Sept. 30, 1958 T. M. COLE 2,854,546

COMPENSATED CIRCUIT BREAKERS

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Fig. 1.

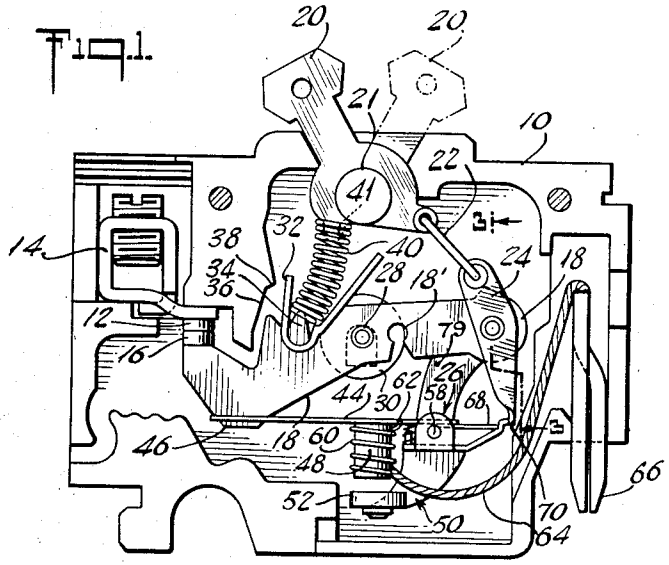


Fig. 2.

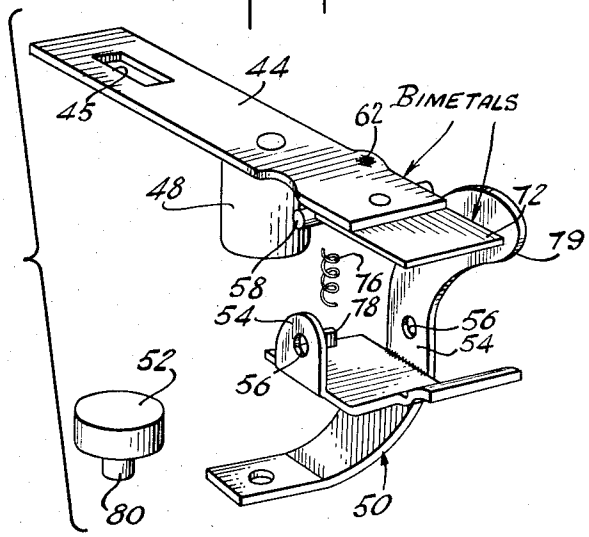
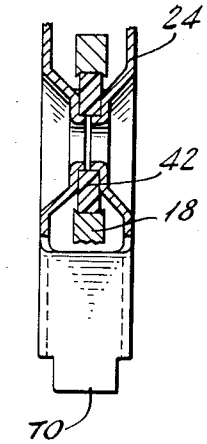


Fig. 3.



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COMPENSATED CIRCUIT BREAKERS

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Fig. 4.

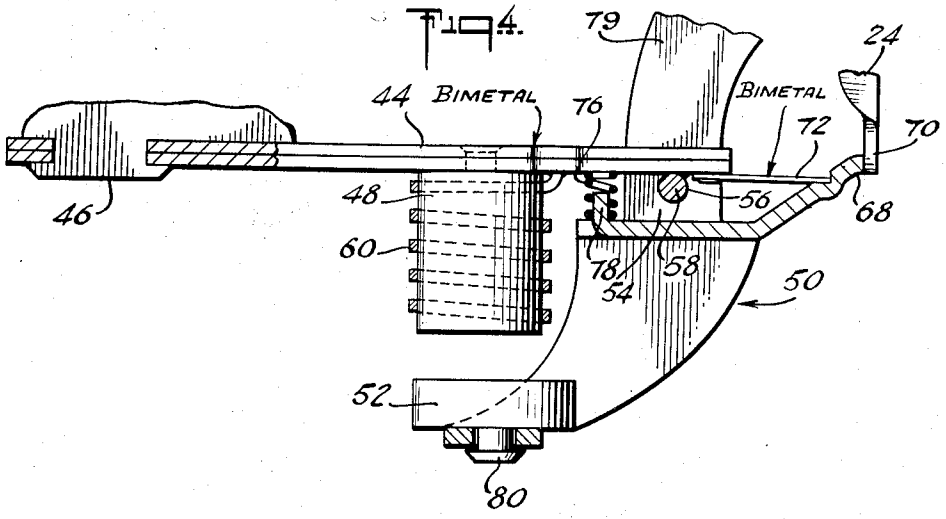


Fig. 5.

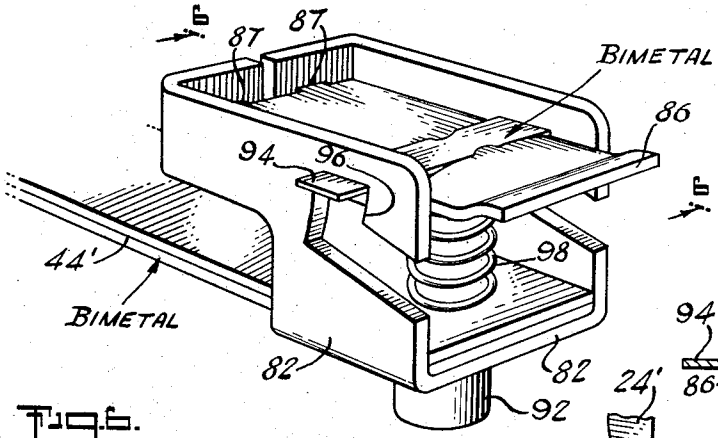


Fig. 6.

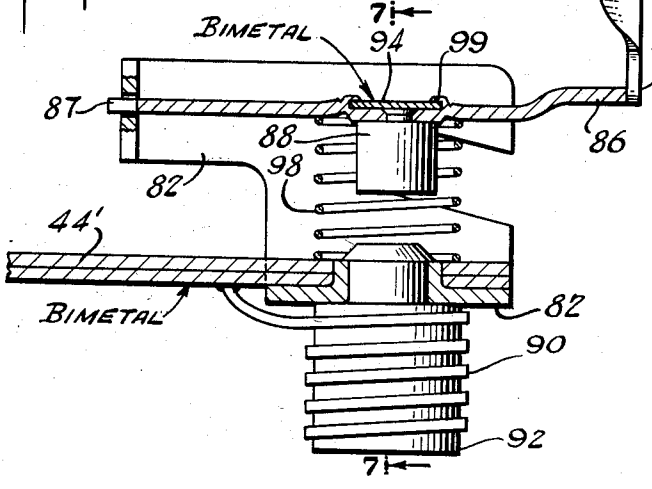
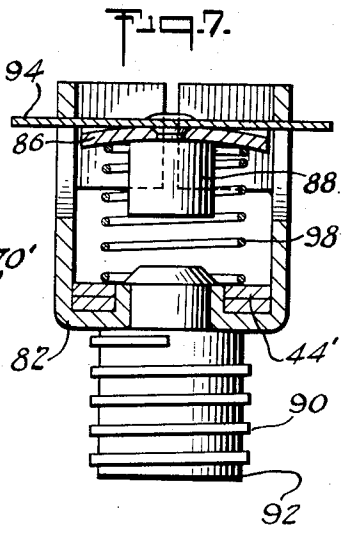


Fig. 7.



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2,854,546

COMPENSATED CIRCUIT BREAKERS

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Application January 10, 1955, Serial No. 480,636

20 Claims. (Cl. 200—88)

The present invention relates to automatic circuit breakers of the type having a current responsive bimetal which trips the circuit breaker upon occurrence of an overload. In more specific aspect, the invention relates to circuit breakers of the type having the bimetal assembled to a moving contact, as disclosed for example in Patent 2,681,396 filed jointly by Paul M. Christensen and myself, and assigned to the assignee of this application.

Circuit breakers of the type having a bimetal heated by overload currents for tripping the breaker have been known for long, as have magnetically tripped circuit breakers. In the thermally tripped form of circuit breaker, a bimetal is heated by the current passing through the circuit breaker and the heating causes the bimetal to deflect. Where the magnetic field is relied upon, an armature is utilized to trip the circuit breaker. Both forms of tripping have been combined in circuit breakers where thermal tripping is relied upon for moderate overloads of long duration and where magnetic tripping is relied upon for sudden higher-level overloads.

An object of the present invention is to improve circuit breakers of the type having provision for thermal and magnetic tripping so as to compensate partly or wholly for the effects of the changing ambient temperatures on the current-sensitive bimetal. In particular, an object is to provide a circuit breaker having integrated therein a thermal tripper, a sensitive magnetic tripper, and an ambient temperature compensator. A more specific but no less important object of the invention is to incorporate ambient-temperature compensation in a breaker having thermal and magnetic tripping devices where the breaker is of the type having a subassembly including a movable contact carrying the thermal tripping element. In the illustrative embodiments of the invention, the thermal and magnetic tripping and the ambient-temperature-compensating devices are carried at least in part with the movable contact subassembly of the circuit breaker. In general, the broad object of the invention is to improve automatic circuit breakers.

In two practical forms of the invention, described in greater detail below, a compensating bimetal is interposed between the current responsive bimetal and a pivoted latch which retains the breaker in closed condition until either the magnetic trip or the thermal trip releases the latch. In the embodiments of the invention to be described, the thermal trip and the magnetic trip are both part of the moving contact sub-assembly. This sub-assembly can be calibrated in advance in respect to current levels at which tripping occurs, and then it is assembled in its casing together with a cooperating contact (usually fixed) and with an operating handle.

The nature of the invention and its further features of novelty will appear from the following detailed disclosure of two illustrative embodiments of the invention shown irn the accompanying drawings. In the drawings:

Figure 1 is a somewhat enlarged side view of a circuit breaker of generally known construction and embodying the present improvements, a side wall of the casing being removed to reveal the internal arrangement of parts;

Figure 2 is an exploded perspective of certain portions of the mechanism in Figure 1;

Figure 3 is an enlarged fragmentary cross-section of a portion of Figure 1 along the line 3—3 in Figure 1;

Figure 4 is a greatly enlarged fragmentary side view of the thermal and magnetic latching assembly of the mechanism in Figure 1;

Figure 5 is a greatly enlarged perspective of a modification of the mechanism in Figure 4, the remainder of the circuit breaker as shown in Figure 1 being omitted;

Figure 6 is a cross-sectional view of the mechanism along the line 6—6 in Figure 5; and

Figure 7 is a transverse cross-sectional view along the line 7—7 in Figure 6.

Referring now to Figure 1 there is shown a circuit breaker mechanism supported in one casing part **10**, the other part which normally conceals the mechanism being removed for clarity. A fixed contact **12** is welded to external terminal **14**, which is held in position by matching recesses formed in the casing parts. The breaker is "closed" when movable contact **16** on moving contact member **18** engages contact **12**. Handle **20** has pivots **21** that have bearings in the casing. The contacts are closed, as shown in Figure 1, by a linkage including handle **20**, stiff wire link **22**, actuating member **24**, and latching assembly **26**. The moving contact member **18** and actuating member **24** operate as a unit when latched by assembly **26**. Link **22** and the portion of handle **20** below its pivot constitute a toggle which operates the latched unit **18—24—26** when handle **20** is moved from the "open" position represented in dotted lines, to close the circuit breaker.

Member **18** pivots about a helical coil spring **28** that has a bearing in boss **30** in casing part **10**, a similar bearing being formed in the casing wall that has been removed to reveal the mechanism. A J-shaped element **32** is carried on movable contact element **18**, being held thereon by a projection **34** extending through a slot in element **32**. The left-hand arm of element **32** rides along a cam surface **36** in the casing during closing operation of handle **20**. At a certain phase of this operation member **32** reaches a shoulder **38**, and advance of contact **16** is temporarily arrested. Thereafter operation of handle **20** and linkage **22—24—18—26** bows spring pivot **28** down and to the right (as seen in Figure 1).

A compression spring **40** is interposed between J-shaped member **32** and a projection **41** of the handle **20**. At about the time that the toggle including handle **20** and link **22** pass the straightened condition so as to over-center, the compression spring **40** is driven by projection **41** to engage the long right-hand arm of the J-shaped member **32** so as to shift the left-hand arm of that member away from shoulder **38**. The result of this is to permit spring **28** to drive moving contact **16** against contact **12**. In this operation spring **28** is more powerful than spring **40**. The straightening operation of toggle **20—22** is also effective to bow spring **28** to the right as previously mentioned, and this has the further effect of shifting member **32** together with member **18** to the right and thereby to move J-shaped member **32** out of engagement with shoulder **38**, additionally promoting release of the moving contact member.

This arrangement has several desirable effects, causing contacts **16** and **12** to engage each other with a snap action, and causing the contacts to engage each other with a wiping component of motion of one contact along the surface of the other; and it further prevents "teasing" of the contacts by very gradually operating handle **20**

from the open to the closed position thereof. In the closing motion as described, handle 20 can be operated as slowly and carefully as conceivable, yet the contacts snap closed.

When the breaker is to be manually opened, handle 20 is operated toward the dotted-line position; and after toggle 20—22 passes reversely through dead-center, the portion of handle 20 which engages link 22 strikes the long right-hand arm of J-shaped member 32 so as to drive moving contact member 18 counterclockwise in the opening direction. At the same time, spring 40 pushes the moving contact member 18 counterclockwise to separate the contacts.

In case of automatic operation of the circuit breaker, latching assembly 26 moves down and out of engagement with actuating member 24, thereby allowing that member to swing rapidly clockwise and allowing spring 40 to drive the moving contact 16 away from fixed contact 12, to open the circuit breaker. Additionally, if the handle is not restrained manually, it moves to its reset dotted-line position, in condition to reclose the breaker when the latching assembly resumes its normal, undeflected configuration.

The casing part 10 and the casing part omitted from the breaker shown in Figure 1 are of insulating material. An insulating bearing 42 is provided in the pivot between member 24 and moving contact member 18, as shown in Figure 3. Consequently there is no current path from latching assembly 26 through link 24 and member 18 to the moving contact 16. The only current path through the moving contact subassembly is through the current-responsive latching assembly 26, as will be more specifically described.

With the foregoing, the general operation of circuit breakers of the type having the latching assembly movable with the moving contact member will be understood. It is a feature of circuit breakers of this type, that the latching assembly, the actuating member 24, and the moving contact member 18 are of such mechanically integrated character that the critically related parts can be calibrated before this "metal-heart" of the breaker is put into the casing. The calibration is stable irrespective of potential dimensional changes of the casing. For calibrating this "metal heart," moving contact member 18 is bent to the extent necessary (especially in the region of slot 18') to produce a critical degree of overlap of latching assembly 26 and actuating member 24. In this way the amount of current-induced deflection of the latching assembly 26 that is required to trip the breaker can be preset. It will be understood that the greater amount of overlap of the lower extremity 70 of member 24 across the end of latching assembly 26, the greater will be the amount of current-induced deflection that is necessary to trip the circuit breaker. This increases the tripping-current rating of the circuit breaker. Reverse adjustment to decrease the amount of overlap of the latch-engaging portion 70 of actuating member 24 across the end of latching assembly 26 increases the sensitivity of the breaker, that is, renders the circuit breaker effective to trip open in response to lower current levels.

The detailed nature and function of the latching assembly 26 will be explained in connection with Figures 1, 2, and 4. Latching assembly 26 includes a bimetal 44 that is rigidly joined at its left-hand extremity to member 18 by a rivet extending integrally from member 18 through a hole 45 in the bimetal, this connection also forming an electrical joint. Near the middle of bimetal 44 there is a soft iron core 48 joined to the bimetal 44, as by means of a rivet extending integrally from core 48.

Latch member 50 has a pair of ears 54 with bearing holes 56 therein which receive the projecting ends of a pivot rod 58 that is welded transversely to the lower surface of bimetal 44 at the right-hand or free extremity of that bimetal.

A copper coil 60 having a thin insulating coating is wound about core 48 and has one end welded to the bimetal 44 at a point 62 between pivot 58 and core 48, and coil 60 has a flexible "pigtail" connection 64 at its opposite end which extends to a "stab" terminal 66 at the end of the circuit breaker casing opposite from the external terminal 14 of fixed contact 12.

Pivoted member 50 has a latch arm 68 the end of which abuts the downward extending portion 70 of pivoted actuating member 24. Member 50 is held in a normal attitude in relation to bimetal 44 by the balanced action of an ambient temperature compensating bimetal 72, which is suitably united to the free end of bimetal 44, and a coil spring 76. Bimetal 72 and spring 76 act on pivoted member 50 at opposite sides of pivot 58. Spring 76 is quite weak, being not appreciably stronger than is required to press the pivoted member 50 against bimetal 72 when member 50 is unrestrained. A lug 78 extends up from member 50 to enter spring 76 and prevent it from leaving the assembled position illustrated. The arm of member 50 that carries armature 52 is so relieved as to avoid engaging coil 60 during operation of member 50 about its pivot.

As particularly emphasized in Figure 4, the thickness of bimetal 44 is much greater than that of bimetal 72. Their relative thicknesses are substantially related to each other inversely as their lengths, and they are equal in width, adjusted empirically to respond equally in respect to deflection in response to changing ambient temperatures, for 100% compensation. Actually something less than 100% compensation may be desirable, as an assurance that there will be no instance of unsafe, overcompensation; and in that event the bimetals are proportioned somewhat differently. It is desirable for the compensating bimetal to be sufficiently stiff to transmit the deflection force of the current-responsive bimetal, in tripping the circuit breaker. For this purpose it can be made as wide as need be, without serious effects on its temperature-deflection characteristics. Bimetal 44 which is shown to be long and comparatively thick, is to carry the main current of the circuit breaker, whereas bimetal 72 is only to deflect under the influence of changing ambient temperatures. The proportions of the bimetals are such that, when the ambient temperature changes, each bimetal has the same total deflection of its free end, referred to its supported end. The high-expansion sides of the bimetals are reversed so that these deflections are in opposite directions. Consequently when there is a change in ambient temperature, the bimetal assembly 44—72 has developed within it two reverse curves, but the free end of this assembly does not shift. For 90% compensation, it moves down a bit.

It is important for bimetal 44 to be relatively thick for the heat-induced tendency to bend downward to release actuating member 24 must act at the latching point 68—70, a long distance from rivet 46, and in deflecting, bimetal 44 must overcome the latch friction. This is likely to be high because of the high spring pressure developed in the closing operation of the circuit breaker. The deflecting force developed by current-responsive bimetal 44 at its free end is transmitted to latch 68 by compensating bimetal 72. While this bimetal is thin, it is also short, with the result that it is effectively stiff and entirely capable of transmitting the deflecting force of bimetal 44 to cause release of the latch.

The path of the current through latching assembly 26 and the rest of the circuit breaker may be traced from fixed external terminal 14, by way of contacts 12 and 16, through rivet 46 and bimetal 44 to coil 60 and pigtail 64 to the opposite external terminal 66. The current passes through bimetal 44 along a path that includes more than half its total length, and the deflection of the bimetal produced by the heating that results

from this current is nearly as great as if the weld point **62** had been made at the free end of bimetal **44**. Nevertheless there is very little heat transmitted from weld point **62** to that portion of bimetal **72** that is out of contact with bimetal **44**.

When the circuit breaker is closed as shown in Figure 1 and current passes from terminal **14** to terminal **66**, bimetal **44** is heated at the varying levels determined by the changing load circuit that is protected by the circuit breaker. This causes bimetal **44** to deflect downward, its high expansion side facing upward in the drawing driving ambient temperature compensating bimetal **72** downward and moving the latch **68** downward along the latching portion **70** of actuating member **24**. When a moderate load decreases, bimetal **44** decreases its curvature and thereby elevates pivot **58**. This has the effect of lifting ambient temperature compensating bimetal **72** slightly out of contact with latch **68** of the latch member **50**, but only until the load current again rises. When the current rises gradually to the tripping level, bimetal **44** moves ambient compensating bimetal **72** so as to drive latch **68** down and out of the path of latching portion **70**, allowing actuating member **24** to swing clockwise and allowing the circuit breaker to spring open under the impulse of spring **40**.

The latch **68** moves part way toward the tripping position in response to moderate currents passing through the latching assembly. When the current diminishes, bimetal **44** raises pivot **58**, but latching friction retains latch **68** in its previous deflected position. Spring **76** is comparatively weak, and is inadequate to force latch member **68** to return with the bimetal assembly **44—72**. With the end of latch **68** restrained, returning displacement of pivot **58** swings armature toward coil **60** and its core **48**. This decreased magnetic gap may be considered an advantage, in making the magnetic trip somewhat more sensitive than it is when the breaker is initially closed. However, the air gap between armature **52** and core **48** is made large enough to avoid excessive variations in the sensitivity of the magnetic trip.

The deflection of main current bimetal **44** under the influence of the heat produced by the load current through the circuit breaker is one that develops gradually, and the deflection is therefore a relatively gradual phenomenon even where the load very abruptly increases to many times the sustained minimum level at which bimetal **44** would cause tripping. For this reason the described sensitive magnetic tripping arrangement has been provided. The current through coil **60** develops a magnetic field that attracts armature **52**, the magnetic flux having a return path through elements **50** and **44**. When an overload current is suddenly passed through coil **60**, armature **52** is immediately attracted, causing latch portion **68** to release actuating member **24** and allow the breaker to trip open. During this tripping action, weak spring **76** introduces only slight resistances to the motion of the pivoted member **50**. Latch **68** moves away from the bimetal assembly **44—72**, relieving any pressure of the bimetals against latch **68**, so that the magnetic tripping is not burdened with any need for deflecting a bimetal.

It will be noted in Figure 4 that member **50** has a headed integral extension **80** which fits loosely in the hole provided for it in member **50**. This is a desirable feature, for when a heavy overload is instantly developed, member **50** moves in response to the sudden attraction of the magnetic field and an impact is developed against pivoted member **50**. This impact is helpful in overcoming the static friction of latching portions **68** and **70**. The magnetic tripping arrangement is extremely sensitive. Counterweight **79** extending from an ear **54** guards against tripping of the breaker as a result of mechanical shock.

The combined thermal and magnetic latching assembly described is of particular interest in connection with circuit breakers of the form shown wherein the latching assembly is part of the "metallic heart" of the circuit breaker. It can be calibrated before it is assembled into the circuit breaker casing and it retains calibration despite dimensional changes in the insulating material that forms the casing. For this reason it is significant that the entire structure including the armature, the latch **68**, the pivot **58**, and the coil **60** and its core **48**, the compensating bimetal **72**, are all carried by the main current bimetal, as part of the moving contact assembly. Additionally, the moving contact assembly can be fabricated on semi-automatic or automatic machinery and these parts can then be inserted as a unit in the casing, leaving only a few other easily handled parts to be assembled for completing the circuit breaker.

While the foregoing represents a highly advantageous form of circuit breaker construction, certain variations are contemplated. Thus, it may prove desirable to mount the coil below bimetal **44**, supported on its core that is joined to member **18** at rivet **46**, and with the armature **52** extending downward at right angles to latch portion **68** of the pivoted element **50**. Another application of broad aspects of the invention includes the latching arrangement described, involving the compensating bimetal and magnetic trip, in connection with circuit breakers not having the latching assembly mounted on the moving contact.

The compensated thermal trip and magnetic trip as described in connection with Figures 1 to 4 inclusive may be modified so as to take the form in Figures 5, 6, and 7. In these figures the main current bimetal is represented by the element **44'**, the remainder of the circuit breaker of Figure 1 being essentially unchanged. A cradle **82**, welded to bimetal **44'**, pivotally supports a combined latch and armature **86**, optionally having a moving core portion **88**. Below bimetal **44'** is a coil **90** of insulated wire about a core **92** which extends through a passage in bimetal **44** to the upper side of that bimetal. Conveniently cradle **82** is of brass so as to be non-magnetic. In this way a passage is provided for the magnetic flux of electromagnet **90—92** to extend to the upper side of the bimetal so as to attract armature **86—88**. Coil **90** is electrically connected to bimetal **44'** as illustrated.

As appears in Figure 7 the portion of armature **86** to which core **88** is attached is curved downward laterally. It has a channel or recess **99** in its upper surface which receives a temperature compensating bimetal **94**, this being fixed in place by swaging the edges of the channel in member **86** so as to grip the compensating bimetal at the middle. Temperature-deflection and stiffness characteristics of bimetal **94** are related to those of bimetal **44'** in the same manner as was discussed in relation to bimetals **44** and **72**. Bimetal **94** extends out of cradle through passages **96**, and those bimetal extensions are pressed against the cradle by spring **98** that is shown in the form of a coil spring but evidently may take the form of a leaf spring or the like. Incidentally, if a leaf spring were used, core **88** could be omitted entirely and armature **86** could be disposed quite close to core member **92**. Significantly, however, a weak spring acts on latch **86** to press the latch against the short and thin compensating bimetal which in turn acts against an element **82** that may be considered a unitary part of bimetal **44'**. Actually the temperature compensating bimetal **94** might equally well be secured to cradle **82** and merely press against armature **86**. In either event bimetal **94** acts to avoid disturbing the position of latch **86**, by having its ends curve downward with rising ambient temperature which also causes the main current bimetal to deflect downward. Bimetals **44'** and **94** have their high-expansion sides facing upward so that heating causes their active ends to move downward.

It will be noted that near its free end, armature-latch **86** is offset upward. This is to provide assurance that

when latch 86 is tripped, either because of a heavy sudden current in coil 90 or because of thermal deflection of bimetal 44', and when latching portion 70' of actuating member 24' is freed so as to swing to the left in Figure 7, there will be no obstruction to that motion and the tripping operation can proceed without obstruction.

It is contemplated that the combined magnetic and thermally tripped latching assembly, and the circuit breaker including that latching assembly, may be modified by omitting the coils 60 and 90 found in the two forms illustrated. Instead, the armatures may be arranged to be attracted by the magnetic field produced about the current bimetal, advantageously augmented by a magnetic yoke or flux-concentrating channel extending about three sides of the bimetal so as to attract a movable armature on the fourth side. This involves decreased sensitivity of the magnetic trip, but this may be suitable for certain applications.

What is claimed is:

1. An automatic circuit breaker including relatively movable contacts, actuating means for closing said contacts, spring bias means operable to separate said contacts, and a latching assembly normally preventing contact separation, said assembly including a current-responsive bimetal having fixed and free ends, a latching device pivoted to the current-responsive bimetal adjacent the free end thereof, said latching device having a latching portion, and an ambient temperature responsive bimetal interposed to act between said current-responsive bimetal and said latching portion and arranged to transmit tripping pressure from the current-responsive bimetal to said latching portion only in the tripping direction, and electromagnetic means operative to draw said latch in the tripping direction and to relieve said bimetal-applied pressure.

2. An automatic circuit breaker including relatively movable contacts, actuating means for closing said contacts, spring bias means operable to separate said contacts, and a latching assembly normally preventing contact separation, said assembly including a current-responsive bimetal having fixed and free ends, a latching device pivoted to the current-responsive bimetal adjacent the free end thereof, said latching device having a latching portion, and an ambient temperature responsive bimetal interposed to act between said current-responsive bimetal and said latching portion and arranged to transmit tripping pressure from the current-responsive bimetal to said latching portion only in the tripping direction, and an electromagnet including a coil carried by said current-responsive bimetal and connected electrically in series with said current-responsive bimetal, said electromagnet being arranged to cooperate with an armature operatively connected to said latch and to transmit tripping force to said latch in the direction to relieve said bimetal-applied pressure.

3. An automatic circuit breaker including relatively movable contacts, actuating means for closing said contacts, spring bias means operable to separate said contacts, and a latching assembly normally preventing contact separation, said assembly including a latching device having a latching portion, a current-responsive bimetal having fixed and movable ends and movably supporting said latching device adjacent the free end thereof, an ambient temperature responsive bimetal interposed to act between said current responsive bimetal and said latching portion and arranged to apply tripping pressure to said latch, and electromagnetic means operative to draw said latch in the tripping direction and to relieve said bimetal-applied pressure.

4. An automatic circuit breaker including relatively movable contacts, actuating means for closing said contacts, spring bias means tending to separate said contacts, and a latching assembly normally preventing contact separation, said assembly including a latching device having a latching portion, a current-responsive bimetal having fixed and movable ends and movably supporting said latching device, an ambient temperature responsive bimetal interposed between said current responsive bimetal and said latching portion and arranged to transmit tripping pressure to said latching portion upon thermal deflection of said current responsive bimetal, and electromagnetic means including an armature constituting a portion of said latching device and a coil carried by said current responsive bimetal and series-connected thereto, said coil being in cooperative relation with said armature and operative to draw said latching device in the tripping direction and to relieve said bimetal-applied pressure.

5. An automatic circuit breaker including a fixed contact, a movable contact assembly, and manual means for operating said moving contact assembly to establish engagement with said fixed contact, said moving contact assembly including spring bias means tending to open the circuit breaker and a latching assembly normally arresting said spring biased means and thereby preventing contact separation, said latching assembly including a latching device having a latching portion, a current responsive bimetal carried by said movable contact member and supporting said movable contact member, and ambient temperature responsive bimetal interposed to act between said current responsive bimetal and said latching portion and arranged to transmit tripping pressure to said latching portion, and electromagnetic means connected in series with said current-responsive bimetal and operative to draw said latching device in the tripping direction and to relieve said bimetal-applied pressure.

6. An automatic circuit breaker including a fixed contact, a movable contact member, a manually operative linkage effective to move the movable contact member into engagement with said fixed contact, spring bias means tending to separate said contacts, and a latching assembly movable with said movable contact and normally arresting said spring biased means and thereby preventing contact separation, said assembly including a latching device having a latching portion, a current responsive bimetal having one end thereof fixed to said movable contact member and supporting said latch, an ambient temperature responsive bimetal interposed to act between said current responsive bimetal and said latching portion and arranged to transmit tripping pressure to said latching portion, and an electromagnet cooperating with said latching device to draw said latching device in the tripping direction and in the direction to relieve said bimetal-applied pressure.

7. An automatic circuit breaker including a fixed contact, a movable contact member, actuating means operative to move said movable contact member into engagement with said fixed contact, spring bias means tending to separate said contacts and a latching assembly normally preventing contact separation, said assembly including a latching device having a latching portion, a current responsive bimetal having one end thereof fixed to said movable contact member, said latching device being carried by said current-responsive bimetal adjacent the free end thereof, an ambient temperature responsive bimetal interposed to act between said current responsive bimetal and said latching portion and arranged to transmit tripping pressure to said latching portion, and electromagnetic means including a coil carried by said current responsive bimetal and cooperating with said latching device to draw the latching device in the tripping direction and in the direction to relieve said bimetal-applied pressure.

8. An automatic circuit breaker including a fixed contact and a movable contact member engageable with said fixed contact, actuating means for operating the movable contact member into engagement with said fixed contact, spring bias means tending to separate said contacts, and a latching assembly normally preventing contact separation, said assembly including a current responsive bimetal having one end fixed to said movable contact member, a

movable latch having an armature portion and pivotally carried by said current responsive bimetal, a weak spring biasing said latch in the direction opposing tripping of the latch, an ambient temperature responsive bimetal interposed between said latch and the current responsive bimetal, and an electromagnet operative to draw said armature and the latch in the tripping direction and away from bimetal-applied pressure.

9. An automatic circuit breaker including separable contacts and means to operate said contacts for opening and closing the circuit breaker, current responsive means automatically controlling the opening of said contacts including a current responsive bimetal having fixed and thermally deflected ends, a pivoted control element carried by said current-responsive bimetal at the thermally deflected end thereof, and an ambient temperature responsive bimetal acting between said current responsive bimetal and said control element to drive the element about its pivot, the low expansion side of the current-responsive bimetal facing in the direction of said drive, said current responsive bimetal being comparatively long and thick and said ambient temperature responsive bimetal being relatively short and thin.

10. An automatic circuit breaker including separable contacts and means to operate said contacts for opening and closing the circuit breaker, current responsive means automatically controlling the opening of said contacts including a current responsive bimetal, a pivoted control element, and an ambient temperature responsive bimetal carried by said current responsive bimetal and acting on said control element to drive the element about its pivot, the low expansion side of the current-responsive bimetal facing in the direction of said drive, circuit connections to said current responsive bimetal at an intermediate point and an end point thereof, said ambient temperature responsive bimetal being supported by the current responsive bimetal at a position thereof outside the region heated by current passing through the bimetal between said circuit connections, said current responsive bimetal being comparatively long and thick and said ambient temperature responsive bimetal being relatively short and thin.

11. An automatic circuit breaker including a fixed contact, a movable contact member engageable with said fixed contact, mechanism for moving said movable contact member for opening and closing the circuit breaker, and means for automatically controlling the opening of the circuit breaker including a comparatively long and thick current responsive bimetal having one end thereof secured to said movable contact member, a comparatively short and thin ambient temperature responsive bimetal carried by said current responsive bimetal at a point remote from the secured end of the current responsive bimetal, and a circuit connection to an intermediate point of said current responsive bimetal, heating caused by current through the current responsive bimetal from said circuit connection to said movable contact member being developed in a region physically spaced away from the ambient temperature compensating bimetal also carried by current responsive bimetal.

12. An automatic circuit breaker including relatively movable contacts, actuating means for closing said contacts, spring bias means tending to separate said contacts, and a latching assembly normally preventing contact separation, said assembly including a latch, a comparatively long and thick current-responsive bimetal having a fixed end and a thermally deflected end, said current-responsive bimetal carrying said latch adjacent the thermally deflected end thereof, a comparatively short and thin ambient temperature responsive bimetal interposed to act between said current responsive bimetal and said latch and arranged to transmit tripping pressure to the latch, and electromagnetic means operative to draw said latch in the tripping direction and to relieve said bimetal-applied pressure.

13. An automatic circuit breaker including relatively movable contacts, one of said contacts being carried by a movable contact member, actuating means for opening and closing the circuit breaker, and control means for automatic opening of the contacts, said control means including a control element, a comparatively long and thick current responsive bimetal joined at one end to said movable contact member, a comparatively short and thin ambient temperature responsive bimetal interposed to act between said current responsive bimetal and the control element and arranged to transmit tripping pressure from the current responsive bimetal to the control element, and electromagnetic means including an armature carried by said movable contact member, said armature being operative to draw said control element in the tripping direction and to relieve pressure transmitted by said ambient temperature responsive bimetal.

14. An automatic circuit breaker including relatively movable contacts, one of said contacts being carried by a movable contact member, actuating means for opening and closing the circuit breaker, and control means for automatic opening of the contacts, said control means including a control element, a comparatively long and thick current responsive bimetal joined at one end to said movable contact member, a comparatively short and thin ambient temperature responsive bimetal carried by said current responsive bimetal and acting between said current responsive bimetal and the control element and arranged to transmit tripping pressure from the current responsive bimetal to the control element, and electromagnetic means including an armature carried by said movable contact member, said armature being operative to draw said control element in the tripping direction and to relieve pressure transmitted by said ambient temperature responsive bimetal.

15. An automatic circuit breaker including relatively movable contacts, one of said contacts being carried by a movable contact member, actuating means for opening and closing the circuit breaker, and control means for automatic opening of the contacts, said control means including a control element, a comparatively long and thick current responsive bimetal joined at one end to said movable contact member, a comparatively short and thin ambient temperature responsive bimetal interposed to act between said current responsive bimetal and the control element and arranged to transmit tripping pressure from the current responsive bimetal to the control element, and electromagnetic means including an armature carried by said movable contact member, said armature being operative to draw said control element in the tripping direction and to relieve pressure transmitted by said ambient temperature responsive bimetal, and a coil carried by said current responsive bimetal and cooperating with said armature.

16. An automatic circuit breaker including relatively movable contacts, one of said contacts being carried by a movable contact member, actuating means for opening and closing the circuit breaker, and control means for automatic opening of the contacts, said control means including a control element, a comparatively long and thick current responsive bimetal joined at one end to said movable contact member, a comparatively short and thin ambient temperature responsive bimetal interposed to act between said current responsive bimetal and the control element and arranged to transmit tripping pressure from the current responsive bimetal to the control element, and electromagnetic means including an armature carried by said movable contact member, said armature being operative to draw said control element in the tripping direction and to relieve pressure transmitted by said ambient temperature responsive bimetal, and a coil carried by said current responsive bimetal and cooperating with said armature, said ambient temperature responsive bimetal and sail coil being disposed at opposite sides of said armature.

17. An automatic circuit breaker including relatively

movable contacts, one of said contacts being carried by a movable contact member, actuating means for opening and closing the circuit breaker, and control means for automatic opening of the contacts, said control means including a control element, a current responsive bimetal joined at one end to said movable contact member, an ambient temperature responsive bimetal interposed to act between said current responsive bimetal and the control element and arranged to transmit tripping pressure from the current responsive bimetal to the control element, and electromagnetic means including an armature carried by said movable contact member, said armature being arranged to draw said control element in the tripping direction and to relieve pressure transmitted by said ambient temperature responsive bimetal.

18. An automatic circuit breaker including relatively movable contacts, one of said contacts being carried by a movable contact member, actuating means for opening and closing the circuit breaker, and control means for automatic opening of the contacts, said control means including a control element, a current responsive bimetal joined at one end to said movable contact member, an ambient temperature responsive bimetal interposed to act between said current responsive bimetal and the control element and arranged to transmit tripping pressure from the current responsive bimetal to the control element, and electromagnetic means including an armature carried by said movable contact member, said armature being arranged to draw said control element in the tripping direction and to relieve pressure transmitted by said ambient temperature responsive bimetal, and a coil carried by said current responsive bimetal and cooperating with said armature, said ambient temperature responsive bimetal and said coil being disposed at opposite sides of said armature.

19. An automatic circuit breaker including separable contacts and means to operate said contacts for opening and closing the circuit breaker, current-responsive means automatically controlling the opening of said contacts, said current-responsive means including a current-responsive bimetal having a fixed end and a thermally deflected end, a pivoted control element carried by said current-responsive bimetal adjacent the thermally deflected end thereof, an ambient temperature responsive bimetal for acting between said pivoted control element and the current-responsive bimetal to adjust their relationship so as to compensate for the deflection of the current responsive bimetal due to temperature variations, and electromagnetic current responsive means including an armature carried by said pivoted control element and operable in the tripping direction independent of the deflection of the thermally deflected end of said current-responsive bimetal.

20. An automatic circuit breaker including separable contacts and means to operate said contacts for opening and closing the circuit breaker, current-responsive means automatically controlling the opening of said contacts, said current-responsive means including a current-responsive bimetal having a fixed end and a thermally deflected end, and a control element normally effective to hold the circuit breaker closed and to release the circuit breaker upon occurrence of abnormal conditions, said control element being pivoted to said current-responsive bimetal adjacent the thermally deflected end thereof, said pivoted control element carrying a magnetic armature, an ambient temperature compensating bimetal having a portion thereof fixed in relation to said armature and effective to adjust said control element about its pivot for compensating for the effects of ambient temperature variations on said current-responsive bimetal, and electromagnetic means cooperating with said armature to rock the control element about its pivot independent of deflection of the thermally deflected end of the current-responsive bimetal.

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