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CIRCUIT BREAKER WITH IMPROVED BIMETALLIC
AND ELECTROMAGNETIC TRIP DEVICE
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Fig. 1.

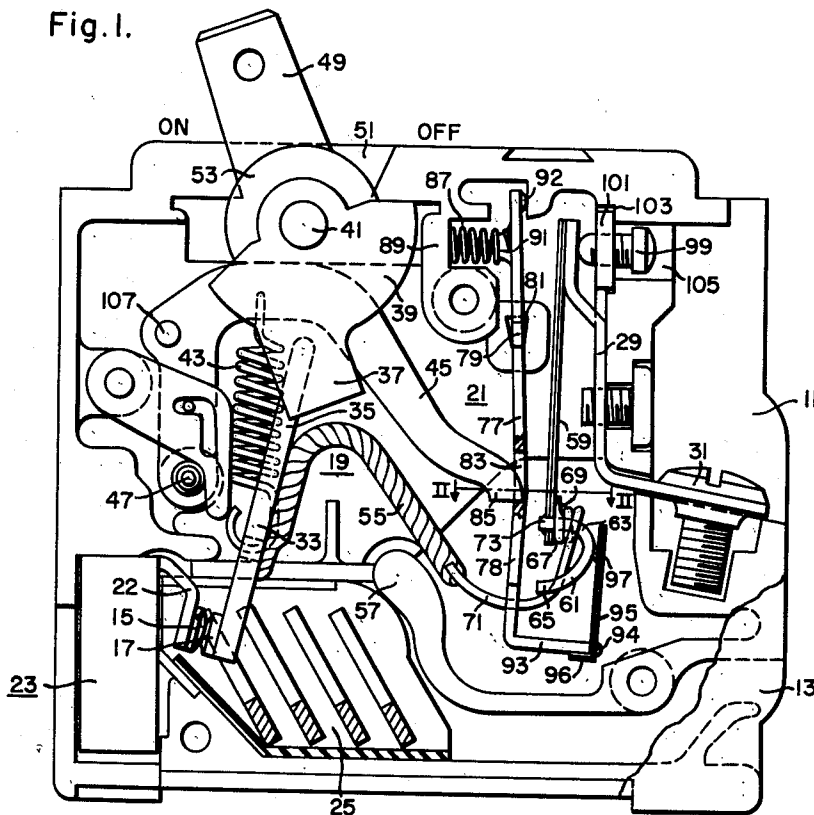


Fig.5.

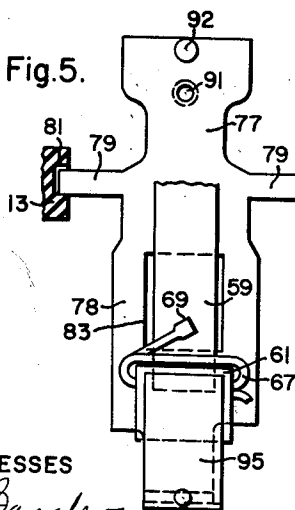


Fig.3.

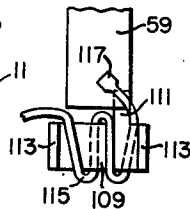


Fig.4.

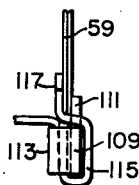
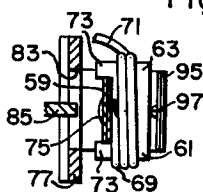


Fig.2.



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3,178,535

AUTOMATIC CIRCUIT BREAKER WITH IMPROVED BIMETALLIC AND ELECTROMAGNETIC TRIP DEVICE

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8 Claims. (Cl. 200—88)

The invention relates to circuit breakers and more particularly to circuit breakers of the type which are automatically operated instantaneously on heavy overload currents, and after a time delay in response to persistent overload currents of lesser magnitude.

An important object of the invention is to provide a more sensitive magnetic trip which will operate instantaneously on lower values of overload currents than where the trip magnet is energized only by the single turn provided by the current flow through the bimetallic element.

An additional object is to also improve the sensitivity of the trip device by reducing the reluctance of the magnetic circuit by using a U-shaped magnet with both ends facing an armature which is movable against a relatively light spring rather than against the resilience of the bimetallic element which may be relatively stiff.

An object of the invention is to provide a circuit breaker having an improved electromagnetic and a bimetallic trip device in which the magnet yoke is mounted on and extends beyond the free end of the bimetallic trip element.

Another object of the invention is to provide a circuit breaker embodying an improved electromagnetic and a bimetallic trip device in which one leg of a U-shaped magnet yoke is mounted on the free end of the bimetallic element and the other leg of the magnet yoke extends beyond the free end of the bimetallic element.

Another object of the invention is to provide a circuit breaker having an improved magnetic and bimetallic trip device in which a U-shaped magnet yoke is mounted by one of its legs on the free end of the bimetal and the other leg of the magnet yoke extends beyond the free end of the bimetal element, a multiple turn energizing coil surrounding one leg of the magnet yoke is movable with the bimetal and the magnet yoke.

Another object of the invention is to provide a circuit breaker having a bimetallic thermal trip which may be fully or partially compensated for changes in ambient temperature in a simple and inexpensive manner.

The invention, both as to construction and operation, together with additional objects and advantages thereof, will be best understood from the following detailed description thereof when read in conjunction with the accompanying drawing.

In said drawing:

FIGURE 1 is a vertical elevational view of a circuit breaker, with the cover mostly broken away, embodying the principles of the invention;

FIG. 2 is a sectional view taken along line II—II of FIG. 1 and looking in the direction indicated by the arrows;

FIGS. 3 and 4 illustrate a modification of the magnet yoke;

FIG. 5 is an end elevational view of the trip device with the bimetal element broken away for clearness.

Referring to the drawing, the circuit breaker comprises

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generally an enclosing housing including an open sided base or housing member 11 and a cover plate or cooperating housing part 13 both made of molded insulating material, the cover plate being shown mostly broken away for clearness, a stationary contact 15, a movable contact 17, an operating mechanism 19, a trip device 21 and an arc extinguisher 25.

The stationary contact 15 is rigidly secured to the inner end of a conducting member 22 which is integral with a plug-in line terminal connector 23 supported in the housing 11 and in the cover 13 at one end of the housing.

At the opposite end of the housing 11 is disposed, a conducting strip 29 which, at its inner end, is connected to the trip device 21 and which at its outer end is provided with a load terminal connecting means, such as a screw 31, for connecting the breaker in an electrical circuit.

The movable contact 17 is rigidly secured on the free end of a U-shaped switch arm 33 of conducting material having its legs 35 supported in recesses in the legs 37 of a U-shaped operating lever 39 of molded insulating material. The operating lever 39 is pivotally supported by trunnions 41 molded integral with the operating lever and mounted in companion openings in the housing members 11 and 13. An overcenter spring 43 is connected under tension between the bight of the switch member 33 and a releasable carrier member 45 pivoted on a pin 47 supported in the housing members 11 and 13.

The operating lever 39 is provided with an integral handle portion 49 which extends outwardly through an opening 51 in the top of the housing member 11. The operating lever 39 is also provided with an arcuate portion 53 cooperating with the housing parts 11 and 13 to substantially close the opening 51 in all positions of the operating lever. The switch member 33 is electrically connected by a flexible conductor 55 of stranded wire to the trip device 21 as will be more fully described later.

The switch arm 33 is operated to manually open and close the contacts by operation of the lever 39 which is effected by manipulation of the handle 49. Movement of the handle 49 in a clockwise direction carries the pivoted ends of the legs of 35 of the switch member 33 across to the left of the line of force of the operating spring 43 which then biases the switch member to the open position and causes movement of the switch member to the open position with a snap action.

The contacts are manually closed by reverse movement of the operating lever 39. Counterclockwise movement of the operating lever 39 from the "off" to the "on" position moves the upper pivoted ends of the legs 35 of the switch member 33 across to the right of the line of force of the spring 43 which then acts to close the contacts with a snap action.

The circuit breaker is tripped open after a time delay in response to overload currents below a predetermined value and instantaneously in response to overload currents above the predetermined value, or in response to short-circuit currents, by operation of the trip device 21 which will be hereinafter described in detail. Operation of the trip device 21 causes release of the carrier means 45 whereupon the operating spring 43 moves the releasable carrier means 45 clockwise about its pivot 47. This moves the line of force of the spring 43 across to the right of the center line and pivot point of the switch arm 33, and the spring then acts to move the switch arm to the open position with a snap action. The movement of the releasable means 45 is arrested by engagement with a projection

or wall 57 molded integral with the housing parts 11 and 13.

The trip device 21 comprises a bimetal element 59 having one end supported on the inner end of the conducting strip 29 and its lower end free. A U-shaped magnet yoke 61 has one leg 63 rigidly mounted on the bimetal element 59 adjacent the free end thereof and the other leg 65 of the yoke 61 of magnetic material extends downwardly and is spaced from the free end of the bimetal element. A multiple turn energizing coil 67 is wound about one of the legs, preferably the upper leg 63, of the magnet yoke 61 and has one end 69 suitably secured, as by welding, to the bimetal element 59 near its lower end. The other end 71 of the coil 67 is welded, or otherwise suitably secured to the end of the stranded flexible conductor 55. The coil 67 is made of solid wire which retains its coiled shape, and is enameled, varnished or otherwise insulated to prevent its turns being short circuited.

As shown best in FIG. 2, the upper leg 63 of the magnet 61 is provided with projections 73 disposed at the opposite edges of the bimetal element 59, and form pole pieces to the left of the bimetal element as seen in FIGS. 1 and 2. A center portion 75 (FIG. 2) of the upper leg 63 extends through an opening in the bimetal element 59 and is riveted over against the left side of the bimetal element to rigidly secure the magnet yoke thereto.

A trip member 77 having an armature portion 78 of magnetic material is pivotally supported by means of lateral projections 79 thereon which extend into opposed openings 81 (FIG. 5) in the housing parts 11 and 13. The trip and armature member 77 extends along the left or high expansion side of the bimetal 59 and has a latch opening 83 therein into which the latch end 85 of the releasable carrier 45 extends and is thereby releasably restrained in operative position. A relatively light spring 87 compressed between a spring seat 89 in the housing portion 11 and a spring guide 91 on the armature above the pivot 79 biases the trip member 77 to latching position. The spring 87 is closer to the pivot 79 than the armature portion 78 opposite the magnetic member 61, so that a smaller magnetic force can overcome the spring and trip the breaker. A stop portion 92 at the top of the trip member 77 engages the housing to fix the latching position of the trip member and the maximum latch overlap between the latch end 85 and the edge of the opening 83.

A portion 93 of the lower end of the trip member 77 is formed substantially at right angles to the main body 77 of the trip member and extends toward the right below the magnet yoke 61. An ambient temperature compensating bimetal element 95 is rigidly secured to the right end of the portion 93 and extends upwardly to the right of the magnet yoke 61. The compensating bimetal 95 is secured to the end portion 93 to the trip member 77 preferably by having a projection 94 on the portion 93 extending through a hole in the bimetal and spun or riveted over as shown, with the bent over lower end 96 of the bimetal preventing it from turning on the projection 94. An insulating button 97 on the compensating bimetal element 95 adjacent the magnetic yoke 61 insulates it from the magnet yoke so that none of the current of the circuit flows through the compensating bimetal element.

Means is provided for calibrating the trip device and comprises a screw 99 threaded through a nut 101 disposed in a recess 103 in the adjacent end wall of the housing 11. The inner end of the screw 99 engages the upper end of the conducting strip 29 on which the bimetal element 59 is mounted. An access opening 105 is provided through which the screw 99 may be rotated to adjust the trip device after which the opening 105 may be sealed to prevent tampering. Turning the screw 99 causes bending of the conductor 29 and corresponding variation of the position of the bimetal element 59 according to the

direction in which the screw is rotated to thereby vary the thermal tripping point of the breaker.

It will be noted that movement of the calibrating screw 99 inwardly to move the lower end of the bimetal to the right does not increase the air gap between the pole pieces or ends of the yoke 61 and the armature portion 78 to an amount greater than as shown, since the armature portion moves with the magnet after it engages the button 97, thus keeping the maximum air gap constant. This same action takes place when the bimetal is moved thermally so that the magnetic trip point remains constant irrespective of the thermal tripping action of the bimetal.

Upon the occurrence of a low persistent overload current below a predetermined value of, for example, ten times normal rated current, the bimetal element 59 is heated and bends toward the right carrying the magnet yoke 61 therewith. The magnet yoke 61 through the insulating button 97 and the ambient temperature compensating bimetal element 95 rotates the trip member 77 including the armature portion 78 counterclockwise causing it to release the carrier 45. The releasable means or carrier 45 then causes movement of the switch arm 33 to the open contact position in the previously described manner.

When an overload current above a value such, for example, as ten times normal rated current or a short circuit current occurs, the electromagnetic trip means is energized and the armature portion 78 of the trip member 77 is attracted toward the magnet yoke 61 causing instantaneous release of the carrier means 45 and opening of the contacts. This action takes place independently of the bimetal 59 which does not have to be bent and may be relatively stiff. The magnetic tripping action is quite sensitive because of (1) the increased number of ampere turns provided by the multi-turn coil (2) the low reluctance of the iron path where both ends of the yoke 61 face the armature portion 78, and (3) the mechanical advantage obtained by having the armature portion 78 at a greater distance from the pivots 79 than the spring 87.

The releasable means 45 is reset and relatched and the contacts closed following an automatic opening operation by first moving the handle 49 clockwise to the "off" position and then counterclockwise to the "on" position. When the handle is moved to the "off" position, the legs 37 of the operating lever 39 engage a pin 107 in the releasable means 45 and move it counterclockwise about its pivot 47 until the latch end 85 thereof is opposite the latch opening 83 in the armature 77 at which time the spring 87 returns the armature to latching position. This resetting action is easy because the trip member 77 is movable relative to the bimetal upon the rounded end of the end portion 85 of the releasable member 45 engaging the trip member 77 just below the opening 83 to rotate the trip member 77 against the force of the spring 87 only and without bending the bimetal 59. This protects the bimetal against possible loss of thermal calibration by being mechanically bent each time that the breaker is reset.

The high expansion sides of the tripping bimetal element 59 and of the compensating bimetal element are on the same side, that is, the left side, hence, movement of the tripping bimetal 59 in response to changes in ambient temperature is compensated for by a corresponding movement of the compensating bimetal 95 in the same direction.

According to the modification shown in FIGS. 3 and 4 a U-shaped magnet yoke 109 is mounted on the free end of the bimetal element 59 by means of a projection 111 on the magnet yoke which is rigidly secured to the bimetal element. The magnet yoke 109 is provided with pole pieces 113 that are spaced transversely of the bimetal element 59 and below the free end of the bimetal element. A multiple-turn energizing coil 115 is wound around the magnet yoke and has one end 117 secured to the bimetal element in any suitable manner that provides

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a good mechanical and electrical connection. The other end of the coil 115 is connected to the flexible conductor 55 (FIG. 1) and thereby to the movable switch member 33.

The bimetal and magnet assembly of FIGS. 3 and 4 is used with the same other structure as shown in FIG. 1 and the operation of the modification shown in FIGS. 3 and 4 is the same as that previously described for the device shown in FIG. 1.

We claim as our invention:

1. A circuit breaker comprising relatively movable contact means and means releasable to effect automatic opening of said contact means, a trip device operable to effect release of said releasable means and comprising a bimetal element having one end supported and the other end movable, electromagnetic trip means comprising a U-shaped magnet yoke having one leg secured to the bimetal element adjacent the movable end thereof and the other leg of said magnet yoke extending beyond the movable end of said bimetal element, said legs of said magnet yoke forming pole pieces spaced apart longitudinally of said bimetal element, an energizing coil surrounding said magnet yoke, and armature means adjacent said pole pieces to be attracted by energization of said electromagnetic means to move to effect release of said releasable means.

2. A circuit breaker comprising relatively movable contact means and means releasable to effect automatic opening of said contact means, a trip device operable to effect release of said releasable means comprising a bimetal element having one end supported and the other end free, electromagnetic trip means comprising a U-shaped magnet yoke having one leg secured to the bimetal element adjacent to the free end of the bimetal element, said magnet yoke extending beyond the free end of said bimetal element, said magnet yoke having spaced pole pieces, an energizing coil surrounding said magnet yoke, a trip member having armature means adjacent said pole pieces to be attracted by energization of said electromagnetic means to move to effect release of said releasable means, and means on said trip member positioned to be engaged by said magnet yoke upon thermal bending of said bimetal to actuate said trip member and effect release of said releasable means.

3. A circuit breaker comprising relatively movable contact means and means releasable to effect automatic opening of said contact means, a trip device operable to effect release of said releasable means comprising a current responsive bimetal element having one end supported and the other end free, electromagnetic trip means comprising a U-shaped magnet yoke having one leg secured to the bimetal element adjacent the free end thereof and the other leg of said magnet yoke extending beyond the free end of said bimetal element, said legs of said magnet yoke forming pole pieces spaced apart longitudinally of said bimetal element, an energizing coil surrounding one leg of said magnet yoke, a trip means including an armature adjacent said pole pieces to be attracted by energization of said electromagnetic means to move to effect release of said releasable means, and a temperature compensating bimetal element mounted on said trip means and positioned to be engaged by said magnet yoke upon thermal bending of said tripping bimetal element to actuate said trip means and effect release of said releasable means.

4. A circuit breaker having relatively movable contact means and means releasable to effect opening of said contact means, a trip device comprising a bimetal element having one end supported and the other end free, electromagnetic trip means comprising a U-shaped magnet yoke mounted on and extending beyond the free end of said bimetal element, the legs of said magnet yoke forming two spaced pole pieces, a multiple turn energizing winding surrounding said magnet yoke, an armature tripping structure, pivotal support means supporting said armature tripping structure on a first side of said

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bimetal and magnet yoke, said armature tripping structure comprising an armature part facing said two pole pieces, said armature tripping structure comprising an extension part extending to the side of said bimetal and magnet yoke that is opposite said first side, biasing means disposed on a first side of said pivotal support means and biasing said armature tripping structure to bias said armature part away from said two pole pieces, said bimetal element being thermally operable to flex to move said magnet yoke to thereby move said extension part to move said armature tripping structure to effect release of said releasable means, and said electromagnetic trip means being magnetically operable to move said armature part toward said two pole pieces to thereby move said armature tripping structure independent of said bimetal element to effect release of said releasable means.

5. A circuit breaker comprising relatively movable contact means and means releasable to effect opening of said contact means, a trip device operable to effect release of said releasable means comprising a bimetal element mounted at one end and having the other end free, electromagnetic means comprising a U-shaped magnet yoke having one leg mounted on the bimetal element adjacent the free end thereof, the other leg of said magnet yoke extending beyond the free end of said bimetal element, an energizing coil surrounding said magnet yoke, a rigid pivoted armature and trip means, pivotal support means pivotally supporting said armature and trip means intermediate the ends of said armature and trip means, said armature and trip means extending along one side of said bimetal element, said armature and trip means comprising an armature part disposed on a first side of said pivotal support means opposite said magnet yoke pole pieces, biasing means on the side of said pivotal support means that is opposite said first side and biasing said armature and trip means about said pivotal support means to bias said armature part away from said magnet yoke pole pieces, a portion of said armature and trip means extending below and to the opposite side of said magnet yoke, thermal bending of said bimetal element causing said magnet yoke to engage and move said armature and trip means to effect release of said releasable means, and upon sufficient energization of said coil said magnet yoke being energized to attract said armature part to effect pivotal movement of said armature and trip means independent of said bimetal to thereby effect release of said releasable means.

6. A circuit breaker comprising relatively movable contact means and means releasable to effect opening of said contact means, a trip device operable to effect release of said releasable means comprising a bimetal element supported at one end and having the other end free, electromagnetic means comprising a U-shaped magnet yoke having one leg mounted on the bimetal element adjacent the free end thereof, an energizing coil surrounding one leg of said magnet yoke, the other leg of said magnet yoke extending beyond the free end of said bimetal element, said legs of said magnet yoke comprising spaced pole pieces, movable armature means extending along one side of said bimetal element opposite said spaced pole pieces and having a portion connected thereto disposed at the other side of said bimetal element adjacent said magnet yoke so that thermal bending of said bimetal element causes said magnet yoke to engage and actuate said armature means to effect release of said releasable means.

7. A circuit breaker comprising relatively movable contact means and means releasable to effect automatic opening of said contact means, a trip device operable to effect release of said releasable means comprising an elongated bimetal element having one end supported and the other end movable, electromagnetic trip means comprising a U-shaped magnet yoke carried by the movable end of the bimetal element and having two pole faces both facing in the same direction to one side of the bimetal element, said U-shaped magnet yoke extending past the

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movable end of the bimetal element, said U-shaped magnet yoke being carried on the bimetal element such that the direction of spacing between said pole faces is generally in the direction of elongation of the bimetal element, a multi-turn coil of wire on said magnet yoke on said bimetal element with one end of the coil electrically connected to the bimetal element and the other end of the coil electrically connected to the contact means, a rigid pivoted armature having a portion opposite both of said pole faces and movable theretoward to cause said releasable means to effect opening of the contact means, and means also causing movement of said armature portion upon thermal movement of the bimetallic element.

8. A circuit breaker comprising relatively movable contact means and means releasable to effect automatic opening of said contact means, a trip device operable to effect release of said releasable means comprising an elongated bimetal element having one end supported and the other end movable, electromagnetic trip means comprising a U-shaped magnet yoke carried by said movable end of the bimetal element and having two pole faces both facing in the same direction to one side of said bimetal element, said pole faces being spaced generally in the direction of elongation of said bimetal element, said U-shaped magnet yoke extending past the movable end of said bimetal element, a multi-turn coil of wire on said magnet yoke carried on said bimetal element with one end of the coil electrically connected to said bimetal element adjacent the movable end of said bimetal element, a flexible conductor connecting the other end of the coil to the contact means, a rigid pivoted member of magnetic material extending along said bimetal element with an armature portion on one side thereof opposite both of said pole faces and movable about its pivot toward said pole faces to cause said releasable means to effect opening of the contact means, and a portion on said rigid pivoted member extending to the other side of said bimetal element for also causing movement of said rigid member of magnetic material about its pivot upon thermal bending of said bimetal element.

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