Jan. 6, 1953

M. BINGENHEIMER

2,624,816

CIRCUIT BREAKER

Filed May 9, 1945

Fig. 1.

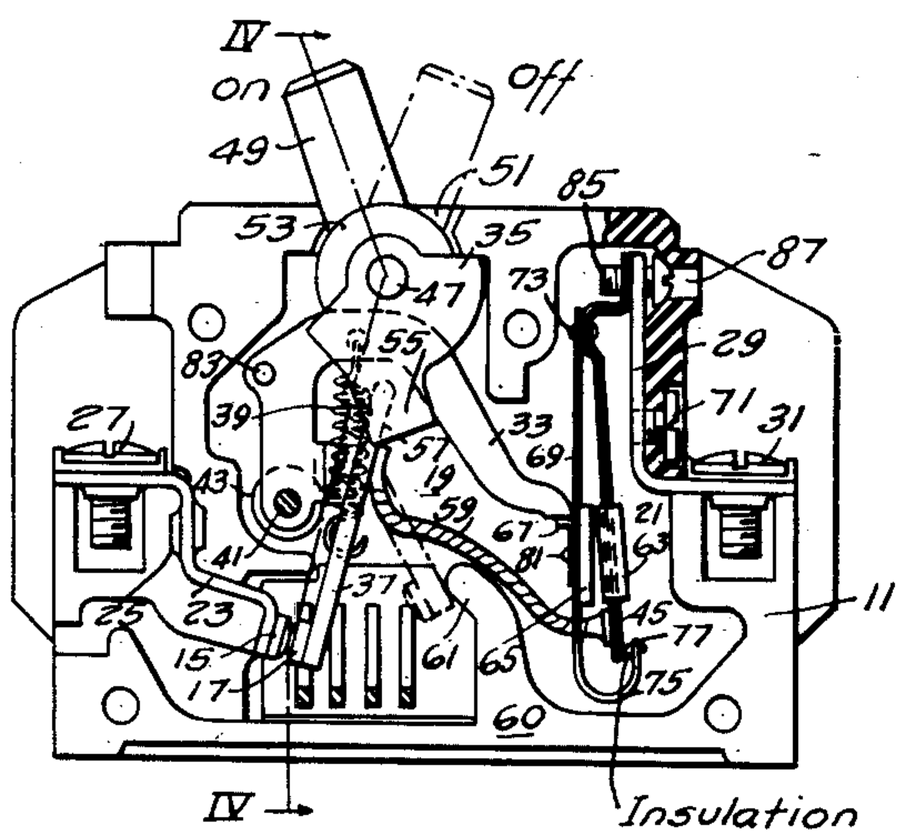


Fig. 2.

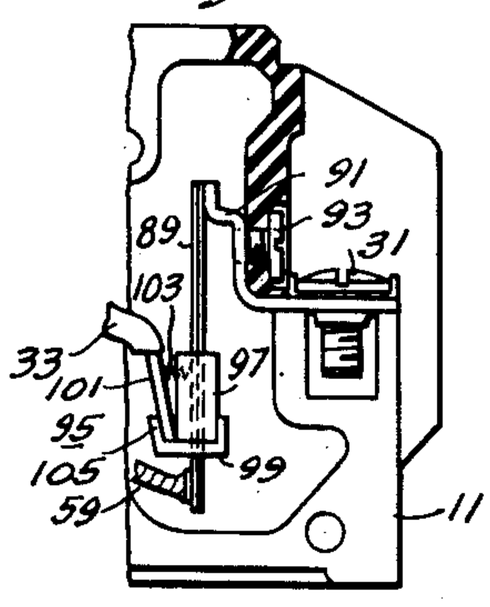


Fig. 3.

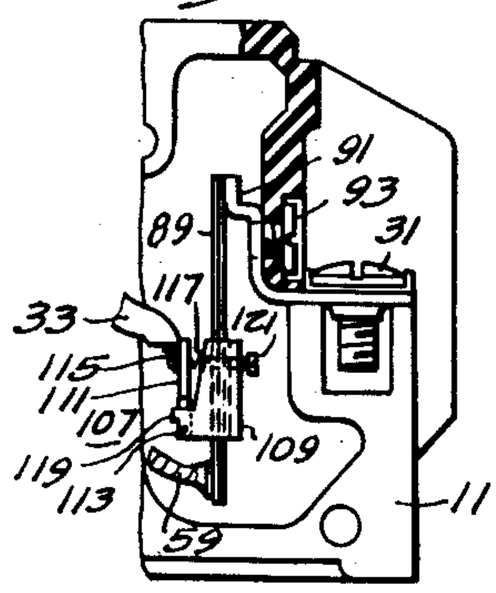
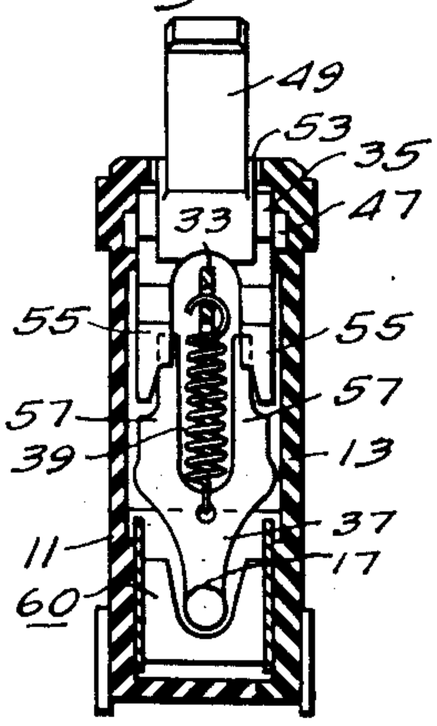


Fig. 4.



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UNITED STATES PATENT OFFICE

2,624,816

CIRCUIT BREAKER

Melvin Bingenheimer, East McKeesport, Pa., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application May 9, 1945, Serial No. 592,804

11 Claims. (Cl. 200—88)

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This invention relates to circuit breakers, and more particularly to circuit breakers for controlling lighting and moderate power circuits. My application S. N. 278,018, filed May 9, 1952, is a division of this application.

An object of the invention is to provide a circuit breaker embodying an improved thermally and magnetically responsive trip device wherein the magnetically responsive means is supported entirely by the thermally responsive means.

Another object of the invention is to provide an improved thermally and magnetically responsive trip device wherein operation of the magnetic element applies no bending stress to the thermal element and avoids the possibility of the thermal element taking a permanent set due to its being bent when in heated condition.

Another object is to provide a trip device having an armature movable against the bias of a spring other than the thermal element, so that a stiffer thermal element may be used without requiring a large magnetic force for magnetic tripping.

A further object is to improve the accuracy of calibration of the trip device and to insure that accuracy is maintained even after interrupting heavy short-circuit currents.

Another object of the invention is to provide a circuit breaker embodying an improved thermally and magnetically responsive trip device having the magnetically responsive means mounted on the thermally responsive means in a manner to permit adjustment of the thermally responsive means without changing the magnetic airgap.

Another object of the invention is to provide a circuit breaker embodying a thermally and magnetically responsive trip device wherein the magnetically responsive means comprises a core member and a movable armature both mounted on the thermally responsive means to permit altering the set of the thermally responsive means without disturbing the adjustment of the magnetic airgap of the movable armature.

Another object of the invention is to provide a circuit breaker which is simple, safe and reliable in operation, and which is inexpensive to manufacture.

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

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the following detailed description of several embodiments thereof when read in conjunction with the accompanying drawing, in which:

Fig. 1 is a side elevational view, partly in section, of a circuit breaker embodying the invention;

Fig. 2 is a fragmentary elevational view showing a modification of the trip device;

Fig. 3 is a fragmentary elevational view showing a further modification of the trip device; and

Fig. 4 is a sectional view taken substantially on line IV—IV of Fig. 1, and looking in the direction of the arrows.

Referring to Fig. 1 of the drawing, the circuit breaker comprises a housing 11 and a cover plate 13 therefor, both constructed of molded insulating material, stationary contact means 15, movable contact means 17, an operating mechanism 19 and a trip device 21.

The stationary contact 15 is rigidly secured to the inner end of a multi-angular terminal member 23 which is seated in an angular slot 25 in the molded housing 11. The outer end of the terminal 23 is provided with a connecting means 27 for connecting the terminal 23 in an electric circuit. At the opposite end of the housing 11 is disposed a terminal 29 which at its inner end supports the trip device (to be later described) and which is provided with a connector 31 at its outer end for connecting the terminal in an electric circuit.

The movable contact 17 is rigidly secured on the free end of a U-shaped switch arm 37 having its legs 57 supported in recesses in the legs 55 of a U-shaped operating lever 35. The operating lever 35 is pivotally supported on a pivot pin 47 mounted in a suitable opening in the housing 11 and a matching opening in the cover 13. An operating spring 39 is connected under tension between the switch arm 37 and a releasable carrier 33 pivoted on a pin 41 supported in companion openings in the housing 11 and the cover 13. Spacers 43 are provided to maintain the carrier 33 properly spaced from the walls of the housing and the cover plate.

The operating lever 35 is provided with an operating handle 49 molded integral therewith and extending through an opening 51 in the housing 11. The operating lever is also provided with an arcuate member 53 molded integral therewith co-operating with the housing 11 to substantially close the opening 51 in any position of the handle 49. The switch arm 37 is electrically connected by means of a flexible connection 59 to one end

of a bimetal element 45 forming a part of the trip device 21 and which is suitably secured, preferably by welding, to the inner end of the terminal 29.

The switch arm 37 is operated to manually open and close the contacts by manipulation of the handle 49. Movement of the handle in a clockwise direction from the full line position carries the legs 57 of the switch arm 37 across to the left of the line of action of the operating spring 39 which then biases the switch arm to the open position and causes movement of the switch arm to open position with a snap action. The operating mechanism and switch arm are shown in the manually open position by dot and dash lines in Fig. 1.

The contacts are manually closed by reverse operation of the handle. Counterclockwise movement of the handle 49 from the dot and dash position (Fig. 1) to the full line position moves the legs 57 of the switch arm 37 across to the right of the line of action of the spring 39 which thereupon acts to close the contacts with a snap action.

An arc extinguisher 60 is provided to quickly extinguish the arc drawn when the circuit is interrupted. The arc extinguisher may be of any suitable type, the one illustrated comprising a series of slotted plates into which the arc is drawn and extinguished.

The circuit breaker is adapted to be tripped open instantaneously in response to overloads above a predetermined value, or a short circuit, and after a time delay on lesser overloads by means of the trip device 21. Operation of the trip device 21 releases the carrier 33 whereupon the overcenter spring moves the carrier clockwise moving the line of action of the overcenter spring 39 to the right of the center line of the switch arm 37. Thereafter the spring 39 acts to move the switch arm to open position with a snap action. The movement of the carrier 33 is arrested by engagement with a projection 61 of the housing 11.

The operating mechanism is more fully described and claimed in application Serial No. 592,446, filed May 7, 1945, by H. S. Gano and G. J. Freese and assigned to the assignee of this invention.

The current responsive means or trip device 21 comprises the bimetal element 45 connected by means of the flexible conductor 59 to the switch arm 37, an electromagnet including two members of magnetic material, one of which is a channel-shaped core member 63 and the other a movable armature 65, a latch element 67 and a resilient member 69 rigidly secured to the bimetal element for supporting the armature 65. The terminal 29 is secured to the end wall of the casing 11 by means of a screw 71 and the bimetal element 45 is rigidly secured by suitable means such as welding to the upper inner end of the terminal 29. Just below the point of attachment of the bimetal element to the terminal 29 the bimetal element is formed inwardly at right angles and then downwardly for a short distance substantially parallel to the terminal 29 to form a flat surface to which the resilient member 69 is secured. The resilient member or spring 69 is secured to the bimetal element by means of a rivet 73. Below the rivet 73 the bimetal extends downwardly at a slight angle to the terminal 29. The lower end of the spring 69 is looped as shown at 75 (Fig. 1) and the upwardly extending end thereof carries an insulating button 77 for insulating the free end of the bimetal element 45 from the free end of the spring 69. The looped end of the biased member 69 and the button 77 thereon provide a lost motion connection between the free and movable ends of the bimetal 45 and the biased member 69, since movement of the bimetal to the right carries the biased member with it, but movement of the biased member toward the bimetal is permitted without movement of the bimetal.

The channel-shaped core member 63 straddles the bimetal element 45 and is secured thereto preferably by welding. The armature 65 is secured to the spring 69 adjacent the core member 63 by means of a rivet 81 which also serves to secure the latch element 67 to the spring 69.

The latch element 67 normally is biased by the resilient or biased member 69 to a position where it engages and restrains the carrier 33 in operative position as shown in Fig. 1. Upon the occurrence of an overload current below a predetermined value of, for instance, 1000% of normal rated current, the bimetal element 45 deflects moving its free lower end toward the right (Fig. 1). The bimetal element 45, through the insulating button 77, moves the biased spring member 69 in the same direction and causes the latch element 67 to release the carrier 33 whereupon the operating mechanism functions in the previously described manner to automatically open the contacts.

Before the contacts can be closed following an automatic opening operation, it is necessary to reset and relatch the mechanism. This is accomplished by moving the handle 49 clockwise to the full open position during which movement the leg 55 of the operating lever 35 engages a pin 83 in the carrier 33 and moves the carrier counterclockwise about its pivot 41. Near the end of its counterclockwise movement, the free end of the carrier 33 wipes by the latch member 67, slightly flexing the spring 69 against its bias. Thereafter the switch arm is moved to close the contacts 15—17 in the previously described manner by movement of the handle 49 counterclockwise to the closed position.

Upon the occurrence of a heavy overload or short circuit, such for example as 1000% of rated current or over, the current flowing through the bimetal element 45 energizes the core member 63 a sufficient amount to instantaneously attract and operate the armature 65 against the bias of the biased member 69, releasing the carrier 33 and effecting instantaneous opening of the contacts. It is thus seen that the latch 67 is a single actuating portion which is moved either magnetically when the armature 65 is attracted to the core 63, or thermally when the bimetal 45 flexes and bodily moves both the core 63 and armature 65.

The invention provides a circuit breaker of few parts and simple and inexpensive construction having an improved trip device wherein all of the elements are mounted at a single point on one of the terminals of the breaker, the electromagnetic trip device being mounted entirely on the bimetal trip element. By this construction the magnetic trip values are not affected by adjustment of the thermal trip element. The bimetal element can be made stiffer without affecting the relatching effort thereby providing a more positive thermal trip action. Another advantage of the invention is that the magnetic airgap remains constant regardless of changes in ambient temperature.

Means is provided whereby the trip device may be adjusted to vary the tripping time of the time delay trip means. The adjusting means comprises a screw **85** threadedly engaging the upper end of the terminal **29** and having its rounded head bearing against a concave recess in the housing **11**. An opening **87** in the casing permits the insertion of a suitable tool for turning the screw **85** to thereby adjust the trip device without removing the cover **13**. This opening may be sealed to prevent tampering.

According to the modification of the invention illustrated in Fig. 2 of the drawing, a straight strip of bimetal **89** is secured, preferably by welding, to the inner end of a terminal **91** which is secured to the housing by means of a screw **93**. An electromagnet, indicated generally at **95**, is securely mounted on the bimetal **89**. The electromagnet **95** comprises a U-shaped core member **97** and a yoke **99** each being secured, preferably by welding, to the bimetal element **89**, and a movable armature **101** pivotally supported on the yoke member **99**. A compression spring **103** biases the armature **101** to the unattracted position against a limit stop comprising a portion **105** of the yoke **99**. The airgap of the magnet may be varied by bending the portion **105** of the magnet yoke thus changing the position of the stop for the armature. In the unattracted position, the armature **101** acts as a latch for releasably restraining the releasable carrier **33** in operative position.

When the bimetal element **89** (Fig. 2) is heated a predetermined amount in response to overload currents below a predetermined value of, for instance 1000% of rated current, it deflects in a direction to move the free end thereof, together with the entire magnet **95**, away from the operating mechanism, thereby releasing the carrier **33** and causing automatic opening of the contacts. When energized in response to overload currents above a value, such for example as 1000% of rated current, or in response to short circuits, the core member **97** attracts the armature **101** to effect instantaneous tripping of the breaker.

After an automatic opening operation, the mechanism may be reset and the contacts closed in the previously described manner.

In the Figure 3 modification, the electromagnet indicated generally at **107** is of somewhat different form although the magnet is supported entirely on the bimetal element **89**. A U-shaped core member **109** is suitably secured, preferably by welding, to the bimetal element. An armature **111**, pivotally mounted on a pivot pin **113** supported in the legs of the U-shaped magnet core **109**, has a latch member **115** thereon normally engaging and restraining the releasable carrier **33** in operative position. The armature **111** is biased by means of a spring **117** against a fixed stop **119** formed inwardly from one leg of the core member **109** thus providing a fixed magnetic airgap. A screw **121** threadedly engaging the core member **109** and the bimetal element **89** is provided for varying the tension of the armature spring **117** to thereby vary the minimum overload current required to instantaneously trip the breaker.

The operation of the Fig. 3 modification of the invention is substantially the same as that of the Fig. 2 modification. When an overload below a predetermined value occurs in the circuit of the breaker, the bimetal element **89** becomes heated, and when heated a predetermined amount, the free end thereof deflects toward the

right (Fig. 3) moving the electromagnet including the armature **111** therewith. This movement disengages the latch member **115** from the releasable member **33** and causes opening of the contacts.

When a heavy overload above the predetermined value occurs, the electromagnet **107** (Fig. 3) is energized and attracts the armature **111** to unlatch the member **33** and effect instantaneous opening of the contacts.

After any automatic opening operation the mechanism is reset and the contacts closed in the manner previously described in connection with the Figure 1 modification of the invention.

From the foregoing it will be seen that there is provided an improved circuit breaker of simple and inexpensive construction, wherein all elements of the trip device including the electromagnetic trip means and movable armature are mounted on the bimetallic trip element. By this construction the bimetal element may be adjusted to vary the time delay tripping time of the breaker without changing the magnetic airgap or affecting the instantaneous trip time of the breaker.

While the invention has been disclosed in accordance with the provisions of the patent statutes, it is to be understood that various changes in the structural details and arrangement of parts 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 interpretation as the prior art permits.

I claim as my invention:

1. In a circuit breaker comprising relatively movable contacts and a releasable member biased to effect opening of said contacts, trip means operable to release said releasable member in response to overload currents comprising an electromagnet having a core member and an armature movable magnetically relative to each other, a current responsive bimetal element which flexes when heated, said core member and armature surrounding said bimetal element and both being carried by said bimetal element which forms the sole support therefor, a single latch portion connected to and movable at all times with said armature and normally engaging and restraining said releasable member against its bias, said single latch portion releasing said releasable member both upon thermal movement of the bimetal element and upon magnetic attraction of the armature to the core member, said core member and said armature both being connected to be moved by flexing of the bimetal element while the said core member and armature remain in substantially fixed relation to each other to thereby cause movement of said single latch portion connected to the armature and release of said releasable member upon the occurrence of overloads of relatively low values, resilient means opposing movement of said armature toward said core member, said armature being magnetically movable toward said core member against the bias of said resilient means without substantially moving said bimetal element to thereby cause movement of said single latch portion connected to the armature and relase of the releasable member upon the occurrence of heavy overloads or short circuits, and said releasable member having an end portion engageable with said single latch portion to move it and the armature against the bias of the

resilient means opposing movement of the armature so as to relatch with said single latch portion without substantial movement of the bimetal element.

2. In an automatic electric circuit breaker having separable contacts and means releasable to effect separation of said contacts, current responsive means for effecting the release of said releasable means upon the passage of an overload current through the circuit breaker comprising a bimetallic member heated in response to the flow of current through the breaker, said bimetallic member being mounted adjacent one end and having its other end movable, a biased member supported at one end and extending along said bimetallic member and having its other end cooperating with the movable end of the bimetallic member for movement thereby, a magnetic core member mounted on said bimetallic member, an armature portion and a latch portion rigidly fixed together and to the movable part of said biased member for movement therewith at all times and said latch portion normally engaging and holding said releasable means, said core member and armature portion being both moved together upon deflection of the bimetallic member with the airgap therebetween remaining substantially fixed to cause said latch portion to release said releasable means, and said core member and armature portion being energized by current flowing through the breaker and operable when energized by currents above a predetermined value to move said rigidly fixed together armature portion, latch portion and biased member against the bias of the biased member and relative to said bimetallic member to cause the latch portion to release said releasable means.

3. In a circuit breaker having a spring-actuated trip arm, means for normally restraining said trip arm comprising a thermally-actuated member, a magnet and an armature carried by and movable with said member, said armature having a catch coacting with said trip arm, a connection between the magnet and armature limiting the airgap therebetween, said thermally-actuated member being warped and movable with the magnet and armature by a moderate slow overload without altering the airgap between said magnet and its armature and said armature being drawn to said magnet upon a sudden excessive overload to release said trip arm.

4. In a circuit breaker having relatively movable contacts and means releasable to effect opening of said contacts, a trip device for effecting release of said releasable means comprising a bimetal element having one end rigidly supported, a resilient member having one end rigidly supported adjacent the rigidly supported end of said bimetal element and having at its free end a lost motion connection with the free end of said bimetal element through which movement of the bimetal element is transmitted to move said resilient member but permitting movement of the resilient member toward the bimetal element without movement of the bimetal element, said bimetal element deflecting when heated a predetermined amount in response to overload currents to flex said resilient member and cause release of said releasable means, and electromagnetic means comprising a core member and an armature one of which is rigidly mounted on a portion of said bimetal element and the other mounted on a portion of said resilient member which is flexed by said

bimetal element to cause release of said releasable means, said core member and armature being energized by current flowing through said bimetal element and operable when energized by overload currents above a predetermined value to instantaneously flex said resilient member and release said releasable means.

5. In a circuit breaker having relatively movable contacts and a member releasable to effect opening of said contacts, a trip device for effecting release of said releasable member comprising a bimetal element, a resilient member having one end rigidly secured to one side of said bimetal element and having its free end formed to engage the opposite side of said bimetal element, latch means on said resilient member normally restraining said releasable member against operation, said bimetal element when heated a predetermined amount in response to overload currents below a predetermined value moving said resilient member to cause release of said releasable member, and electroresponsive means supported by said bimetal element at a position spaced from the place where the resilient member is secured to the bimetal element and said electroresponsive means acting on said resilient member when energized in response to overload currents above said predetermined value to flex said resilient member and instantaneously release said releasable member.

6. In a circuit breaker comprising a casing, separable contact means and means releasable to effect separation of said contact means, a conducting member extending into said casing and rigidly secured thereto, a trip device operable to effect release of said releasable means comprising a bimetal element mounted on the inner end of said conducting member, electromagnetic trip means comprising a member of magnetic material mounted on said bimetal element and an armature, means supporting said armature, said armature being mounted close to said member of magnetic material with an airgap therebetween and operable upon magnetic attraction to effect instantaneous release of said releasable members, a stop portion carried with said bimetal element and the member of magnetic material thereon fixing the maximum magnetic airgap between said member of magnetic material and said armature independently of the position of the bimetal element, and means for adjusting said bimetal element without affecting the said maximum magnetic airgap comprising a screw threadedly engaging said conducting member and having a head bearing in a recess in said casing.

7. In an automatic electric circuit breaker having separable contacts and means releasable to effect separation of said contacts, current responsive means for effecting the release of said releasable means upon the passage of an overload current through the circuit breaker comprising a bimetallic member, conductors electrically connecting the bimetallic member in the circuit through the contacts to be traversed by current and heated in response to the flow of current through the breaker, said bimetallic member being mounted adjacent one end and having its other end movable, a biased member supported at one end adjacent the mounted end of the bimetallic member and extending for a major part of its length along the high expansion side of said bimetallic member and having its other end extending around the bimetallic member and cooperating with the low expansion side

of the movable end of the bimetallic member for movement thereby, a magnetic core member mounted on said bimetallic member and movable therewith at all times, an armature portion and a latch portion rigidly fixed together and to the movable part of said biased member for movement therewith at all times and said latch portion normally engaging and holding said releasable means, said armature portion being on the opposite side of the bimetallic member from the core member, said core member and armature portion being both moved together upon deflection of the bimetallic member with the airgap therebetween remaining substantially fixed to cause said latch portion to release said releasable means, and said core member and armature portion being energized by current flowing through the bimetallic member of the breaker and operable when energized by currents above a predetermined value to move said rigidly fixed together armature portion, latch portion and biased member against the bias of the biased member and relative to said bimetallic member to cause the latch portion to release said releasable means.

8. In an automatic electric circuit breaker having separable contacts and means releasable to effect separation of said contacts, current responsive means for effecting the release of said releasable means upon the passage of an overload current through the circuit breaker comprising a bimetallic member heated in response to the flow of current through the breaker, said bimetallic member being mounted adjacent one end and having its other end movable, a biased member supported at one end and extending along said bimetallic member and having adjacent its other end lost motion means cooperating with the movable end of the bimetallic member for causing movement of the biased member thereby and permitting movement of the biased member toward the bimetallic member, a magnetic core member mounted on said bimetallic member, an armature portion and a latch portion rigidly fixed together and to the movable part of said biased member for movement therewith at all times and said latch portion normally engaging and holding said releasable means, an adjusting screw for moving said bimetallic member to change its calibration while said lost motion means limits the separation between said core member and armature to prevent the magnetic trip calibration being increased beyond a predetermined value, said core member and armature portion being both moved together upon deflection of the bimetallic member with the airgap therebetween remaining substantially fixed to cause said latch portion to release said releasable means, and said core member and armature portion being energized by current flowing through the breaker and operable when energized by currents above a predetermined value to move said rigidly fixed together armature portion, latch portion and biased member against the bias of the biased member and relative to said bimetallic member to cause the latch portion to release said releasable means.

9. In an automatic electric circuit breaker having separable contacts and means releasable to effect separation of said contacts, current responsive means for effecting the release of said releasable means upon the passage of an overload current through the circuit breaker comprising a bimetallic member heated in response to the flow of current through the breaker, said bimetallic

member being mounted adjacent one end and having its other end movable, a member of resilient material supported at one end adjacent the mounted end of the bimetallic member and extending along said bimetallic member, lost motion means adjacent the other end of said member of resilient material cooperating with the movable end of the bimetallic member for causing movement of the member of resilient material thereby and permitting movement of the member of resilient material toward the bimetallic member, an armature portion and a latch actuating portion each affixed to the movable part of said member of resilient material at positions spaced from the supported end thereof for movement therewith at all times, a magnetic core member mounted on a movable part of said bimetallic member, said core member and armature portion being both moved together upon deflection of the bimetallic member with the maximum airgap therebetween limited by said lost motion means to cause said latch actuating portion to release said releasable means, and said core member and armature portion being energized by current flowing through the bimetallic member of the breaker and operable when energized by currents above a predetermined value to move said armature portion and said latch actuating portion by flexing said member of resilient material against its bias and toward said bimetallic member to cause the latch actuating portion to release said releasable means.

10. In an automatic electric circuit breaker having separable contacts and means releasable to effect separation of said contacts, current responsive means for effecting the release of said releasable means upon the passage of an overload current through the circuit breaker comprising a bimetallic member heated in response to the flow of current through the breaker, said bimetallic member being mounted adjacent one end and having its other end movable, a biased member supported at one end and extending along said bimetallic member and having its other end cooperating with the movable end of the bimetallic member for movement thereby, a magnetic core member mounted on said bimetallic member, an armature portion and a latch portion rigidly fixed together and to the movable part of said biased member for movement therewith at all times and said latch portion normally engaging and holding said releasable means, said core member and armature portion being both moved together upon deflection of the bimetallic member with the airgap therebetween remaining substantially fixed to cause said latch portion to release said releasable means, and said core member and armature portion being energized by current flowing through the breaker and operable when energized by currents above a predetermined value to move said rigidly fixed together armature portion, latch portion and biased member against the bias of the biased member and relative to said bimetallic member to cause the latch portion to release said releasable means, and said releasable means comprising a pivoted member having an end portion engageable with the latch portion to move it and the armature portion against the bias of the biased member so as to relatch with the latch portion without substantial deflection of the bimetallic member.

11. In an automatic electric circuit breaker having separable contacts and means releasable to effect separation of said contacts, current responsive means for effecting the release of said

releasable means upon the passage of an overload current through the circuit breaker comprising a bimetallic member heated in response to the flow of current through the breaker, said bimetallic member being mounted adjacent one end and having its other end movable, a biased member supported at one end and extending along said bimetallic member and having adjacent its other end lost motion means cooperating with the movable end of the bimetallic member for causing movement of the biased member thereby and permitting movement of the biased member toward the bimetallic member, a magnetic core member mounted on the movable portion of said bimetallic member for movement therewith at all times, an armature portion and a latch portion rigidly fixed together and to the movable part of said biased member for movement therewith at all times, said core member and armature portion being connected through said lost motion means to limit the maximum airgap therebetween, said latch portion normally engaging and holding said releasable means, said biased member being free of connection to the movable part of the bimetallic member through which the force exerted by said releasable means on said latch portion could be transmitted to the movable part of the bimetallic member longitudinally thereof but said force being transmitted longitudinally of said biased member to its end at which it is supported, said core member and armature portion being both moved together upon deflection of the bimetallic member with the airgap therebetween remaining substantially fixed at said maximum airgap to cause said latch portion to release said releasable means, and said core member and armature portion being energized by current flowing through the breaker and operable when energized by currents above a predetermined value to move said rigidly fixed together armature portion, latch portion and biased member against the bias of the biased member and relative to said bimetallic member to cause the latch portion to release said releasable means.

MELVIN BINGENHEIMER.

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