorporating the present invention is adapted for use in protecting electrical circuits against low current overloads of continued duration or heavy overloads or short circuit conditions. To this end the breaker embodies both thermal and magnetic tripping means for opening the breaker contacts. More particularly, a circuit breaker of this type includes a spring actuated opening mechanism for effecting rapid separation of the electrical contacts and a tripping device for releasably latching the operating mechanism. The tripping mechanism is adapted to actuate the contact opening mechanism immediately upon the occurrence of a heavy overload, or after a predetermined interval in response to a moderate overload of continued duration.

One suitable form of tripping mechanism, as disclosed in my prior Patent No. 2,716,679, includes a thermal element in the form of an elongated bi-metallic strip which is heated by the current flow through the breaker and bends in response to any continued excessive flow to release the spring actuated contact opening mechanism. The tripping mechanism also includes a magnetically responsive core carried by the bi-metallic strip and adapted to release the operating mechanism upon being drawn to an armature by the magnetic field force resulting from a sudden current surge through the breaker.

In addition to these elements, a circuit breaker includes a flexible conductor secured to the free end of bi-metallic element and to a contact carrying member of the operating mechanism. This flexible connector carries the current through the breaker from the breaker contacts to the bi-metallic strip.

The principal object of the present invention is to provide a magnetically responsive release mechanism in which the magnetic force available for effecting release of the contact opening mechanism is substantially increased to provide rapid and dependable opening of the contacts upon occurrence of a heavy overload condition. In accordance with the present invention, the flexible connector is positioned and configured to produce a magnetic field of high intensity so that a maximum magnetic force is provided for effecting rapid release of the operating mechanism to open the contacts in case of a heavy overload.

More specifically, the present invention is predicated upon the concept of coiling a flexible conductor around a magnetically responsive core which is carried by the thermally responsive strip. In a typical embodiment of the invention, the core is mounted at the free end of a bi-metallic strip and includes at least one arm normally spaced from a magnetically responsive armature, but adapted to be drawn into contact with the armature as a result of the magnetic attraction established by a high current flow through the breaker. In accordance with the present invention, the flexible connector is coiled about the core, preferably about the arm, forming the air gap with the armature. Preferably, but not necessarily, this arm of the core includes a flange extending at right angles to the arm, substantially parallel to the armature. In such an embodiment, current flowing through the coil

sets up a magnetic field which is substantially greater than that produced by current flow through a flexible conductor passing directly from the bi-metallic strip to the switch arm; in addition the area of the air gap between the core and the armature is appreciably enlarged further increasing the magnetic force between these two members.

In addition to providing an increased magnetic attraction between the core and armature, the coil construction of the present invention is advantageous since in effect, the flexible connector forms a knot about the core. This knot maintains the conductor in a predetermined position in which the conductor does not interfere with the movement of the armature and core during substantial overloads; and does not engage the housing to hinder movement of the bi-metallic strip during moderate overloads. Furthermore, the knot relieves any strain on the welded connection between the flexible connector and the bi-metallic strip. Consequently, these two members have no tendency to separate despite repeated flexing of the strip.

A further advantage of the present coil construction is that it is extremely simple and economical to manufacture. The coil does not require any welding in addition to that required in previous circuit breakers, not having coils, for example the circuit breaker shown in Patent No. 2,716,679. Moreover the flexible conductor does not need to be precoiled but rather as explained in detail below can readily be coiled during the assembly of the breaker.

These and other objects and 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 embodiment 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 partial elevational view showing details of the operating and trip mechanism.

FIGURE 3 is an enlarged perspective view of the latch and coil.

FIGURE 4 is a cross sectional view taken along line 4-4 of FIGURE 3.

FIGURE 5 is a perspective view similar to FIGURE 3, of a modified form of latch.

FIGURE 6 is a cross sectional view taken along line 6-6 of FIGURE 5.

FIGURE 7 is a cross sectional view taken along line 7-7 of FIGURE 1.

As shown in FIGURE 1, a circuit breaker 10 constructed in accordance with the principles of the present invention comprises a housing 11 formed of two mating sections 12 fabricated from a suitable molded insulating material such as Bakelite. Only one of the housing sections is shown, to provide a better view of the operating mechanism of the breaker. The housing encloses a stationary contact 13, a movable contact 14, an operating mechanism 15 for shifting the movable contact into and out of contact with the fixed contact, and a tripping mechanism 16. The various breaker parts are supported within the housing which is preferably configured to form various recesses and projections for receiving and retaining the various parts without the need of additional mounting elements.

The stationary contact 13 is welded or otherwise rigidly secured to the inner face of a conducting strip 17. This strip is of an irregular configuration and is connected at its outer end to a connector 18 in the form of contact jaws 20, which are spaced from one another to permit insertion of a contact blade or other conduc-

tive member and are spring urged toward one another by means of a U-shaped spring clip 21 to insure good electrical contact. At the opposite end of the housing 11 is a second irregularly configured conducting strip 22. This conducting strip includes an outer arm 23 which functions as a terminal connector and threadably receives screw 24. At its inner end conducting strip 22 includes a segment 25 which is connected to trip device 16 through foot 26 of bi-metallic strip 27, the foot of the bi-metallic strip being welded or otherwise permanently secured to conducting strip 22.

The movable contact 14 is rigidly secured as by welding to the free end of switch arm 28 forming one element of the operating mechanism 15. The opposite end of the switch arm is cradled in recesses 30 formed in carrier member 31. Carrier member 31 is pivotally mounted upon a pin 32 which extends transversely across the housing and is supported in suitable journal openings formed in the housing sections. An over center spring 33 functions to position switch arm 28, the spring being stretched between an aperture 34 provided in that arm and a tang 35 formed on operating lever 36.

One end of operating lever 36 is disposed in a transverse recess 37 formed in the undersurface of a sliding plate 38. This plate is guided for sliding movement within the breaker housing by grooves 40 and is preferably formed integral with an operating handle 41 which extends outwardly through a suitable opening 42 formed in the front face of housing 11. The opposite end of operating lever 36 lies adjacent to the inner surface of one wall of housing 11 between that wall and carrier member 31. A generally V shaped shoulder 45 having a rounded apex 46 is provided for pivotally supporting the lower end of the operating lever. Carrier member 31 preferably comprises two spaced arms 47 and 48 extending in parallel spaced relationship to one another and connected by a cross strip 49. One arm 48 of the carrier member includes an extending segment 50 adapted to function as a release arm for cooperative engagement with the core of the tripping mechanism. The tripping mechanism is effective to releasably latch the operating mechanism with the stationary and movable contacts in their closed position; and to release the operating mechanism so that over center spring 33 is effective to rotate the carrier and switch arm in a counterclockwise direction as viewed in FIGURES 1 and 2, thereby opening the contacts.

As shown in FIGURES 1 through 4, one form of tripping mechanism 16 comprises bi-metallic element 27, the foot 26 of which is welded or otherwise secured to connector strip 22. The upper, or free, end of the bi-metallic strip carries a generally U shaped ferromagnetic core member 51 which is welded or otherwise secured to the bi-metallic strip with arms 52 and 53 of the core facing outwardly away from operating mechanism 15. A connecting segment 54 of the core is disposed on the side of the bi-metallic strip adjacent to carrier member 31. As best shown in FIGURE 3, arm 53 is appreciably shorter than arm 52. An armature 55 extends across the open end of the U, the armature including a tang 56 loosely extending through an opening 57 formed in support arm 52, the tang being provided with projections 58 effective to hold the armature and core in assembled relationship. As shown particularly in FIGURE 7, the ends of armature 55 reside in recesses 59 and 60 formed in the opposite housing section.

In addition to core 51, the upper end of bi-metallic strip 27 also is joined to flexible conductor, or pigtail 61. The pigtail is preferably in the form of a braided copper wire which is welded or otherwise secured to the upper end of bi-metallic strip 27 as at 62. The pigtail passes upwardly from the end of the bi-metallic strip and is coiled around arm 53 of core member 51 in such a manner that the free end of the pigtail 61

passes between the coiled section 63 of the pigtail and the cross piece 54 of the core. Conductor 61 is pulled taut so that it makes a full and complete turn around the core and in effect a knot, somewhat similar to a half hitch, is formed about the armature. As best shown in FIGURES 3 and 4, the portion of pigtail 61 forming this coil is insulated in any suitable manner such as by being encased in a flexible plastic tube 64. The opposite end of flexible conductor 61 is welded or otherwise secured to switch arm 28.

When the contacts are closed, current flows through the breaker from contact blade 18 through conducting strip 17, stationary contact 13, movable contact 14, switch arm 28, flexible conductor 61, bi-metallic strip 27, and conductor strip 22 to terminal 23.

When arm 50 is in a latched position, in engagement with the core and the contacts are closed, the free end of the armature is spaced from arm 53 of the core. The armature is prevented from moving toward the core by shoulder 65 of the housing. Consequently, an air gap, the size of which is determined by the difference in length of arms 52 and 53 of the core, is established between arm 53 of the core and armature 55. Both the armature and core are free to move within recesses 59 and 60 in the direction of movement of the hot bi-metallic strip, that is, to the right in FIGURE 1. For reasons explained in Patent No. 2,716,679, the depth of these recesses is preferably such that the core and armature are free to move a distance several times that required to effect release of arm 50 of the carrier.

When the circuit breaker is installed in a circuit, movable contact 14 is shifted to its closed position by actuating operating handle 41. This handle is first shifted from its left hand position as shown in FIGURE 1 to a position at the opposite end of the slot. When shifted in this direction, operating handle 41 carries the upper end of operating lever 36 to the right, in turn causing spring 33 to pivot in a clockwise direction about the upper end of switch arm 28.

During its counterclockwise movement, operating lever 36 engages a projecting lug 67 formed on arm 48 of carrier member 31, thereby forcing the carrier member to rotate clockwise about pivot pin 32. Near the end of its clockwise movement, extension 50 of the release arm 48 engages cross segment 54 of core 51. Extension 50 forces the core to the right, slightly flexing the bi-metallic strip, to permit passage of the release arm under the latching surface 68 formed on the lower edge of the core segment 54. After the arm passes under this latching surface, the bi-metallic strip returns to its original position so that latching surface 68 extends over the end of extension 50 a predetermined distance and is effective to lock the release arm in place.

The operating handle is then returned to its left hand "on" position as shown in FIGURE 1, thereby effecting manual closing of movable contact 14. Movement of operating handle 41 to the left causes a counterclockwise pivotal movement of operating lever 36, the lower end of this lever pivoting about recess 46 formed in the housing wall. As operating lever 36 pivots in a counterclockwise direction, it carries with it main operating spring 33. As the operating handle approaches its extreme left hand position spring 33 is moved beyond its overcenter position, whereby the spring urges contact arm 28 to pivot in a clockwise direction about the crutches provided in carrier 31, thereby bringing movable contact 14 into firm engagement with stationary contact 13.

Upon the occurrence of a low persistent overload current below a predetermined value; for example, below ten times normal rated current, bi-metallic element 27 is heated and bends to the right in FIGURES 1 and 2 causing latching surface 68 on the core to move beyond the end of release arm 50 to effect release of that member which rotates in a counterclockwise direction under the

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influence of main operating spring 33. Rotation of the carrier member in a counterclockwise direction brings the upper end of switch arm 28 to a position in which spring 33 is over center on the opposite side of the arm and causes the arm to pivot rapidly in a counterclockwise direction opening contacts 13 and 14.

When an overload, or short circuit occurs, causing current above a predetermined value, in the example given ten times the rated load, to flow through bi-metallic strip 27 and coil 63 of flexible conductor 61, this current establishes a strong magnetic field in the core. The effect of this magnetic field is to cause the attraction of free end 70 of the armature and ram 53 of the core. However, the armature is restrained from movement to the core by its engagement with shoulder 65 of recess 60 so that the core is forced to move toward the armature. In the strong magnetic field which is created by coil 63, the core moves very rapidly toward the armature quickly disengaging itself from release arm 50 of carrier member 31. The carrier member is thereby freed for counterclockwise rotation to effect similar rotation of switch arm 28 and opening of contacts 13 and 14 as explained above.

A slightly modified form of construction is shown in FIGURES 5 and 6. As there shown, a bi-metallic strip 27 supports a generally U-shaped core 71 of magnetically permeable material having support arm 72 and a second arm 73 extending parallel to arm 72. Arm 73 is slightly shorter than arm 72 and is provided with a flange 74 extending outwardly from the arm at substantially right angles thereto. The core also includes a connecting segment 75 joining arms 72 and 73. This segment is secured to the free end of bi-metallic strip 27 in the same manner as segment 50 of the previously described embodiment. A flexible conductor 61 is welded or otherwise secured to the upper end of bi-metallic strip 27 and is wound around arm 73 of the core to form a loop around that arm as best shown in FIGURE 6. The connector is pulled tight so that a firm frictional grip is obtained upon the core. Flexible connector 61 is provided with an insulating covering 64, which as explained above is preferably in the form of a flexible plastic tube through which the connector is inserted. Flange 74 is substantially the same width as the flexible connector and is effective to increase the area of the air gap 76 between that connector and armature 77, the armature having a tang 78 disposed within aperture 80 of mounting arm 72.

It will be appreciated that in manufacturing breakers embodying the coil and core constructions of either the embodiment shown in FIGURE 3 or the embodiment shown in FIGURE 5, one end of the flexible conductor is first welded to the free end of the bi-metallic strip. Next, the insulating tube is placed over the conductor and the conductor is pulled over arm 53, drawn under the arm and upwardly along the bi-metallic strip, between arm 54 of the core and the portion of the conductor passing over arm 53. After being looped about the core, the conductor is drawn tight and thereafter the opposite end of the conductor is welded to switch arm 28. Alternatively, the flexible conductor can be welded to the free end of the bi-metallic strip and to the switch arm. Next a loop is formed in the conductor and the conductor is slipped between the armature and arm 53 of the core. Thereafter the conductor is pulled taut to form a knot about the core. In either method of assembly, the present coil requires no additional welding or special pre-fabrication of the coil. Moreover the coil provides security of mounting of the flexible conductor to the bi-metallic strip eliminating the tension on the welded joint of the coil and strip and eliminating any tendency of the coil and strip to become disengaged after repeated flexing.

While the present coil construction is particularly advantageous when used in conjunction with the particular core and armature shown in the drawings, it will be understood that it can be used with a core and armature of a different configuration if desired.

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Having described my invention, I claim:

1. In a circuit breaker having a movable contact carrying arm and a spring actuated release arm, means for normally restraining said release arm, said means comprising a bi-metallic strip, a magnetic core mounted on the free end of the bi-metallic strip, said core having two spaced arms, a cooperating magnetically responsive armature mounted in spaced relationship with a portion of said core, a continuous braided flexible current carrying conductor secured to the free end of the bi-metallic strip and said movable contact carrying arm, said conductor extending upwardly between the arms of the core, over and around one arm, and passing between the core and the upwardly extending portion of the conductor, the portion of said conductor adjacent to said core being covered with insulating material, said conductor being knotted sufficiently taut to provide a frictional grip upon said core, thereby relieving the stress at the juncture of said braided conductor and bi-metallic strip whereby a strong magnetic field is established between the core and armature, and the portion of the core spaced from the armature is drawn toward the armature upon an excessive current overload to effect release of the release arm.

2. In a circuit breaker having a movable contact carrying arm and means including a spring-actuated release arm for shifting said contact carrying arm, means for normally restraining said release arm, said means comprising a bi-metallic strip, a magnetic core mounted on the free end of the bi-metallic strip, a magnetically responsive armature mounted within said breaker in spaced relationship with a portion of said core, a continuous braided flexible current carrying conductor secured at one end to the contact carrying arm and at the other end to the free end of the bi-metallic strip, said conductor forming a knotted coil about the core, whereby a strong magnetic field is established between the core and armature upon an excessive current overload to effect release of the release arm, the knotted coil being sufficiently taut to provide a frictional grip upon said magnetic core thereby relieving the stress at the juncture of said braided conductor and said bi-metallic strip.

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BERNARD A. GILHEANY, *Primary Examiner.*

75 MAX L. LEVY, RICHARD M. WOOD, *Examiners.*