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TEMPERATURE COMPENSATED CIRCUIT BREAKERS

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Fig. 1.

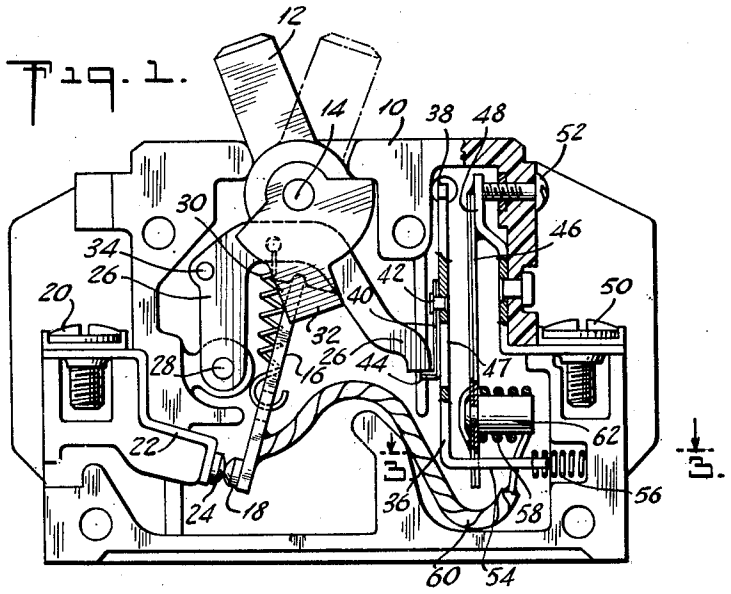


Fig. 2.

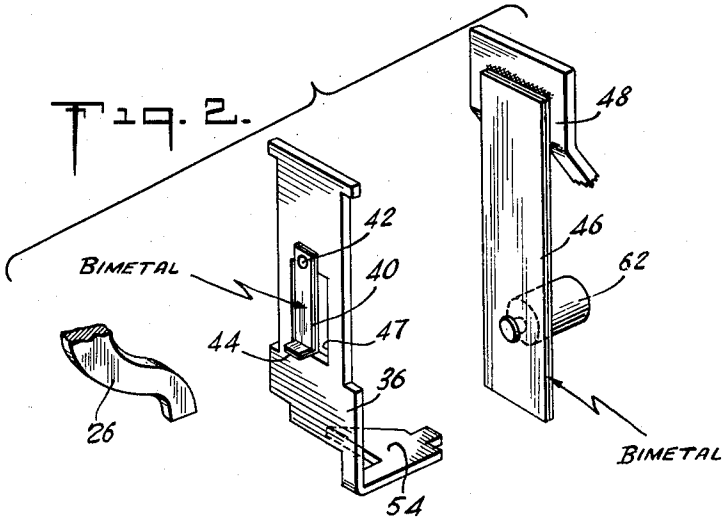
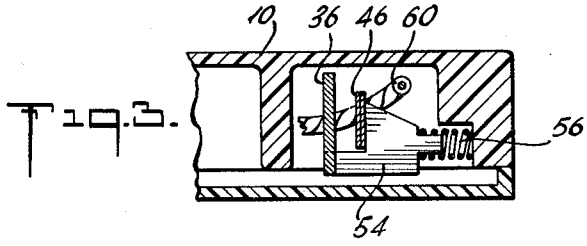


Fig. 3.



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TEMPERATURE COMPENSATED CIRCUIT BREAKERS

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The present invention relates to circuit breakers. A particular aspect of this invention relates to compensation for ambient temperature variations in circuit breakers incorporating both bimetal and electromagnetic tripping.

Circuit breakers are known in which contacts, latched closed under normal conditions, are released to be driven apart by spring action when a current overload occurs in the protected circuit. Overload release occurs in response to delayed deflection of a bimetal where the overload is one that is just marginally above the trip rating of the circuit breaker; and tripping is also caused to occur in response to a current burst of very short duration which exceeds by many times the trip rating of the circuit breaker. The latter is effected by an electromagnet. Both thermal and magnetic tripping mechanisms have long been incorporated in circuit breakers.

It is sometimes considered important that the magnetic tripping level shall be constant regardless of the adjustment of the bimetal and regardless of the moderate deflection of the current responsive bimetal carrying normal current at any given time. Quite separately, it is known that changes in ambient temperature which cause unintentional deflection of the current responsive bimetal can be compensated through the use of an ambient temperature responsive bimetal operating in reverse to the current-responsive bimetal, both responding to ambient temperature variations.

An object of the present invention is to make available a circuit breaker having a tripping mechanism that is compensated for ambient temperature variations while at the same time preserving a constant magnetic air gap in a tripping mechanism having both magnetic and thermal tripping arrangements.

A further object of the invention is to incorporate an ambient temperature compensating bimetal as a latching element largely under tension and in such fashion as to inherently minimize tripping friction.

Further objects and advantages of the invention and further features of novelty will be apparent from the detailed disclosure of a presently preferred illustrative embodiment that follows below. In this preferred embodiment, a typical design of circuit breaker is shown for illustrative purposes which includes a releasable member that is normally latched by a current responsive tripping mechanism. The illustrative tripping mechanism includes an ambient temperature compensating bimetal that is the latch for the releasable member. The compensating bimetal is carried by a pivoted armature. A current responsive bimetal is arranged to act as an electromagnet or to bear an electromagnet so as to operate the armature in a tripping direction in response to current excesses; and the current responsive bimetal inherently is deflected in the same direction, with some delay, by circuit breaker current. Increases in ambient temperature cause substantially equal and opposite deflections of both bimetals. The armature is coupled to the moving end of the current-responsive bimetal in such fashion as to be moved positively by the current responsive bimetal in the tripping direction and to be spring-biased against the bimetal in the reverse direction.

When the ambient temperature changes, the current responsive bimetal is inherently deflected in the tripping direction and it carries the armature with it. The engagement of the releasable member by ambient temperature compensating bimetal is substantially unaffected by such deflection because, even though the armature is carried with the current responsive bimetal, the temperature compensating bimetal deflects equally and oppositively, in the case of 100% compensation. Latching of the releasable mechanism, as measured by the extent of overlap of the bimetal latch and the releasable member, remains constant due to ambient temperature compensation; and the magnetic gap also remains constant, independent of ambient temperature compensation. It should be understood that a degree of compensation less than 100% may be desirable as a manufacturing objective, in order to avoid over-compensation.

The invention will be more fully appreciated from the following detailed disclosure in which reference is made to the accompanying drawings of an illustrative embodiment of the invention. In the accompanying drawings:

FIG. 1 is a lateral view of a circuit breaker embodying the various features of the invention, a cover of the two-part casing being removed to reveal the mechanism contained therein;

FIG. 2 is a fragmentary exploded view of portions of the tripping mechanism in the circuit breaker of FIG. 1; and

FIG. 3 is a fragmentary cross-section along the line 3—3 of FIG. 1.

Referring now to the drawings, there is shown a casing of typical design formed in two parts divided parallel to the view. Casing part 10 appears in the drawing; a companion part of the casing has been omitted to expose the operating mechanism. Handle 12 for circuit breaker actuator is formed of insulating material, pivoted at 14 in the two part casing. Handle 12 has a downward depending portion forming a seat for movable contact member 16 which carries a contact 18 at its lower extremity. Terminal 20 at the left end of casing 10 in the drawing has a metal strip 22 which carries stationary contact 24 to coact with contact 18.

A releasable member 26 is pivoted at point 28 in the casing, this part 26 commonly being called a "cradle". Over the center spring 30 engages cradle 26 at its upper end, at a point above the pivot end of contact arm 16; and spring 30 engages contact arm 16 at its lower end, spring 30 operating in tension to hold contact arm 16 against the seat formed in handle 12. An arm 32 is provided on handle 12 for engaging pin 34 etxending laterally from cradle 26 for resetting this cradle in the event that the circuit breaker is tripped by an overload and the cradle is released by the tripping mechanism, as will seen from the following description of that tripping mechanism.

The operation of the circuit breaker thus far described is as follows:

Handle 12 shown in its solid position and cradle 26 in the position shown are effective through control spring 30 to bias contact arm 16 into the closed condition of the circuit breaker shown. When handle 12 is operated reversely into the dotted line position in the drawing, the seat of contact arm 16 is shifted across the line of action of tension spring 30 and after that point further shifting of this contact arm seat causes spring 30 to snap the contacts apart. Reverse actuation of contact arms 16 occurs through reverse operation of handle 12, to snap the contacts closed.

With the contacts closed as illustrated, release of the right hand end of cradle or releasable member 26 allows spring 30 to swing that member 26 clockwise about its pivot 28, thereby to shift spring 30 across the seat of contact arm 16. After this point is passed, spring 30 acts, as before, to drive moving contact 18 away from fixed contact 24.

In order to reclose the circuit breaker it is necessary first to relatch cradle 26, to assume the latched position illustrated. This is effected by operating handle 12 in the resetting direction, that is, in the "Off" direction so as to drive extension 32 of the handle against pin 34 of the cradle and thus operate cradle 26 counterclockwise until it is relatched.

The latching mechanism of the circuit breaker now to be described is effective to control the circuit breaker thus far described latching cradle 26 as shown and automatically releasing cradle 26 in response to overload currents. The latching mechanism will be recognized as effective with many other types of circuit breakers employing different contact-operating mechanisms.

A member 36 of soft iron is pivoted in recesses 38 in the casing. Member 36 has secured thereto an ambient temperature compensating bimetal 40 riveted at 42 so as to be tensioned by engagement of cradle 26 with the lower hooked portion 44 of that bimetal. Cradle 26 engages the rolled, smooth surface of bimetal 40 and not a ragged cut edge, thereby minimizing the friction and the variation of friction of a cut edge that is formed in some latch arrangements. Member 36 has a hole 47 formed therein so as to allow ambient temperature compensating bimetal 40 to deflect both to the right and to the left of the position shown. Also, by mounting bimetal 40 at the left hand side of the member 36, greater thermal isolation from the current responsive bimetal 46 is realized than would be the case if compensating bimetal 40 were mounted on the other face of element 36.

Current responsive bimetal 46 is suitably united to a fixed terminal strip 48 at the upper extremity of these parts. Terminal strip 48 extends to external terminal 50 at the end of the circuit breaker opposite terminal 20. An adjustment screw 52 operates in compression against the joint of parts 46 and 48, to adjust bimetal 46 properly in relation to the latch portion of cradle 26.

The current path from terminal 50 to bimetal 46 extends further through a coil 58 and through flexible braid 60 to moving contact arm 16 and contacts 18 and 24 of the mechanism previously described, to opposite terminal 20. Coil 58 extends about core 62 so as to constitute an electromagnet. That portion of iron member 36 opposite core 62 functions as the armature of this electromagnet. The lower end of temperature responsive bimetal 46 is engaged at its right hand face in FIG. 1 by a hook 54 that is formed at the lower extremity of member 36, and compression spring 56 holds hook 54 against the bimetal in the configuration shown. It is apparent that, as screw 52 is operated to adjust bimetal 46, the spacing between the armature portion of member 36 and electromagnet 58, 62 remains constant. During this adjustment, ambient temperature compensating bimetal 40 is adjusted in proper latching relation to releasable member 26. After the adjustment of bimetal 46 has been completed and member 26 is properly latched for release when current of the proper level flows through bimetal 46, the circuit breaker is in adjustment. Current is passed through bimetal 46 and coil 50, with the circuit breaker closed, and this causes bimetal 46 to curve and its lower end deflects to the right in the drawing. This carries member 36 to the right correspondingly, and it also shifts ambient bimetal 40 to the right. When the latch end 44 of bimetal 40 frees element 26, the circuit breaker trips open.

That the element 44 which engages cradle 26 is formed of bent strip stock is of significant manufacturing and operational advantage, because the rolled side face of that piece of bimetal strip stock is consistently smooth in contrast to other types of latching elements formed with the cut edges for latching frictional engagement with a releasable part.

When the current carried by member 46 rises to a point below the tripping level and thereafter decreases, bimetal 46 moves to some deflected position to the right of that shown in the drawing and then returns leftward; and when this occurs spring 56 biases member 36 so as to keep hook 54 in engagement with the right hand surface of member 46 and at the same time to slide hook 54 of bimetal 40 leftward along the lower latching surface of member 26. In this operation it is apparent that the magnetic gap between electromagnet 58, 62 and its armature 36 remains constant.

Apart from all question of current that may be carried by bimetal 46, this bimetal may deflect to the right with temperature increases, and like reasoning will apply also to reverse deflection with temperature decreases. When a rise in ambient temperature causes deflection of the lower end of bimetal 46 to the right, armature 36 is carried with it to maintain a constant air gap; but bimetal 40 deflects reversely and to an equal extent so as to maintain the latch engagement of hook portion 44 with cradle 26 unchanged. The extent of this latching engagement may be of the order of 0.050 inch. This is the same order of magnitude as the deflection of bimetal 46 as well as bimetal 40 through the ordinary range of ambient temperature variations to be expected in varied application of such a circuit breaker.

The arrangement shown evidently achieves temperature compensation for a tripping mechanism wherein thermal and magnetic tripping are provided, and where the thermal compensation in no way disturbs the constant air gap. This latter feature, it should be noted, means that sudden current bursts which might trip the circuit breaker magnetically will be effective with equal sensitivity regardless of the condition of the ambient temperature responsive bimetal, or of the current responsive bimetal as affected by the current that it may be carrying and as affected by the ambient temperature that prevails. The circuit breaker and tripping mechanism described are naturally susceptible to a wide variety of detailed changes, as will be evident to those skilled in the art. Thus, while an electromagnet 58, 60 is shown in the form of a separate coil and core, a simple U-shaped core might be attached to the right hand face of bimetal 46 with the legs of the "U" projecting toward member 36 at the left. Such substituted electromagnet would be effective because bimetal 46 would then constitute a half-turn electromagnet with a U shaped core, as is well known. The electromagnet shown is of course much more sensitive and will respond to much lower currents than the alternative half-turn electromagnet suggested above.

It may be noted that the arrangement illustrated embodies a current path which is in parallel to coil 58. Bimetal 46 which engages hook 54 establishes an electrical path through member 36 and cradle 26, through spring 30 to contact member 16, which is a current path that parallels coil 58, 60. However, the numerous high resistance mechanical contacts included in that path add to such high resistance in comparison to that of coil 58 that the shunt path is of little interest or concern. However, if this were considered objectionable, hook 54 may readily be insulated from bimetal 46.

Further variations in detail and varied application of the invention described above will occur to those skilled in the art. Accordingly it is appropriate that the present invention should be broadly construed, consistent with the spirit and scope thereof.

What is claimed is:

1. A circuit breaker including a fixed contact and a movable contact, actuating means for the movable contact including a spring and a releasable member for opening said contacts upon occurrence of an abnormal condition, and a trip mechanism normally preventing such contact opening, said trip mechanism including a movable magnetic armature, an ambient temperature compensating bimetal carried by said armature and normally in latching engagement with said releasable member, a rigidly mounted current responsive bimetal, electromagnetic means carried by said current-responsive bimetal at a portion thereof that deflects in response to

heating and a one way mechanical driving connection between said current responsive bimetal and said armature to move the armature with said current-responsive bimetal in the tripping direction and to allow said armature to move independently in the tripping direction, whereby changes in ambient temperature causing deflection of said current-responsive bimetal are largely ineffective to change the extent of said latching engagement and of the magnetic air gap between said armature and said electromagnetic means.

2. A circuit breaker including fixed and movable contacts, actuating means for the movable contact including a spring and a releasable member for opening said contacts and a trip mechanism normally preventing such contact opening, said trip mechanism including a current responsive bimetal and an ambient temperature compensating bimetal having a one-way driving mechanical connection to each other and arranged normally to latch said releasable member, and an electromagnet and armature interposed in said connection between said bimetals said electromagnet being arranged to move with the thermally deflected portion of the current responsive bimetal, said mechanical connection including constant means to fix the maximum separation between said armature and said electromagnet, so that ambient temperature variations do not substantially disturb either the latching of the releasable member or the gap of the electromagnet.

3. A circuit breaker including a fixed contact and a movable contact, actuating means for the movable contact including a spring and a releasable member for opening said contacts and a trip mechanism normally preventing such contact opening, said trip mechanism including a current-responsive bimetal and an ambient temperature compensating bimetal having a one-way driving mechanical connection therebetween, one of said bimetals constituting a latch for said releasable member, the other of said bimetals having a fixed support, and an electromagnet and armature both mounted for movement together with the thermally moved end of one of said bimetals and interposed to act between said bimetals, said mechanical connection including means to fix the maximum spacing between said armature and said electromagnet.

4. In a circuit breaker, a releasable member and a latching mechanism therefor, said latching mechanism including a bimetal rigidly mounted at one end thereof and having connections thereto for carrying the circuit breaker current, an armature coacting with a movable part of said bimetal to move positively therewith in the tripping direction and yieldably movable relative to the bimetal to cause tripping independent of bimetal deflection, an electromagnet carried by said movable part of said current-responsive bimetal, and an ambient temperature responsive bimetal having a hooked portion at one end engaged by said releasable member and secured at the opposite end thereof to said armature.

5. In a circuit breaker, a releasable member and a latching mechanism therefor, said latching mechanism including a bimetal rigidly mounted at one end thereof and having connections thereto for carrying the circuit breaker current, an armature member disposed opposite to and coacting with a movable part of said bimetal to move positively therewith in the tripping direction and yieldably movable relative to the bimetal to cause magnetic tripping independent of bimetal deflection, means forming an electromagnet at said movable part of said current-responsive bimetal, and an ambient temperature responsive bimetal having two portions that are movable relative to each other in response to ambient temperature changes, one of said portions being fastened to one of said members for movement therewith and the other of said portions being latched to the other of said members.

6. In a circuit breaker, a releasable member and a latching mechanism therefor, including a bimetal rigidly mounted at one end thereof and connections thereto for carrying the circuit breaker current, an armature coacting with a movable part of said bimetal to move positively therewith in the tripping direction and yieldably movable relative to the bimetal to cause tripping, independent of bimetal deflection, an electromagnet carried by said movable part of said current-responsive bimetal, and an ambient temperature responsive bimetal having one end joined to said armature and having a laterally extending portion engaged by said releasable member so as to tension said ambient temperature responsive bimetal in the latched condition of the circuit breaker.

7. In a circuit breaker, a releasable member and a latching mechanism therefor, said latching mechanism including a bimetal rigidly mounted at one end thereof and having connections thereto for carrying the circuit breaker current, an armature coacting with a movable part of said bimetal to move positively therewith in the tripping direction and yieldably movable relative to the bimetal to cause tripping, independent of bimetal deflection, an electromagnet carried by said movable part of said current-responsive bimetal, an ambient temperature responsive bimetal supported as a longitudinally tensioned latch between said armature and releasable member.

8. In a circuit breaker, a releasable member and a latching mechanism therefor, said latching mechanism including a current responsive bimetal and an ambient temperature compensating bimetal having a one-way driving mechanical connection to each other and arranged to latch releasable member, and an electromagnet and armature mounted movably and united with movable portions of said bimetals respectively and interposed in said connection between said bimetals, said mechanical connection including constant means to fix the maximum separation between said armature and said electromagnet, so that ambient temperature variations do not substantially disturb either the latching of the releasable member or the gap of the electromagnet.

9. In a circuit breaker, a releasable member and a latching mechanism therefor, said mechanism including a current-responsive bimetal and an ambient temperature compensating bimetal mechanically connected together to latch said releasable member, and a fixed-gap electromagnet and armature interposed between said bimetals with the compensating bimetal in engagement with said releasable member and carried by said armature and with said electromagnet carried by a thermally deflected portion of said current-responsive bimetal, said electromagnet and armature having means limiting their separation, so that ambient temperature variations do not substantially disturb either the latching of the releasable member or the gap of the electromagnet.

10. In a circuit breaker, a releasable member spring-biased in a tripping direction and a latching mechanism therefor, said latching mechanism including a bimetal rigidly mounted at one end thereof, a pivoted magnetic armature coacting with a movable part of said bimetal to move positively therewith in the tripping direction, and an ambient temperature responsive bimetal tensioned between said pivoted magnetic armature and releasable member.

11. A circuit breaker including a fixed contact and a movable contact, actuating means for the movable contact including a spring and a releasable member for opening said contacts upon occurrence of an abnormal condition, and a trip mechanism normally preventing such contact opening, said trip mechanism including a movable magnetic armature, an ambient temperature compensating bimetal carried by said armature and normally in latching engagement with said releasable member, a current-responsive bimetal having a fixed end and a thermally deflected end, an electromagnet core carried by said current-responsive bimetal at a thermally deflected portion thereof and having a one-way mechanical driving connection to said armature to limit the maximum spacing between said electromagnet core and said armature

and to move the armature with the current-responsive bimetal in the tripping direction upon thermal deflection thereof and said mechanical connection being arranged to allow said armature to move independently of the current-responsive bimetal in the tripping direction upon actuation of said armature toward the electromagnet core, whereby changes in ambient temperature causing deflection of said current-responsive bimetal are largely ineffective to change the extent of said latching engagement and of the magnetic air gap between said armature and said electromagnet core.

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