

[54] **CIRCUIT BREAKER WITH IMPROVED FLUX TRANSFER MAGNETIC ACTUATOR**

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[52] U.S. Cl. **335/174, 335/229, 335/262**

[51] Int. Cl. **H01h 9/20**

[58] Field of Search..... **335/174, 177, 179, 335/229, 230, 234, 262**

[56] **References Cited**

UNITED STATES PATENTS

1,650,799	11/1927	Lee	335/262
2,998,552	8/1961	Ray	335/262
3,530,414	9/1970	Wagner.....	335/174

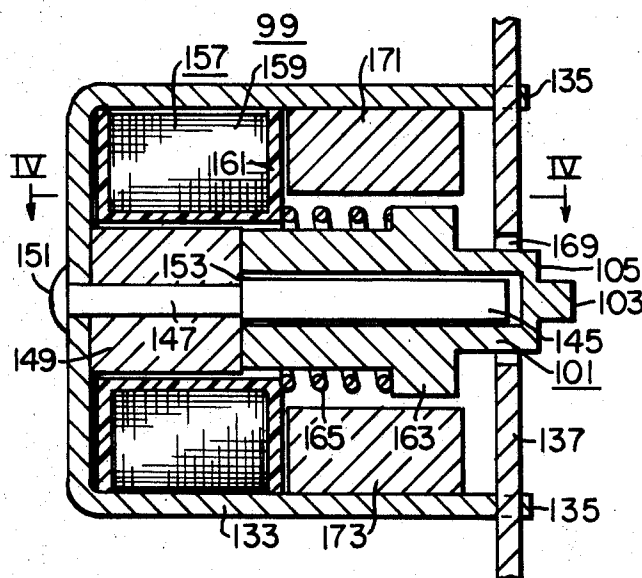
3,544,932	12/1970	Kuhn	335/174
3,675,166	7/1972	McCloskey et al.	335/229

Primary Examiner—Harold Broome
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[57] **ABSTRACT**

A circuit breaker comprises a magnetic trip actuator comprising an armature movably supported on a stationary non-magnetic support pin, and permanent magnet means supplying magnetic flux that operates through a magnetic supporting frame to maintain the armature in an initial position. When released, the armature moves in an opening in the frame to actuate the breaker mechanism to trip the breaker. Upon movement of an operating handle structure to a reset position to reset the mechanism of the circuit breaker, the handle structure engages a pivoted reset member to move the reset member against the armature to thereby reset the armature in the initial position.

7 Claims, 4 Drawing Figures



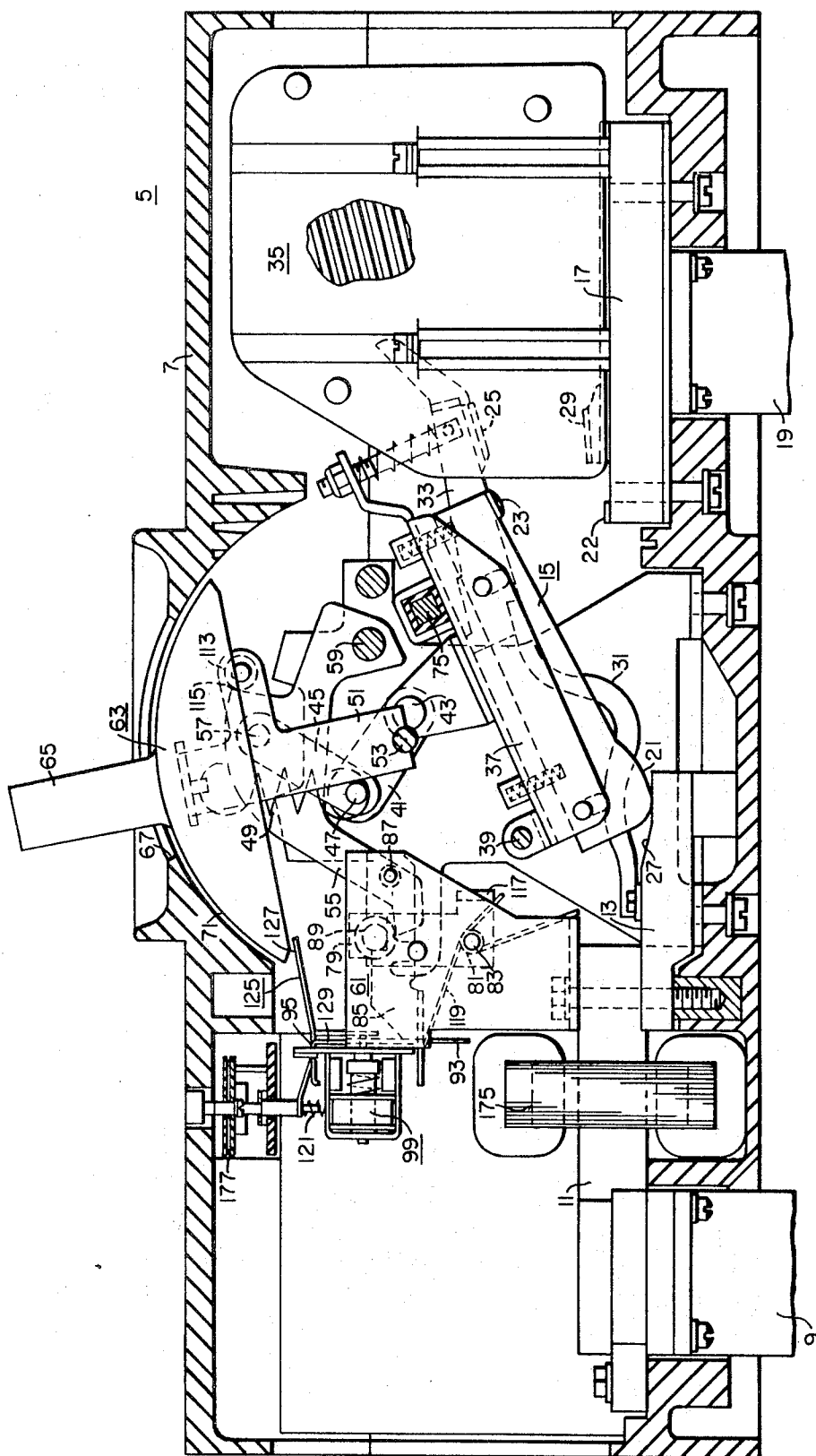


FIG. 1

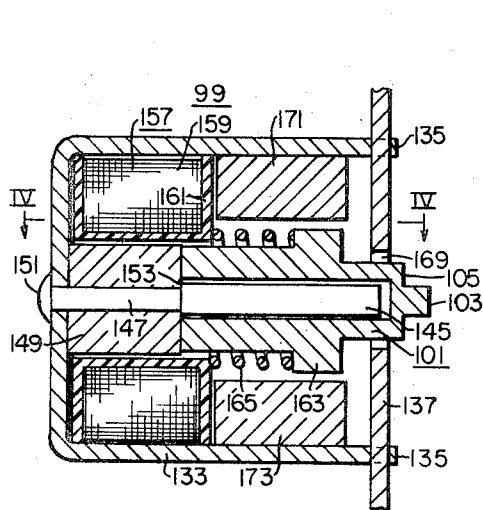


FIG. 3

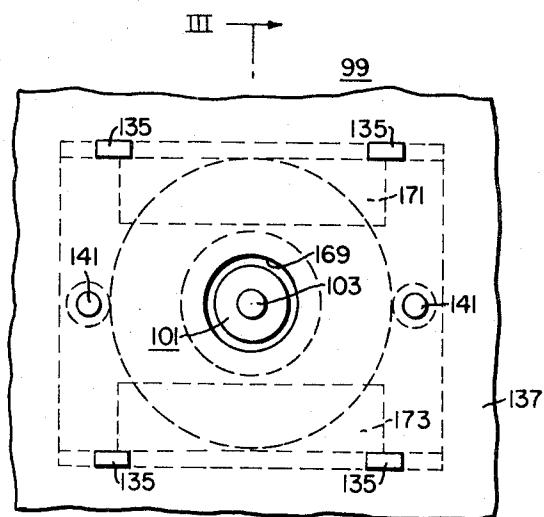


FIG. 2

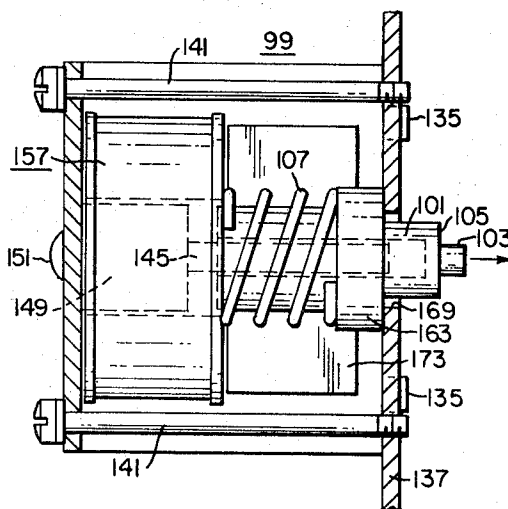


FIG. 4

CIRCUIT BREAKER WITH IMPROVED FLUX TRANSFER MAGNETIC ACTUATOR

CROSS-REFERENCES TO RELATED APPLICATIONS

The hereindisclosed circuit breaker is more specifically disclosed and described in the copending applications of Alfred D. Maier Ser. No. 327,961, filed Jan. 30, 1973; Alfred E. Maier et al Ser. No. 327,964, filed Jan. 30, 1973, and Alan B. Shimp Ser. No. 327,973, filed Jan. 30, 1973.

BACKGROUND OF THE INVENTION

1. Field of the Invention:

Circuit breakers of the type comprising a releasable mechanism releasable to trip the breaker and a flux transfer magnetic trip actuator operable to effect release of the releasable mechanism.

2. Description of the Prior Art

In the patents of Kuhn, U.S. Pat. No. 3,544,932 issued Dec. 1, 1970; to Patel, U.S. Pat. No. 3,544,931 issued Dec. 1, 1970; and to Wagner, U.S. Pat. No. 3,530,414 issued Sept. 22, 1970, there are disclosed circuit breakers having flux transfer magnetic trip actuators of the type comprising an armature structure releasable to trip the breaker and permanent-magnet means operating to maintain the armature structure in an initial non-tripping position.

SUMMARY OF THE INVENTION

A circuit breaker comprises cooperable contacts, a releasable mechanism releaseable to effect a tripping operation automatically opening the contacts and a flux transfer magnetic trip actuator operable to release the mechanism. The trip actuator comprises a frame of magnetic material having an opening therein, a non-magnetic support pin supported in the frame and a tubular shaped magnetic armature supported on the support pin in an initial position. Spring means biases the armature toward an actuating or tripping position. Permanent magnet means supported in the frame supplies magnetic flux that operates in a first magnetic circuit through the frame and armature to maintain the armature in the initial position. Coil means supported in the frame is energizable to affect the magnetic flux to thereby effect release of the armature whereupon the spring means moves the armature through the opening in the frame to the tripping position to release the mechanism to thereby affect opening of the contacts. During resetting operations of the mechanism, when the circuit breaker handle structure is moved to a resetting position, the handle structure engages a pivoted reset member to move the reset member against the armature structure to thereby reset the armature structure in the initial position.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side sectional view, with parts broken away, of the center pole unit of a three-pole circuit breaker constructed in accordance with the principles of this invention;

FIG. 2 is an end view, with parts broken away, of the flux transfer magnetic trip actuator seen in FIG. 1;

FIG. 3 is a sectional view taken generally along the line III—III of FIG. 2; and

FIG. 4 is a sectional view taken along the line IV—IV of FIG. 3 with the armature shown in the actuated or tripping position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, there is shown in FIG. 1 the center pole unit of a three-pole molded-case type circuit breaker 5. The circuit breaker mechanism is more specifically described in the above-mentioned patent applications Ser. No. 327,961 and Ser. No. 327,964. Thus, only a brief description of the circuit breaker mechanism is provided herein. The circuit breaker 5 comprises an insulating housing 7 and suitable barrier means that separates the housing into three adjacent insulating compartments for housing the three pole units of the three-pole circuit breaker in a well-known manner. In the closed position of the circuit breaker, a circuit through each pole unit extends from a terminal 9 through a conductor 11, a conductor 13, a movable contact structure indicated generally at 15, a conductor 17, to another terminal 19. Contacts 21, 23 and 25 on the movable contact structure 15 cooperate with stationary contacts 27, 28 and 29 to bridge the conductors 13, 17 in the closed position of the movable contact structure 15. A flexible conductor 31 electrically connects the conductor 13 and a movable contact arm 33, that supports the arcing contacts 25. During opening operations of the movable contact structure 15, the arcing contact 25 separates from the stationary arcing contact 29 last to draw arcs in an arc-extinguishing structure indicated generally at 35. The movable contact structure 15 is supported on a contact carrier 37 that is supported for pivotal movement on a pin 39. A lower toggle link 41 is pivotally connected to the contact carrier 37 at the lower end thereof by means of a pivot pin 43. The lower toggle link 41 is pivotally connected to an upper toggle link 45 by means of a knee pivot pin 47. A pair of over center tension springs 49 are connected at the lower ends thereof to the knee pivot 47 of the toggle and at the upper ends thereof to the bight portion of an operating lever 51. The operating lever 51 is an inverted generally U-shaped lever that is supported on the inner ends of the legs thereof for pivotal movement about a pair of pins 53. The upper toggle link 45 is pivotally connected to a releaseable member 55 by means of a pivot pin 57. The releaseable member 55 is supported for pivotal movement at one end thereof on a pin 59 and is latched at the other end thereof by means of a latch structure indicated generally at 61. A handle structure indicated generally at 63 is connected to the upper end of the operating lever 51 and comprises a handle part 65 that protrudes through an opening 67 in the front of the housing 7 to permit manual operation of the circuit breaker. The handle structure 63 also comprises a shroud part 71 that substantially closes the opening 67 in all positions of the handle structure 63.

The circuit breaker is shown in FIG. 1 in the open position with the releasable trip member 55 latched in the latched position by means of the latch structure 61. In order to close the circuit breaker, the handle 65 is moved in a clockwise direction from the "off" position to an "on" position to move the operating lever 51 clockwise about the pivot 53. During this movement, the springs 49 are moved overcenter to erect the toggle 41, 45 to thereby pivot the movable contact carrier 37

of the center pole unit in a clockwise direction about the pivot pin 39 to move the movable contact structure 15 into the closed position. Since all of the contact carriers 37 of the three pole units are connected for simultaneous movement by means of a rigid insulating tie bar 75, this movement simultaneously closes the contact structures of all three pole units. In order to manually open the circuit breaker, the handle structure 63 is moved counterclockwise to the off position seen in FIG. 1. This moves the springs 49 overcenter to cause collapse of the toggle 41, 45 to thereby pivot the three contact carriers 37 about the pivot pins 39 in a counterclockwise direction to the open position shown in FIG. 1.

The free end of the releasable member 55 is engaged under a roller member 79 that is mounted on a first latch member 81 that is pivotally supported on a fixed pivot pin 83. A second latch member 85, that is supported for pivotal movement on a pair of spaced pins 87 (only one of which is seen in FIG. 1) comprises a pair of arms that engage a pair of second rollers 89 that are supported on the first latch member 81 to latch the first latch member 81. A third latch member 93 is supported for pivotal movement about an axis that extends normal to the plane of the paper as seen in FIG. 1 and that is indicated at 95. The latch member 81 comprises a window opening that receives a projection on the second latch member 85 to latch the second latch member 85 in the latched position seen in FIG. 1.

An improved flux transfer magnetic trip actuator indicated generally at 99 is provided to effect tripping operations of the circuit breaker, in a manner to be hereinafter described, upon the occurrence of an overload current in any of the three pole units of the circuit breaker. The magnetic trip actuator 99 comprises an armature 101 (FIGS. 2-4) that comprises a projection 103 and a shoulder 105. When the armature 101 is released, in a manner to be hereinafter described, a spring 107 moves the armature from the initial position seen in FIG. 3 to the actuated or tripping position seen in FIG. 4. During this movement, the projection 103 moves through an opening in the third latch member 93 (FIG. 1) and the shoulder portion 105 engages the third latch member 93 to pivot the third latch member 93 in a counterclockwise direction about the axis 95 thereof. With the circuit breaker in the closed position and the toggle 41, 45 in the erected position the springs 49 are in a charged condition, and movement of the latch member 93 to the unlatching position will release the latch structure 61 to release the releasable member 55 whereupon the charged springs 49 will collapse the toggle 41, 45 to trip the breaker. Upon movement of the third latch member 93 to the unlatched position the second latch member 85 and first latch member 81 will be free to move to an unlatched position. The charged springs 49, operating against the releasable member 55 biasing the releasable member 55 in a clockwise direction about the pivot 59, will force the releasable member 55 clockwise to force the first latch member 81 counterclockwise to force the second latch member 85 counterclockwise, and the releasable member 55 will move clockwise changing the line of action of the overcenter springs 49 whereupon the springs 49 will collapse the toggle 41, 45 and move the contact carriers 37 of the three pole units to a tripped open position. This movement will move the handle structure 63 to a position intermediate the on and off positions to pro-

vide a visual indication that the circuit breaker has been tripped.

Following a tripping operation, it is necessary to reset and relatch the mechanism before the circuit breaker can be closed. In order to reset the circuit breaker, the handle structure 63 is moved counterclockwise from the intermediate position to an reset position past the off position seen in FIG. 1. During this movement, a pin portion 113 on the operating lever 51 engages a shoulder 115 on the releasable member 115 to rotate the releasable member 115 in a counterclockwise direction whereupon the free end of the releaseable member engages a part 117 of the first latch member 81 to pivot the first latch member 81 in a clockwise direction about the pivot pin 83 to a reset position whereupon spring means 119 biases the second latch member 85 to the latching position and spring means 121 biases the third latch member 93 to the latching position. During the resetting operation, the handle structure 63 is moved to the reset position which reset position is almost to the limit of movement of the operating above-mentioned handle structure 63 in the opening 67. During this movement, the shroud 81 on the handle structure 63 engages a reset member 125, that comprises a horizontal arm 127 and a generally vertical arm 129. The reset member 125 is supported for pivotal movement about the axis 95. Upon movement of the handle structure 63 to the reset position, the shroud 71, engaging the arm 127 of the reset member 125, pivots the reset member 125 in a clockwise (FIG. 1) direction whereupon the arm 129, operating against the projection 103 (FIG. 4) of the magnetic trip actuator 99, moves the armature 101 from the actuated or tripping position seen in FIG. 4 to the initial or reset position seen in FIG. 3 whereupon the magnetic trip actuator is reset and will be maintained in the reset position in a manner to be hereinafter described. Following a resetting operation, the circuit breaker can be operated in the same manner as was hereinbefore described. The manual, tripping and resetting operations of the circuit breaker are more specifically described in the above-mentioned patent application of Alfred E. Maier Ser. No. 327,961.

The flux transfer magnetic trip actuator 99 (FIGS. 2-4) comprises a U-shaped magnetic frame 133 of soft magnetic material such as iron. There are two projecting end portions 135 on each of the legs of the U-shaped frame 133, and the projecting portions 135 project through openings in a magnetic plate 137 of soft magnetic material such as iron. Two elongated bolts 141 (FIGS. 2-4) are threaded into the plate 137 to secure the magnetic plate 137 and magnetic frame parts 133 together to provide a magnetic frame that houses the parts of the magnetic trip actuator 99. A pin 145 of non-magnetic material such as brass, is provided with a reduced portion 147 that extends through an opening in a magnetic pole piece 149 of soft magnetic material such as iron, and through an opening in the end part of the frame 133. The pin 145 is riveted over at 151 to secure the pin 145 and pole piece 149 to the frame 133. As can be understood with reference to FIG. 3, the pin 145 comprises a shoulder part 153 that is drawn against the pole piece 149 to secure the pole piece 149 and pin 145 in a stationary position when the pin is riveted over at 151. A coil 157, that comprises a conducting coil part 159 and an insulating cover 161, is positioned over the pole piece 149. The armature

101, which is of soft magnetic material such as iron, comprises a collar part 163. A coil spring 165, which is supported over the armature 101, is disposed between the coil 157 and collar part 163 to bias the armature 101 toward an extended actuating position. As can be understood with reference to FIG. 3, the armature 101 comprises a tubular part and the armature fits over the non-magnetic pin 145 which serves as a bearing support permitting rectilinear movement of the armature 101 on the pin 145. The armature 101 comprises a first reduced end portion that fits through an opening 169 in the magnetic plate 137. A pair of permanent magnet members 171 and 173 are disposed on opposite sides of the armature 101 and magnetically held in place against the opposite legs of the magnetic frame 133.

In each pole unit of the circuit breaker, a current sensing transformer 175 is disposed over the conductor 11 to sense the overload current and operate through another transformer (not shown) and a static circuit supported on a static circuit board 177, to energize the coil 157 of the magnetic trip actuator to release of the armature 101 to thereby effect a tripping operation of the circuit breaker in response to overload current conditions above a predetermined value. The tripping operation is more specifically described in the patent applications of Alfred E. Maier et al Ser. No. 327,961, and Alan B. Shimp Ser. No. 327,973.

Referring to FIGS. 1 and 3, the magnetic trip actuator 99 is shown therein in the initial or non-tripping position. The armature 101 is maintained in this position against the bias of the spring 165 by the magnetic flux that is supplied by the permanent magnets 171, 173. The magnetic flux from the permanent magnet 171 works in a magnetic circuit that extends from the permanent magnet 171 through the magnetic frame part 133, the pole piece 149, the armature 101, the collar 163 of the armature 101, through the gap between the collar 163 of the armature and the permanent magnet 171, and back through the permanent magnet 171. The magnetic flux from the permanent magnet 173 works in a magnetic circuit from the permanent magnet 173 through the magnetic frame part 133, the magnetic pole piece 149, the armature 101, the collar portion 163 of the armature, the air gap between the collar portion 163 and the permanent magnet 173, back through the permanent magnet 173. The magnetic flux from the permanent magnets 171, 173 is strong enough to maintain the armature 101 in the initial or non-tripping position, abutting the pole piece 149, against the bias of the coil spring 165 which biases the armature 101 toward an actuating or tripping position. When the coil 157 is energized by a DC current upon the occurrence of an overload current condition above a predetermined value through the circuit breaker, the reluctance of the above-mentioned magnetic holding circuits is increased and the spring 165 overcomes the holding force of the permanent magnets 171, 173 and moves the armature 101 to the right to the actuating or tripping position seen in FIG. 4, which movement is limited by the engagement of the collar portion 163 of the armature 101 with the magnetic plate 137. Upon movement of the armature 101 to the tripping position seen in FIG. 4, the circuit breaker mechanism is released and the circuit breaker is tripped open in the same manner as was hereinbefore described. With the armature 101 in the tripping position, the flux from the permanent

magnet member 171 operates through the adjacent leg of the magnetic frame 133, the magnetic plate 137, the radial air gap at the opening 169, the armature 101, the air gap between the collar portion 163 of the armature 101 and the permanent magnet member 171, back through the permanent magnet member 171. The flux from the permanent magnet member 173 operates through the lower leg (FIG. 3) of the magnetic frame part 133, the magnetic plate 137, the radial air gap at the opening 169, the armature 101, the collar portion 163 of the armature 101, the air gap between the collar portion 163 of the armature 101 and the permanent magnet member 173, back through the permanent magnet 173. The armature 101 will remain in the actuating or tripping position seen in FIG. 4 until the circuit breaker is reset and relatched in the same manner hereinbefore described during which operation the reset member 125 (FIG. 1) is pivoted in a clockwise direction to move against the projecting part 103 of the armature 101 to move the armature 101 back to the initial position seen in FIG. 3. When the armature 101 reaches the initial position seen in FIG. 3, the permanent magnets 171, 173 will maintain the armature 101 in the initial position against the bias of the spring 165 in the same manner as was hereinbefore described. The armature 101 will remain in the initial position until the coil 157 is again energized to effect another tripping operation.

Referring to FIG. 3, it can be understood that during the assembly operation, the pole piece 149 and coil 157 are moved down into place in the U-shaped frame part 133 and thereafter the spring 165, armature 163 and non-magnetic pin 145 are moved into position. The end of the pin 145 protrudes through the opening in the frame 133 and is thereafter riveted over to secure the parts in position. Thereafter the permanent magnets 171, 173 are set in place and the magnetic frame plate 137 is moved into position receiving the leg parts 135 in openings thereof whereupon the bolts 141 are threaded into the magnetic plate 137 to hereby secure the assembly together as shown in FIGS. 2-4.

The design of the magnetic trip actuator 99 provides for a relatively simple construction that is easily assembled and that provides an armature of reduced mass that is less likely to be accidentally released under physical shock conditions or under stray magnetic fields. Armature acceleration is also enhanced by the reduced mass of the armature. The armature, which is mounted for generally rectilinear movement on the non-magnetic support pin, is well aligned with the pole piece 149 providing a good flat mating surface between the armature and the pole piece in the initial position of the armature. The provision of the second magnetic circuit through the radial air gap of the back plate enhances increased speed of flux transfer and therefore faster switching speed during tripping operations and cooperates with the advantage of having the armature of reduced mass to enable a lighter biasing spring for biasing the armature toward the tripping position which also enables the utilization of smaller permanent magnets in the construction. Although the magnetic trip actuator is herein specifically disclosed in combination with a molded-case type circuit breaker, it is to be understood that the magnetic trip actuator could be utilized with other apparatus and with other types of circuit breakers or switching devices.

We claim:

1. A circuit breaker comprising a pair of contacts, a trip actuator, said trip actuator comprising a frame of magnetic material, said frame having an opening therein, a non-magnetic support pin supported in said frame, a tubular shaped magnetic armature supported for movement on said stationary support pin in proximity to said opening, permanent magnet means supported in said frame and supplying magnetic flux that operates in a first magnetic circuit through said support frame and said armature to maintain said armature in an initial position, spring means biasing said armature toward an actuating position, coil means energizable to affect said magnetic flux to thereby effect release of said armature, and upon release of said armature said spring means moving said armature on said stationary support pin through said opening to a tripping position to effect opening of said contacts.

2. A circuit breaker according to claim 1, said magnetic frame comprising a magnetic generally U-shaped part and a magnetic base part extending across the legs of said magnetic generally U-shaped part, said first magnetic circuit extending through said permanent magnet means in said generally U-shaped magnetic part, and upon movement of said armature to said tripping position said permanent magnet means supplying magnetic flux that operates in a second magnetic circuit through the leg portions of said generally U-shaped part said magnetic base plate and said armature. magnetic.

3. A circuit breaker according to claim 1, said magnetic frame comprising a generally U-shaped magnetic part comprising a pair of opposite legs and a bight portion between said opposite legs, said magnetic frame comprising a magnetic base plate part extending across said opposite legs in proximity to the free ends of said opposite legs, a magnetic pole piece on said support pin between said armature and said bight portion, said opening in said frame being in said magnetic base plate part, said coil being disposed between the legs of said magnetic U-shaped part over said pole piece, said permanent magnet piece comprising a pair of magnet members each of which magnet members is disposed adjacent a different leg of U-shaped part with said magnet members being disposed on opposite sides of said

armature, said permanent magnet members supplying magnetic flux that operates in said first magnetic circuit through said opposite legs of said U-shaped part, said bight part, said pole piece means and said armature to maintain said armature in said initial position against the bias of said spring means, upon energization of said coil magnetic flux being transferred to a second magnetic circuit through said permanent magnet members, said opposite of said U-shaped part said magnetic base plate part and said armature whereupon said spring means moves said armature through said opening to said second position to effect opening of said contacts.

4. A circuit breaker according to claim 1, said circuit breaker comprising an insulating housing having an opening therein, an operating handle extending through said opening and being manually operable to open and close said contacts, upon the occurrence of a tripping operation said operating handle being movable to a reset position to reset said circuit breaker, and upon movement of said handle to said reset position said handle structure operating to move said armature back to said initial position.

5. A circuit breaker according to claim 4, an intermediate reset member pivotally supported in proximity to said armature, said operating handle upon movement to said reset position pivoting said reset member whereupon said reset member operates against said armature to move said armature to said initial position.

6. A circuit breaker according to claim 3, said circuit breaker comprising an insulating housing having an opening therein, an operating handle extending through said opening and being manually operable to open and close said contacts, upon the occurrence of a tripping operation said operating handle being movable to a reset position to reset said circuit breaker, and upon movement of said handle to said reset position said handle structure operating to move said armature back to said initial position.

7. A circuit breaker according to claim 6, an intermediate reset member pivotally supported in proximity to said armature, said operating handle upon movement to said reset position pivoting said reset member whereupon said reset member operates against said armature to move said armature to said initial position.

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