Aug. 12, 1958 P. M. CHRISTENSEN ET AL 2,847,532

CIRCUIT BREAKERS

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Fig. 1.

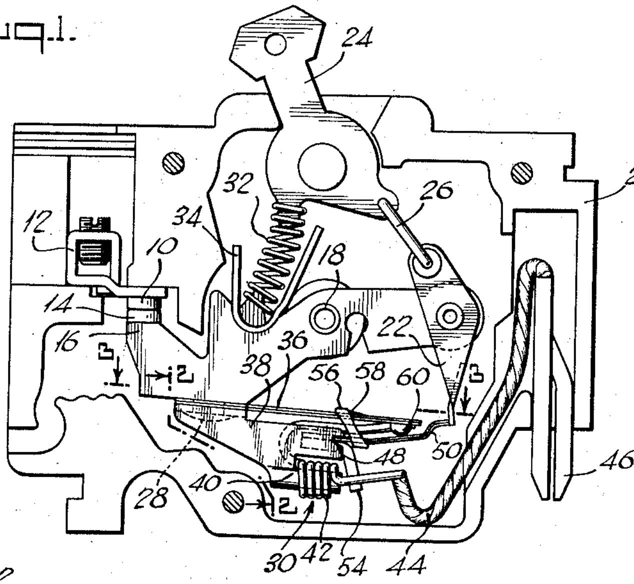


Fig. 2.

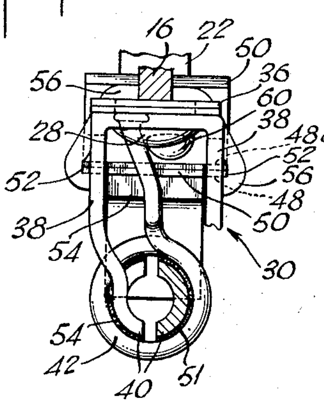


Fig. 3.

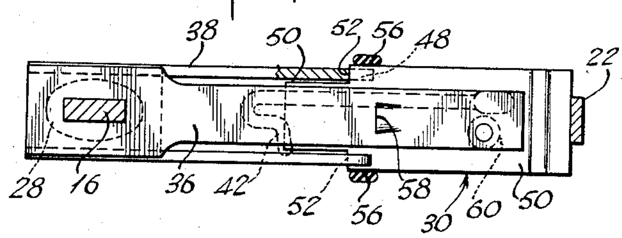
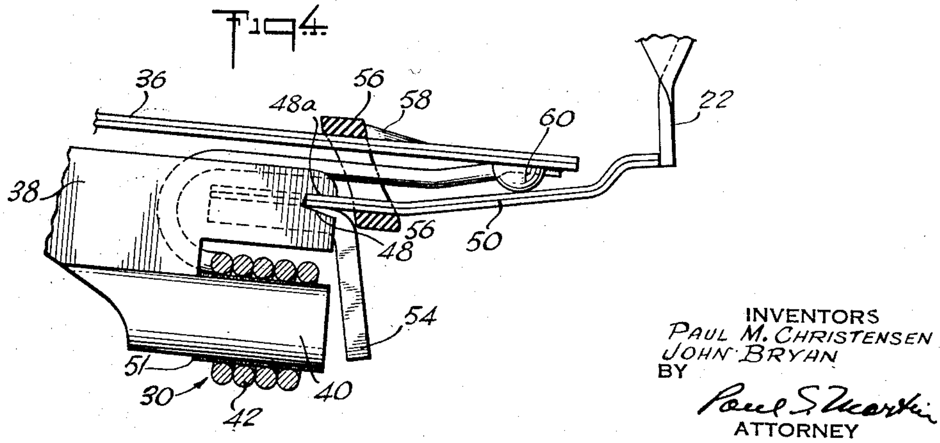


Fig. 4.



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CIRCUIT BREAKERS

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6 Claims. (Cl. 200—88)

This application relates to automatic circuit breakers and in particular it relates to circuit breakers having provision for thermal tripping, magnetic tripping, and compensation for variations in ambient temperature.

In application, Serial No. 590,684, filed concurrently herewith by Paul M. Christensen, there is disclosed a circuit breaker having a combined latch and armature that has a pivot at a position closely adjacent but separated from a current-responsive bimetal. This combined latch and armature unit has a shoulder which is rockably received in a notch, forming a readily separable pivot. The combined armature and latch unit is firmly pressed against the bottom of the notch by the circuit-breaker-opening mechanism which the latch arrests or, in the case of an overload, which the latch releases. In order that the latch may remain physically assembled between the time that the circuit breaker is tripped and until it is reset, and in addition, in order that the latch may be returned to the position in which it obstructs the releasable element of the circuit breaker opening mechanism, spring bias means is required. Two separate functions are to be accomplished, namely: The biasing of the latch in the direction to prevent release of the circuit breaker and the biasing of the latch in its seat.

An object of the present invention is to provide a combined thermal and magnetic latch assembly for circuit breakers having novel, effective biasing means for holding the latch in the assembly, and for biasing the latch toward its circuit-breaker-latching position. A further object is to provide such apparatus of a form to be readily manufacturable.

In carrying out the foregoing objects, and in achieving further advantages and features of the present invention, the illustrative embodiment of the invention detailed below has been provided. This embodiment has a current-responsive bimetal electrically connected in series with a coil which, with a magnetic core structure, forms an electromagnet. The core structure and the bimetal are united at a common point, forming part of the electrical circuit through the bimetal. The latch is formed of a bimetal for compensating for the effects of ambient temperature on current-responsive bimetal. The current-responsive bimetal bears laterally against the latch member to produce latch-releasing deflection in response to thermal over load currents. The latch pivot to the core structure causes the latch to operate at the same potential as the fixed end of the bimetal. An insulating element is interposed between the free, movable end of the current-responsive bimetal and the latch member to avoid forming an electrical path through the latch member and its support, which electrical path would shunt the path through the current-responsive bimetal. Normally, there is only a very small voltage drop in the current-responsive bimetal, but it is nevertheless important to avoid such shunt path. For one reason, the shunt path resistance is likely to be erratic, and would prevent the circuit breaker from tripping consistently at its rated thermal current level. Furthermore, in the event of a short circuit in the protected load, virtually the full voltage of the source is momentarily impressed on the bimetal. It is important that such voltage shall not be developed in any circuit involving the latch pivot which, in the event of a sort circuit, might weld.

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An insulating tensioner is provided in the illustrative embodiment between the latch-and-armature unit and the current-responsive bimetal; and this tensioner is disposed to apply two components of force, one toward the pivot seat of the latch member and the other toward the current-responsive bimetal. More specifically, a band of silicone rubber encircles the latch member and the bimetal and engages longitudinally offset abutments on the latch member and the bimetal to produce the dual tensions described. The silicone rubber is an insulator and thus meets the requirement that there be no shunt path formed by the tensioner to a part of the current-responsive bimetal. The band, when extended in all directions, may be readily slipped over both the latch and the current-responsive bimetal and then allowed to snap into place. Thus, during assembly, the latch and the tensioner of the latch may both be moved along the current-responsive bimetal, moving from the free end of that bimetal towards its fixed support. This simplicity of assembly of the novel construction is an important factor in the practicality of the construction. The silicone rubber is of long life and of stable characteristics despite occasional high operating temperatures of the bimetal. Furthermore, the band may be disposed quite close to the very pivot of the latch and consequently it may be quite a strong element without producing an excessive moment of force that must be overcome by the current-responsive bimetal or by the electromagnet in the circuit breaker for tripping the circuit breaker.

The nature of the invention and its further novel features will be better appreciated from the following detailed disclosure thereof. The illustrative embodiment is shown in the accompanying drawings, forming part of this disclosure, wherein:

Fig. 1 is a side view of an assembled circuit breaker with one part of a two-part enclosure of insulation removed to reveal the internal construction;

Fig. 2 is a fragmentary end view of certain parts in Fig. 1 viewed from the line 2—2;

Fig. 3 is a fragmentary cross-section along the line 3—3 in Fig. 1; and

Fig. 4 is an enlarged portion of Fig. 1.

Referring now to the drawings there is shown in Fig. 1 a circuit breaker assembly including a fixed contact **10** carried by one terminal member **12** and a movable contact member **14** carried by movable contact arm **16**. Contact arm **16** is pivoted on a helical spring **18** whose axis extends perpendicular to the drawing and whose ends are received in recesses in the side walls of the two-part enclosure, only one part **20** being shown in the drawing. A metal actuator **22** has a metallic pivotal connection to the right-hand extremity of moving contact arm **16**. That a metal pivot rather than an insulated pivot may be employed at this point is significant because it facilitates the problem of holding close tolerance at this relatively critical part of the mechanism. A handle **24** of insulation is pivoted in the side walls of the insulated housing and is connected by a link **26** to operate actuator **22**. Member **26** is U-shaped with one leg (perpendicular to the drawing) received in a hole in handle **24** and the other leg of the U being received in a bearing in actuator **22**.

Moving contact arm **16** has a downward extension formed as a rivet **28** to unite latching assembly **30** to the moving contact arm, in position normally to obstruct and thereby to latch actuator **22**.

A spring **32** is held in compression between handle **24** and moving contact arm **16**. Contacts **10** and **14** are shown closed, and handle **24** is in the "closed" position. If handle **24** is operated clockwise from the position shown, the handle shifts link **26** so that the link and actuator **22** (which constitute a toggle) tend to swing actuator **22** counterclockwise and to allow spring **32** to drive moving contact arm **16** counterclockwise. When this occurs, assuming handle **24** is retarded, spring **32** is also effective to drive the handle clockwise all the way to its "off" position in readiness for renewed closing of the circuit breaker.

When handle **24** is operated in the counterclockwise direction (Fig. 1) from its "off" position, link **26** drives actuator **22** against the end of the latching assembly **30** to be arrested there. Further counterclockwise operation of the handle drives the moving contact arm **16** into contacts-closed position. Spring **18** allows the relatively rigid members **24**, **20**, **26** and **16** to complete their operation into "on" configuration even though moving contact **14** engages fixed contact **10** shortly before the handle completes its "on" stroke. V-shaped member **34** coacts with casing formations and with springs **18** and **32** to first arrest contact arm **16** and then release it for contact-closing with "snap" action.

Latch assembly **30** includes a current-responsive bimetal **36** secured by integral rivet **28** to moving contact arm **16** mechanically and electrically. This integral rivet also secures a magnetic core structure **38** fixedly to moving contact arm **16**.

Member **38** has a connecting portion through which rivet **28** extends (Fig. 2) and a pair of side walls extending therefrom to incorporate a two-part curved core **40** about which a coil **42** as of copper wire is wound. One terminal of this coil is welded to the right-hand extremity of current-responsive bimetal **36** while the other terminal of the coil is joined to flexible copper braid **44** for connection to external terminal **46**.

The side walls of magnetic structure **38** have notches **48** formed therein, opening toward actuator **22** pivotally or rockably supporting a latch member **50** by virtue of the shoulders **52** thereof. Armature **54** is united to the left-hand extremity of latch member **50**. As shown in Fig. 4, this latch member has one arm which substantially occupies the space between the side walls of magnetic member **38** in the region of notches **48**, this arm moving laterally along those magnetic side walls when coil **30** is appropriately energized. Armature **54** also has an arm extending downward and opposite the end of core **40**. It is evident that a highly efficient magnetic circuit is formed of core **40** and the side walls of magnetic structure **38** which embrace the first-mentioned arm of armature **54**. Consequently the current that flows through the circuit breaker energizes coil **40** and exerts a comparatively strong attraction for armature **54**, and this in turn produces a tripping force exerted clockwise to swing latch member **50** out of the path of actuator **22** when the predetermined level of magnetic-tripping current flows.

Members **50** and **54** which are secured together as a combined latch-and-armature unit, are biased to the left and counterclockwise in Fig. 4 by a band **56** that is of insulation and acts as a spring. A lance **58** projects upward from bimetal **36** to prevent the upper part of band **56** from sliding to the right (Fig. 1) on the bimetal. Armature **54** is a corresponding formation on latch-and-armature unit **50—54** that prevents the lower part of band **56** from shifting to the left (Fig. 1). In this way band **56** retains assembly **50—54** into its supporting notches **48**, and band **56** also biases latch **50** in the reset or latching direction, that is, in the direction for operative engagement with bimetal **36**.

In the extreme counterclockwise position of member **50** as illustrated, it bears against a button **60** of insulation carried by current-responsive bimetal **36**. Core **40** is coated with insulation **51**, and, as noted, band **56** is of insulation. Thus, the coil **42** and the movable end of bimetal **36** are insulated from core structure **38** that is united electrically to the contact arm **16** and is therefore at the same potential as the fixed end of bimetal **36**.

The operation of the above tripping mechanism may now be described. Current flowing from one terminal **46** and braid **44** through coil **42** travels along current-responsive bimetal **36**, to moving contact arm **16**, through contacts **14** and **10**, to opposite terminal **12**. For small levels of current, the current-responsive bimetal **36** deflects downward only slightly, and the magnetic field produced by coil **42** and core **40** is inadequate to cause tripping. Before tripping can occur, latch **50** must be pressed down through a sufficient distance to clear actuator **22**. Bimetal **36** is required to overcome the latch friction of latch **50** wiping across the latching end of actuator **22**, this deflecting force requiring a much lower order of strength or stiffness than would be required of it if it were also to resist the endwise force applied by actuator **22** against the end of latch **50**. Because only a low order of deflecting force is needed bimetal **36** can be made of relatively slender proportions so that its resistance can be relatively high and consequently tripping heat can be developed in response to low values of rated tripping current. In other words high thermal sensitivity can be realized.

When the current rises to a sufficient level, and for a sufficient period of time for the bimetal temperature to rise and cause sufficient deflection, thermal tripping takes place. Button **60** of insulation pushes latch **50** down out of the path of actuator **22**. The latter swings clockwise quickly and spring **32** is then enabled to drive contact arm counter-clockwise. If handle **24** is not held, it is also returned to "off" position at this time by spring **32**. The linkage **26**, **22** is then in condition for renewed closing of the circuit breaker. If handle **24** is later released, spring **32** effects resetting of the circuit breaker in condition for reclosing.

Thermal tripping requires some short delay-time during which the current-responsive bimetal is heated by the current through the circuit breaker. Magnetic tripping involves no such delay, but magnetic tripping is commonly desired to operate at a level of 6 to 10 times the thermal tripping level in order that the circuit breaker shall not open in response to safe surge currents such as the in-rush current of a cold tungsten lamp load, which, when heated, draws a much lower operating current. In order to achieve magnetic tripping of 6 to 10 times the thermal trip rating, especially for small values of rated current, the present circuit breaker construction provides excellent sensitivity without an undue, massive number of turns in coil **42**. Low mass is important for a minimum of inertia of parts carried by the moving contact arm, such inertia having a retarding effect on opening of the contacts after tripping occurs.

When the instantaneous current through the circuit breaker exceeds the magnetic tripping level, armature **54** swings clockwise and pulls latch **50** away from button **60** and out of latching engagement with actuator **22**. Contact opening after magnetic tripping is the same as in connection with thermal tripping described above, but magnetic tripping involves no such delay as that occasioned by heating of the bimetal.

In the event of a short circuit being imposed on the circuit protected by the circuit breaker, a high instantaneous voltage develops between the wire of coil **42** and the metallic assembly **16—38—40**. For this reason it is desirable to coat either or both of members **40** and **42** with insulation as, for example, an insulating enamel **51** on core **40**. This insulation, and button **60** and band **56** of insulation prevent any portion of the normal circuit breaker current from by-passing bimetal **36** and the insulation also prevents occasionally heavy currents from flowing from the movable end of bimetal **36** to latch **50**, to iron structure 38 joined to the fixed end of bimetal 36. Sparking or welding at the latch pivot might otherwise result in extreme conditions.

Member 50, described as a latch, is formed as a bimetal and arranged to curve in the reverse direction, compared to bimetal 36. The low-expansion sides of those bimetals face each other. Insulation button 60 bears against bimetal 50 between the ends thereof and, when bimetal 36 curves downward, not in response to current but in response to an ambient temperature rise, bimetal 50 compensates by curving downward. In the embodiment illustrated, insulating button 60 engages bimetal latch 50 closer to the latching point than to latch pivot 52. This is of particular advantage in circuit breakers of low current ratings, where weak current bimetals may be expected. The force developed by bimetal 36 for tripping the breaker is required to overcome resistance to unlatching movement of the latch, developed at the point of engagement with actuator 22. This frictional resistance is developed at the end of the full length of lever 50, where the unlatching force developed by bimetal 36 is applied to lever 50 at a fraction of its length. This ratio of lever lengths is a disadvantage to circuit breakers that depend on weak current-responsive bimetals; and the mechanical disadvantage in such breakers can be minimized by arranging effective coaction between the bimetals to be at a point of compromise between the ends of the compensating bimetal nearer to actuator 22 than to pivot 48—52.

It has been noted that band 56 is an insulated tensioner between the bimetal 36 and the latch 50. In the circuit breaker this tensioner is required to serve reliably for an indefinitely long period, and it is also subject to the elevated temperatures that may develop in current-responsive bimetal 36 due to overload. This band 56 is particularly effective when made of silicone rubber which has the properties of sustained resilience over long periods of time and of stable characteristics at normal and elevated temperatures, and is thus of special value in the organization described.

Tensioning band 56 is effective to bias the combined armature and latch unit 50—54 against the left-hand extremity the bottom of notch 48. It also biases member 50 against the top edge 48*a* of notch 48, and against button 60 carried by bimetal 36. Because of the few dimensional variables in the unity core structure 38 and in the latch-and-armature unit 50, the orientation of latch member 50 is quite stable when once calibrated. This factor is of great importance in the routine production of circuit breakers which are to have and retain consistent characteristics. A further factor in this consistency is that, even with relatively strong bands 56 and firm, possibly variable tensions developed by the several bands 56 in many circuit breakers made in production, the magnetic tripping sensitivity is high and consistent. This tensioning band applies its force close to the pivot point of latch 50, that is, close to shoulder 52, and the distance between the band and that shoulder can readily be held to a consistent dimension, so that the counterclockwise tensioning moment is small. Magnetic tripping force must overcome latch friction and little more. Consequently the magnetic tripping sensitivity as previously noted remains consistent from each breaker to the next in mass produced circuit breakers, and the sensitivity is high.

The initial calibration of the circuit breaker is achieved as in a widely used circuit breaker of this type by driving a wedge in the calibrating notch in arm 16 between pivot 18 and actuator 22 when the bimetal 36 has been heated by carrying rated current for a rated time interval. The wedge is then driven into the notch sufficiently to cause latch 50 to move relatively down and out of obstructing position at the end of latch 22, and the calibrating wedge is removed.

In this circuit breaker, actuator applies an endwise, compressional force on latch 50 toward the latch pivot, being the principal force holding the latch in its separable pivot or hinge seat 48—52 when the circuit breaker is closed. Viewed otherwise, the latching end of acuator 22 moves in the direction along which latch 50 extends, at the instant of release of the actuator. When the circuit breaker is open, band 56 holds latch 50 in its seat.

It will be appreciated that the illustrative embodiment employs various features of the invention in exemplary fashion, but that certain features may well be applied to other types of circuit breakers than that illustrated; and consequently this invention should be broadly construed in accordance with its spirit and scope.

We claim:

1. In a circuit breaker having separable contacts, manually operable mechanism for opening and closing the contacts, and a latching assembly causing automatic opening of the contacts in response to fault currents, said latching assembly including a current-responsive bimetal arranged to carry circuit breaker current, a latch extending generally along said bimetal and having a latching end and having a separable pivot at the opposite end, thereof, said pivot being separable in the direction toward said latching end, and an insulating tensioner connected between said current-responsive bimetal and said latch, biasing the latch both endwise towards its pivot and pivotally into cooperation with the current-responsive bimetal.

2. Apparatus in accordance with claim 1 wherein said current-responsive bimetal and said latch co-act with each other through an interposed element of insulation and wherein said tensioner engages said latch member between said element of insulation and said pivot.

3. Apparatus in accordance with claim 2 wherein said tensioner is an elastic band encircling said latch and said current-responsive bimetal, and wherein portions of the band engage formations on the bimetal and the latch and are thus held offset from each other longitudinally of the latch and the bimetal.

4. In a circuit breaker having separable contacts, manually operable mechanism for opening and closing the contacts, and a latching assembly causing automatic opening of the contacts in response to fault currents, said latching assembly including a current-responsive bimetal arranged to carry circuit breaker current, a latch extending generally along said bimetal and having a latching portion at one extremity thereof and having a pivot at the opposite end thereof, said latching assembly also having a notch formed as a pivotal seat for rockably receiving said latch, said seat being disposed adjacent the current-responsive bimetal, said seat opening toward said latching portion of the latch, and an insulating tensioning band of silicone rubber about said current-responsive bimetal and said latch, said tensioning band being positioned by formations on the latch and on the current-responsive bimetal disposed to bias the latch both towards its seat and pivotally into cooperation with current-responsive bimetal.

5. A circuit breaker including separable contacts manual mechanism for opening and closing the contacts, a releasable member effective to hold the contacts closed, and a latching assembly for providing automatic release of the releasable member in response to current overload, said latching assembly including a current-responsive bimetal, a magnetic core structure having a coil thereon connected electrically in series with the current-responsive bimetal, and a combined latch-and-armature unit having shoulders rockably received in corresponding notches in the magnetic core structure, and an insulating tensioner connected between said latch and said current-responsive bimetal disposed to bias said unit both toward said current-responsive bimetal for mechanical co-action therewith and toward said seat, for remaining in assembly therewith.

6. A circuit breaker having separable contacts, a mov-

able arm carrying one of said contacts, manually operable mechanism to operate said arm into open and closed positions, a releasable member carried by said contact arm and effective when released to initiate opening operation of the contact arm, and a latching assembly carried by said contact arm, said latching assembly including a current-responsive bimetal and a magnetic core structure both mechanically and electrically joined at a common point to said contact arm, said current-responsive bimetal having a movable end, a coil carried by said core structure and connected to said movable bimetal end for passing said current through the bimetal and for magnetizing said core structure, a combined latch-and-armature unit forming a separable pivotal connection to an open seat in the magnetic core structure,

and an elastic insulating tensioner connected between said unit and said bimetal for maintaining assembly of the latch-and-armature unit in the open set and for biasing the latch into mechanical co-action with the current-responsive bimetal without however providing a shunt electrical path through the tensioner.

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