

- [54] **MULTI-POLE CIRCUIT BREAKER WITH SINGLE TRIP ADJUSTMENT FOR ALL POLES**
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- [73] Assignee: **Westinghouse Electric Corporation**, Pittsburgh, Pa.
- [22] Filed: **Feb. 6, 1968**
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- [52] U.S. Cl. **335/8, 335/42, 335/17**
- [51] Int. Cl. **H01h 71/74**
- [58] Field of Search **335/8, 9, 10, 38**
335/42, 17

[56]

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Primary Examiner—Harold Broome

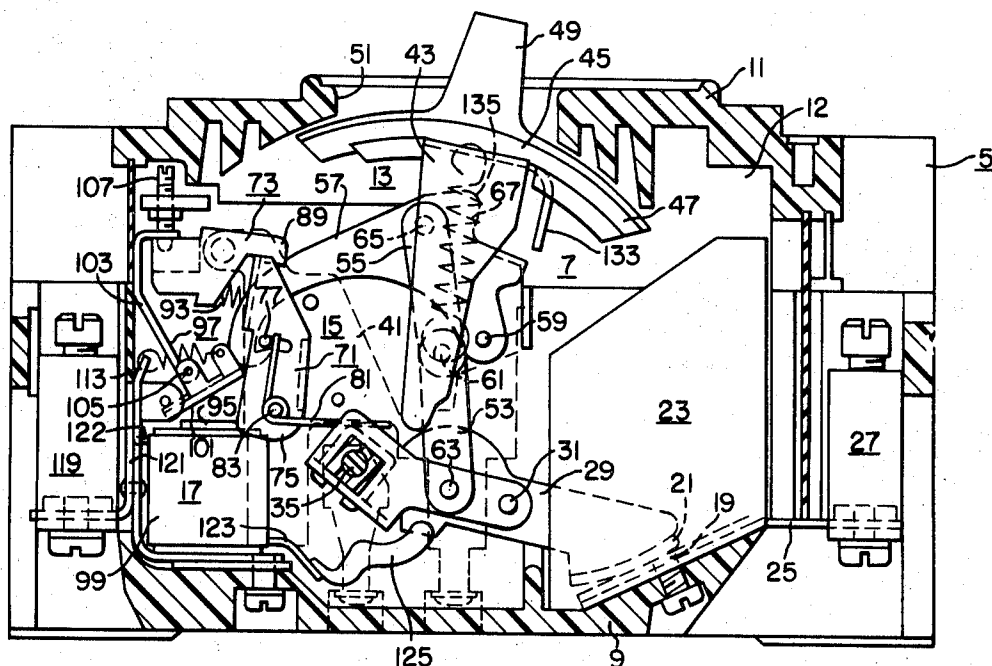
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ABSTRACT

A multi-pole circuit breaker comprising a separate trip device for each pole and a single trip adjusting means operable to simultaneously vary the tripping characteristics of all of the poles.

12 Claims, 14 Drawing Figures



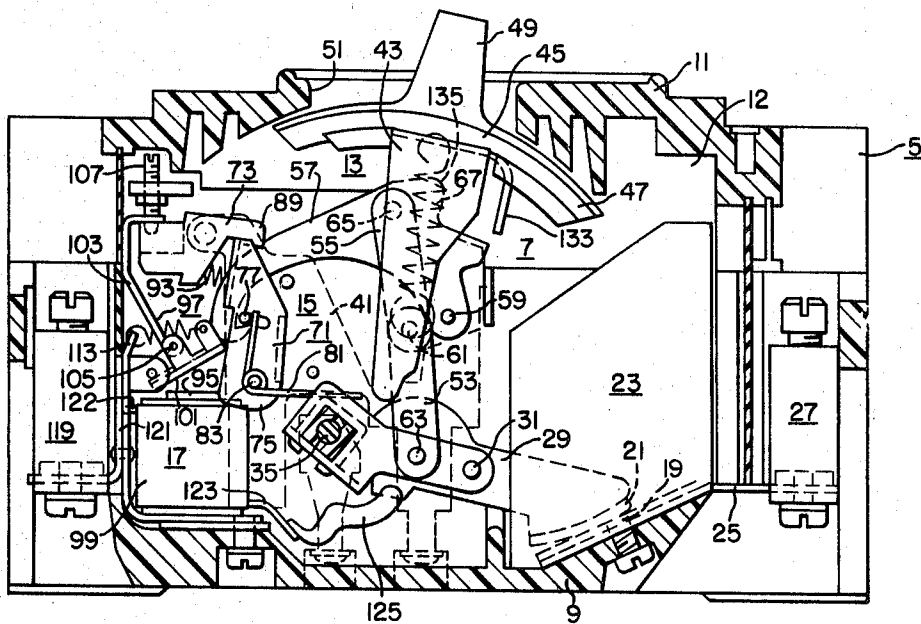
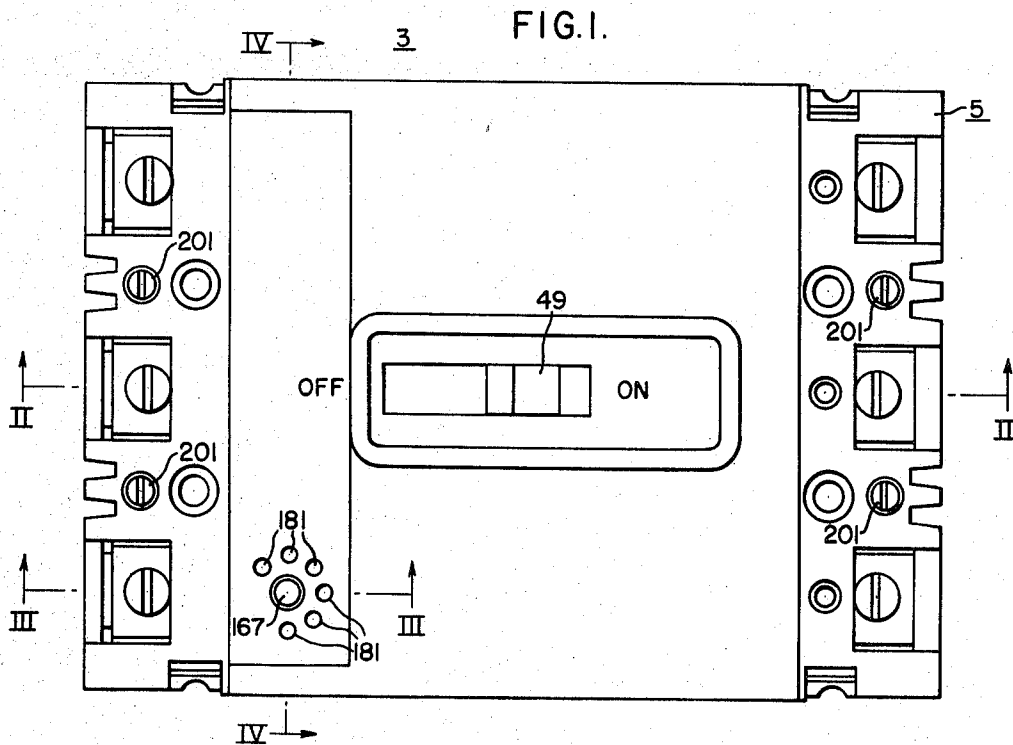


FIG. 2.

WITNESSES

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FIG. 4.

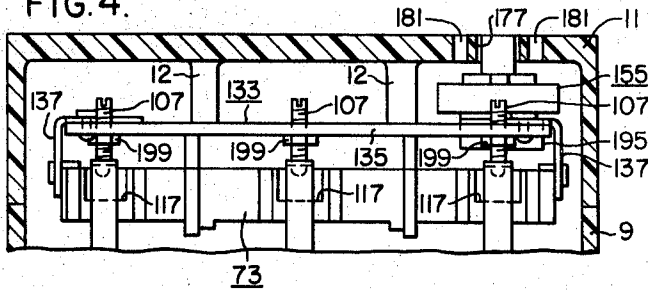


FIG. 3.

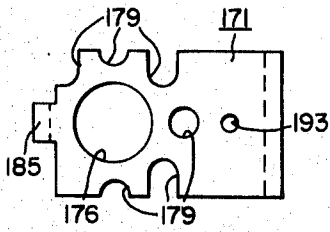
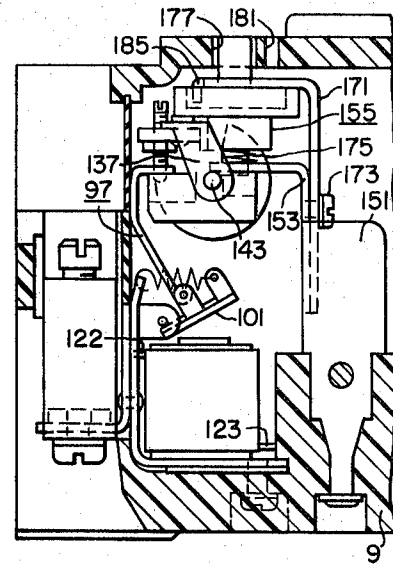


FIG. 7.

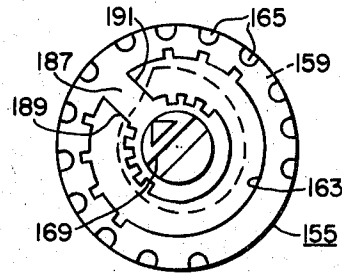


FIG. 6.

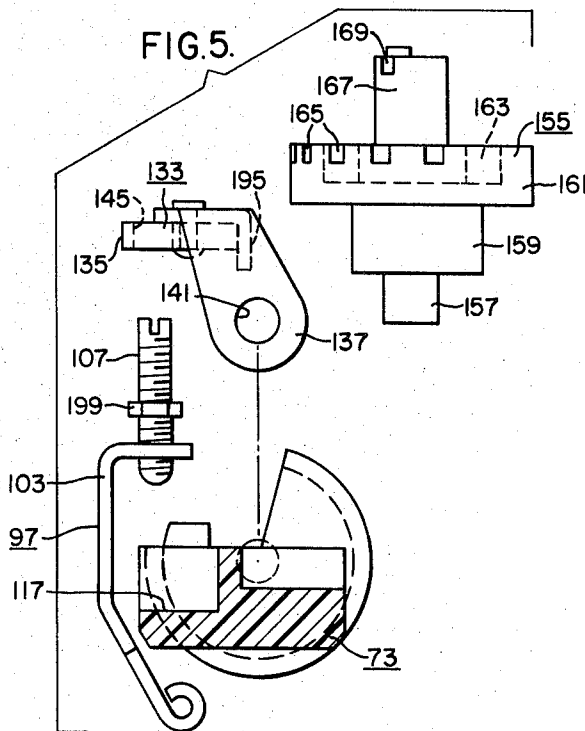


FIG. 5.

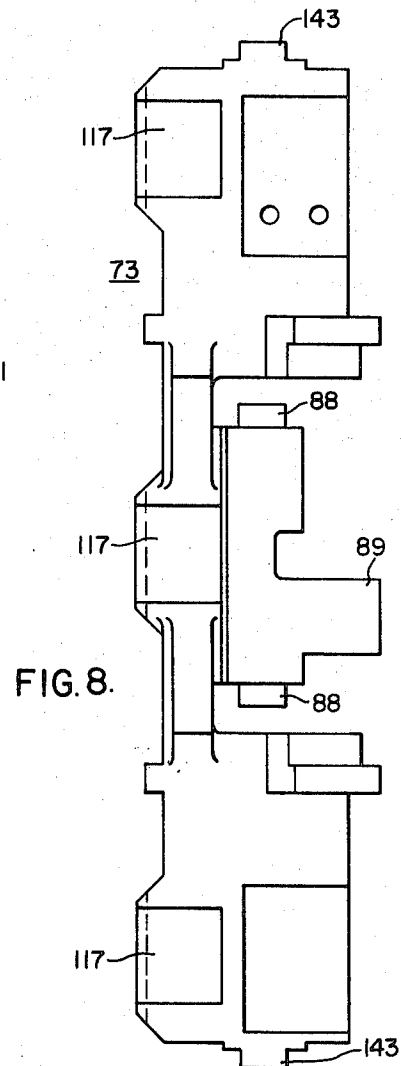


FIG. 8.

FIG. 9.

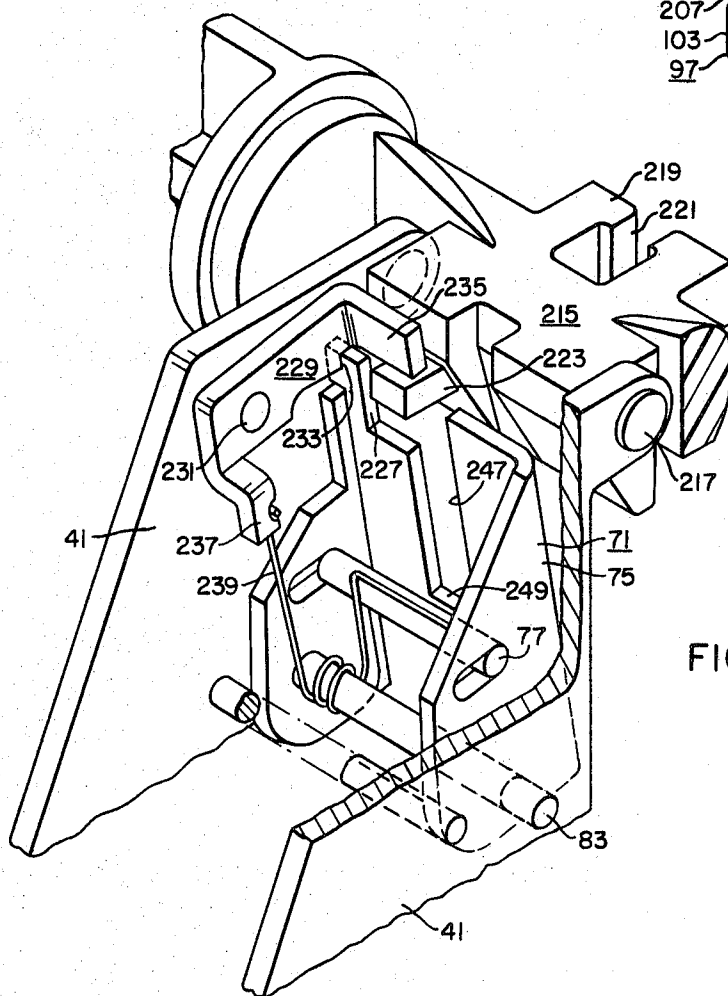
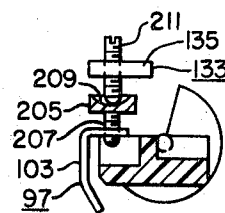


FIG. 14.

FIG.12.

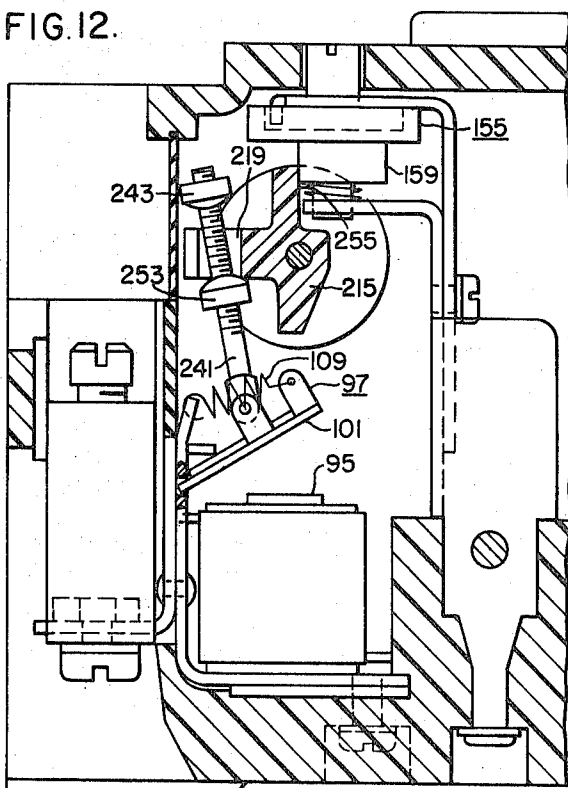


FIG.13.

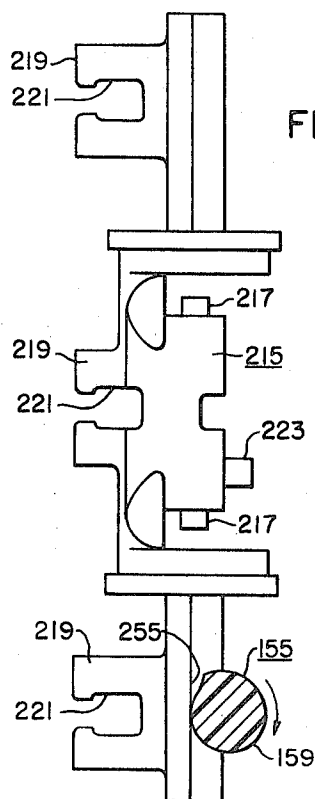


FIG.10.

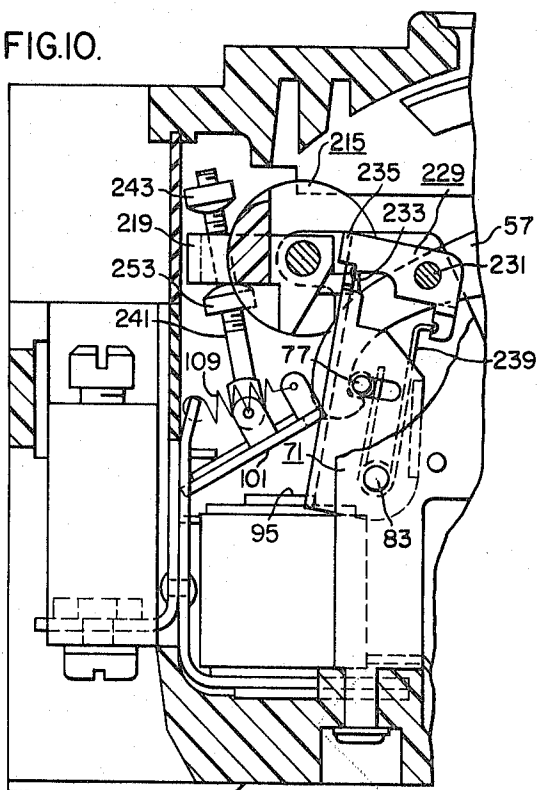
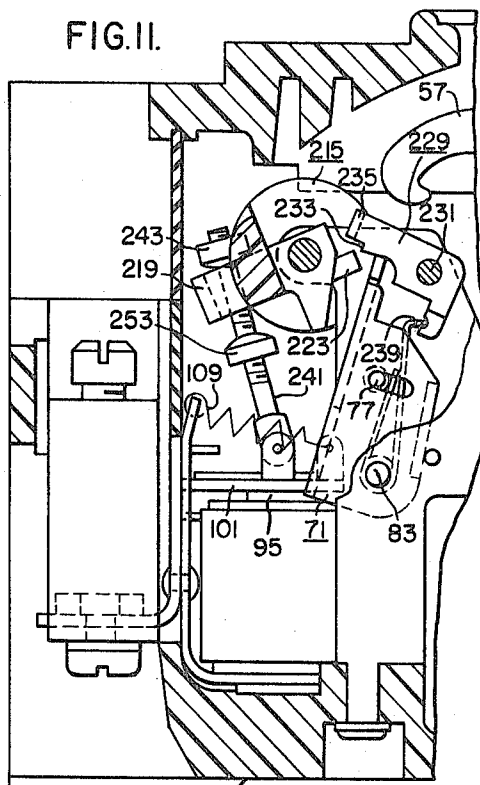


FIG.11.



MULTI-POLE CIRCUIT BREAKER WITH SINGLE TRIP ADJUSTMENT FOR ALL POLES

CROSS-REFERENCE TO RELATED APPLICATIONS

Certain features disclosed herein are disclosed in the copending patent application of James P. Ellsworth et al. Ser. No. 703,409 filed concurrently herewith, now U.S. Pat. No. 3,575,679.

BACKGROUND OF THE INVENTION

It is desirable to provide a multi-pole circuit breaker with a single trip adjustment for all poles so that a worker need only make one adjustment to adjust the breaker. Moreover, certain types of multi-pole circuit breakers are constructed with a single operating mechanism and latching mechanism in only one pole unit, and with the trend toward making circuit breakers more compact it becomes increasingly difficult to provide enough space for a trip adjusting structure in the pole unit that houses the operating mechanism and latch mechanism. With a single trip adjustment, the trip adjusting structure can be mounted in the pole unit that does not house the operating and latch mechanism to thereby enable the construction of a more compact multi-pole circuit breaker with adequate trip adjustment. This construction also leaves space for an attachment device in one of the outer pole units.

SUMMARY OF THE INVENTION

A multi-pole circuit breaker comprises an insulating housing having barrier means therein forming a plurality of compartments in a side-by-side relationship with each compartment housing a separate pole unit that comprises a separate pair of contacts. An operating mechanism that is operable to simultaneously open and close all of the pairs of contacts, comprises a latched trip member releasable to effect automatic opening of all of the pairs of contacts. A trip bar common to all of the pole units is operatively movable to effect release of the releasable trip member. In each pole unit there is a separate electromagnetic trip device comprising a stationary magnetic member and a movable armature structure in an initial position spaced from the stationary magnetic member by an air gap. A single adjusting means comprises an adjusting bar common to all of the pole units and an adjusting member operable to move the adjusting bar to simultaneously move the armature structures to thereby simultaneously vary the air gaps. The housing comprises a generally planar back, and the adjusting member, which is rotatable about an axis normal to the plane of the back, is accessible for operation from the front of the housing. In the preferred embodiment, the trip bar is in latching engagement with a latch structure to latch the releasable member, and the adjusting bar is mounted for movement about an axis common to the axis of movement of the trip bar for movement relative to the trip bar. In this embodiment, the trip bar does not move during adjustment so that the latch engagement between the trip bar and the latch structure is not disturbed during the adjustment. In another embodiment of the invention, a separate latch is provided to latch the latch structure, and the trip bar, which is not in engagement with the latch structure or separate latch, moves to a position engaging the separate latch to effect release of the latch structure and releasable member during tripping opera-

tions. In this embodiment, the trip bar serves as the common adjusting bar since adjusting movement of the trip bar does not disturb or vary any latch engagement. In each of the embodiments, three adjustments are made. One adjustment in each pole provides that the trip bar will be picked up and moved to the tripping position near the end of the armature movement. A second adjustment is provided in each pole to provide an initial calibration setting the magnetic air gap in the associated pole. The first and second adjustments are made during assembly of the breaker. The third adjustment is the single external adjustment for simultaneously adjusting the air gaps of the three poles of the assembled breaker. A fourth adjustment can be made during the assembly of the breaker in that the spring tension of each armature structure can be adjusted by bending the associated spring supporting frame.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top plan view of a multi-pole circuit breaker constructed in accordance with principles of this invention;

FIG. 2 is a sectional view taken generally along the line II—II of FIG. 1;

FIG. 3 is a sectional view taken generally along the line III—III of FIG. 1;

FIG. 4 is a sectional view, with parts broken away, taken generally along the line IV—IV of FIG. 1;

FIG. 5 is an exploded view, partly in section and with parts broken away, of parts of the trip and adjusting structures seen in FIG. 3;

FIG. 6 is a top plan view of the adjusting member seen in FIG. 5;

FIG. 7 is a top plan view of the support member seen in FIG. 3;

FIG. 8 is a top plan view of the trip bar seen in FIGS. 2-5;

FIG. 9 is a side view, with parts broken away, and with parts shown in section, illustrating a modification of the trip and adjusting means disclosed in FIGS. 2-5;

FIG. 10 is a partial view similar to FIG. 2 illustrating still another embodiment of the invention;

FIG. 11 is a view similar to FIG. 10 with the parts shown in the tripped open position;

FIG. 12 is a view similar to FIG. 3 of the embodiment disclosed in FIGS. 10 and 11;

FIG. 13 is a top plan view of the trip bar disclosed in FIGS. 10-12 with part of the adjusting member of FIG. 12 shown in section to illustrate the cooperation between the cam adjusting member and the trip bar; and

FIG. 14 is a perspective view, with parts broken away and on an enlarged scale relative to FIGS. 10-13, illustrating the latch structure disclosed in FIGS. 10 and 11.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, there is shown, in FIGS. 1 and 2, a three-pole circuit breaker 3 comprising an insulating housing 5 and a circuit breaker mechanism 7 supported in the housing 5. The housing 5 comprises an insulating base 9, having a generally planar back, and an insulating front cover 11 secured to the base 9. The housing 5 comprises insulating barrier means 12 separating the housing into three adjacent side-by-side pole unit compartments in a manner well known in the art.

The circuit breaker mechanism 7 comprises a single operating mechanism 13 and a single latch mechanism

15. The circuit breaker mechanism 7 also comprises a separate electromagnetic trip device 17 in each of the three pole units.

A stationary contact 19; a movable contact 21 and an arc-extinguishing unit 23 are provided in each pole unit of the breaker. The stationary contact 19 for each pole unit is fixedly mounted on the inner end of a conducting strip 25 that extends outward to an external cavity where a solderless terminal connector 27 is secured to the outer end of the member 25. The movable contact 21 for each of the pole units is mounted on a conducting contact arm 29 that is pivotally mounted, by means of a pin 31, on a switch arm 33 that is fixedly secured to an insulating tie bar 35. The switch arms 33 for all three of the pole units are secured to the common tie bar 35 for common movement with the tie bar that is pivotally mounted, by means of suitable pivot pins, on the side walls of the breaker housing. Suitable spring means (not shown) in each pole unit biases the associated contact arm 29 in a clockwise (FIG. 2) direction about the associated switch arm 33 to provide contact pressure in the closed position of the contacts. Suitable stop means is provided to limit clockwise movement of the contact arm 29 on the associated switch arm 33.

The single operating mechanism 13 is positioned in the center pole unit of the three-pole circuit breaker. The operating mechanism 13 is supported on a pair of spaced metallic rigid supporting plates 41 that are fixedly secured to the base 9 in the center pole unit of the breaker. An inverted U-shaped operating lever 43 is pivotally supported on the spaced plates 41 with the inner ends of the legs of the lever 43 positioned in U-shaped notches in the plates 41. An insulating operating member 45, comprising an insulating shield 47 and an insulating handle part 49, is fixedly secured to the front portion of the operating lever 43. The handle 49 protrudes out through an opening 51 in the front of the cover 11, and the shield 47 closes the opening 51 in all positions of the handle.

The switch arm 33 for the center pole unit is operatively connected, by means of a toggle comprising toggle links 53 and 55, to a releasable trip member 57 that is pivotally supported on the supporting plates 41 by means of a pin member 59. The toggle links 53, 55 are pivotally connected together by means of a knee pivot pin 61. The toggle link 53 is pivotally connected to the switch arm 33 of the center pole unit by means of a pin 63, and the toggle link 55 is pivotally connected to the releasable trip member 57 by means of a pin 65. Overcenter springs 67 are connected under tension between the knee pivot 61 and the bight portion of the operating lever 43. The contacts are manually opened by movement of the handle 49 in a counterclockwise (FIG. 2) direction from the "on" to the "off" position. This movement carries the line of action of the overcenter springs 67 to the left causing collapse, to the left, of the toggle 53, 55 to thereby rotate the tie bar 35 in a counterclockwise direction to simultaneously move the three switch arms 33 to the open position opening the contacts of the three pole units. The contacts are manually closed by reverse movement of the handle 49 from the "off" to the "on" position, which movement moves the line of action of the overcenter springs 67 to the right to move the toggle 53, 55 to the position seen in FIG. 2, which movement rotates the tie bar 35 in clockwise direction to move the switch arms 33 of the three pole units to the closed position seen in FIG. 2.

The releasable member 57 is latched in the position seen in FIG. 2 by means of the latch mechanism 15. The latch mechanism 15 is of the type more specifically described and the copending patent application of Nick Yorgin et al., Ser. No. 621,321, filed Mar. 7, 1967, now U.S. Pat. No. 3,460,075. Thus, only a brief description of the latch mechanism is given herein. The latch mechanism 15 comprises a roller latch member 71 and an insulating trip bar 73. The roller latch member 71 comprises a generally U-shaped main body part 75 and a roller member 77 movably supported for limited travel in a pair of slots in the opposite legs of the part 75. A torsion spring 81 biases the roller member 77 to one end of the slots. The roller latch member 71 is pivotally supported on the supporting plates 41 by means of a pin member 83. The free end of the releasable trip member 57 moves within a slot in the bight portion of the part 75.

The trip bar 73 (FIGS. 2, 4 and 8) is a molded insulating member formed to provide a pair of insulating pin portions 88 that are disposed in suitable openings in the supporting plates 41 to pivotally support the trip bar 73. The trip bar 73 is provided with a latch part 89 for engaging the bight portion of the main body part 75 of the roller latch member 71 to latch the roller latch member 71 in the position seen in FIG. 2. A compression spring 93 is positioned between the latch member 71 and the trip bar 73 to bias the trip bar 73 in the latching direction. As can be seen in FIG. 2, the releasable trip member 57 is provided with a hook portion at the free end (on the left as seen in FIG. 2) thereof for engaging the roller 77 to latch the trip member 57 in the position seen in FIG. 2.

There is a separate electromagnetic trip device 17 in each pole unit. Each of the electromagnetic trip devices 17 comprises a stationary magnetic core member 95, an armature structure 97 and a coil 99. Each armature structure 97 comprises a magnetic armature 101, an armature extension 103 secured to the armature 101 by means of a pivot pin 105 and a screw 107 threaded into a tapped opening in the upper end of the extension 103. Each armature structure 97 is biased to the initial position seen in FIG. 2 by means of a tension spring 109 that engages an arm portion of the armature 101 at one end thereof and a magnetic generally L-shaped member 113 at the other end thereof. As can be seen in FIG. 2, the armature structure 97 is positioned in the initial position with an air gap between the armature 101 and the stationary magnetic core 95. The armature 101 is pivotally supported at the left end thereof on an extension of the L-shaped magnetic member 113. The spring tension of each spring 109 can be adjusted by bending the upper spring support part of the associated member 113. As will be understood with reference to FIGS. 2-5 and 8, the insulating trip bar 73 is provided with a separate cavity for each pole unit with a separate actuating surface 117 as the bottom surface of each cavity. In each pole unit the upper part of the armature extension 103 is positioned just over the associated cavity so that the associated screw 107 is positioned above the associated actuating surface 117 of the trip bar 73.

In the closed position of the circuit breaker, the circuit through each pole unit extends from a solderless terminal connector 119 through a conducting strip 121 to a coil lead 122, through the coil 99, a coil lead 123, a flexible conductor 125 that is secured at one end thereof to the coil lead 123 and at other end thereof to

the associated conducting contact arm 29, the contact arm 29, the contacts 21, 19, the conducting strip 25 to the other solderless terminal conductor 27.

When the circuit breaker is in the latched position seen in FIG. 2, the tension springs 67 operate through the toggle link 55 and pivot 65 to force the trip member 57 in a clockwise (FIG. 2) direction about the pivot 59. Clockwise movement of the trip member 57 is restrained by the engagement of the free end thereof under the roller member 77 of the roller latch 71 with the trip member 57 pulling the roller latch 71 in a clockwise direction about the pivot 83. Clockwise movement of the roller latch 71 about the pivot 83 is restrained by the engagement of the roller latch 71 with the latch part 89 of the trip bar 73. The force of the roller latch 71 against the latch part 89 of the trip bar 73 operates through the axis of the pivot of the trip bar 73 so that clockwise movement of the roller latch 71 is restrained by the trip bar 73 without tending to move the trip bar 73 about the axis of the pivotal support 88 of the trip bar 73. Thus, the trip bar 73 is in a neutral or latching position latching the roller latch 71 and trip member 57 in the latched position seen in FIG. 2.

The circuit breaker is shown in the closed and latched position in FIG. 2. Upon the occurrence of an overload current above a predetermined value in any of the pole units, the armature 101 is attracted toward the associated stationary magnetic member 95 whereupon the armature 101 pivots in a clockwise (FIG. 2) direction closing the air gap between the magnetic members 95, 101 and pulling the armature extension 103 downward. Near the end of this downward movement of the armature extension 103, the screw 107 engages the actuating surface 117 (FIG. 5) of the trip bar 73 to rotate the trip bar 73 in a counterclockwise (FIG. 2) direction moving the latch part 89 of the trip bar 73 to a position releasing the roller latch 71. Upon release of the roller latch 71 the springs 67 (FIG. 2) operate to rotate the trip member 57 in a clockwise direction about the pivot 59 with the roller latch 71 moving in a clockwise direction about the pivot 83. The trip member 57 moves in a clockwise direction to the tripped position which movement is limited by engagement of the trip member with a suitable stop on the supporting frame plates 41. During movement of the trip member 57 to the tripped position, the toggle 53, 55 collapses rotating the switch arm 33, that is attached to the lower toggle link 53, to move the tie bar 35 and all three of the switch arms of the three pole units in a counterclockwise direction to simultaneously open the contacts of the three pole units. During this movement, the handle 49 is moved to a position intermediate the "off" and "on" positions in a well-known manner to provide a visual indication that the circuit breaker has been tripped.

Before the circuit breaker can be manually operated after an automatic tripping operation, the circuit breaker mechanism must be reset and relatched. Resetting is effected by movement of the handle 49 from the intermediate position to the full "off" position. During this movement, a part 133 on the operating lever 43 engages a shoulder portion 135 on the trip member 57 to rotate the trip member 57 in a counterclockwise direction about the pivot 59. During this movement, the free end of the trip member 57 moves down in the slot in the bight portion of the main part 75 of the roller latch 71 and the end part of the trip member 57 engages the

roller 77 moving the roller 77 in the slots in which the roller member 77 is seated to wipe past the roller member 77, and when the end part of the releasable member 57 passes the roller 77 the spring 81 biases the roller 77 back to the position seen in FIG. 2. During this resetting movement of the trip member 57, the end part thereof engages a surface at the bottom of the slot in the bight portion of the main body part 75 of the roller latch 71 to move the roller latch 71 in a counterclockwise direction about the pivot 83 to the position seen in FIG. 2. As the roller latch 71 reaches the position seen in FIG. 2, a part of the roller latch clears the hook or latch part 89 of the trip bar 73 whereupon the spring 93 biases the latch part 89 into latching engagement with the roller latch 71 to latch the roller latch 71 in the position seen in FIG. 2. Thereafter, upon release of the handle 49 by the operator, the springs 67 again bias the toggle link 55 to bias the trip member 57 in a clockwise direction to move the trip member up to engage the roller 77 in the latched position seen in FIG. 2. Thereafter, the handle 49 can be manually moved between the "off" and the "on" positions to operate the contacts in the manner hereinbefore described. A more detailed description of the tripping operation is set forth in the above-mentioned copending patent application of Nick Yorgin et al., Ser. No. 621,321.

Improved means is provided for adjusting the trip means of the circuit breaker. As can be seen in FIGS. 4 and 5, an elongated adjusting bar 133 comprises an elongated bar 135 and a pair of supporting arms 137 secured to the bar 135 by means of rivets 139. Each of the supporting arms 137 is provided with an opening 141 for receiving a molded pin portion 143 (FIG. 8) of the trip bar 73 to pivotally support the adjusting bar 133 on the pins 143. The adjusting bar 133 moves about an axis aligned with the axis of movement of the trip bar 73. The elongated bar 135 is provided with a separate opening 145 for each of the screws 107 of the three-pole circuit breaker. Each of the openings 145 is of a large enough dimension to permit the associated screw 107 to move vertically and laterally relative to the bar 135.

Referring to FIG. 3, a supporting plate 151 is fixedly secured to the base 9 in one of the outer pole units (the lower one as seen in FIG. 1). A first inverted generally L-shaped bracket 153 is fixedly secured to the plate 151 to support an insulating adjusting cam member 155. The insulating adjusting cam member 155 (FIGS. 5 and 6) comprises a lower cylindrical part 157 that fits, for rotation, in a suitable opening in one leg of the supporting member 153 (FIG. 3); a cam surface 159; a part 161 having a slot 163 and a plurality of indentations 165 in the top or front part thereof; and a front part 167 having a slot 169 therein. As can be seen in FIG. 3, another generally L-shaped support member 171 is connected to the first support member 153 by means of a screw 173. A spring member 175 biases the adjusting member 155 upward or frontward (FIG. 3) and the part 161 of the adjusting member 155 engages the member 171 to limit the upward movement of the adjusting cam member 155. The part 167 of the adjusting cam member 155 protrudes through an opening 176 (FIG. 7) in the member 171 and through an opening 177 (FIGS. 3 and 4) in the front part 11 of the circuit breaker housing. The member 171 (FIG. 7) is provided with a plurality of openings or notches 179 that align with a plurality of openings 181 (FIGS. 1, 3 and

4) in the housing part 11 to receive a locking pin that is more specifically described in the above-mentioned patent to James P. Ellsworth et al., U.S. Pat. 3,575,679. The member 171 (FIGS. 3 and 7) is provided with a bent-over end projection 185 that extends down into the slot 163 in the adjusting member 155. As can be seen in FIG. 6, the slot 163 does not complete a circle in that the member 155 is provided with a surface 187 that extends up higher than the base of the slot 163 to provide a first stop 189 and a second stop 191 for engaging the projection 185 (FIGS. 3 and 7) to limit rotational movement of the member 155. The member 171 (FIG. 7) is provided with an indentation 193 that protrudes from the lower surface thereof to index the adjusting member 155 that is biased frontward (FIG. 3) to position the indentation 193 in one of the notches 165 of the adjusting member 155.

During the assembly of the circuit breaker, in addition to the hereinbefore mentioned adjustment of the spring tension of each of the springs 109, two adjustments are made before the cover 11 is mounted on the base 9, and a third common adjustment can be made externally after the cover 11 is mounted on the base 9. With the cover 11 removed, the adjusting member 155 is rotated to the setting which provides the maximum air gap, which setting is the setting where the low part of the cam surface 159 engages a surface 195 on the arm 137 (FIGS. 3-5) that supports the adjusting bar 135. The adjusting member 155 is in this position when the projection 185 (FIGS. 3 and 7) on the member 171 engages the stop surface 189 (FIG. 6) on the adjusting member 155. Each of the separate screws 107 (FIGS. 4 and 5) is then adjusted so that the screw 107 will engage the surface 117 and move the trip bar 73 to a tripping position at the end of the armature movement. The critical adjustment of the screw 107 is such that the screw does not pick up the trip bar 73 during the initial armature movement so that there is no resistance from the latching trip bar during the initial armature movement, and the screw adjustment 107 must be such that before the end of the armature movement the screw will in fact move the trip bar to a tripping position. Each of these adjustments of the screw 107 on the armature extension 103 is made by rotating the screw 107 to vary the relative position of the head of the screw 107 relative to the associated surface 117 on the trip bar 73. After adjustment of the screws 107 on the armature extensions 103, the individual magnetic air gaps are adjusted so that each pole unit will magnetically trip at a predetermined current. This adjustment is made by a separate nut 199 on each of the screws 107. The nut 199 is rotated on the associated screw 107 to engage the lower surface of the bar 135, and with the surface 195 of the adjusting bar structure 133 engaging the cam surface 159 on the adjusting member 155, to limit clockwise (FIG. 3) movement of the adjusting bar structure 133, as the nut 99 is moved upward on the associated screw 107 the associated armature structure 97 is moved downward to reduce the associated magnetic air gap between the associated armature 101 and the associated stationary magnetic member 95. For example, if it is desirable to provide a circuit breaker wherein the maximum trip setting is 80 amps, each of the nuts 199 is rotated to move upward against the common adjusting bar 135, the adjusting bar 135 being restrained from clockwise movement by engagement (FIGS. 3 and 5) of the surface 195 with the low point

of the cam surface 159, to move the associated armature structure 97 downward to reduce the associated magnetic air gap until the circuit breaker trips with a current of 80 amps passing through the associated pole unit that is being adjusted. Each of the air gaps is thus individually adjusted with current flowing through the associated pole unit to trip the circuit breaker at 80 amps. After the adjustment of each screw on the associated armature extension 103, the screw can be cemented in the adjusted position; and after the adjustment of each nut 199 on the associated screw 107 the nut can be cemented in the adjusted position. Thereafter, the cover 11 can be moved into position and secured to the base 9 by means of a plurality of screws 201 (FIG. 1).

With the cover 11 in the mounted position, the three trip units can be simultaneously adjusted by operation of the single adjusting member 155. With the adjusting member 155 positioned such that the low point of the cam 159 engages the surface 195 of the adjusting bar structure 133, a current of the predetermined value such, for example, as 80 amps through any of the three pole units will operate the electromagnetic trip device in that pole unit to rotate the trip bar 73 to the tripped position to effect a tripping operation in the manner hereinbefore described. When it is desired to provide that the circuit breaker will trip upon the occurrence of a lesser overload current, a screwdriver is placed in the slot 169; a downward force is applied to the screwdriver to move the adjusting member 155 downward to release the notch 165 (FIG. 6) from the indentation 193 (FIG. 7); and the screwdriver is rotated in a clockwise (FIG. 6) direction to a lower trip setting whereupon the downward force against the screwdriver can be released so that the spring 175 (FIG. 3) will bias the adjusting member 155 upward to position another of the notches 165 in a nested relationship with the indentation 193 (FIG. 7) to stabilize the adjusting member 155 in the newly adjusted position. As can be understood with reference to FIG. 6, as the adjusting member 155 is rotated in a clockwise direction the distance between the axis of the adjusting member 155 and the surface of the cam 159, that is opposite the surface 195 (FIG. 5) of the adjusting bar structure 133, increases so that clockwise movement of the adjusting member 155 moves the adjusting bar structure 133 in a counterclockwise (FIGS. 3 and 5) direction. As the adjusting bar structure 133 moves counterclockwise the bar 135 engaging the three nuts 199 moves the three armature structures 97 downward to reduce the magnetic air gaps of the three electromagnets. Clockwise (FIG. 6) adjusting movement of the adjusting member 155 is limited when the stop surface 191 engages the stationary projection 185 that is disposed in the slot 163. It can be understood with reference to FIG. 6 that when the stop surface 191 engages the projection 185 (FIGS. 3 and 7) the high point of the cam 159 is opposite the surface 195 (FIG. 5) so that the adjusting bar structure 133 will be at the maximum counterclockwise adjusted position and the three armature structures 97 will be at their lowest positions so that the magnetic air gaps will be adjusted to the minimum dimension. When the armature structures 97 are adjusted to provide the minimum magnetic air gaps the circuit breaker will trip when a minimum of overload current such, for example, as 30 amps passes through any of the three pole units of the circuit breaker. The surface 195 of the ad-

justing bar structure 133 is biased against the cam surface 159 by the three springs 109 (FIG. 2) of the three armature structures 97 which springs bias the armature structures toward the open position to bias the nuts 199 (FIGS. 4 and 5) into engagement with the adjusting bar structure 133 to thereby bias the adjusting bar 133 in a clockwise (FIGS. 2, 3 and 5) direction. Suitable indicating means may be provided on the front of the circuit breaker (FIG. 1) to indicate at which current the circuit breaker will trip when the adjusting member 155 is in each of the positions indexed by each of the notches 165. As can be understood with reference to FIGS. 2-5 and 8, the adjusting bar structure 133 pivots on the pins 143 (FIG. 8) about the same axis that the trip bar 73 pivots, with the trip bar 73 being mounted on the supporting plates 41 (FIG. 2) for pivotal movement about the pins 88 (FIG. 8). It can be understood that by adjusting the tripping characteristics of the circuit breaker by moving an adjusting bar 133 that moves relative to the trip bar 73, the trip bar 73 does not move during adjustment so that the amount of latch engagement between the latch part 89 of the trip bar 73 and the roller latch 71 (FIG. 2) is not varied or disturbed by the trip adjustment.

The openings or notches 179 (FIG. 7) in the member 171 and the openings 181 (FIGS. 1, 3 and 4) in the housing cover 11 are provided for receiving a locking member that may be inserted through the aligned openings into the notch 163 (FIG. 6) of the adjusting member 155 to limit the rotational movement of the adjusting member 155 to thereby limit the trip setting of the circuit breaker. This aspect of the circuit breaker is described and claimed in the above-mentioned copending application of James P. Ellsworth et al., Ser. No. 3,575,679.

Another embodiment of the invention is disclosed in FIG. 9. In this embodiment, a member 205, having a lower screw part 207 is threaded into the armature extension 103 to provide that the trip bar will be engaged by the screw 207 and moved to the tripping position near the end of the armature movement, which adjustment is similar to the adjustment of the screw 107 in the armature extension 103 of the first embodiment. The member 205 is provided with a front cavity 209, and an adjusting screw 211 is threaded into a tapped opening in the adjusting bar 135 to engage the member 205 in the cavity 209 to adjust the magnetic air gap to provide that the breaker will trip when a predetermined current passes through the associated pole unit. This adjustment is similar to the adjustment of the screw 199 (FIG. 5) against the adjusting bar 135. A circuit breaker with the embodiment of FIG. 9 in each pole unit thereof will operate in all other respects in the same manner as the circuit breaker described with reference to FIGS. 1-8.

Another embodiment of the invention is disclosed in FIGS. 10-14. In this embodiment, a separate latch is provided for latching the roller latch 71, and the trip bar, which does not latch the roller 71, serves as the common adjusting bar. Since the trip bar does not provide the latching function in this embodiment, it can be understood that the trip bar can be rotated a limited amount to provide the required adjustment without affecting the amount of latch engagement between latching members. There is disclosed, in FIGS. 10-12, part of a circuit breaker with the center pole unit shown in FIGS. 10 and 11 and the one outer pole unit where the

adjustment is being made shown in FIG. 12. The parts not shown in FIGS. 10-14 are like the parts disclosed in FIGS. 1 and 2. The parts disclosed in FIGS. 10-14 that are like the parts of the first embodiment disclosed in FIGS. 1-8 are given the same reference characters as those used in FIGS. 1-8 for the purpose of clarity. Parts that have been substantially modified are given new reference characters in FIGS. 10-14. Referring to FIGS. 10-14, an insulating trip bar 215 is provided with a pair of pins 217 for supporting the trip bar for pivotal movement in the same manner as was described with reference to the trip bar 73. The trip bar 215 is provided with a separate part 219 in each pole unit with an opening 221 in each of the parts 219. The trip bar 215 does not have a latching part similar to the latching part 89 of the trip bar 73. The trip bar 215 is provided with an insulating actuating part 223 thereon that operates during tripping operations in a manner to be hereinafter specifically described. As is best seen in FIG. 14, the main body part 75 of the roller latch 71 is provided with a notched part 227 for receiving the actuating part 223 of the trip bar 215. A separate latch member 229 is mounted for pivotal movement on one of the supporting plates 41 by means of a pin 231. The latch member 229 is provided with a cutout portion to provide a latch surface 233 that engages the main body part 75 of the roller latch member 71 to latch the roller latch member 71. The latch 229 is provided with a bent-over arm 235 that is positioned above the actuating part 223 of the trip bar 215. The latch member 229 is provided with another arm 237 that is engaged by one end of a torsion spring 239 which biases the latch member 229 into the latching position seen in FIG. 14. As can be seen in FIG. 14, the torsion spring 239 also biases the roller 77 to the latching position. Referring to FIGS. 10-12, a separate elongated screw 241 is pivotally connected to each armature 101 in place of the armature extension 103 described in the first embodiment. Each of the screws 241 extends through the associated opening 221 (FIG. 13) in the trip bar 215, and a separate nut 243 is connected at the upper end of each of the screws 241. Upon the occurrence of a predetermined overload current in any of the three pole units of the three-pole circuit breaker, the associated armature 101 is attracted to the associated stationary magnetic member 95 pulling the screw 241 downward whereupon the nut 243 engages the part 219 of the trip bar 215 to rotate the trip bar 215 in a counterclockwise (FIGS. 10-12) direction. As the trip bar 215 is moved counterclockwise from the initial position seen in FIG. 10 to the tripped position seen in FIG. 11, the actuating part 223 thereof engages the leg 235 of the latch 229 (FIG. 14) of the latch 229 to move the latch in a clockwise (FIG. 11) direction to the tripped position seen in FIG. 11. This movement releases the roller latch 71 which then moves to the tripped position releasing the trip member 57 to trip the circuit breaker in the same manner as was hereinbefore described with regard to the embodiment disclosed in FIGS. 1-8. The parts are shown in the tripped position in FIG. 11 with a lower part of the latch 229 resting on top of the main body part 75 of the roller latch 71. The circuit breaker is reset following a tripping operation by movement of the trip member 57, in the same manner as was hereinbefore described, to the resetting position. During this movement, the trip member 57 moves down in the slot 247 (FIG. 14) in the part 75 of the roller latch 71 to en-

gage the ledge 249 to move the roller latch 71 from the tripped position seen in FIG. 11 to the latching position seen in FIG. 10. When the roller latch reaches the latching position, the spring 239 biases the latch 229 into the latching position where the surface 233 again latches the roller latch 71. Thereafter, upon release of the circuit breaker handle, the springs 67 (FIG. 2) again bias the trip member 57 (FIG. 10) into engagement with the roller 77 where the trip member 77 is latched. Thereafter, the circuit breaker can be operated in the same manner as was herein-before described with reference to FIGS. 1-8. With the additional latch 229 serving to latch the roller latch 71, it can be understood that the trip bar 215 can be rotated a limited amount to adjust the circuit breaker which rotation will not affect the latching engagement of the latch surface 233 with the roller latch member 71.

Similar to the adjustment of the first embodiment in addition the spring tension adjustments of the springs 109, two adjustments are made during assembly of the breaker when the cover 11 is removed, and the third adjustment is an external adjustment that is made when the cover 11 is in place. With the cover 11 removed, each pole unit is adjusted so that associated screw 243 will engage and move the trip bar such that the actuating part 223 (FIG. 13) of the trip bar will engage the latch 229 to move the latch to the tripped position near the end of the armature movement. Thereafter, with the low part of the cam surface 159 (FIGS. 12 and 13) engaging a surface 255 on the trip bar 215, a separate screw 253 on each member 241 is rotated to move against the undersurface of the associated part 219 of the trip bar 215 to diminish the associated air gap until the breaker trips at the predetermined maximum adjusted tripping current of, for example, 80 amperes. With each of the three pole units adjusted to trip the breaker near the end of the associated armature movement, and with each of the three pole units adjusted so that each pole unit will trip at an overload of, for example, 80 amperes with the cam 159 positioned such that the low part thereof is adjacent the surface 255 (FIG. 13), the cover 11 is then mounted on the base 9 in the same manner as was hereinbefore described. Thereafter, the magnetic air gaps of the three pole units can be simultaneously externally adjusted by rotating the single adjusting cam member 155 in a clockwise (FIG. 13) direction which movement rotates the trip bar 215 counterclockwise to simultaneously move the three armature structures 97 downward to simultaneously reduce the three magnetic air gaps of the three pole units. The embodiment disclosed in FIGS. 10-14 can be adjusted from a maximum trip setting such, for example, as 80 amperes to a minimum trip setting, such for example, as 30 amperes by means of the adjusting member 155 in the same manner as was hereinbefore described with reference to the embodiment of FIGS. 1-8. In this embodiment (FIGS. 10-14) it can be understood that the common trip bar 215 serves also as the common adjusting bar and that the adjustment of the common trip bar 215 does not vary the latching engagement between the latching parts 229 and 75.

We claim as our invention:

1. A multi-pole circuit breaker comprising an insulating housing having a front and a back, said front having an opening therein, said housing comprising insulating barrier means forming a plurality of compartments in a side-by-side relationship, a separate pole unit com-

prising a pair of cooperable contacts in each of said compartments, a single operating mechanism comprising an operating handle extending through said opening in said front, said operating mechanism being operable to simultaneously operate all of said pairs of contacts between opened and closed positions, said operating mechanism comprising a latched releasable member releasable to effect automatic opening of all of said pairs of contacts, a trip bar common to all of said pole units and being operatively movable to effect release of said releasable member, a separate trip device for each pole unit, each of said trip devices comprising a stationary magnetic member and a movable armature structure supported in an initial position with an air gap between the armature structure and the associated stationary magnetic member, upon the occurrence of a predetermined overload in any of said pole units the associated armature structure moving from the initial position diminishing the associated air gap to an actuating position to operatively move said common trip bar to effect release of said releasable member, and adjusting means comprising an elongated adjusting bar supported on said common trip bar for movement relative to said common trip bar, said adjusting bar being movable to simultaneously move said armature structures to simultaneously vary said air gaps, and said adjusting means comprising an adjusting member accessible from outside of said housing and operable to move said adjusting bar to simultaneously vary said air gaps.

2. A multi-pole circuit breaker according to claim 1, said opening in the front of said housing comprising a first opening, said housing having a second opening in the front thereof, said adjusting member comprising a part accessible at said second opening, and said adjusting member being mounted for movement about an axis that extends in the direction from front to back of said circuit breaker which movement about said axis moves said adjusting bar to simultaneously vary said air gaps.

3. A circuit breaker according to claim 2, said housing comprising a base and a cover removably connected to said base, each of said trip devices comprising a separate first internal adjusting means adjustable when said cover is removed to provide that said releasable member will be released near the end of the associated armature structure movement, each of said pole units comprising a separate second internal adjusting means adjustable when said cover is removed to provide an individual adjustment of the associated air gap.

4. A circuit breaker according to claim 1, a latch structure latching said releasable member, and said trip bar comprising a latch part in latching engagement with said latch structure, said trip bar being operatively movable to unlatch said latch structure to effect release of said releasable member.

5. A multi-pole circuit breaker comprising an insulating housing having an opening in the front thereof, said housing comprising insulating barrier means forming a plurality of compartments in a side-by-side relationship, a separate pole unit in each of said compartments, each of said pole units comprising a pair of cooperable contacts, a single operating mechanism comprising an operating handle extending through said opening, said operating mechanism being operable to simultaneously operate all of said pairs of contacts between opened and closed positions, a latched releasable member releasable to effect automatic opening of all of said pairs

of contacts, a latch structure in latching engagement with said latch releasable member, a trip bar common to all of said pole units and being operatively movable to engage said latch structure to move said latch structure to a position releasing said releasable member, a separate trip device for each pole unit, each of said trip devices comprising a stationary magnetic member and a movable armature structure in an initial position, upon the occurrence of a predetermined overload in any of said pole units the associated armature structure moving from the initial position diminishing the associated air gap to an actuating position to move said common trip bar to a tripping position during which movement said common trip bar engages said latch structure to move said latch structure to a position releasing said releasable member, said common trip bar being movable to simultaneously move said armature structures to simultaneously vary said air gaps, and a single adjusting member operable to move said trip bar to adjust said air gaps.

6. A multi-pole circuit breaker according to claim 5, said housing having a second opening in the front thereof, said adjusting member being accessible at said second opening and being mounted for movement about an axis extending in the direction from front to back of said circuit breaker, said adjusting member comprising a cam part operable against said common trip bar to move said common trip bar to simultaneously vary said air gaps.

7. A multi-pole circuit breaker having a pair of separable contacts per pole, common operating means for opening and closing said contacts conjointly, said operating means including a releasable member and latch means for releasably restraining said releasable member, overcurrent responsive means including a trip member extending across all of the poles for causing automatic opening of all of the contacts in response to an overload in any one pole, a magnetic core assembly in each pole, a winding about said core for generating a magnetic field therein proportional to the current flowing through said winding, an armature pivotally mounted on said core for cooperation therewith, said armature being operatively connected to said trip member, an actuator bar extending across all of said poles, said actuator bar being mounted on said trip member for movement relative to said trip member, air gap adjusting means at each of said poles for presetting the air gap at each of said poles independently, and means adjacent said actuator bar for changing the position of said actuator bar for simultaneously changing the air gaps at all of said poles to thereby change their overcurrent response.

8. A multi-pole circuit breaker comprising an insulating housing formed to provide a plurality of side-by-side pole-unit compartments therein, a separate pole unit in each of said compartments with each of said pole units comprising a separate pair of cooperable contacts, an operating mechanism manually operable to simultaneously open and close all of said pairs of cooperable contacts, a latched releasable member releasable to effect simultaneous opening of all of said pairs of cooperable contacts,

a separate trip device for each of said pole units, each of said separate trip devices comprising a station-

ary magnetic member and a movable magnetic armature structure and an armature spring means biasing the movable magnetic armature structure away from the stationary magnetic member to an unattracted position,

a common trip bar common to all of said pole units movable to effect release of said releasable member, upon the occurrence of an overload current above a predetermined value in any of said pole units the associated armature structure being automatically attracted to the associated magnetic member and moving against the bias of the associated armature spring means during which movement the associated armature structure moves said common trip bar to effect release of said releasable member,

said insulating housing comprising an insulating base and an insulating cover secured to said insulating base,

each of said trip devices comprising internal adjusting means adjustable during assembly of said circuit breaker when said insulating cover is removed from said insulating base to adjust the trip characteristics of the associated trip device, each of said internal adjusting means comprising means for adjusting the associated armature spring means,

an adjusting bar common to all of said pole units and cooperable with each of said trip devices, said adjusting bar being movable to simultaneously adjust the trip characteristics of all of said trip devices,

said insulating cover having a first opening therein and a second opening therein, with said insulating cover secured to said insulating base an operating handle protruding through said first opening, said operating handle being manually operable to simultaneously operate all of said pairs of contacts,

a single adjusting member comprising an adjusting part accessible at said second opening when said insulating cover is secured to said insulating base, said adjusting member being adjustably movable to move said adjusting bar to simultaneously adjust the trip characteristics of all of said trip devices.

9. A circuit breaker according to claim 8, said single adjusting member and said adjusting bar comprising cooperating cam parts operating to cam said adjusting bar to simultaneously adjust the trip characteristics of all of said trip devices upon adjusting movement of said single adjusting member.

10. A circuit breaker according to claim 9, said insulating base comprising a generally planar back, said single adjusting member being supported for movement about an axis generally normal to said generally planar back.

11. A multi-pole circuit breaker according to claim 10, said adjusting bar being movably mounted on said trip bar for adjusting movement relative to said trip bar.

12. A multi-pole circuit breaker according to claim 11, said trip bar being supported for movement about an axis generally parallel to said generally planar back, and said adjusting bar being supported on said trip for adjusting movement relative to said trip bar about said axis generally normal to said generally planar back.

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