Dec. 9, 1952 H. F. MASON 2,621,236

CIRCUIT BREAKER SYSTEM

Filed Dec. 13, 1947 2 SHEETS—SHEET 1

Fig. 1

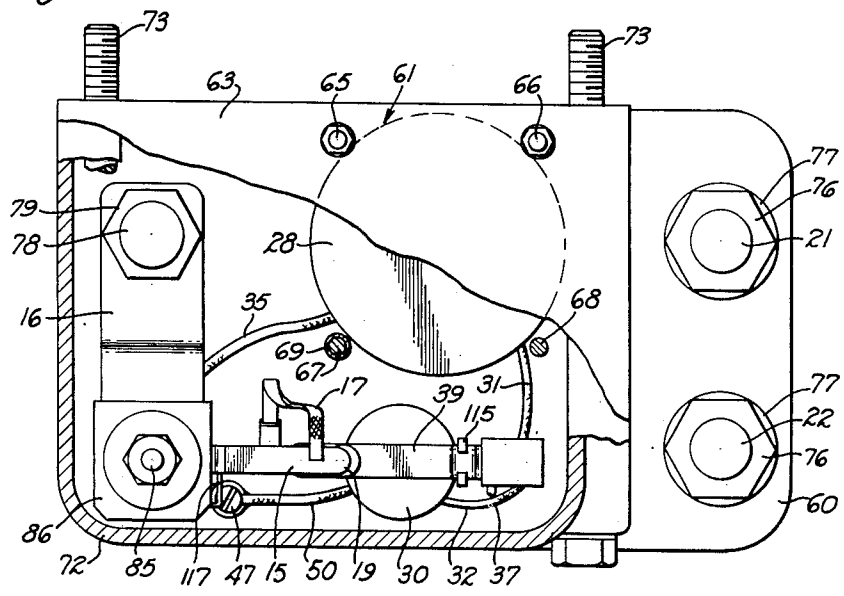
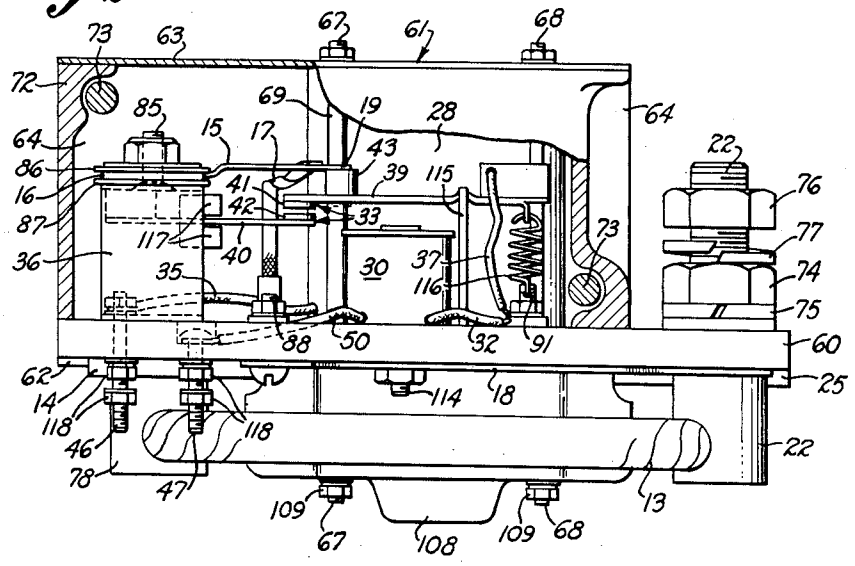


Fig. 2



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Fig. 3

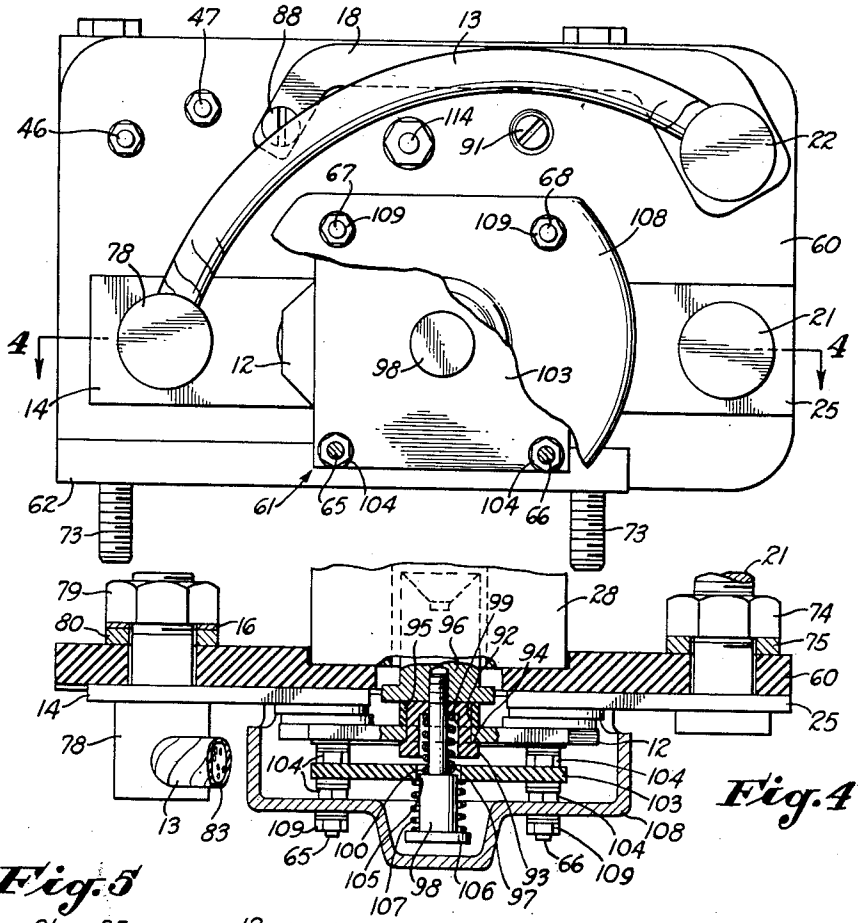
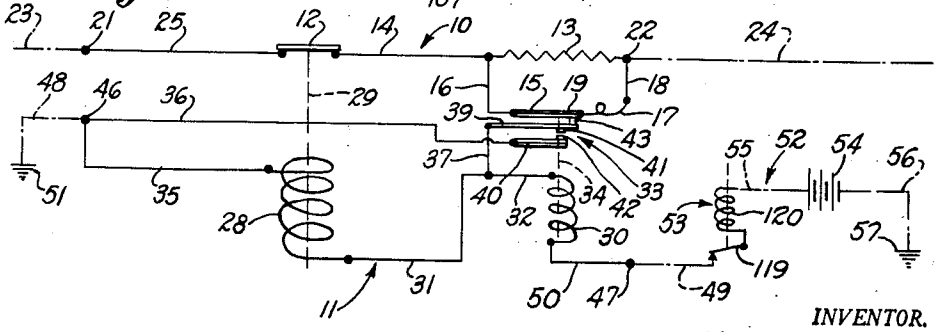


Fig. 4

Fig. 5



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CIRCUIT BREAKER SYSTEM

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11 Claims. (Cl. 175—294)

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My invention relates to circuit breakers and a primary object thereof is to provide a circuit breaker which is responsive to temperature variations resulting from variations in an electrical current flowing through a circuit in which it is connected.

An important object of the present invention is to provide a circuit breaker of the foregoing character which includes means for compensating for ambient temperature variations so that it will open the circuit in which it is connected at a constant value of current for a wide range of ambient temperatures.

Another object is to provide a circuit breaker whose operating characteristics remain substantially constant irrespective of the altitude at which the device is used and regardless of whether the device is enclosed, used in still air, or in an air blast.

A further object is to provide a circuit breaker which will open the circuit in which it is connected whenever a predetermined current flows through the circuit, regardless of the length of time current has been flowing through the circuit.

Another important object of my invention is to provide a circuit breaker having delayed operating characteristics so that it will not open the circuit in which it is connected until a predetermined interval of time has elapsed after the current flowing through the circuit reaches the predetermined value. This construction insures that the device will not operate to break the circuit during short intervals of high current flow, which is an important feature of the invention.

Another object is to provide a circuit breaker whose operation is not affected by vibration.

Still another object is to provide a circuit breaker which may be used in a location remote from a control station, and which may be used in connection with a device at the control station for indicating that the circuit breaker has been actuated to open the circuit in which it is connected.

A further object is to provide a device which may be used as a remotely controlled switch as well as a circuit breaker.

Another important object of the present invention is to provide a circuit breaker which includes a main relay for holding closed a main switch in a line circuit in which the device is connected, and which includes means for short-circuiting the main relay whenever a predetermined current flows through the circuit so as to permit the main switch to open.

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More specifically, an object of my invention is to provide a circuit breaker having an auxiliary switch in parallel with the main relay, and having means responsive to the current flowing in the line circuit for closing the auxiliary switch so as to short-circuit the main relay whenever the line current reaches the predetermined value.

Still another object is to provide a circuit breaker wherein the aforesaid current responsive means for closing the auxiliary switch includes an operating bimetallic element through which part of the current flowing through the line circuit may flow.

Another object of the invention is to provide a circuit breaker wherein the operating bimetallic element is connected in parallel with a resistor which, in turn, is connected in series with the main switch, an important object in this connection being to provide a device wherein the resistor is formed of a material whose resistance increases as its temperature increases so that the current flowing through the parallel bimetallic element increases as the temperature of the resistor increases due to an increased current flow therethrough. This construction provides a time delay while the temperature of the resistor is increasing, which is an important feature of my invention.

A further object is to provide a circuit breaker having means associated with the operating bimetallic element for compensating for changes in ambient temperature.

Still another object is to provide a temperature compensating means which includes a compensating bimetallic element which is mounted parallel to the operating bimetallic element which forms part of the auxiliary switch for short-circuiting the main relay.

Still another object of the present invention is to provide a compensating bimetallic element which is designed to bend faster than the operating bimetallic element for a given change in the temperature of the elements, a related object being to provide means for retarding the rate of bending of the compensating bimetallic element after it has deflected a predetermined amount so that the operating bimetallic element may close the auxiliary switch to short-circuit the main relay. This construction provides an additional time delay in the operation of the circuit breaker, which is another important feature of the invention.

An additional object is to provide a circiut breaker having an auxiliary relay for holding the

auxiliary switch closed after it has been closed by the operating bimetallic element.

A further object of the invention is to provide a circuit breaker of the foregoing general character which may be reset from a remotely located control station.

The foregoing objects of my invention and the advantages suggested thereby, together with various other objects and advantages which will be evident hereinafter, may be attained through the utilization of the exemplary embodiment of the invention which is illustrated in the accompanying drawings and which is described in detail hereinafter. Referring to the drawings, which are for illustrative purposes:

Fig. 1 is a plan view of a circuit breaker which embodies the invention, parts of the device being broken away to reveal the structure thereof more clearly;

Fig. 2 is a front elevational view of the circuit breaker with parts thereof broken away;

Fig. 3 is a bottom view of the circuit breaker with parts thereof broken away;

Fig. 4 is a fragmentary, sectional view taken along the broken line 4—4 of Fig. 3; and

Fig. 5 is a diagrammatic view illustrating the electrical circuits incorporated in the circuit breaker.

Referring particularly to Fig. 5 of the drawings, my circuit breaker includes a line circuit, indicated generally by the numeral 10, and a control circuit indicated generally by the numeral 11. The line circuit 10 includes a main switch 12, a resistor 13 connected in series with the main switch by a conductor 14, and an operating bimetallic element 15 connected in parallel with the resistor by a conductor 16, a flexible conductor 17 and a conductor 18, the operating bimetallic element being of the cantilever type in the particular construction illustrated and having a free end 19 to which the flexible conductor 17 is connected. The line circuit 10 also includes two line terminals 21 and 22 to which may be connected wires 23 and 24 forming parts of an electrical circuit (not shown) in which the circuit breaker is to be connected, the main switch 12 being connected to the terminal 21 by a conductor 25 and the resistor 13 and the conductor 18 being connected to the terminal 22.

The control circuit 11 includes a main relay 28 which is connected to the main switch 12, as indicated diagrammatically by the broken line 29, and which is adapted to hold the main switch closed to close the line circuit 10 whenever it is energized to a predetermined extent as will be discussed in more detail hereinafter. The control circuit 11 also includes an auxiliary relay 30 which is connected in series with the main relay 28 by wires 31 and 32, the auxiliary relay being connected to an auxiliary switch 33, as indicated schematically by the broken line 34, and being adapted to hold the auxiliary switch closed whenever it is energized to a predetermined extent in a manner to be described. The auxiliary switch 33 is connected in parallel with the main relay 28 and in series with the auxiliary relay 30 by a wire 35, a conductor 36, and a wire 37. The auxiliary switch 33 includes a movable switch element 39 which serves as the armature of the relay 30, and includes a compensating bimetallic element 40 which is of the cantilever type in the particular construction illustrated which is spaced from and is substantially parallel to the element 15. The switch element 39 is adapted to be actuated by the operating bimetallic element 15 to move a contact 41 thereon into engagement with a contact 42 at the free end of the compensating bimetallic element 40 so as to short-circuit the main relay 28 as will be discussed in more detail hereinafter, the switch element being separated from the operating bimetallic element by an insulating element 43 carried by the switch element.

The control circuit 11 also includes control terminals 46 and 47 to which wires 48 and 49 may be connected, the wire 35 and the conductor 36 being connected to the terminal 46, and the auxiliary relay 30 being connected to the terminal 47 by a wire 50. In the particular circuit illustrated in Fig. 5 of the drawings, the wire 48 connected to the control terminal 46 is grounded, as indicated at 51, and the wire 49 connected to the control terminal 47 leads to a control station, indicated generally by the numeral 52, and is connected to a device 53 such as a cutout switch, for automatically opening the control circuit 11 under conditions to be described hereinafter. A battery 54 or other voltage source is connected in series with the device 53 by a wire 55, the other terminal of the battery being connected to a wire 56 which is grounded as indicated at 57.

Having described the various components of the line and control circuits 10 and 11 and the electrical relationship thereof, the structural relationship of these components will now be considered in detail with particular reference to Figs. 1 to 4 of the drawings. As best shown in Figs. 2 and 4, the circuit breaker includes a base 60, which is preferably formed of insulating material, and a U-shaped housing 61 which is connected to the base, the housing including a flange 62 which is seated against one side of the base 60, a wall 63 which is generally parallel to and spaced from opposite side of the base, and a wall 64 which connects the flange 62 and the wall 63 and which forms the rear wall of the circuit breaker, as viewed in the drawings. The housing 61 is secured to the base 60 by bolts 65, 66, 67 and 68 which extend through the base and the wall 63 of the housing, the bolts 65 and 66 also extending through the flange 62 thereof. One of these bolts, e. g., the bolt 67, is preferably provided with a sleeve 69 thereon which maintains the base 60 and the wall 63 of the housing 61 in spaced relationship. The circuit breaker also includes a U-shaped enclosure 72 which is insertable between the base 60 and the wall 63 of the housing 61, this enclosure being provided with holes therethrough for bolts 73 which may be used to mount the circuit breaker on any suitable supporting structure (not shown).

Considering the manner in which the various components of the line circuit 10 are mounted, and referring particularly to Figs. 1, 2 and 4 of the drawings, the line terminals 21 and 22 are preferably bolts which extend through suitable holes in the base 60, the line terminals being secured to the base by nuts 74 threaded thereon. Preferably, lock washers 75 are interposed between the nuts 74 and the base 60 to provide a positive connection between the line terminals 21 and 22 and the base. The wires 23 and 24 which are adapted to be connected to the line terminals 21 and 22 may be secured by nuts 76 threaded on the line terminals, lock washers 77 preferably being provided to insure positive connections between the line terminals and the respective wires 23 and 24 as is well known in the art.

As best shown in Fig. 4 of the drawings, the main switch 12 comprises a bar which is adapted

to engage the conductors 14 and 25 and which is connected to the main relay 28 in a manner to be described in more detail hereinafter, the conductors 14 and 25 preferably being bars which are seated against one side of the base 60. The conductor 25 is secured to the base 60 by the line terminal 21, and the conductor 14 is secured to the base by a bolt 78 which extends through aligned holes in the conductor 14 and the base, the bolt 78 being secured to the base by a nut 79 threaded thereon. A lock washer 80 is preferably disposed between the nut 79 and the base 60 to provide a positive connection between the bolt 78 and the base.

The resistor 13 is connected at one end to the line terminal 22 and at its other end to the bolt 78 so that it is connected in series with the main switch 12, the location of the resistor being shown best in Figs. 2 and 3 of the drawings. For a reason which will be discussed in more detail hereinafter, the resistor 13 is formed of a material whose resistance increases as its temperature increases, whereby the resistance of the resistor 13 increases as the current flowing therethrough increases. Preferably, the resistor 13 is covered with heat insulating material 83, as best shown in Fig. 4, to reduce radiation losses of heat generated by current flowing through the resistor.

As best shown in Fig. 2 of the drawings, the operating bimetallic element 15 is mounted in such a manner that its free end 19 engages the insulating element 43 on the switch element 39, the opposite end of the operating bimetallic element being rigidly connected to a metallic support which forms the previously mentioned conductor 36 for connecting the control terminal 46 to the auxiliary switch 33. The operating bimetallic element 15 is secured to the conductor 36 by a bolt 85 and is electrically insulated with respect to the conductor 36 and the bolt 85 by insulating elements 86 and 87. The conductor 36 on which the operating bimetallic element 15 is mounted is secured to the base 60 of the circuit breaker by a bolt which, as will be discussed in more detail hereinafter, forms the control terminal 46.

The fixed end of the operating bimetallic element 15 is connected to one end of the resistor 13 by the conductor 16, which is preferably a metal strap having one end connected to the fixed end of the operating bimetallic element and having its other end connected to the previously discussed bolt 78, as best shown in Figs. 1 and 4 of the drawings. The free end 19 of the operating bimetallic element 15 is connected to the opposite end of the resistor 13 by the flexible conductor 17 and the conductor 18, the latter being a strap in the construction illustrated. As best shown in Fig. 2 of the drawings, the flexible conductor 17 is attached at one end to the free end 19 of the operating bimetallic element, and is connected to the base 60 at its other end by a bolt 88, this flexible conductor preferably being formed of woven wire or other suitable material to permit free movement of the end 19 of the bimetallic element 15. One end of the strap 18 is secured to the base 60 and is connected to the flexible conductor 17 by the bolt 88, and the other end of this strap is secured to the base by the line terminal 22, as best shown in Figs. 2 and 3 of the drawings. Thus, part of the current flowing through the resistor 13 is shunted through the operating bimetallic element 15 from the line terminal 22

to the bolt 78 by way of the strap 18, the bolt 88, the flexible conductor 17, and the strap 16.

Considering the structural relationship of the various components of the control circuit 11, the main relay 28 is enclosed by the bolts 65, 66, 67 and 68 which connect the housing 61 to the base 60 of the circuit breaker, the wires 31 and 35 connected to the main relay being best shown in Figs. 1 and 2 of the drawings. The outer end of the wire 31 is connected to a bolt 91 which extends through the base 60 and the outer end of the wire 35 is connected to the bolt forming the control terminal 46.

Referring particularly to Fig. 4 of the drawings, the main switch 12 is provided with a central opening 92 which receives an insulating element 93 having a shoulder 94 thereon, the main switch being clamped between the shoulder 94 and an insulating collar 95 which is frictionally telescoped over the insulating element 93. The upper end of the insulating element 93, as viewed in Fig. 4, is seated against the armature 96 of the main relay 28 by a compression spring 97 which encircles a plunger 98 threaded into the armature, one end of the spring 97 being seated against the base wall of a recess 99 formed in the insulating element 93 and the other end of this spring being seated against a shoulder 100 formed on the plunger 98. The purpose of the spring 97 is to provide a yieldable connection between the main switch 12 and the armature 96 of the main relay 28 so that the main switch will be held in positive engagement with the bars 14 and 25 when the main relay is energized to draw the armature thereof upwardly, as viewed in Fig. 4, during operation of the circuit breaker as will be discussed in more detail hereinafter.

Downward movement of the main switch 12, as viewed in Fig. 4, is limited by an insulating plate 103 against which the insulating element 93 is adapted to seat, the plate 103 being clamped between nuts 104 threaded on the bolts 65 to 68 and being provided with a central opening 105 through which the plunger 98 extends. Disposed between the insulating plate 103 and a head 106 formed on the outer end of the plunger 98 is a compression spring 107 which tends to move the armature 96 and the main switch 12 downwardly, as viewed in Fig. 4 of the drawings, to disengage the main switch from the conductors 14 and 25 so as to open the line circuit 10. Thus, the spring 107 serves as means for opening the main switch 12 during the operation of the circuit breaker and is adapted to be overcome by the main relay 28 when energized to a predetermined extent, as will be discussed in more detail hereinafter. The main switch 12 and the plunger 98 are preferably enclosed by a cap 108 which is secured by means of nuts 109 threaded on the bolts 65 to 68.

Continuing the consideration of the structural relationship of the various components of the control circuit 11, the auxiliary relay is secured to the base 60 of the circuit breaker by a bolt 114, as best shown in Fig. 2 of the drawings. The wires 32 and 50 connected to the auxiliary relay 30 are best shown in Figs. 1 and 2, the outer end of the wire 32 being connected to the bolt 91 and the outer end of the wire 50 being connected to a bolt forming the control terminal 47.

The switch element 39 forming part of the auxiliary switch 33 forms the armature of the auxiliary relay 30 and is located above the auxiliary relay, as viewed in Fig. 2, in alignment therewith, the switch element being pivoted on a support 115 which is mounted on the base 60. The switch

element 39 is biased for rotation in the clockwise direction, as viewed in Fig. 2, by a tension spring 116 so as to hold the insulating element 43 in engagement with the free end 19 of the operating bimetallic element 15, the spring being connected at one end to the switch element 39 and at its other end to the bolt 91. The wire 37 connecting the switch element 39 to the main relay 28 and the auxiliary relay 30 is also connected to the bolt 91.

The compensating bimetallic element 40 is so mounted that the contact 42 at its free end is aligned with the contact 41 on the switch element 39, the opposite end of the compensating bimetallic element being rigidly connected to the conductor 36 which forms the support for the operating bimetallic element 15. The two bimetallic elements 15 and 40 are mounted in substantially parallel relationship and are adapted to bend in the same direction for like changes in the temperatures thereof, the compensating bimetallic element being designed to bend at a greater rate than the operating bimetallic element for equal temperature changes for a reason to be discussed hereinafter. Mounted on the conductor 36 on either side of the compensating bimetallic element 40 and spaced therefrom are members 117 which are engaged by the compensating bimetallic element after it has moved upwardly or downwardly a predetermined amount from the position shown in Fig. 2. When the compensating bimetallic element 40 engages one or the other of the members 117, the free length of this bimetallic element is, in effect, reduced so that the rate of bending of the compensating element for a given rate of temperature change is decreased. Thus, the members 117 serve as means for retarding bending of the compensating bimetallic element 40 after it has bent a predetermined amount, the reason for this being discussed in more detail hereinafter.

The circuit breaker may be connected in a circuit which is to be protected from damage due to a predetermined overload current by connecting the wires 23 and 24 forming part of the circuit to be protected to the line terminals 21 and 22, respectively, the wires 23 and 24 preferably being provided with suitable terminals (not shown) which may be clamped in place by the nuts 76 on the line terminals in an obvious manner. Similarly, the wires 48 and 49 may be provided with terminals (not shown) which may be clamped in place on the control terminals 46 and 47, respectively, by nuts 118 threaded on the control terminals. As previously mentioned, the wire 48 connected to the control terminal 46 is grounded at 51, and the wire 49 connected to the control terminal 47 is connected to the device 53, the latter preferably being a cutout switch which is adapted to open the control circuit automatically whenever a predetermined current flows therethrough as will be discussed in more detail hereinafter, and which is adapted to be reset manually. The device 53 may be a simple circuit breaker comprising a switch 119 which is controlled by a relay 120, the relay being connected in series with the switch.

Considering the operation of the circuit breaker, as long as the cutout switch 53 is closed so that the control circuit 11 is energized, and as long as the current flowing through the line circuit 10 is less than the predetermined overload value, the various components of the circuit breaker will occupy substantially the positions shown throughout the drawings. In other words, under the conditions set forth, the main switch 12 is closed, and the two bimetallic elements 15 and 40 are substantially parallel so that the auxiliary switch 33 is open.

Consequently, the current flowing through the control circuit 11 must flow through both the main relay 28 and the auxiliary relay 30. The electrical characteristics of the main and auxiliary relays 28 and 30 are such that the current flowing through the control circuit 11 when the auxiliary switch is open energizes the main relay to an extent sufficient to hold the main switch 12 closed, but does not energize the auxiliary relay to an extent sufficient to hold the auxiliary switch closed. To insure that the auxiliary switch 33 will not be closed during normal operation of the circuit breaker, a small magnetic diverter (not shown) is preferably placed between the core and frame of the auxiliary relay 30, the flux capacity of this diverter being sufficient only to prevent closure of the auxiliary switch under the conditions hereinbefore set forth.

Whenever ambient temperature changes are encountered, the operating bimetallic element 15 and the compensating bimetallic element 40 bend in unison so that the spacing therebetween is maintained substantially constant to prevent closure of the auxiliary switch 33. For example, if an increase in the ambient temperature is encountered, the two bimetallic elements 15 and 40 will bend downwardly, as viewed in Fig. 2, at substantially the same rate so that, although the switch element 39 is moved downwardly by the operating bimetallic element, the spacing between the contacts 41 and 42 carried by the switch element and the compensating bimetallic element will be maintained substantially constant. Thus, it will be apparent that the operation of the circuit breaker is not affected by ambient temperature changes.

Since the operating bimetallic element 15 is electrically connected to the resistor 13 in the manner previously discussed, it will be apparent that some of the heat generated by the current flowing through the resistor will be conducted to the operating bimetallic element, thereby causing the operating bimetallic element to bend so as to tend to decrease the spacing between the two bimetallic elements. However, since the two bimetallic elements are mounted on the same metallic support, viz., the conductor 36, the two elements are thermodynamically connected so that any heat conducted to the operating bimetallic element 15 is conducted to the compensating bimetallic element 40 in substantially the same amount, the amount of heat conducted to the compensating bimetallic element from the resistor 13 being slightly less than that conducted to the operating bimetallic element therefrom because of the fact that the two bimetallic elements are separated by the insulating element 87. In order to compensate for this difference in the amounts of heat conducted to the operating and compensating bimetallic elements, the compensating bimetallic element is designed to bend an amount greater than the amount which the operating bimetallic element bends when the temperatures of the two elements are changed equal amounts. Thus, it will be apparent that the operation of the circuit breaker is not affected by changes in temperature due to conduction of heat, as well as changes in the ambient temperature.

Preferably, the compensating bimetallic element 40 bends at a greater rate than the oper-

ating bimetallic element 15 for equal temperature changes only during the interval that the circuit breaker is warming up after operation thereof is initiated. After stabilized operating temperatures have been attained, the operating characteristics of the two bimetallic elements are preferably substantially identical, the retarding members 117 being provided for this purpose. Referring particularly to Fig. 2 of the drawings, assuming that the temperatures of the two bimetallic elements are increased by conduction from the resistor 13 and/or by an increase in the ambient temperature, both bimetallic elements will bend downwardly, as viewed in Fig. 2, with the compensating bimetallic element 40 bending at a greater rate. However, after the compensating element 40 has bent downwardly a predetermined amount, it will engage the lowermost of the retarding members 117 so that, in effect, the length of the compensating bimetallic element is reduced, thereby reducing its rate of bending. The lowermost retarding member 117 is so positioned that the effective reduction in the length of the compensating bimetallic element 40 is sufficient to reduce the activity of the compensating bimetallic element to a value comparable to that of the operating bimetallic element 15, and is so positioned that it will be engaged by the compensating bimetallic element when stabilized operating temperatures are attained.

The retarding members 117 also produce another important result in that they tend to balance the activities of the two bimetallic elements. As is well known in the art, the activity of most bimetallic elements tends to decrease at elevated temperatures and, since the operating bimetallic element reaches higher temperatures than the compensating bimetallic element, the retarding members 117 tend to equalize the activities of the two elements by reducing the activity of the compensating bimetallic element.

The discussion thus far has been limited to normal operation of the circuit breaker, i. e., its operation when the current flowing through the line circuit 10 is less than the predetermined overload current. If the current increases to a value greater than the overload current for a predetermined interval of time, the increased current shunted through the operating bimetallic element 15 will heat it and cause it to bend at a much greater rate than the compensating bimetallic element 40 so that the operating bimetallic element rotates the switch element 39 to close the auxiliary switch 33. However, as will be discussed in the succeeding paragraph, closure of the auxiliary switch 33 does not occur instantaneously so that brief current surges above the overload value will not result in closure of the auxiliary switch 33, thereby permitting normal operation to continue unless the overload current persists, which is an important feature of my invention. In this connection, it will be understood that my circuit breaker is intended to be used in circuits which will not be damaged by brief surges of the current above the overload value.

The time delay discussed in the preceding paragraph is due to the use of a material for the resistor 13 whose resistance increases as its temperature increases due to an increased current flow therethrough. Thus, whenever an overload current flows through the line circuit 10, the resistance of the resistor 13 increases so that the ratio of the current shunted through the operating bimetallic element 15 to that flowing through the resistor 13 increases, thereby increasing the bending rate of the operating bimetallic element and increasing the rate of movement of the switch element 39 toward the compensating bimetallic element 40 thereby. However, the temperature of the resistor 13 will not increase instantaneously when the current flow through the line circuit 10 increases so that the desired time delay results.

Whenever an overload current flows through the line circuit 10 for an interval of time equal to the time delay discussed in the preceding paragraph, the operating bimetallic element 15 bends sufficiently to close the auxiliary switch 33, i. e., to move the contact 41 on the switch element 39 into engagement with the contact 42 on the compensating bimetallic element 40. Upon closure of the auxiliary switch 33 in this manner, a low-resistance current path is established in parallel with the main relay 28 so that the main relay is short-circuited, thereby reducing the current flowing through the main relay to such an extent that it is no longer energized sufficiently to hold the main switch 12 closed in opposition to the action of the compression spring 107. Consequently, the spring 107 opens the main switch 12 to break the line circuit 10.

In addition to de-energizing the main relay 28, short-circuiting the main relay through the auxiliary switch 33 reduces the resistance of the control circuit 11 so that the current flowing through the auxiliary relay 30 is increased to an extent sufficient to hold the auxiliary switch closed. Preferably, the resistance of the auxiliary relay 30 is such that, upon removal of the resistance of the main relay 28 from the circuit by short-circuiting it in the manner described, the auxiliary relay is energized sufficiently to lock the auxiliary switch 33 closed in a positive manner. Thus, no triggering of the circuit breaker can occur due to vibration or the like.

As previously mentioned, the circuit breaker is preferably used with the cut-out switch 53 connected in series with the auxiliary relay 30, the cut-out switch being located at the control station 52 which may, for example, be the cockpit of an airplane, the circuit breaker itself being located in some other part of the airplane. The relay 120 of the cut-out switch 53 is designed to be energized to an extent sufficient to open the switch 119 when the current flowing through the control circuit 11 increases upon short-circuiting of the main relay 28 by closure of the auxiliary switch 33 in the manner previously described. Thus, upon opening of the switch 119, current flow through the control circuit 11 ceases. If desired, a light (not shown) or other indicating device which is actuable by the cut-out switch 53 may be located at the control station 52 to provide the operator with an indication that the line circuit 10 has been broken.

It will be apparent that the circuit breaker may be re-set by closing the cut-out switch 53, the switch preferably being designed to permit manual closing thereof. If, after closing the cut-out switch 53, the condition which caused the overload current to flow through the line circuit 10 still obtains, the circuit breaker will operate in the manner hereinbefore discussed to break the line circuit again. However, if the current flowing through the line circuit upon closure of the cut-out switch 53 is below the overload current, normal operation will be resumed.

In addition to providing a remotely controlled circuit breaker, my invention provides a device which may be used as a remotely controlled

switch. It will be apparent that if the cut-out switch 53 is opened manually, the main relay 28 will be de-energized to permit the spring 107 to open the main switch 12, subsequent closure of the cut-out switch resulting in closure of the main switch.

Although I have disclosed an exemplary embodiment of my invention herein for illustrative purposes, it will be understood that various changes, modifications and substitutions may be incorporated in this embodiment without necessarily departing from the spirit of the invention, and I hereby reserve the right to all such changes, modifications and substitutions as properly come within the scope of my invention as set forth in the appended claims.

I claim as my invention:

1. In a circuit breaker, the combination of: a main switch; resilient means for opening said main switch; a main relay connected to said main switch and adapted, when energized, to hold said main switch closed in opposition to the action of said resilient means; an auxiliary switch in parallel with said main relay; means responsive to current flow through said main switch for closing said auxiliary switch so as to short-circuit said main relay whenever a predetermined current flows through said main switch, whereby to permit said resilient means to open said main switch; and an auxiliary relay connected to said auxiliary switch and adapted, when energized to a predetermined extent, to hold said auxiliary switch closed, said auxiliary relay being connected in series with said main relay and said auxiliary switch and being adapted to be energized to an extent sufficient to hold said auxiliary switch closed upon short-circuiting of said main relay.

2. In a circuit breaker, the combination of: a line circuit including a main switch and a resistor in series; resilient means for opening said main switch; a main relay connected to said main switch and adapted, when energized, to hold said main switch closed in opposition to the action of said resilient means; an auxiliary switch in parallel with said main relay and adapted, when closed, to short-circuit said main relay so as to permit said resilient means to open said main switch; and thermostat means in parallel with said resistor for closing said auxiliary switch when a predetermined current flows in said line circuit, said thermostat means including an operating bimetallic element, and said auxiliary switch including a compensating bimetallic element which is parallel to said operating bimetallic element and which is provided with a contact thereon, said auxiliary switch also including a movable switch element having a contact thereon which is adapted to engage said contact on said compensating bimetallic element to short-circuit said main relay, said switch element being actuable by said operating bimetallic element.

3. In a circuit breaker, the combination of: a main switch; resilient means for opening said main switch; a main relay connected to said main switch and adapted, when energized, to close said main switch in opposition to the action of said resilient means; a resistor in series with said main switch; an operating bimetallic element in parallel with said resistor; an auxiliary relay in series with said main relay; and an auxiliary switch in series with said auxiliary relay and in parallel with said main relay, said auxiliary switch including a compensating bimetallic element having a contact thereon, and including a movable switch element having a contact thereon which is adapted to engage said contact on said compensating bimetallic element, said switch element being actuable by said operating bimetallic element to move said contact thereon into engagement with said contact on said compensating bimetallic element, and said switch element having an insulating element thereon which separates it from said operating bimetallic element.

4. In a circuit breaker, the combination of: a main switch; resilient means for opening said main switch; a main relay connected to said main switch and adapted, when energized, to close said main switch in opposition to the action of said resilient means; spaced, substantially parallel, first and second bimetallic elements, said bimetallic elements being adapted to bend in the same direction as the temperature thereof changes, said first bimetallic element being connected in series with said main switch, and said second bimetallic element being provided with a contact thereon; means for supporting said bimetallic elements; a movable switch element having a contact thereon which is adapted to engage said contact on said second bimetallic element, said switch element being actuable by said first bimetallic element to move said contact thereon into engagement with said contact on said second bimetallic element whenever the temperature of said first bimetallic element differs from that of said second bimetallic element by a predetermined amount, said contacts forming an auxiliary switch which is connected in parallel with said main relay so that closure of said auxiliary switch shunts said main relay to de-energize it, whereupon said resilient means opens said main switch; and means for supporting said switch element.

5. A circuit breaker as set forth in claim 4 wherein said second bimetallic element is adapted to bend at a greater rate than said first bimetallic element for a given change in the temperature of said bimetallic elements.

6. A circuit breaker as set forth in claim 5 including means engageable by said second bimetallic element for retarding bending of said second bimetallic element after it has bent a predetermined amount.

7. A circuit breaker as set forth in claim 4 wherein said bimetallic elements are electrically insulated with respect to each other but are thermally connected so that any heat conducted to one of the elements is conducted to the other in substantially the same amount.

8. In a circuit breaker, the combination of: a main switch; a main relay connected to said main switch and adapted, when energized, to hold said main switch closed; an auxiliary switch in parallel with said main relay; thermostat means responsive to current flow through said main switch for closing said auxiliary switch so as to short-circuit said main relay whenever a predetermined current flows through said main switch; and an auxiliary relay connected to said auxiliary switch and adapted, when energized to a predetermined extent, to hold said auxiliary switch closed, said auxiliary relay being connected in series with said main relay and said auxiliary switch and being adapted to be energized to an extent sufficient to hold said auxiliary switch closed on short-circuiting of said main relay.

9. A circuit breaker according to claim 8 wherein said thermostat means includes an element connected in circuit with said main switch.

10. A circuit breaker according to claim 8 wherein said thermostat means includes an element connected in parallel with a resistor which is connected in series with said main switch.

11. In a circuit breaker, the combination of: a line circuit including a main switch and a resistor in series; resilient means for opening said main switch; a main relay connected to said main switch and adapted, when energized, to hold said main switch closed in opposition to the action of said resilient means; an auxiliary switch in parallel with said main relay and adapted, when closed, to short-circuit said main relay so as to permit said resilient means to open said main switch; thermostat means in parallel with said resistor for closing said auxiliary switch when a predetermined current flows in said line circuit; and an auxiliary relay which is connected to said auxiliary switch and which is adapted, when energized to a predetermined extent, to hold said auxiliary switch closed, said auxiliary relay being connected in series with said main relay and said auxiliary switch, and being adapted to be energized to an extent sufficient to hold said auxiliary switch closed upon short-circuiting of said main relay by closure of said auxiliary switch.

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