July 9, 1963 H. S. WINGARD ETAL 3,097,277

LATCH-TRIP CIRCUIT BREAKERS

Filed Nov. 10, 1959 2 Sheets-Sheet 1

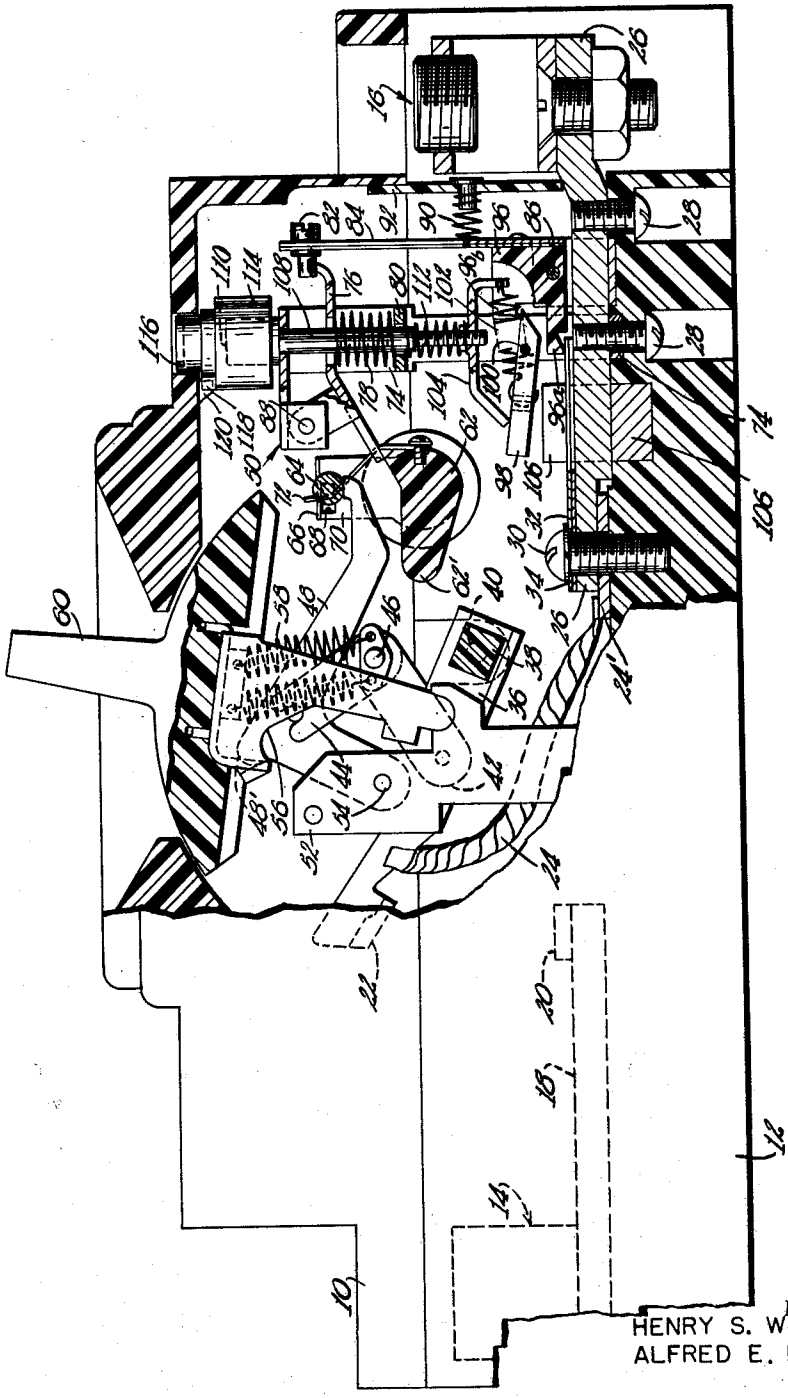


FIG. 1

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FIG. 2

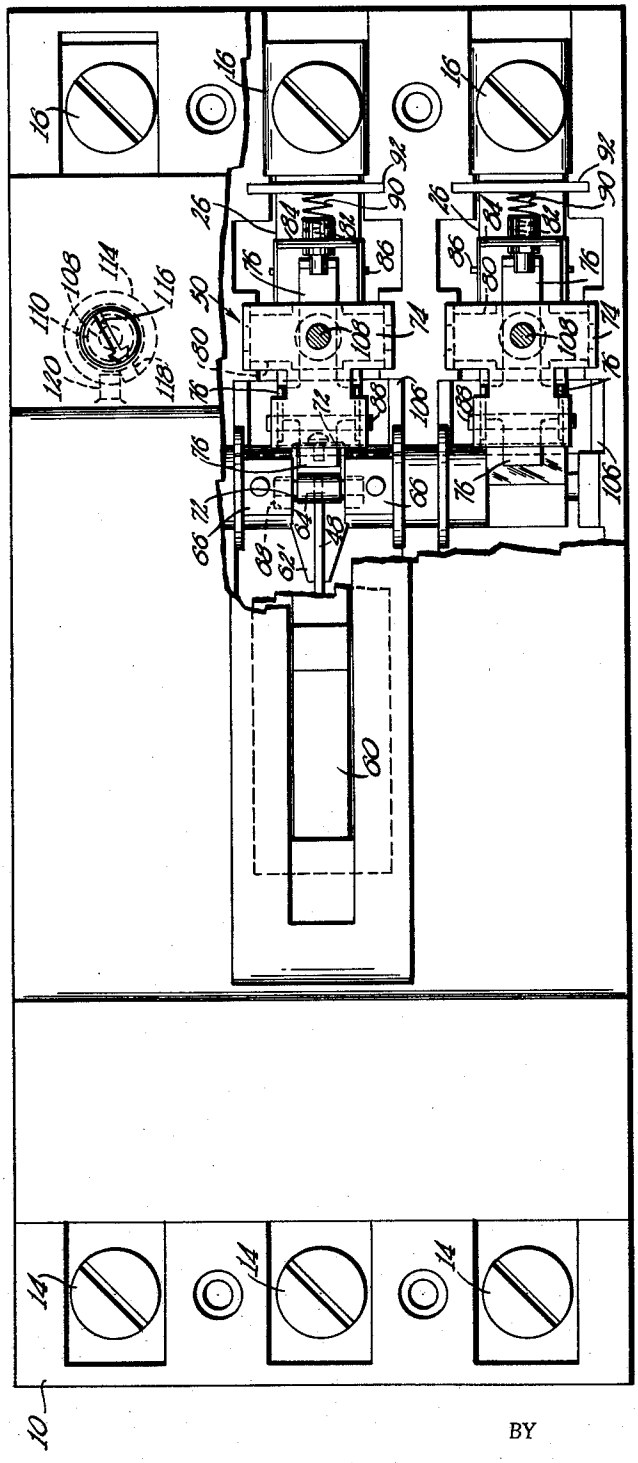


FIG. 4

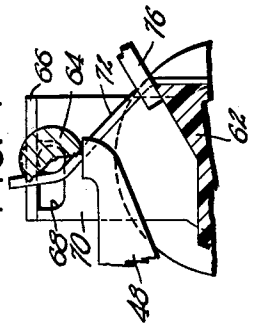
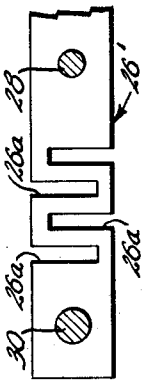


FIG. 3



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LATCH-TRIP CIRCUIT BREAKERS

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17 Claims. (Cl. 200—88)

This invention relates to circuit breakers and, more particularly, to molded-case multipole circuit breakers, with self-contained overcurrent release means.

One object of the present invention is in the provision of a circuit breaker, more particularly a circuit breaker of the enclosed molded-case type, having a substantially higher current rating than previous circuit breakers of corresponding proportions. A feature of the present invention resides in the provision of a novel thermal control overload tripping mechanism which efficiently utilizes the heat developed by the conductors forming the current path through the circuit breaker for activating the bimetal. In this way the normal temperature rise within the circuit breaker is held to a relatively low value. A circuit breaker of given proportions utilizing this novel feature can be rated at more than double the maximum current rating of previous commercial breakers of the same proportions.

In the novel circuit breaker disclosed in detail below, the current-responsive thermal overload release means is effectively related to an ambient temperature compensating device to realize the requisite current-response sensitivity despite the minimized current-induced temperature rise above ambient. Ambient temperature compensating bimetals have been used with indirectly heated current-responsive bimetals in circuit breakers heretofore, mainly as a refinement. The current-induced temperature rise for activating the bimetals in known circuit breakers has been made deliberately high in relation to the ambient temperature variation. A typical ambient temperature variation is 15° C. whereas bimetal heating for over-current tripping has commonly required a temperature rise of 80–110° C. In one aspect of the present invention the inherent heating due to the overload current through the conductors in the circuit breaker produces a much lower temperature rise, typically 35°–40° C. so that the ambient temperature variation becomes a larger, controlling factor, and yet the novel thermal tripping mechanism is efficiently utilized to produce reliable tripping performance when exposed to the practical range of ambient temperature variations. This yields the result of sharply increasing the current rating that is possible in a circuit breaker of given proportions. It is particularly significant in molded-case circuit breakers where the current-responsive bimetal and the ambient temperature bimetal are both enclosed in the same space and where, therefore, the ambient temperature compensating bimetal is inevitably exposed in some degree to the heating due to the current through the breaker.

The current-responsive thermal control device is in intimate heat transfer relation with the conductors forming an essentially straight current path through the circuit breaker and thus utilizes the heating that is normally developed by such conductors. The previously used high-temperature resistance-element bimetal heaters are eliminated, eliminating the built-in heat source that caused a high temperature rise within the enclosure.

Another object and feature of the present invention resides in the provision of an improved mounting for the current-responsive bimetal. In the novel circuit breaker described hereinbelow, the enclosed current-responsive bimetal is carried by the same unitary bar that extends outside the enclosure to a terminal. This minimizes the number of internal heat-producing connections and simplifies

the construction. Such bar is of heavy cross-section and is secured in position in a manner to resist the stresses imposed by an external heavy conductor that is to be secured in the external terminal. The bimetal remains in stable heat-transfer relation to the bar and to the mechanism controlled by the bimetal.

Another object and feature of the present invention is the provision of an overload release which requires a much smaller operating force to trip the circuit breaker in response to an overload. The novel overload release includes a virtually frictionless latching mechanism for the contact operating mechanism whereby to effectively restrain the relatively heavy spring pressure in the contact-operating mechanism while at the same time providing for virtually frictionless overcurrent release by thermal and magnetic current-responsive mechanism.

In the illustrative embodiment of the invention described in detail below spring levers are utilized to drive a trip bar to release the cradle that forms part of the contact operating mechanism, these spring levers being controlled by magnetic and thermal release mechanism. Pursuant to a further feature of the present invention such spring levers can be considerably softer than was heretofore feasible when used with the aforenoted frictionless latching mechanism. The advantages achieved by this arrangement include the considerable reduction of the frictional force at the latch point of the spring lever so that a smaller operating force of the thermal control device will reliably effect tripping of the circuit breaker in response to an overload, under conditions of minimized temperature-rise. The magnetic tripping sensitivity is similarly enhanced. An additional important benefit is that the effort required to relatch the entire mechanism is considerably reduced because of the softer springs of said spring levers to be loaded in the relatching operation.

Another object and feature of the present invention is the provision of a novel and improved magnetic overload release which functions for severe short-circuits for instantaneous release of the circuit breaker. A feature of the magnetic release mechanism is in its adjustability over a wide range. In a practical example it can be adjusted to respond to any value of current from 250 amperes to 2500 amperes. In the novel circuit breaker a pivoted armature of the magnetic overload release is biased away from its companion pole piece by a biasing force which acts along a line close to the line between the pivot of the armature and the biasing connection therewith and thus only slightly increased tension is developed during armature operation. Once movement of the armature is initiated in response to an overload, it tends to operate with a fast snap action. Cooperatively arranged with respect to the armature is a common member which is adjustable to both increase the magnetic air gap and the component of force exerted by the biasing means urging the armature away from the pole piece, this arrangement attaining the wide range of magnetic overload release adjustment mentioned previously.

A further feature of the present invention resides in the provision of an especially effective ambient temperature compensation arrangement, which takes on added significance in view of the relatively low tripping temperatures for operation of the current responsive bimetal. The ambient temperature compensation bimetal is disposed to be remote from the heating produced by the conductors forming the multipole current paths through the breaker, as compared to the current responsive bimetals which are in intimate heat transfer relation with such conductors. In the novel circuit breaker the ambient temperature compensation bimetal takes the form of a pivoted latch for the contact operating mechanism responsive to both the thermal and magnetic current-

responsive mechanism, i.e., responsive to both the armature of the magnetic overload release and to the current responsive bimetal. This pivoted latch arrangement also aids in reducing the energy required to relatch the cradle subsequent to tripping. This ambient temperature compensating bimetal as a latching member is essentially in tension, and thus can be relatively thin and sensitive.

Yet another object of the present invention is the provision of a generally improved compact breaker of high rating which is of unique design and construction and which is eminently suitable for its intended purposes.

The above and other objects, features and advantages of the present invention will be more fully understood from the following description of an illustrative embodiment of the invention considered in connection with the accompanying drawings forming part of the disclosure.

In the drawings:

FIG. 1 is a side elevational view, shown partly in section to reveal the internal parts, of a circuit breaker embodying the present invention, the breaker being shown in a circuit "open" condition and the contact operating mechanism shown latched by the overload release mechanism;

FIG. 2 is a plan view thereof with parts broken away to reveal the internal parts;

FIG. 3 is a fragmentary plan view of a modified form of conductor; and

FIG. 4 is an enlarged fragmentary side view showing a detail of the latch.

Referring now to the drawings, a so-called molded-case circuit breaker is illustrated having a cover **10** and a base **12** of molded insulation conventionally secured to each other so as to enclose the contacts, the operating mechanism and the automatic over-load release mechanism. Terminals **14** and **16** are external connectors provided for connection to circuit wiring. Between these connectors there is a substantially straight-line current path through the circuit breakers, extending from terminal **14**, along conductor **18**, fixed contact **20**, moving contact **22**, flexible conductive braid **24**, and conductor **26**, to terminal **16**. Conductor **26** is a substantially uniform bar of copper of rectangular cross-section. It has slight upward offset adjacent to terminal **16**, so that both terminals **14** and **16** are spaced equally from the bottom of the circuit breaker. A pair of mounting screws **28** unite conductor **26** mechanically to the molded base **12**, thereby restraining any force that might be imposed by heavy external circuit conductors clamped in connector **16**, to avoid displacement of conductor **26**.

Conductive braid **24** has a flat terminal piece **24'** welded to it, and this is of relatively thin and ductile copper. Screw **30** extends through holes in conductors **26** and **24'** to establish tight contact between these elements over a very broad area. Both elements **24'** and **26** are silver-plated for minimizing contact resistance at this point. Screw **30** also grips the fixed end of current responsive bimetal **32** against conductor **26**, a lock washer **34** being interposed to maintain contact pressure. The whole length of bimetal **32** extends very close to conductor **26**, and actually engages conductor **26** at normal temperatures and when no current is carried by conductor **26** bimetal **32** has its high-expansion side facing conductor **26** so that it deflects upward in response to heating. Bimetal **32** forms part of the overload release mechanism to be described in detail below.

As seen in FIG. 2 there are three side-by-side poles in the circuit breaker, and in each pole there is a current path including the elements **14**, **18**, **20**, **22**, **24**, **26** and **16**. Additionally a conventional overcenter spring-and-toggle mechanism is provided in the center pole for mechanically operating the respective moving contacts **22** of the three poles. Each moving contact **22** is resiliently carried by contact carrier **36**; and contact carriers **36** in turn are united to a square insulating shaft **38** that extends all the way across the circuit breaker,

shaft extensions **40** of square shaft **38** being suitably supported for rotation.

A pair of toggle links **42** and **44** are pivoted to each other at their knee **46**. Lower link **42** is pivoted to the center-pole contact carrier **36** and upper toggle link **44** is pivoted to a releasable cradle **48** that is normally restrained by latching mechanism **50**. Cradle **48** has a pivot **54** in stationary frame **52**. A two-legged manual actuating lever **56** is pivotally supported at its lower extremity. Four springs **58** (only two being shown) are tensioned between knee **46** of the toggle at the lower ends of the springs and the actuating lever **56** at the upper ends of the springs. A lever extension or handle **60** of insulation is secured to actuating lever **56**, and projects through a slot in the cover **10** so as to be accessible externally, this handle having usual lateral extensions that close off the slot in all positions of the handle.

The overcenter spring-and-toggle mechanism illustrated is in its open condition; and by operating handle **60** to the left in FIG. 1, the springs are shifted so as to cause the toggle to straighten and overcenter slightly, thereby to close the contacts of all three poles. In the closed condition of the circuit breaker, in the event that the latching mechanism **50** should release cradle **48**, the cradle swings counterclockwise past the line of action of these springs, resulting in collapse of the toggle and automatic opening of the contacts.

The foregoing contact operating mechanism is entirely conventional, forming part of the illustrative circuit breaker.

Latching mechanism **50** is contained in the same molded-case enclosure as the current paths of the respective poles. The individual current-responsive mechanisms of the several poles are coordinated by a common trip bar **62** that is journaled at its ends in the molded base **12**. The latched surface of cradle **48** presses upward against roller **64**; and the reduced-diameter end portions of roller **64** press upwardly against a pair of metal plates **66** that are riveted to upward internal extensions of trip bar **62** (FIG. 2). These reduced end portions of the latch roller can operate between horizontal limits defined by the walls of opposed pockets **68** formed in extensions **70**. The legs of a generally U-shaped spring **72**, secured to trip bar **62**, biases roller **64** to the right. It will be apparent that, when trip bar **62** is rocked clockwise, it will cause roller **64** to roll with virtually no friction between the bearing surfaces of cradle **48** and metal plates **66** in the direction to release cradle **48** for automatic opening of the contacts. Spring **72** is relatively weak and is for the purpose of properly locating roller **64** during the resetting operation following an overload release of the circuit breaker.

Resetting is accomplished by operating handle **60** from its "on" or its "trip" position towards the right so as to engage projection **48'** of the cradle, driving the cradle clockwise against a reset arm **62'** of the trip bar. Resulting counterclockwise rotation of the trip bar resets the individual current responsive mechanisms of the three poles.

An individual current responsive mechanism is provided in each pole, having both magnetic and thermal current responsive devices. Each such mechanism includes a stationary frame **74** secured to the molded base **12**. Frame **74** pivotally supports a spring lever **76** that is biased counterclockwise by a compression spring **78** on frame portion **80**. Spring lever **76** is latched by an adjustable screw **82** on a pivoted latch member, formed as a temperature compensating bimetal **84**. Latching engagement between screw **82** and spring lever **76** involves a force acting along a line passing through the pivot **86** substantially at right angles to the line between the latching point and the pivot **88** of the latched spring lever **76**. There is virtually no tendency of the spring biased lever **76** to operate the pivoted latch **82—84** in the releasing direction; and because screw **82** is only a negligible frac-

tion of the length of member **84**, there is almost pure tension developed in member **84**. Consequently member **84** (a bimetal) can be relatively thin and, therefore, sensitive. Compression spring **90** which bears against an insulating barrier **92**, biases member **84** counterclockwise, that is, in the direction to position latch screw **82** above lever **76** during the resetting operation; but spring **90** is made deliberately weak so as to offer negligible resistance to the clockwise operation of member **84** in effecting overcurrent release, and negligible resistance to the clockwise swing of member **76** during resetting.

Ambient temperature compensating bimetal **84** is united to a member **96** of electrical insulation which is also chosen as a good thermal insulator, and it is in this element **96** that pivots **86** are fixed. A projection **96***a* engages the active end of current responsive bimetal **32**, at a point relatively remote from the end of the bimetal **32** fixed by screw **30**. In addition, a projection **96***b* is formed on member **96** which rests above the right-hand extension of an armature **98** that has a pivot **100** in frame **74**. Armature **98** is biased clockwise by a spring **102**. Clockwise motion of armature **98** is limited by an adjustable stop member **104**, and spring **102** is secured at its right-hand extremity to a portion of the adjustable stop member **104**. Armature **98** is disposed above conductor **26**; and this armature is movable between the side arms of a U-shaped magnetic core **106** that is set into the molded base **12** and extends about three sides of conductor **26**. Current carried by conductor **26** develops a magnetic field in core **106** that attracts armature **98** in the direction to trip member **84**; and when this current is at a sufficiently high level to start armature **98** moving, the air gap between armature **98** and core **106** decreases so as to increase the armature-operating force. Spring **102**, acting along a line close to the line between the pivot **100** and the spring engagement with armature **98**, develops only slightly increased tension during this action of the armature. As a result, once the armature starts to move in response to a high current level, it tends to operate with snap action. The line of action of spring **102** never crosses the point **100**, so the armature is spring-restored when the overload current is interrupted.

Stop **104** is adjustably carried by a shaft **108**, resting on top of frame **74**. At its lower extremity member **108** is threaded into stop member **104**. A compression spring **112** biases stop member **104**, shaft **108**, and head **110** downward.

On top of knurled head **110** there is force-fitted an adjustment knob **114**, in which there is a slot **116** (formed in the shape of an arrow) for receiving the blade of a screwdriver. A projection **118** integral with knob at **114** is engageable with a fixed stop **120** projecting integrally that is formed from cover **10**, for the purpose of limiting knob **114** to approximately a 300° range of rotation. This adjusts position of stop **104**, this arrangement giving the user of the circuit breaker a limited range of magnetic tripping adjustment.

With the cover **10** open and before knob **114** is mounted in the position shown, shaft **108** can be adjusted to establish an end point of the limited range of adjustment available to the user. With the arrangement shown, a remarkably wide range of adjustment in magnetic tripping level has been realized.

The magnetic overload release is normally adjusted to a value somewhere between six and ten times the so-called normal rating of the circuit breaker. This magnetic release functions for severe short-circuits for instantaneous release of the circuit breaker but does not respond to normal motor-starting currents and similar momentary overloads. It is a feature of this magnetic overload release mechanism that it can be adjusted to respond to any value of current over a very wide range, 250 amperes to 2,500 amperes, for example. As stop **104** is raised in position so as to increase the gap between armature **98** and core **106** (thereby to raise the current level required to overcome the spring tension) the line of action of spring **102** is also changed so as to increase the component of spring tension urging armature **98** away from core **106**. These factors combine in attaining an especially wide range of adjustment.

Tripping of the circuit breaker in response to its "normal" current rating is effected by bimetal **32** which deflects upward in response to heating in conductor **26**, as previously mentioned. Such upward deflection drives member **84** clockwise about pivot **86**, releasing the circuit breaker. The intimate engagement of bimetal **32** with conductor **26** makes it possible to utilize the heating that is normally developed by the straight-through conductors forming the current path through the circuit breaker, and without resort to elaborate U-shaped resistors for heating the bimetal. In an important commercial advance, a circuit breaker constructed in the form illustrated has a rating of 225 amperes whereas the previous rating of a like circuit breaker having the same external proportions was only 100 amperes. Elimination of the previously used high-temperature resistance-element heating of the current responsive bimetal has significantly eliminated a built-in heat source that caused a high temperature rise within the enclosure. Elimination of this extra internal heat has made possible the great increase in maximum current rating of a given size of circuit breaker. Elimination of the separate heater and the arrangement of the current-responsive bimetal flat against the straight-through conductor **26** has also resulted in a compact assembly.

Bimetal **32** operates at a lower tripping temperature than has been customary heretofore. Accordingly this circuit breaker would have a strong tendency to respond to ambient temperature variations; and for this reason an effective ambient temperature compensation arrangement is important.

Ambient temperature compensating bimetal **84** is disposed so as to be remote from the current-produced heating in conductor **26**, compared to bimetal **32**. Compensating bimetal **84** is arranged with its high-expansion side at the right in FIG. 2 so that rises in ambient temperature which would cause upward curving of bimetal **32** are effective to cause leftward curving of bimetal **84** so as to maintain the latching point fixed. The limited extent of deflection of bimetal **84** in response to ambient temperature changes do not have any important effects on the thermal current-responsive tripping level of the circuit breaker.

It has been mentioned previously that the magnetic tripping mechanism is adjustable over a wide range of current values for which this circuit breaker may be made. The identical circuit breaker mechanism can be constructed for 225 amperes and, as well, for 75 amperes. It is desirable for standardized production that the same bimetal **32** shall be useful for a range of circuit breaker ratings. In order that this may be carried out, the form of conductor **26** immediately adjacent to screw **30** may be changed so as to produce an equal temperature rise in a 75 ampere circuit breaker as that for a 225 ampere circuit breaker of the same construction by modifying the form of conductor **26**, as by forming conductor **26** with notches and the like as represented for example in FIG. 3. Despite the fact that the conductor **26'** in FIG. 3 has a sinuous current path, i.e., the conductor **26'** has alternating notches **26***a* so that the current path is sinuous as examined closely, macroscopically the current path through the circuit breaker is still substantially along a straight line when viewed, for example, as in FIG. 1. The mechanical stress resistance of conductor **26** to deflecting forces of a wire in connector **16** is effectively resisted by screws **28** regardless of the form of conductor **26'** near the screw **30**. Localized heating can also be produced by restricting the cross-sectional dimension of the conductor **26'** in the region of screw **30**; but in the form illustrated the width of bimetal **32** is more effectively heated by keeping conductor **26** wide enough to extend all the way across the bimetal that is the same where conductor **26'** is used as in the case

of bar 26, used for the highest-rated circuit breaker of the class.

Operation of the circuit breaker in response to a moderate overload takes place when heating of conductor 26 (or conductor 26') causes sufficient heating of bimetal 32 to swing pivoted ambient-compensating latch 96—84—82 out of the illustrated position to release spring-lever 76. Upon release, this spring lever drives common trip bar 62 clockwise so as to cause roller 64 to travel toward the right, clear of the latched end of cradle 48 and automatic opening of the contacts follows instantly. Cradle 48 exerts relatively heavy upward pressure against roller 64 when latched. This is caused by tension in the four relatively strong springs 58, which are relied upon to drive the contacts open and closed with snap action. The frictionless latching mechanism that includes roller 64 represents an important feature of this apparatus, effectively restraining the cradle 48 against heavy spring pressure while at the same time providing for virtually frictionless release by the thermal and magnetic current-responsive mechanism. Springs 78 for biasing the respective spring-levers 76 can be considerably softer than was heretofore feasible, because of the prominent reduction in the effort required to rotate trip bar 62 in releasing latch roller 64. The reduction in the force exerted by springs 78 against their respective spring levers 76 results in several advantages. Prominently, the frictional force at the latch point between each spring lever 76 and the related screw 82 of the latch mmber 84 is considerably reduced as compared to a similar prior mechanism involving much heavier springs 78. Consequently, a much smaller operating force exerted by bimetal 32 will reliably effect tripping of the circuit breaker in response to an overload, under conditions of minimized temperature-rise. Additionally, the magnetic tripping sensitivity is enhanced, due to the reduced strength of spring 78 and the reduced friction at latch point 76—82.

Reduction in the strength of springs 78 has the further advantage that, when cradle 48 is reset by being swung clockwise by handle 60 the force required at handle 60 is considerably reduced.

The straight-through current path which is here made effective for tripping the circuit breaker thermally is of advantage in respect to branch-circuit protection where the supply line has high current capacity. Electromechanical stresses that might develop in circuit breakers having looped resistive heaters for the bimetals are avoided here, with the straight-through form of conductors in the circuit breaker described.

The foregoing description of an illustrative circuit breaker involves an exemplary application of the invention in its various aspects; but various modifications and varied application of these features will be apparent to those skilled in the art and therefore the invention should be broadly construed in accordance with its full spirit and scope.

Having thus secured our invention, what we claim as new and desire to secure by Letters Patent is:

1. A circuit breaker including a molded case having cooperable contacts, mechanism for operating one of said contacts to open and close the circuit breaker, first and second externally accessible terminals, and thermal overcurrent release means automatically controlling said mechanism for opening the contacts, said circuit breaker when closed having conductive portions forming a current path extending from said first terminal along a substantially straight line to said second terminal and said current path including an elongated conductor in the form of a fixed metal bar, and said over-current release means including an elongated current responsive bimetal extending along and close to said bar and having one end thereof fixed in intimate heat transfer relation with the bar so as to be mechanically responsive to the thermal changes in said metal bar, said bar being substantially straight in the region of said current responsive bimetal, said over-current release means being disposed laterally of said current responsive bimetal and being operable thereby to effect opening of the contacts.

2. A circuit breaker including a molded case, first and second cooperable contacts, a pair of externally accessible terminals connected to said contacts, said circuit breaker when closed having a basically straight current path extending from said first terminal through said contacts to said second terminal and including a moving contact arm, and mechanism disposed lateral of said current path for operating said moving contact arm and over-current release means for automatically controlling said mechanism for opening the contacts, said current path including an elongated conductor in the form of a metal bar extending from one of said terminals externally of the case to the interior of the case along a substantially straight line, said bar having a substantially straight and region, said metal bar being firmly secured to said molded flat region, said metal bar being firmly secured to said molded case, said over-current release means including an elongated substantially straight current responsive bimetal secured at one end to said bar and extending therealong adjacent said flat portion in good heat transfer relation therewith, the opposite end of said bimetal thus being mechanically responsive to the thermal changes in said metal bar, and arranged to effect release of the over-current release means, and an ambient temperature compensating bimetal arranged to be mechanically responsive to said current responsive bimetal in response to temperature changes within said case, said overcurrent release means being disposed laterally of said current responsive bimetal and being operable thereby to effect opening of the contacts.

3. A circuit breaker including a molded case, cooperable contacts, mechanism for operating one of said contacts to open and close the circuit breaker, first and second externally accessible terminals, and thermal overcurrent release means automatically controlling said mechanism for opening the contacts, said circuit breaker when closed having means providing a current path extending from said first terminal to said second terminal along a substantially straight line, and said current path providing means including a metal bar secured to said molded case, an elongated current responsive bimetal extending along said bar in intimate heat transfer relation therewith at a point within the case and mechanically responsive to the thermal changes in said metal bar, said bar and said current responsive bimetal being positioned at the bottom of said case, a pivoted latch member operable by said bimetal only in the tripping direction, and a member latched by said pivoted member and forming part of said over-current release means to release said mechanism and open the breaker on predetermined thermal overloads, said latch member and said latched member being disposed in the space above said bar and said current responsive bimetal in said case.

4. A molded case circuit breaker having cooperable contacts, mechanism for operating said contacts, a pair of externally accessible terminals, and thermal overcurrent release means, the foregoing contained in a molded case of insulation, that improvement which comprises a metal bar extending along a substantially straight line from one of said external terminals to the interior of said molded case towards the other of said terminals and said bar being secured to said molded case so as to resist mechanical stress imposed by an external conductor that may be fixed to said one terminal, said overcurrent release means including an elongated bimetal having one end secured to said metal bar within said case, said bimetal extending closely along said bar and having one end in intimate heat transfer relation to said bar and having a portion arranged to deflect and thereby effect release of said overcurrent release means in response to predetermined thermal overloads.

5. A circuit breaker in accordance with claim 4 where-

in a portion of said bar remote from said first terminal is of reduced cross-section in close proximity to said bimetal.

6. A circuit breaker including a molded case, cooperable contacts, mechanism for operating one of said contacts to open and close the circuit breaker and including a releasable member, first and second externally accessible terminals, and thermal overcurrent release means automatically controlling said mechanism for opening the contacts, said circuit breaker when closed having a current path extending from said first terminal to said second terminal and said current path including a fixed metal bar extending from said first terminal externally of the case to the interior of the case along a substantially straight line, an elongated current responsive bimetal extending along said bar in intimate heat transfer relation therewith at a point within the case and mechanically responsive to the thermal changes in said metal bar, a pivoted latch member operable by said bimetal only in the tripping direction, a spring-biased member latched by said pivoted member, a trip member arranged to be operated in the release direction by said spring-biased member, said releasable member and said trip member having opposite portions, and a latch roller interposed between and in rolling contact with both said opposite portions of said trip member and said releasable member, operation of said trip member in the tripping direction causing rolling travel of said latch roller relative to the members engaged thereby.

7. A circuit breaker including a molded case having cooperable contacts, mechanism for operating one of said contacts to open and close the circuit breaker, first and second externally accessible terminals, and thermal overcurrent release means automatically controlling said mechanism for opening the contacts, said circuit breaker when closed having conductors providing a current path extending from said first terminal to said second terminal and said current path including a fixed metal bar extending from said first terminal externally of the case to the interior of the case, an elongated current responsive bimetal having a portion thereof fixed in intimate heat transfer relation therewith so as to be mechanically responsive to the thermal changes in said metal bar, said operating mechanism including a releasable member, and said overcurrent release means further including latch mechanism for said releasable member comprising a trip member movable in response to overcurrent operation of said bimetal and a traveling roller interposed between said release member and said trip member and in rolling contact with both said release member and said trip member and providing substantially frictionless release of said releasable member in response to predetermined bimetal deflection.

8. Overload release means for a circuit breaker having a heavily spring-biased releasable member, a current-responsive device, and release means controlled by the current-responsive means for normally restraining the releasable member and for effecting release thereof in response to an overload, said release means including a movable member and a latch roller interposed between said movable member and said releasable member, opposite external portions of said roller having rolling-contact with both of said members, one of said members providing loose support for said roller and including end stops limiting the rolling travel thereof, said current-responsive means upon response to an overload being effective to cause movement of said movable member to impart rolling travel to said roller in a direction to release said releasable member, and a spring cooperating with said latch roller for biasing the roller against one of said stops following release of said releaseable member and in readiness for relatching said releasable member.

9. A circuit breaker including a molded case having cooperable contacts, mechanism for operating one of said contacts to open and close the circuit breaker, first and second externally accessible terminals, and over-current release means automatically controlling said mechanism for opening the contacts, said circuit breaker including a fixed metal bar extending from said first terminal externally of the case to the interior of the case along a substantially straight line, and said over-current release means including an elongated current responsive bimetal secured to the end of said metal bar remote from said first terminal and extending closely along said bar toward said first terminal in intimate heat transfer relation with the bar, and magnetic overcurrent release means automatically controlling said mechanism for opening the contacts comprising a magnetic core disposed about said metal bar for energization by the current therein, an armature disposed above said metal bar and above said bimetal, and a spring biasing said armature away from said core, said release means including a pivoted latch having an elongated portion extending away from said bar and operable directly by both said bimetal and said armature to effect automatic opening of the contacts in response to either thermal or magnetic overload.

10. A circuit breaker in accordance with claim 9, wherein said elongated portion of said latch is an ambient temperature compensating bimetal and is disposed adjacent to a wall of said molded case.

11. A circuit breaker including a molded case having cooperable contacts, mechanism for operating one of said contacts to open and close the circuit breaker, first and second externally accessible terminals, and overcurrent release means automatically controlling said mechanism for opening the contacts, said circuit breaker when closed having conductors disposed to provide a substantially straight current path extending from said first terminal to said second terminal and said current path including a fixed metal bar extending from said first terminal externally of the case to the interior of the case, and said overcurrent release means including an elongated current responsive bimetal extending along said bar in intimate heat transfer relation therewith so as to be mechanically responsive to the thermal changes in said metal bar, and magnetic overcurrent release means comprising a magnetic core disposed about said metal bar, and a movable armature having a spring connected thereto for biasing said armature away from said core, and means for adjusting the magnetic tripping current level of said release means comprising an adjustable member constituting both a stop for said armature and a reaction means for said spring, said adjustable member being arranged for coordinately increasing said gap and the spring bias of said armature, and a common latch operable in the releasing direction by both said bimetal and said armature at respective magnetic and thermal current levels.

12. A circuit breaker including a molded case having cooperable contacts, mechanism for operating one of said contacts to open and close the circuit breaker, first and second externally accessible terminals, and thermal overcurrent release means automatically controlling said mechanism for opening the contacts, said circuit breaker when closed having conductors forming a substantially straight current path extending from said first terminal to said second terminal and said conductors including a fixed metal bar extending from said first terminal externally of the case to the interior of the case, said bar having a substantially flat elongated region within said case, and said overcurrent release means including an elongated current responsive bimetal confronting and extending along and closely adjacent to said elongated flat region of said bar in intimate heat transfer relation therewith so as to be mechanically responsive to the thermal changes in said metal bar, said bar and said current responsive bimetal being positioned at the bottom of said case, and magnetic overcurrent release means automatically controlling said mechanism for opening the contacts comprising a magnetic core disposed about said metal bar for energization by the current therein, and an armature dis-

posed above said metal bar and spring biased away from said core, said magnetic and said thermal overcurrent release means being disposed in said casing in the space above said bar.

13. A circuit breaker having cooperable contacts, and mechanism for operating one of said contacts to open and close the circuit breaker, magnetic overcurrent release means automatically controlling said mechanism for opening the contacts comprising a magnetic core and a pivotally movable armature having a spring connection therewith for biasing said armature away from said core, the action of said spring being along a line in close proximity to the line between the pivot of said armature and said spring connection therewith whereby only slightly increased tension is developed in said spring during armature operation in response to predetermined magnetic overloads, and commonly adjustable means cooperating with said armature and said spring connection disposed for coordinately increasing the space between said armature and said core and for increasing said biasing of the armature away from said core.

14. In a circuit breaker having cooperable contacts, and mechanism for operating one of said contacts to open and close the circuit breaker, magnetic overcurrent release means automatically controlling said mechanism for opening the contacts comprising a magnetic core and a pivotally movable armature having a spring connected thereto for biasing said armature away from said core, the action of said spring being along a line in close proximity to the line between the pivot of said armature and the connection of said spring to said armature, and means for adjusting the magnetic tripping current level of said release means comprising an adjustable member arranged as a stop to limit the normal position of said armature and to stress the spring, said member being adjustable in the direction to increase the air gap between said core and said armature and concurrently to change the line of action of the spring in the direction to increase the component of force exerted by said spring in biasing said armature away from said core.

15. Magnetic overcurrent release means automatically controlling a circuit breaker for opening the contacts thereof, comprising a magnetic core and an armature having a spring connected thereto for biasing said armature away from said core, and means for adjusting the magnetic tripping current level of said release means comprising an adjustable stop member for said armature, limiting the magnetic air gap, said spring extending to said stop member, the latter being movable for concomitantly increasing the air gap between said core and said armature and for increasing the bias of said armature away from said core.

16. A circuit breaker including a molded case having cooperable contacts, mechanism for operating one of said contacts to open and close the circuit breaker, first and second externally accessible terminals, and thermal overcurrent release means automatically controlling said mechanism for opening the contacts, said circuit breaker when closed having conductors providing a current path extending from said first terminal to said second terminal and said current path including a fixed metal bar extending from said first terminal externally of the case to the interior of the case, a magnetic core partly surrounding said bar and a movable magnetic armature disposed opposite to said core for cooperation therewith and biased away from said core so as to be mechanically responsive to the current in said metal bar, said operating mechanism including a releasable member, and said overcurrent release means further including latch mechanism for said releasable member comprising a trip member movable in response to overcurrent operation of said armature and a traveling roller interposed between said release member and said trip member in rolling contact with both said members and providing substantially frictionless release of said releasable member in response to predetermined current overloads.

17. A circuit breaker including a molded case having cooperable contacts, mechanism for operating one of said contacts to open and close the circuit breaker, first and second externally accessible terminals, and thermal overcurrent release means automatically controlling said mechanism for opening the contacts, said circuit breaker when closed having conductors providing a current path extending from said first terminal to said second terminal and said current path including a fixed metal bar extending from said first terminal externally of the case to the interior of the case, an elongated current responsive bimetal having a portion thereof fixed in intimate heat transfer relation therewith so as to be mechanically responsive to thermal changes in said bar, a magnetic core partly surrounding said bar and a movable magnetic armature disposed opposite to said core for cooperation therewith and biased away from said core so as to be mechanically responsive to the current in said metal bar, said operating mechanism including a releasable member, and said overcurrent release means further including latch mechanism for said releasable member mechanically coupled to said armature and to said bimetal for control thereby said latch mechanism comprising a trip member movable in response to overcurrent operation of said bimetal and of said armature severally, and a traveling roller interposed between said release member and said trip member in rolling contact with both said members and providing substantially frictionless release of said releasable member in response to predetermined current overloads.

References Cited in the file of this patent

UNITED STATES PATENTS

2,047,739	Lingal	July 14, 1936
2,175,859	Tusing	Oct. 10, 1939
2,414,554	Pierce	Jan. 21, 1947
2,486,300	Lindstrom	Oct. 25, 1949
2,494,761	Jackson et al.	Jan. 17, 1950
2,544,727	Rufolo	Mar. 13, 1951
2,574,093	Edmunds	Nov. 6, 1951
2,600,223	Dorfman	June 10, 1952
2,673,908	Brumfield	Mar. 30, 1954
2,758,174	Cole	Aug. 7, 1956
2,783,330	Casey	Feb. 26, 1957
2,866,872	Turner	Dec. 30, 1958
2,922,008	Cellerini et al.	Jan. 19, 1960