July 14, 1964 A. R. CELLERINI 3,141,081

CIRCUIT BREAKER WITH THERMAL TRIPPING MEANS

Filed Feb. 15, 1960 3 Sheets-Sheet 1

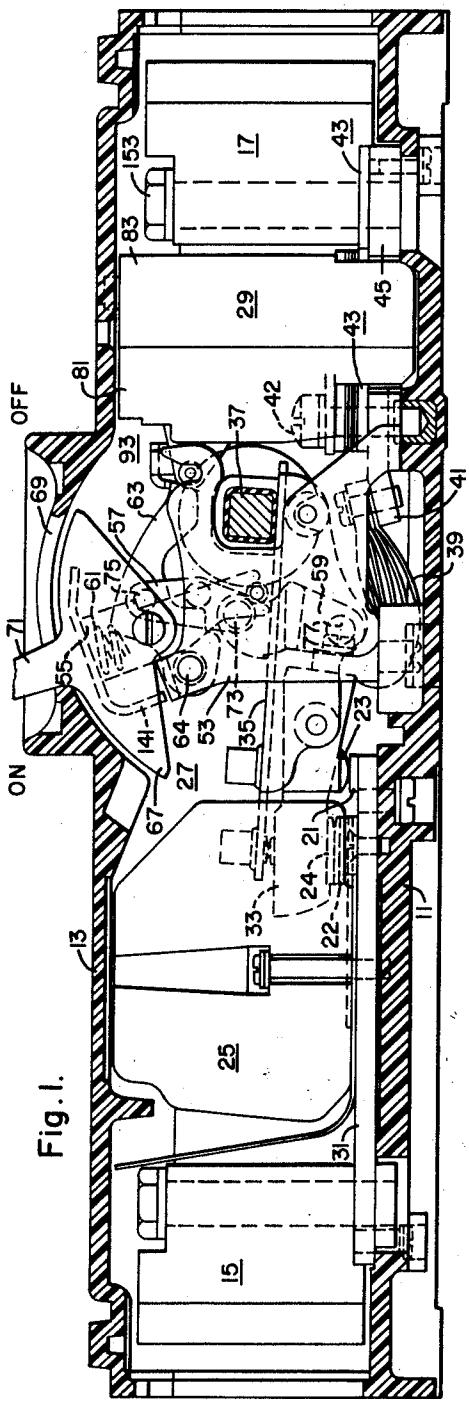


Fig. 1.

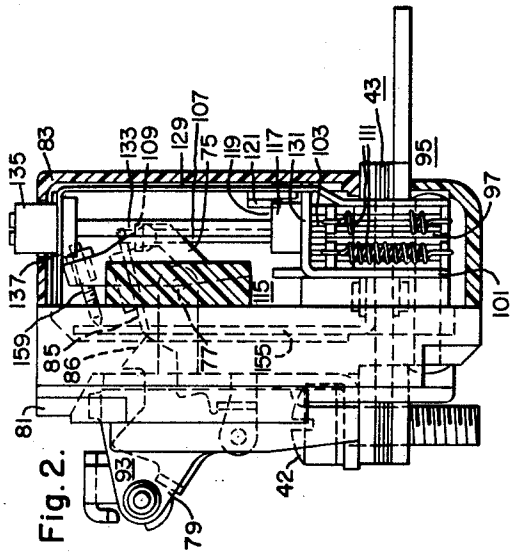


Fig. 2.

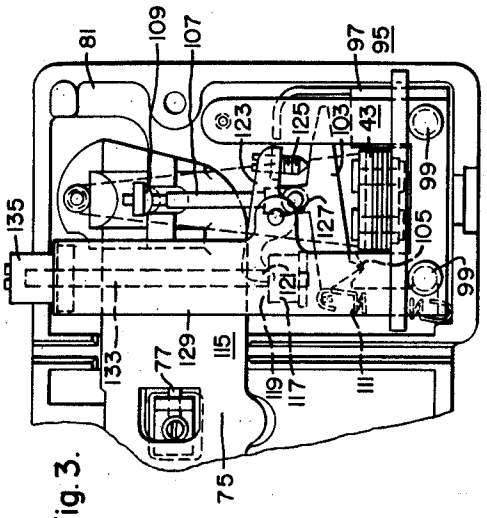


Fig. 3.

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Fig. 4.

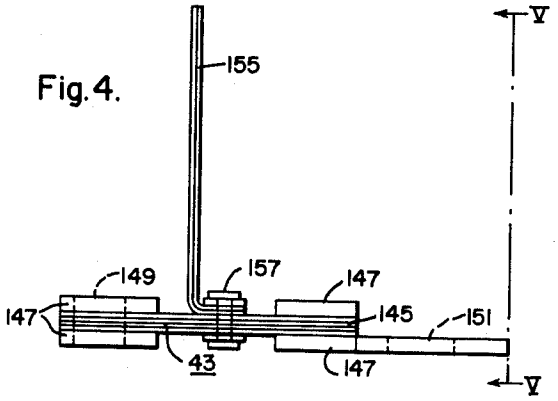


Fig. 5.

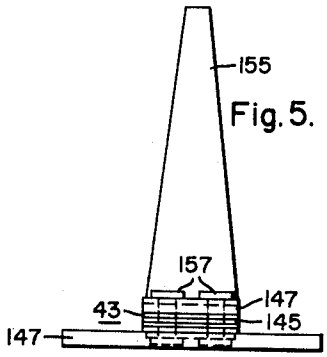


Fig. 9.

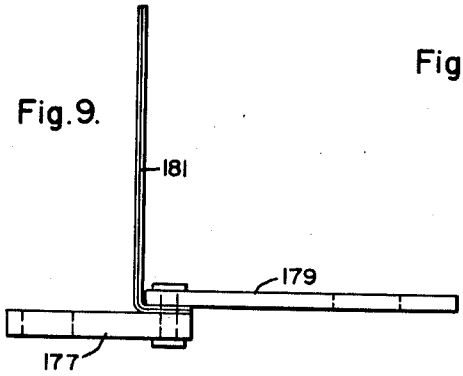


Fig. 8.

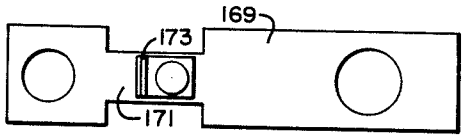


Fig. 7.

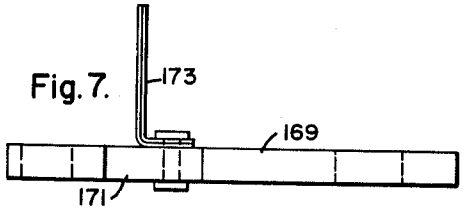
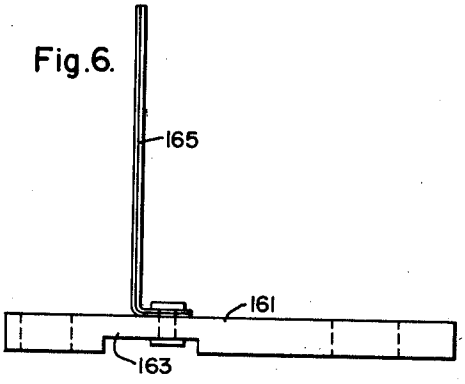


Fig. 6.



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CIRCUIT BREAKER WITH THERMAL TRIPPING MEANS

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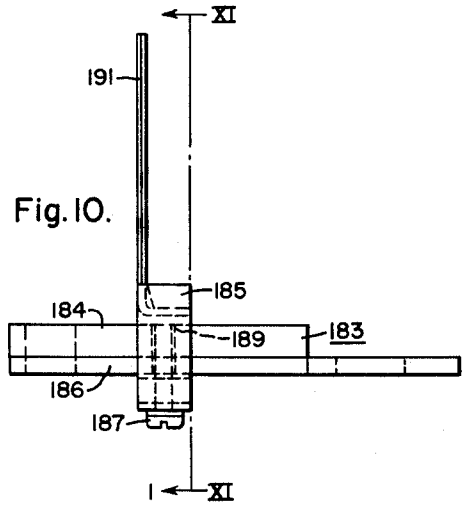


Fig. 10.

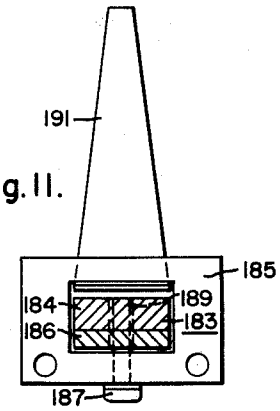


Fig. 11.

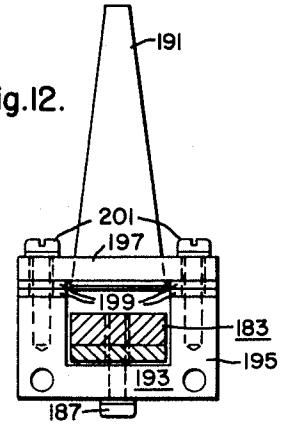


Fig. 12.

United States Patent Office 3,141,081 Patented July 14, 1964

3,141,081

CIRCUIT BREAKER WITH THERMAL TRIPPING MEANS

Albert R. Cellerini, Beaver, Pa., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Filed Feb. 15, 1960, Ser. No. 8,818
3 Claims. (Cl. 200—122)

This invention relates to circuit breakers, and more particularly, to trip devices for effecting automatic tripping of circuit breakers.

An object of the invention is to provide an improved trip device for effecting automatic opening of a circuit breaker.

Another object of the invention is to provide a circuit breaker having a trip device embodying a conducting member that can withstand heavy short circuits without incurring serious damage.

A further object of the invention is to provide a circuit breaker having a trip device comprising a bimetallic member and a substantially straight conducting member for heating the bimetallic member.

Another object of the invention is to provide a circuit breaker embodying a trip device with a conductor having a portion of reduced cross sectional area for more effective heating of the bimetallic member.

A further object of the invention is to provide a circuit breaker embodying a trip device with improved means for heating the bimetallic member by conducting current through the bimetallic member.

Another object of the invention is to provide a circuit breaker embodying a trip device wherein an induced current is utilized in order to effect heating of the bimetallic member.

Another object of the invention is to provide a circuit breaker embodying a trip device with adjustable means heated by an induced current to effect tripping of the breaker.

A more general object of the invention is to provide a circuit breaker with an improved trip device that can be manufactured at a reduced cost.

The novel features that are considered characteristic of the invention are set forth in particular in the appended claims. The invention itself, however, both as to structure and operation, together with additional objects and advantages thereof, will be best understood from the following detailed description when read in conjunction with the accompanying drawings, in which:

FIGURE 1 is a side view, in section, of a circuit breaker embodying the principal features of the invention;

FIG. 2 is an enlarged view, partly in side elevation and partly in section of a trip device utilized in the circuit breaker illustrated in FIG. 1;

FIG. 3 is an end elevational view, on an enlarged scale of part of the trip device the cover being broken away to show the device more clearly;

FIG. 4 is a side elevational view of the conductor and the bimetallic member of the trip device shown in FIG. 2;

FIG. 5 is a view looking in the direction of line V—V of FIG. 4;

FIG. 6 is a side elevational view of another embodiment of a conductor and a bimetallic member for the trip device;

FIG. 7 is a side elevational view of another embodiment of a conductor and a bimetallic member for the trip device.

FIG. 8 is a top view of the conductor and the bimetallic member shown in FIG. 7;

FIG. 9 is a side elevational view of a different embodiment of parts of the trip device.

FIG. 10 is a side elevational view of still another embodiment of parts of the trip device;

FIG. 11 is a view taken along line XI—XI of FIG. 10; and

FIG. 12 is a view similar to FIG. 11 of still another embodiment of parts of the trip device.

Referring to FIGURE 1 of the drawings, the circuit breaker shown therein comprises, generally, a base **11** and a removable cover **13**, both of which may be molded from a suitable insulating material. The breaker is of the three-pole type, each pole being provided with terminal structures indicated generally at **15** and **17** which are mounted at opposite ends of the base **11**. These terminal structures may be of the type specifically described and claimed in the copending application of Albert R. Cellerini and Louis N. Ricci Serial No. 8,819, filed February 15, 1960, and assigned to the assignee of the instant application.

The circuit breaker includes, for each pole unit, a stationary main contact **21**, a stationary arcing contact **22**, a movable main contact **23**, a movable arcing contact **24** and an arc extinguisher indicated generally at **25**. A common operating mechanism indicated generally at **27** is provided for simultaneous actuation of the movable contacts to opened and closed positions. A trip device indicated generally at **29** serves to effect automatic opening of the circuit breaker contacts in response to predetermined overload conditions in the circuit of any pole unit of the circuit breaker. The terminal structure **15**, for each pole unit, is mounted at the outer end of a terminal conducting strip **31** which extends into the housing and rigidly supports the stationary contacts **21** and **22**.

The movable contacts **23** and **24**, for each pole unit, are mounted on a rigid contact arm **33** supported on a switch arm **35** which is secured to a tie bar **37** that extends across all of the pole units of the circuit breaker. The tie bar **37** supports the switch arms **35** for the several pole units of the breaker for unitary movement to the open and closed positions. Each of the contact arms **33** is connected by means of flexible conductors **39** to an intermediate conducting strip **41**. The conducting strips **41** are each connected to a trip unit conducting strip, or heating member, which is indicated generally at **43**, by a bolt **42** which connects the conductors **43** and **41** to the base **11** of the breaker. Each of the trip unit conducting strips **43** passes through the trip unit **29** and is supported at its outer end on a conducting block **45**. A terminal structure **17**, for each pole unit, is mounted at the outer end of each one of the trip unit conductors **43**.

The circuit through each pole unit of the breaker extends from the terminal structure **15** through the conducting strip **31**, stationary contacts **21** and **22**, movable contacts **23** and **24**, movable contact arm **33**, flexible conductors **39**, intermediate conducting strip **41**, trip unit conducting strip **43**, and to the load terminal structure **17**.

The operating mechanism **27** (FIG. 1) is disposed in the center compartment of the housing and is supported by a pair of spaced frame members **53** (only one being shown) secured to the base **11**. The operating mechanism comprises a pivoted forked operating lever **55**, a toggle comprising toggle links **57** and **59**, two overcenter springs **61** (only one being shown) and a pivoted releasable cradle **63** controlled by the trip device **29**. An arcuate insulating shield **67**, for substantially closing an opening **69** in the cover **13**, is mounted on the outer end of the operating lever **55** and has an integral handle portion **71** extending out through the opening **69** to permit manual operation of the breaker.

The toggle links **57** and **59** are pivotally connected together by a knee pivot pin **73**. The toggle link **57** is pivotally connected to the cradle **63** by a pin **75** and the toggle link **59** is pivotally connected to the switch arm

35, of the center pole unit, by a pin 77. The overcenter springs 61 are connected under tension between the knee pivot pin 73 of the toggle 57, 59 and the outer end of the operating lever 55. The circuit breaker is manually operated to the open position by movement of the handle 71 (FIG. 1) in a clockwise direction to the "off" position, which movement actuates the overcenter springs 61 to cause collapse of the toggle 57, 59 and opening movement of the switch arms 35 for all of the pole units of the circuit breaker in a manner well known in the art.

The circuit breaker is manually closed by reverse movement of the handle 71 from the "off" to the "on" position, which movement causes the springs 61 to move overcenter and straighten the toggle 57, 59 thereby moving the switch arms 35, for all of the pole units, to the closed position.

The trip device 29, (FIGS. 2 and 3), includes a molded insulating trip bar 75 which is common to all of the pole units of the breaker. The trip bar 75 is pivotally supported by means of pins 77 (only one being shown in FIGS. 2 and 3) which are supported in a bracket 79 (FIG. 2) that is secured to the base 11 by one of the screws 42. The bracket 79 also supports an insulating base 81 for the trip device. A cover 83 (FIG. 2), of insulating material, cooperates with the base 81 to enclose the parts of the trip device.

A latch 85 (shown in broken lines in FIG. 2), on the trip bar 75, normally engages a latch portion 86 of a latch mechanism indicated generally at 93. The latch mechanism 93 engages and releasably restrains the cradle 63 (FIG. 1) to releasably hold the operating mechanism in the closed position.

A tripping electromagnet, indicated generally at 95 (FIGS. 2 and 3), includes a fixed, laminated, U-shaped magnet yoke 97, the laminations being secured together by rivets not shown. The magnet yoke 97 is supported by means of rivets 99 (FIG. 3) on a bracket 101 (FIG. 2) which is supported on the insulating base 81 by the rivets 99. A movable armature 103 is pivotally supported by means of a knife-edge pivot 105 (FIG. 3) in a V-shaped notch in the fixed yoke 97. A rod 107 is pivotally connected to the armature 103, and it has a head 109 for engaging and operating the trip bar 75 upon energization of the magnet yoke 97. Two springs 111 are connected under tension between an end of the armature 103 and a portion of the fixed magnet yoke 97. The springs 111 bias the armature 103 counterclockwise to the unattracted position shown in FIG. 3. The tripping electromagnet 95 is energized by current flowing in the conductor 43 which extends between the legs of the U-shaped magnet yoke 97.

The circuit breaker is tripped open instantaneously by operation of the tripping electromagnet 95. When the magnet is energized by an overload current of, for instance, 500% of normal rated current, the armature 103 is attracted pulling the rod 107 down, whereupon the head 109, of the rod 107, engages the trip bar 75 causing the trip bar to rotate clockwise as seen in FIG. 2 to disengage the latch 85 from the latch mechanism 93 which, in turn, releases the cradle 63 (FIG. 1).

Upon release of the cradle 63, the springs 61 act to rotate the cradle in a counterclockwise direction about its pivot 64, thus causing collapse of the toggle 57, 59 and movement of the switch arms 35 and movable contacts for all of the pole units to the open position.

An adjusting mechanism, indicated generally at 115 in FIGS. 2 and 3, is provided so that the minimum overload current required to instantaneously trip the breaker can be selected within a predetermined range. This is accomplished by adjusting the position of the armature 103 relative to the magnet yoke 97 to thereby vary the magnetic air gap. The adjusting mechanism is specifically described and claimed in the patent to Glenn R. Thomas and Robert H. Flick, entitled "Circuit Breaker," Patent No. 3,073,925, issued January 15, 1963 and assigned to the assignee of the instant application. For this reason, only a brief description of the adjusting mechanism is given herein.

The adjusting mechanism 115 comprises a cam member 117 having a cam surface 119 which is engaged by one end 121 of a lever 123. An adjustable screw 125 is threaded through the other end of the lever 123, and it engages the armature 103. The lever 123 is pivotally supported intermediate its ends on a pivot pin 127 (FIG. 3) which is supported by a bracket 129 that is supported in the trip device by the rivets 99. The cam member 117 is supported on a bent-over portion 131 (FIG. 2) of the bracket 101. A rod 133 extends from the cam member 117. An adjusting knob 135 is provided at the outer end of the rod 133 and it is supported against lateral movement by a bent-over portion 137 (FIG. 2) of the bracket 129.

Upon rotation of the adjusting knob 135, the cam member 117 is rotated and the cam-following end 121, of the lever 123, follows the cam surface 119 of the cam member 117, to cause the lever 123 to pivot about the pin 127. As the lever 123 pivots, the armature 103, which is biased against the screw 125 by the springs 111, is pivoted about its pivot 105 to vary the magnetic air gap, thereby varying the minimum overload current which is required to instantaneously trip the breaker.

It is necessary to reset and relatch the breaker mechanism, following an automatic opening operation, before the contacts can be closed. Resetting and relatching is effected by moving the handle 71 (FIG. 1) clockwise as far as it will go. During this movement, a projection 141 on the operating lever 55 engages a shoulder on the cradle 63 and moves the latter in a clockwise direction. Near the end of this movement, the free or latching end of the cradle 63 is reengaged with the latch mechanism 93 in a well-known manner. The breaker contacts are then closed in the previously described manner by movement of the handle to the "on" position.

The instantaneous tripping operation, upon the occurrence of overload currents above a predetermined value, is desirable in order to protect the current carrying parts from damage due to sever overheating. As is well known in the art, it is also desirable to have a time delay before the breaker trips automatically upon the occurrence of overload currents below the predetermined value so that the breaker will not trip open if the overload is of short duration. The breaker can be calibrated to trip open after a time delay in response to overloads of, for example, between 100% and 300% of the normal rated current, and to trip open instantaneously, by operation of the tripping electromagnet, upon the occurrence of overloads greater than 300% of the normal rated current.

In accordance with this invention, improved means are provided for effecting automatic tripping of the breaker with a time delay. The time-delay tripping operation is effected, in circuit breakers presently in use, by means of a looped conductor or heating member having a straight bimetal attached to one leg of the loop. The heat generated in the conductor by overload currents is conducted to the bimetal causing the bimetal to bend to effect an automatic tripping operation after a time delay. Upon the occurrence of heavy short circuits, the repelling forces of the looped conductor operate to expand the loop, often bending the conductor out of shape and damaging the bimetal. Thus, the thermal calibration of a circuit breaker under such conditions is often destroyed.

The present invention eliminates this "loop effect" by provding a trip device embodying thermal tripping means having a substantially straight heating member or conducting member and a generally L-shaped bimetallic member having one leg attached to the substantially straight heating member or conducting member. In addition to the elimination of the "loop effect," the step in manufacturing of bending the conducting strip is eliminated by the provision of a substantially straight heating member or conducting member in the trip device. As illustrated in FIGS. 2, 4 and 5, the conducting member

or heating member **43** comprises a number of conducting laminations **145** having outer conducting plates **147**. An opening **149** (FIG. 4) is provided in the conducting member **43** for receiving the mounting bolt **42** (FIGS. 1 and 2) which connects the conducting member **43** to the conductor **41**. An opening **151** (FIG. 4) is provided in the conducting member **43** for receiving a mounting bolt **153** (FIG. 1) which connects the terminal structure **17** to the conducting member **43**. As seen in FIG. 4, one of the lower laminations **147** extends further to the right than the rest of the conducting member **43** providing a recess in the member **43** for receiving the terminal structure **17** (FIG. 1). The conducting member **43**, however, is substantially straight in that there are no loops therein which would expand upon the occurrence of heavy overload currents flowing therethrough. A generally L-shaped bimetallic member **155** is secured, at one leg thereof, to the conducting member **43** by means of two rivets **157**.

The high expansion side of the bimetallic member **155** is to the left as viewed in FIG. 2. Upon the occurrence of an overload current below the predetermined value, the heat generated in the conducting member **43** is conducted to the bimetallic member **155**, causing the bimetallic member to bend to the right to engage an adjustable screw **159** in the trip bar **75** to cause the trip bar **75** to rotate clockwise to disengage the latch **85** from the latch mechanism **93** which, in turn, releases the cradle **63** (FIG. 1). Upon release of the cradle **63**, the breaker trips open in the same manner hereinbefore described. In addition to being more dependable in operation, the trip device, with the substantially straight conducting member **43**, is more easily manufactured and assembled. Moreover, this trip device can be manufactured at a reduced cost.

Another embodiment of the invention is shown in FIG. 6. A straight conducting member or heating member **161** is provided with a portion **163** having a reduced cross sectional area. The conducting member has less height at **163**. One leg of a generally L-shaped bimetallic member **165** is riveted to the conducting member **161** at the reduced portion **163**. It is well known that the resistance of a conductor increases as the cross sectional area decreases. An increased amount of heat, therefore, is generated by the increased resistance at the reduced portion **163**. It can be understood that this embodiment of the invention provides adequate heating capacity for the generally L-shaped bimetallic member **165** even though only a small portion of the bimetallic member contacts the conducting member **161** and the major portion of the bimetallic member is not adjacent the conducting member to receive heat radiated therefrom.

Another embodiment of the invention is shown in FIGS. 7 and 8. In this embodiment, a straight conducting member or heating member **169** is provided with a portion **171** having a reduced cross sectional area. The conducting member has less width at **171**. One leg of a generally L-shaped bimetallic member **173** is riveted to the conducting member **169** at the reduced portion **171**. It is well known that corners and edges will heat more readily than the rest of a conductor upon the passage of current through the conductor. The additional corners and edges provided at the reduced portion **171** of the conducting member **169**, therefore, provide the conducting member with additional capacity to heat the bimetallic member **173**. It can be seen in FIG. 8, that the bimetal **173** is not positioned directly over all of the additional corners and edges made available by the provision of the reduced portion **171**. Heat generated at these corners and edges, however, is conducted through the conductor to the bimetal. It can be understood that when additional thermal sensitivity is required, a bimetal and conductor can be provided wherein the bimetal is positioned directly over the additional corners and edges made available by the provision of a reduced portion of the conductor.

Another embodiment of the invention is shown in FIG. 9. Two straight conducting members or heating members **177** and **179** overlap each other and sandwich between them one leg of a generally L-shaped bimetallic member **181**. The conducting members **177** and **179**, and the bimetallic member **181**, are riveted together as shown. It can be understood that the bimetallic member **181** will be heated not only by the heat conducted from the conducting members **177** and **179**, but also by the current which passes through the bimetallic member. The current passes through the bimetallic member **181** in a direction normal to the planes of the flat faces. The bimetallic member, therefore, can carry a considerable amount of current without being unduly heated because of the large cross sectional area that carries the current.

Another embodiment of the invention is shown in FIGS. 10 and 11. As shown therein, a substantially straight conducting member or heating member **183**, which is formed of two laminations **184** and **186**, passes, through a solid iron core member **185** which forms a one turn magnetic circuit about the conducting member.

The lower lamination **186** (FIG. 10) extends further to the right than the rest of the conducting member **183** providing a recess in the member **183** for receiving the terminal structure **17** (FIG. 1). The conducting member **183**, however, is substantially straight in that there are no loops therein which would expand upon the occurrence of heavy overload currents flowing therethrough. A screw **187** is screwed up through a tapped opening in the core member **185** and it extends into an opening **189** in the conducting member **183** to hold the conducting member in place. The opening **189** is larger than the screw **187** to permit the conducting member **183** to move or "float" in the assembly. This provides flexibility for easier assembly and alignment of parts. A generally L-shaped bimetallic member **191** is welded or brazed at one leg thereof to the core member **185**.

Core losses appear in the form of heat in the core member **185** when an alternating current flows through the conducting member **183**. This heat comprises the heat generated by magnetic hysteresis losses and also the heat generated by eddy currents which are induced in the core member **185**. The heat generated in the core member is conducted to the bimetllic member **191** to cause thermal reaction of the bimetal and thermal tripping of the breaker in the same manner hereinbefore described. It can be seen that the conducting member **183** is substantially straight to enable it to better withstand heavy overload currents. Another advantage is that this embodiment can be used in breakers of high ratings because the thermal action of the bimetal is not caused by heat generated in the conducting member, which member can be made large to run cool in the breaker and to withstand heavier overload currents. The bimetallic member **191** can withstand heavier overload currents because it does not contact the main conducting member **183**.

Another embodiment of the invention is shown in FIG. 12. This embodiment is similar to that shown in FIGS. 10 and 11 except that an adjustable core member indicated generally at **193** is provided in place of the core member **185** of the other embodiment. The core member **193** is of magnetic material, preferably iron, and it comprises a lower portion **195** and an upper portion **197**. Two non-magnetic shims **199** are provided at each side between the lower and upper portions of the core member **193**, and the parts are secured together by two screws **201**. The insertion of the shims **199** between the parts of the core member serves to increase the resistance of the magnetic circuit to provide less heating effect per unit of current flowing through the conducting member **183**. The bimetal thermal reaction, and, therefore, the thermal tripping characteristics of the breaker can be adjusted by varying the number of shims **199** to be placed between the parts of the core member. An advantage of this embodiment is that the same trip device can be used with a number of breakers of different ratings.

The invention provides an improved trip device em-

bodying a substantially straight conducting member. A generally L-shaped bimetallic member is attached at one leg thereof to the conducting member, the other leg being generally perpendicular to the conducting member. The heatiing capacity of the conducting member can be increased by providing a reduced portion to carry the same amount of current. The capacity of the conducting member to heat the bimetallic member can be increased also by providing an increased number of corners and edges on the conducting member. The amount of thermal reaction can be increased by passing the circuit breaker current through the bimetallic member in a direction normal to the plane of the greatest cross sectional area of the bimetallic member.

Improved means are also provided for heating the bimetal by means of an induced current. A one-turn magnetic circuit is formed around the conducting member by a core member. An alternating current passing through the conducting member induces eddy currents in the core member to heat the core member. Hysteresis losses account for additional heating of the core member 185. The heat from the core member is conducted to a bimetal which is attached thereto, and the thermal reaction of the bimetal is utilized to effect tripping of the breaker. The magnetic core member can be made in two parts with means for inserting non-magnetic shims between the parts to vary the bimetal thermal reaction per amount of current so that the same trip device can be used with breakers of different ratings.

While the invention has been disclosed in accordance with the provisions of the patent statutes, it is to be understood that various changes and modifications in the structural details and arrangement of parts of the various embodiments thereof may be made without departing from some of the essential features of the invention. It is desired, therefore, that the language of the appended claims be given as reasonably broad an interpretation as the prior art permits.

I claim as my invention:

1. A circuit breaker comprising, separable contacts and means releasable to effect automatic separation of said contacts, a trip device for effecting release of said releasable means, said trip device comprising a core member comprising a generally U-shaped structure of magnetic material and a top part of magnetic material, means removably mounting said top part on the free ends of said U-shaped structure whereby said top part and said U-shaped structure encompass an opening, a conductor connected in electrical series with said contacts and passing through said opening, an elongated bimetallic member supported at one end thereof on said top part in a heat conducting relationship with said top part and the other end thereof extending away from said core member in the direction of the extension of the legs of said U-shaped structure, said top part being adapted to be heated by hysteresis and eddy current losses therein when said conductor is energized by an alternating current, said heat in said top part being conducted to said bimetallic member to heat said bimetallic member, and said bimetallic member when heated a predetermined amount bending to effect release of said releasable means.

2. A circuit breaker comprising, separable contacts and means releasable to effect automatic separation of said contacts, a trip device for effecting release of said releasable means, said trip device comprising a core member,

said core member comprising a generally U-shaped structure of magnetic material and a top part of magnetic material, a separate member of non-magnetic material disposed at each of the free ends of said U-shaped structure, securing means securing said top part to the free ends of said U-shaped structure and securing said non-magnetic members between said top part and said U-shaped structure to form a core member encompassing an opening, a conductor connected in electrical series with said contacts and passing through said opening, an elongated bimetallic member supported at one end on said top part in a heat conducting relationship with said top part and extending away from said core member in the direction of the extension of the legs of said U-shaped structure, said top part being adapted to be heated by hysteresis and eddy current losses therein when said conductor is energized by an alternating current, the heat in said top part being conducted to said bimetallic member to heat said bimetallic member, said bimetallic member when heated a predetermined amount bending to effect release of said releasable means, and said securing means being removable to permit replacement of said members of non-magnetic material with other members of non-magnetic material whereby said core member can be adjusted to thereby vary the tripping characteristics of said circuit breaker.

3. A circuit breaker comprising, a stationary contact and a movable contact cooperable therewith to open and close said breaker, means releasable to trip open said contacts, a conductor connected in electrical series with said contacts, a core member comprising a generally U-shaped structure of magnetic material and a top part of magnetic material, a separate member of non-magnetic material disposed at each of the free ends of said U-shaped structure, securing means securing said top part to the free ends of said U-shaped structure and securing said non-magnetic members between said top part and said U-shaped structure to form a core member encompassing an opening, said conductor passing through said opening, said top part being adapted to be heated by hysteresis and eddy current losses therein when an alternating current flows through said conductor, a bimetallic member supported on said top part in a heat conducting relationship with said top part, said bimetallic member upon the occurrence of a predetermined overload current in said conductor being heated and bending to effect release of said releasable means after a time delay, and said securing means being removable to permit replacement of said members of non-magnetic material with other members of non-magnetic material whereby said core member can be adjusted to thereby vary the tripping characteristics of said circuit breaker.

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