United States Patent

Hendry et al.

[15] **3,654,535**

[45] **Apr. 4, 1972**

[54] MOTOR OPERATED CIRCUIT BREAKER CONTROL

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[73] Assignee: **Westinghouse Electric Corporation,** Pittsburgh, Pa.

[22] Filed: **Mar. 27, 1970**

[21] Appl. No.: **23,198**

[52] **U.S. Cl.** **318/267,** 318/288

[51] **Int. Cl.** **H02p 1/08**

[58] **Field of Search**.....318/266, 257, 261, 290, 288, 318/267

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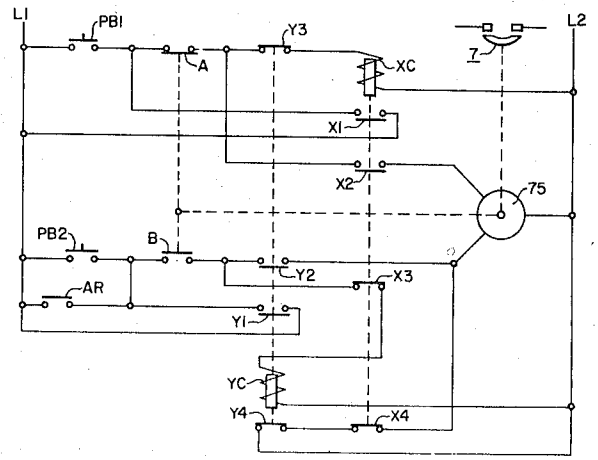
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[57] **ABSTRACT**

A motor operating device for reciprocating a circuit breaker handle structure between operating positions comprises a reversible motor, an opening relay, a closing relay and limit switch means operable to interrupt the motor circuit and to deenergize the energized relay. The limit switch means comprises a pair of mechanicaly interlocked molded-case circuit breakers with each of the circuit breakers being in series with a separate one of the reversible motor windings and in series with a separate one of the relay coils. Each of the relays is a four pole relay with one pole controlling the associated seal-in circuit; one pole controlling the associated motor energizing circuit; one pole providing an electrical interlock with a pole of the other relay; and one pole cooperating with a pole of the other relay to provide a dynamic braking circuit. The motor operated circuit breaker is also manually operable, and the control circuit is automatically prepared for an electrical operation to either the reset position or the closed position following a manual operation to the open position.

14 Claims, 6 Drawing Figures



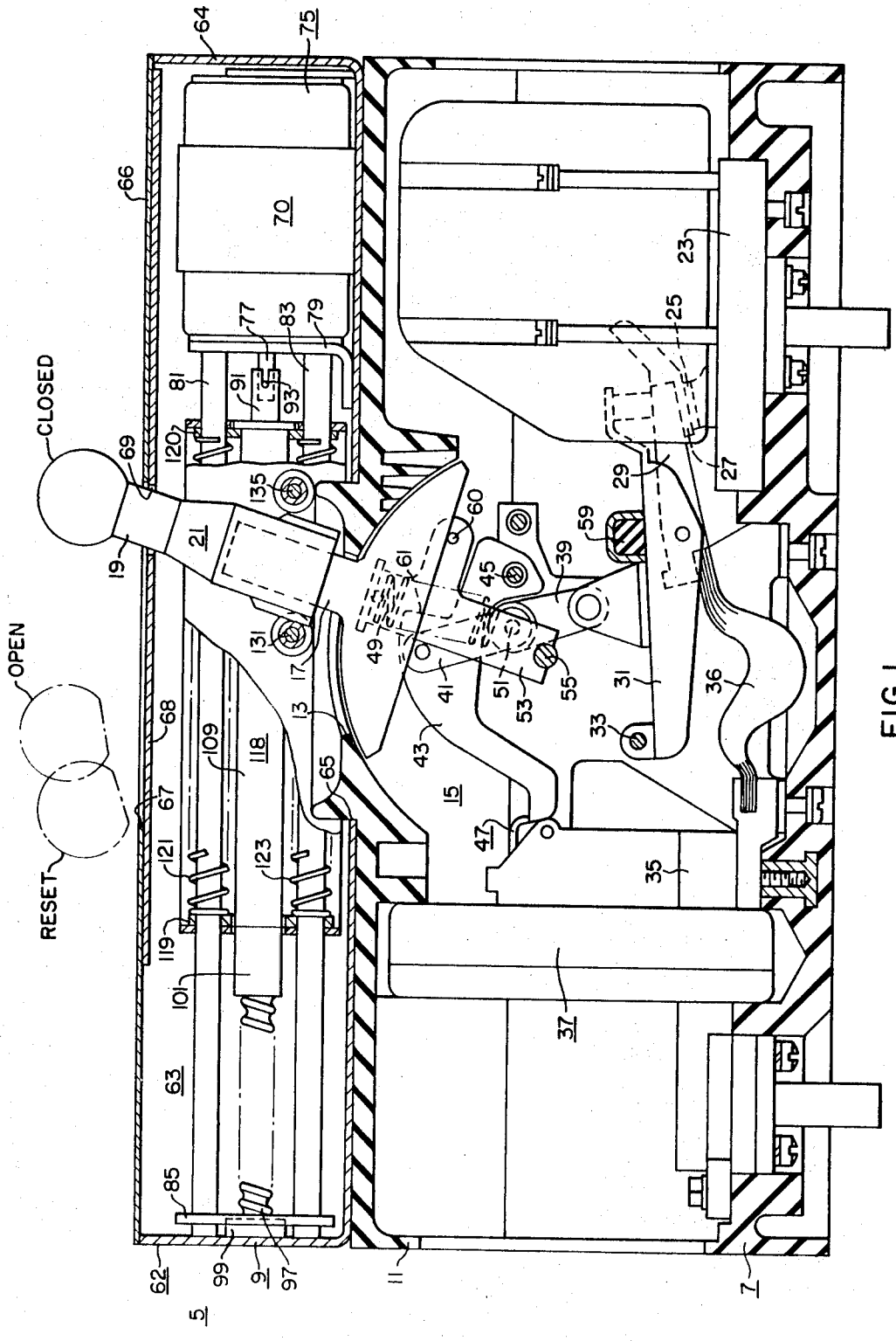

CLOSED
OPEN
RESET
64
75
66
70
77
83
79
81
91
93
120
69
135
19
21
131
17
13
68
109
118
67
65
121
123
119
101
63
85
62
99
9
97
5
11
7
23
25
27
29
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FIG. 1.

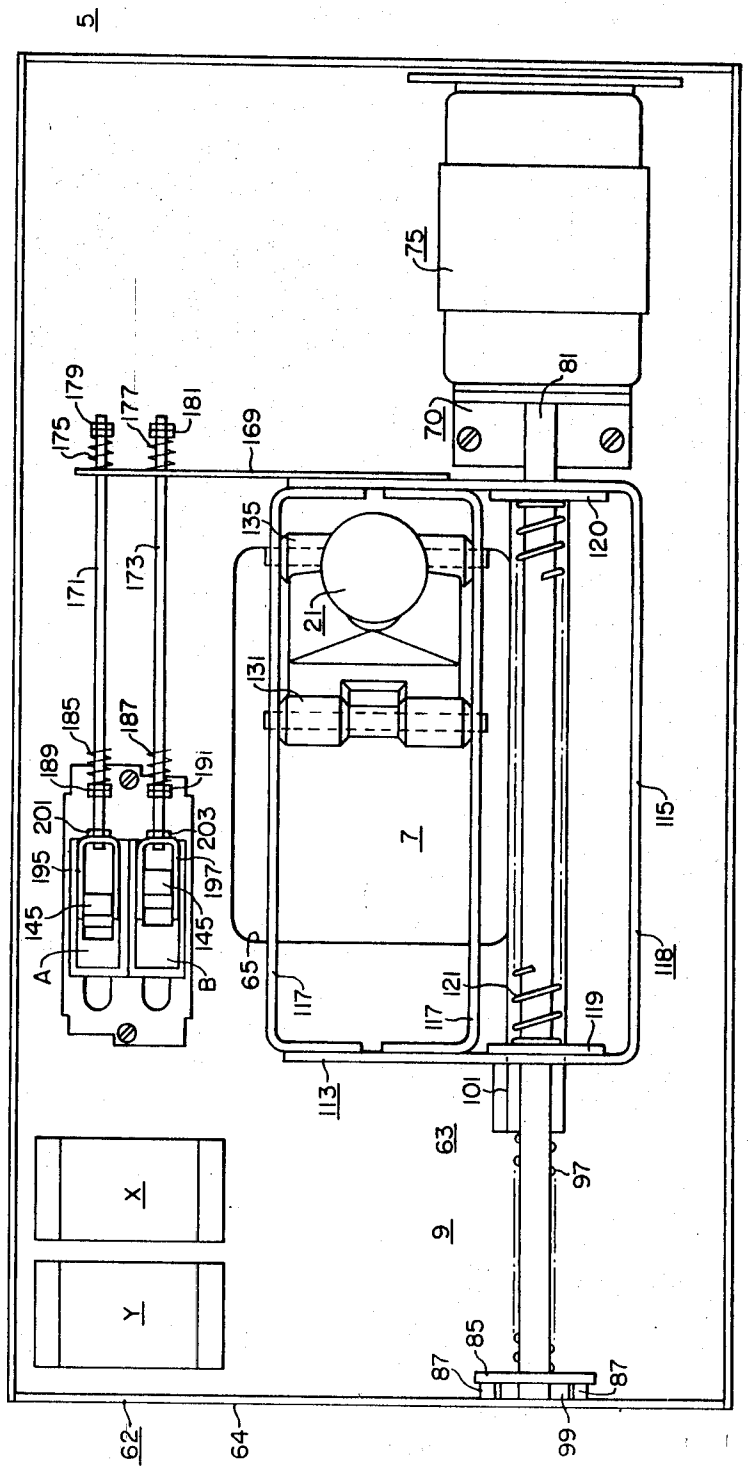

5
75
81
70
179
175
177
181
169
135
120
21
171
173
131
185
187
189
191
201
195
203
197
145
145
A
B
65
117
121
117
119
115
118
113
101
63
9
97
X
Y
85
87
87
62
64
99
Z

FIG. 2.

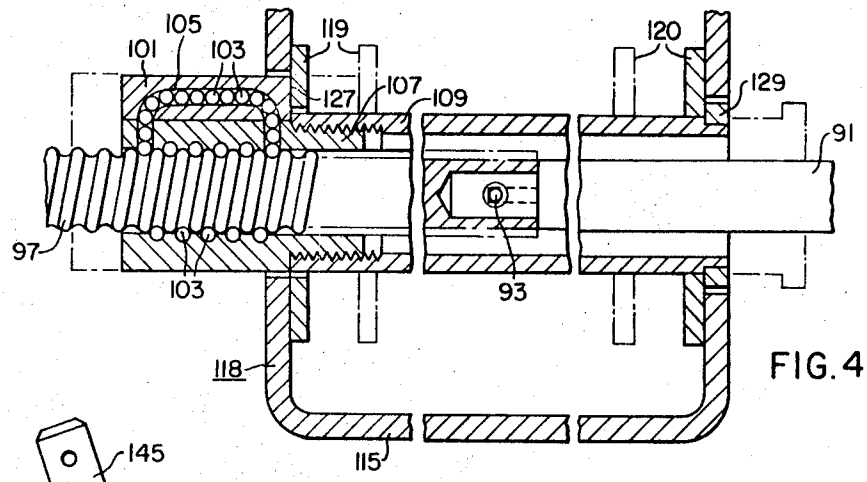


FIG. 4.

FIG. 3.

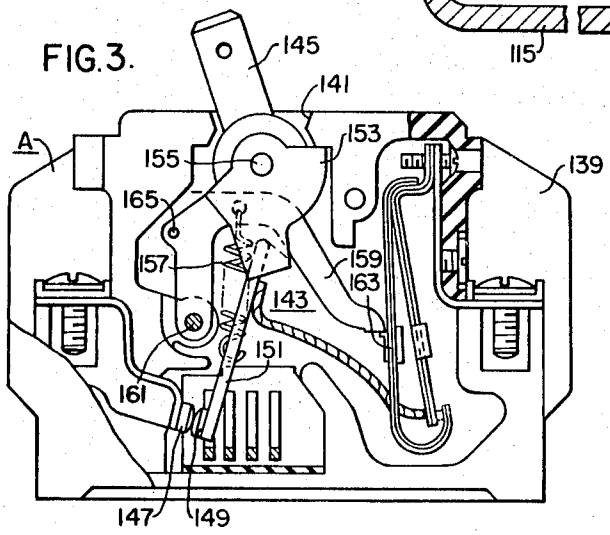
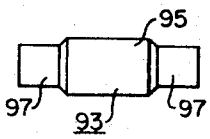


FIG. 5.



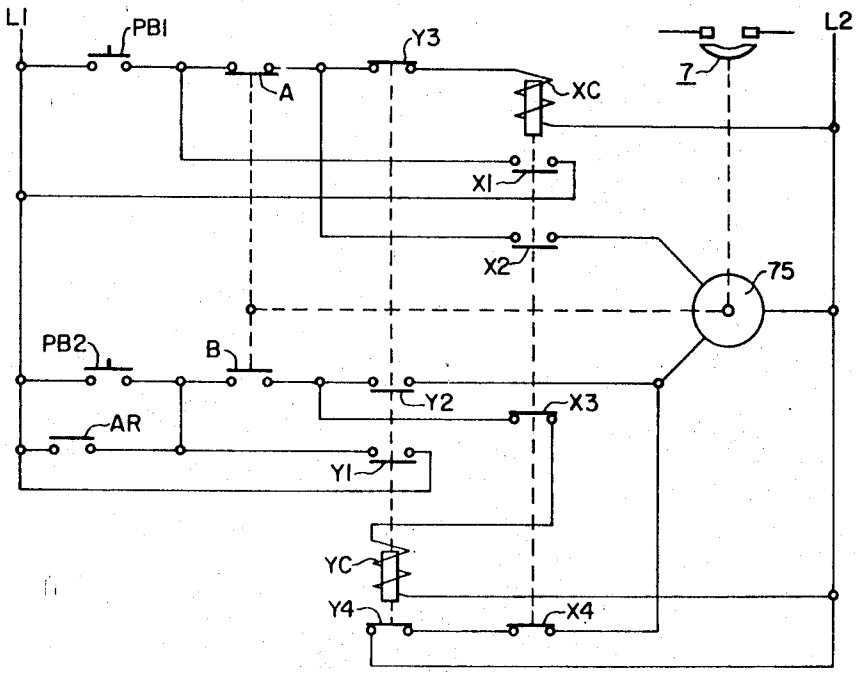


FIG. 6.

MOTOR OPERATED CIRCUIT BREAKER CONTROL

CROSS REFERENCE TO RELATED APPLICATION

Certain parts of the motor operated circuit breaker herein disclosed are disclosed and claimed in the copending application of Alfred E. Maier et al, entitled "Motor Operated Circuit Breaker", Ser. No. 23,199, filed concurrently herewith.

BACKGROUND OF THE INVENTION

It is old in the art to operate a circuit breaker by means of a reversible motor with limit switch means for actuating relay means to interrupt the motor current through the contacts of the relay means. This invention provides improved motor control including limit switch means for interrupting the motor current through the contacts of the limit switch means and for deenergizing the energized relay. This enables the use of smaller and lower cost relays in the control device. Moreover, circuit breakers are herein used to provide the limit switch function, and the circuit breakers can interrupt overload currents through the motor. This invention also provides an improved control means with a dynamic braking circuit automatically operated when the relays are deenergized. The control also includes seal-in circuits enabling the use of momentary push buttons and an electrical interlocking circuit preventing simultaneous energization of the opening and closing relay coils. The opening and closing relays may be manually operated directly by externally operable actuators on the cover of the enclosure for the motor operating mechanism thereby enabling the elimination of separate push button control switches. The motor operated circuit breaker is also manually operable, and the control circuit is automatically prepared for an electrical operation to either the reset position or the closed position following a manual operation to the open position.

SUMMARY OF THE INVENTION

A motor operating device is provided for operating a molded-case type circuit breaker having a pair of contacts and a handle structure operable to open and close the contacts. The motor operating device comprises an electric reversible motor and an operating structure operatively connecting the reversible motor for driving the handle structure of the circuit breaker. A closing relay is operable when energized to energize a first winding of the reversible motor to close the circuit breaker. An opening relay is operable when energized to energize a second winding of the reversible motor to open the circuit breaker. Limit switch means is provided for interrupting the motor circuit through the contacts of the limit switch means and for deenergizing the energized relay. The limit switch means comprises a pair of molded-case type circuit breakers interlocked for operation to reverse positions. Each of the limit switch circuit breakers is operable to interrupt the motor circuit through one of the windings and to deenergize one of the relays with each of the limit switch circuit breakers being capable of interrupting an overload through the motor. Each of the relays is a four pole relay with one pole providing a seal-in circuit to enable the use of momentary control switch means; one pole providing an energizing circuit for one of the windings of the reversible motor; one pole cooperating with a pole of the other relay to provide an electrical interlock preventing the relays from being simultaneously energized; and one pole cooperating with a pole of the other relay to provide a dynamic braking circuit by means of the residual flux in the laminations of the motor. Both of the limit switch circuit breakers are closed following a manual operation opening the motor operated circuit breaker. Thus, the control is automatically prepared for an electrical operation to either the reset position or the closed position following a manual operation to the open position. The control includes an automatic reset circuit for automatically resetting the motor operated circuit breaker following a tripping operation. If desired, the relays can be manually operated directly by manual push button actuators mounted on the cover of the enclosure thereby enabling the elimination of push button switches. If desired, the relays can be manually operable by the actuators mounted on the enclosure and the push button switches can be utilized mounted in a position remote from the motor-operated circuit breaker.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side sectional view of a motor operated circuit breaker with parts broken away and with parts shown in elevation for the purpose of clarity, and with the section illustrating the center pole unit of a three-pole circuit breaker;

FIG. 2 is a plan view of the motor operated circuit breaker of FIG. 1 with the cover of the motor operating mechanism enclosure removed;

FIG. 3 is a side sectional view of one of the limit-switch circuit breakers seen in FIG. 2;

FIG. 4 is a sectional view, with parts broken away, illustrating part of the motor operating mechanism with different parts of the mechanism shown in broken lines to illustrate positions reached during operation of the mechanism;

FIG. 5 is an elevational view of the connecting pin between the motor shaft structure and the driving screw member; and

FIG. 6 is a schematic view of the electrical control for operating the motor operating mechanism.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, there is shown, in FIGS. 1 and 2, a motor operated circuit breaker 5 comprising a circuit breaker 7 and a motor operating mechanism 9.

The circuit breaker 7 is an insulating-housing type three-pole circuit breaker that is more specifically described in the patent to Albert R. Cellerini et al., U.S. Pat. No. 3,287,534, patented Nov. 22, 1966. Thus, only a brief description of the circuit breaker 7 is provided herein. The circuit 7 comprises an insulating housing 11, having an opening 13 at the front thereof, and a circuit-breaker structure 15 supported in the housing 11 with a handle 17 protruding through the opening 13 to enable operation of the circuit breaker. An extension 19 is secured to the handle 17 to provide a handle-structure 21 that is operated by the motor operating mechanism in a manner to be hereinafter described.

Each pole of the three-pole circuit breaker comprises a conductor 23, a stationary contact 25 and a movable contact 27 secured to a movable contact arm 29 that is mounted on a switch arm 31 that is supported for movement about a pivot 33. Each movable contact arm 29 is connected to conducting means 35 by means of a flexible conductor 36. Each conducting means 35 extends through a trip-device 37 that is automatically operable to trip the circuit breaker to the open position in response to an overload in any of the three pole units. The switch arm 31 for the center pole unit is pivotally connected to a toggle link 39 that is in turn pivotally connected to a toggle link 41 that is pivotally connected to a releasable trip member 43. The trip member 43 is pivotally mounted on a pin 45 at one end thereof and latched by means of a latch means 47 at the other end thereof. Overcenter tension spring means 49 is connected at the lower end thereof to the knee pivot 51 of the toggle 39, 41 and at the upper end thereof to the bight portion of an inverted generally U-shaped operating lever 53 that is mounted for pivotal movement on pin means 55. The operating lever 53 is connected to handle structure 21 for operation between open and closed positions.

The circuit breaker 7 is shown in the closed position in FIG. 1. The circuit breaker is operated to the open position by movement of the handle structure 21 about the pivot 55 in a counterclockwise direction from the closed position seen in FIG. 1 to either the open position or the reset position during which movement the spring means 49 is carried overcenter to cause collapse of the toggle 39, 41 and opening movement of all three of the switch arms 31 which are tied together for simultaneous movement by means of a common tie bar 59. The circuit breaker is closed by movement of the handle struc-

ture 21 in a clockwise direction to the closed position seen in FIG. 1 during which movement the overcenter spring means 49 is moved to erect the toggle 39, 41 to simultaneously pivot the switch arm 31 about the pivots 33 to the closed position shown in FIG. 1.

Upon the occurrence of an overload in any of the three pole units, the circuit breaker is tripped open by operation of the trip device 37 which releases the latch 47 to effect automatic release of the latched trip member 43. Upon release of the trip member 43, the overcenter spring means 49 moves the trip member 43 in a clockwise direction to change the line of action of the overcenter spring means 49 and cause collapse of the toggle 39, 41 to simultaneously open the three switch arms 31. The circuit breaker is trip free in that the parts will trip open with the handle structure 21 being held in the closed position due to friction in the motor operating mechanism. Following a tripping operation, the circuit breaker can again be operated only after the releasable trip member 43 is operated to the reset and relatched position. The circuit breaker is reset by movement of the handle structure 21 in a counterclockwise direction to the reset position which is a position past the full off or open position. During this movement, a pin means 60 on the operating lever 53 engages a surface 61 on the releasable trip member 43 to move the trip member 43 in a counterclockwise direction about the pivot 45, and near the end of this movement the releasable trip member 43 is relatched by the latch means 47 in the manner described in the above-mentioned U.S. Pat. No. 3,287,534.

The motor operating mechanism 9 comprises an enclosure 62 and a mechanism 63 supported within the enclosure 62. The enclosure 62 comprises a receptacle part 64, having an opening 65 in the base thereof for receiving the handle structure 21, and a cover 66 supported on the receptacle part 64. The cover 66 has an opening 67 therein for receiving the handle structure 21. A slider 68, is supported on the inside of the cover 66 for generally rectilinear reciprocal movement to move with the handle structure 21. The handle structure 21 protrudes through an opening 69 in the slider 68, and the slider 68 substantially closes the opening 67 in the cover 66 in all positions of the handle structure 21.

The mechanism 67 comprises a motor drive structure 70; a pair of circuit breakers A and B; a pair of relays X and Y all supported in the receptacle part 64 of the enclosure 62. The enclosure 62 of the motor operating mechanism 9 is suitably mounted on the front of the insulating housing 7 with the handle structure 21 protruding through the front of the enclosure 62 as shown in FIG. 1.

The motor drive structure 70 comprises a reversible electric motor 75 having an output shaft 77. The motor 75 is fixedly secured to a bracket 79 that is secured to the base of the receptacle part 64 of the enclosure 62. A pair of guide rods 81 and 83 are fixedly secured at one end thereof to the bracket 79 and at the other end thereof to a plate member 85 that is secured to the end wall of the receptacle 64 by securing screw means 87. The guide rods 81, 83 extend through openings in the plate 85 as shown in FIG. 1. As can be seen in FIG. 1, and elongated extension shaft 91 is connected to the output shaft 77 of the motor 75 by means of a pin 93 (FIG. 5) having a large-diameter part 95 that fits through an opening in the shaft 77 and small-diameter end parts 97 that fit in a pair of slots (FIG. 1) in the extension shaft 91. The slot-and-pin connection between the output shaft 77 and the extension shaft 91 provides a fit that enables the output shaft 77 to rotate the extension shaft 91 while permitting the shafts 77, 91 to be slightly out of alignment due to manufacturing tolerances. Another pin 93 (FIG. 4) similarly connects the extension shaft 91 with a drive screw member 97 so that rotation of the extension shaft 91 will rotate the drive screw member 97 while permitting the parts to be slightly out of alignment due to manufacturing tolerances. One end of the drive screw member 97 is connected to the extension shaft 91 by means of the pin 93 and the other end (FIGS. 1 and 2) of the drive screw member 97 extends through an opening in the plate 85 and is supported on the inner raceway of a ball bearing member 99 that is supported on the end wall of the receptacle 64 by means of the supporting plate 85. The bearing member 99 supports the drive screw member 97 against radial movement and also against elongated thrust movement during operation of the motor operating mechanism. A traveling nut 101, having an internal threaded part (FIG. 4), is supported on the external threaded part of the drive screw member 97 for axial or longitudinal movement on the screw member 97. As can be seen in FIG. 4, the traveling nut 101 is supported on the screw member 97, and a plurality of ball bearings 103 are disposed in the threaded portion between the nut 101 and screw member 97 to reduce friction between these parts during operation of the motor operated circuit breaker 5. The traveling nut 101 comprises a channel part 105 to enable the ball bearings 103 to move through the channel part 105 as they are displaced from the threaded portion when the travelling nut 101 moves in the drive screw member 97. As can be seen in FIG. 4, the traveling nut 101 comprises an externally threaded extension part 107 that is threaded into an internally threaded tube 109 to secure the traveling nut 101 and tube 109 together for unitary movement. As can be seen in FIG. 2, and operating structure 113 comprises a generally U-shaped plate member 115 and a pair of generally U-shaped plate members 117 that are fixedly secured to the opposite legs of the generally U-shaped member 115 to form a movable carriage 118. The carriage 118 is provided with openings in the opposite end walls thereof for receiving the guide rods 81, 83 (FIGS. 1 and 2) which guide the carriage 118 during operation of the motor operated circuit breaker. As can be seen in FIG. 4, a flat spring support or plate member 119 is provided with an opening therein for receiving the tubular member 109 and a pair of openings therein for receiving the guide rods 81, 83 (FIG. 1). Another flat spring support or plate member 120 is provided adjacent the other end wall of the carriage 118. The plate member 120 has an opening therein for receiving the tubular member 109 and a pair of openings therein for receiving the guide rods 81, 83 (FIG. 1). A pair of coil compressions springs 121 and 123 (FIGS. 1 and 2) are supported on the guide rods 81, 83 respectively to bias the plates 119, 120 apart into engagement with the opposite stop parts or end walls of the carriage or frame 118. As can be seen in FIG. 4, the traveling nut 101 comprises shoulder means 127 that engage the plate 119 to move the plate 119 to the right upon movement of the traveling nut 101 to the right. A collar member 129 is provided on the tubular member 109 to provide a shoulder portion that engages the plate 120 (FIG. 4) to move the plate 120 to the left upon movement of the traveling nut 101 to the left.

As can be seen in FIG. 2, the bight portions of the U-shaped plates 117 provide side walls or side plates of the carriage 118 that support a pair of roller members 131, 135 that are supported for rotational movement on the plate parts 117 of the carriage 118. The rollers 131, 135 straddle the handle operator 21 so that upon movement of the carriage 118 the rollers 131, 135 will drive the handle structure 21 and so that upon manual movement of the handle structure 21 the carriage 118 will be operated.

The circuit breaker 7 is shown in the closed position in FIGS. 1 and 2. When it is desired to electrically operate the circuit breaker 7 to open the breaker 7, the reversible motor 75 is energized in a manner to be hereinafter described. Upon energization of the reversible motor 75 the output shaft 77 is rotated to rotate the intermediate shaft 91 to thereby rotate the drive screw member 97. Upon rotation of the drive screw member 97, the traveling nut 101 is driven to the left (FIGS. 1 and 2). As the traveling nut 101 moves to the left, the tubular member 109, that is fixed to the traveling nut 101, moves to the left and moving the shoulder part 129 (FIG. 4) to the left to move the plate 120 to the left. The compression springs 121, 123 are pre-charged sufficiently to immediately start moving the handle structure 21, in a manner to be hereinafter described, upon movement of the plate 120 to the left. Upon movement of the plate 120 to the left, the plate 120 pushes

against the pre-charged springs **121, 123**, to push the plate **119** to the left and the plate **119**, pushing against the end wall part of the carriage **118**, pushes the carriage **118** to the left. Upon movement of the carriage **118** to the left, the roller **135** moves the handle structure **21** from the closed position seen in FIG. **1** to the reset position hereinbefore described. When the carriage **118** and handle structure **21** reach the reset position the parts are stopped in a manner to be hereinafter described. With the handle structure **21** in the open position, the circuit breaker is electrically operated to the closed position by energization of the reversible motor **75** in a manner to be hereinafter described. Closing energization of the reversible motor **75** rotates the output shaft **77**, extension shaft **91** and drive screw member **97** in the opposite direction to move the traveling nut **101** to the right. Upon movement of the traveling nut **101** to the right, the plate **119**, which is engaged by the shoulder **127** (FIG. **4**) of the traveling nut **101**, is moved to the right to push against the pre-charged springs **121, 123** to thereby push the plate **120** to the right, and the plate **120**, pushing against the other end wall of the carriage **118**, moves the carriage **118** to the right. During this movement, the roller **131** moves the handle structure **21** to the closed position seen in FIG. **1**, and at the end of this movement the parts are braked to a stop in a manner to be hereinafter described.

With the motor **75** deenergized, the circuit breaker can be manually operated between the open and closed positions by manual movement of the handle structure **21** between the open and closed positions. During this movement, the rollers **131, 135** are manually moved to operate the carriage **118** and traveling nut **101**, with the drive screw member **97**, extension shaft **91** and output shaft **77** being rotated as the traveling nut **101** moves during manual operation. The ball-bearing connection between the traveling nut **101** and drive screw member **97** reduces the friction so that the manual operation can be performed without disconnecting the handle structure **21** from the motor operating mechanism.

During electrical operations, the carriage **118** is motor driven, and at the end of the operating movement of the handle structure **21**, the motor driven parts may move a limited amount after the handle structure reaches the operating positions before the motor driven parts are braked to a complete stop. It is desirable to provide a resilient connection between the traveling nut **101** and the handle structure **21** so that this additional limited movement can occur without breaking the handle structure **21**. Movement of the handle structure **21** is limited in both directions by the housing of the circuit breaker **7** around the opening **13** (FIG. **1**). As can be seen in FIG. **4**, when the carriage **118** is moved to the right to close the circuit breaker, the traveling nut **101** moves slightly past the limit position of the handle structure **21** moving the plate **119** to the right (to the position shown in broken lines) additionally charging the pre-charged springs **121** and **123** without applying damaging forces to the handle structure **21**. The plate **119** reaches this position only temporarily since the force of the pre-charged springs **121, 123** will move the plate **119** and nut **101** back to the position where the plate **119** engages the one end wall of the carriage **118** after the inertia of the moving parts is taken up by the springs **121, 123**. When the carriage **118** is moved to the left to open the breaker, the traveling nut **101** moves slightly past the limit position of the handle structure **21** moving the plate **120** to the left (to the position shown in broken lines in FIG. **4**) additionally charging the pre-charged springs **121** and **123** without applying damaging forces to the handle structure **21**. The plate **120** reaches this position only temporarily since the force of the pre-charged springs **121, 123** will move the plate **120** and the nut **101** back to the position where the plate **120** engages the associated end wall of the carriage **118** after the inertia of the moving parts is taken up by the springs **121, 123**.

The springs **121, 123**, which provide the resilient connection between the traveling nut **101** and handle structure **21**, are pre-charged sufficiently so that they will immediately start moving the handle structure **21** upon movement of the traveling nut **101**. The springs **121, 123**, however are not so pre-charged that they will cause breakage of the handle operator **21** during electrical operations of the motor-operated circuit breaker **5**. Each of the limit switch circuit breakers A and B is of the type more specifically described in the U.S. Pat. No. 2,624,816, patented June 6, 1953. Thus, only a brief description of the circuit breakers A and B, which are of identical construction, is herein provided. Referring to FIG. **3**, the circuit breaker A comprises an insulating housing **139** having an opening **141** in the front thereof. A circuit-breaker mechanism **143**, supported in the housing **139**, comprises an operating handle **145** that protrudes through the opening **141**. The circuit-breaker mechanism **143** comprises a stationary contact **147** and a movable contact **149** that is mounted on the lower end of a contact arm **151**. The contact arm **151** is a generally U-shaped member that pivotally engages an insulating operating lever **153** that is formed integral with the handle **145** and that is pivotally supported, at **155**, on the side walls of the insulating housing **139**. A tension spring **157** is connected at the lower end thereof to the bight portion of the contact arm **151**, and at the upper end thereof to a releasable trip member **159** that is latched at one end thereof and pivotally supported on a pin **161** at the other end thereof. The releasable trip member **159** is latched by means of a trip device **163**. The circuit breaker A is manually operated to the open position by clockwise movement of the handle **145** to move the contact arm **151** and spring **157** to an overcenter position wherein the spring **157** snaps the contact arm **151** to the open position. The circuit breaker is manually closed by counterclockwise movement of the handle **145** to the position seen in FIG. **3** to move the contact arm **151** and spring **157** to an overcenter position wherein the spring **157** snaps the contact arm **151** to the closed position seen in FIG. **3**. The circuit breaker A is tripped open automatically upon the occurrence of an overload current above a predetermined value by operation of the trip device **163** which moves to the right to release the trip member **159**. Upon release of the trip member **159** the spring **157** pivots the trip member **159** in a clockwise direction about the pivot **161** to cause the opening movement of the contact arm **151** in a well-known manner. Following a tripping operation, the circuit breaker is reset and relatched by movement of the operating handle **145** to a position slightly past the full open or off position during which movement the member **153** engages a pin **165** on the trip member **159** to pivot the trip member **159** in a counterclockwise direction to a position wherein the trip member **159** is relatched by means of the trip device **163**. Thereafter, the circuit breaker A can be manually operated in the same manner as was hereinbefore described. Reference is made to the above-mentioned patent to Bigenheimer, U.S. Pat. No. 2,624,816 for a more complete description of the construction and operation of the circuit breakers A and B.

Referring to FIG. **2**, it will be noted that a plate member **169** is fixedly secured to the carriage **118**, and a pair of drive rods **171, 173** extend through openings in the plate **169**. A pair of springs **175, 177** are supported on the rods **171, 173** between the plate **169** and a pair of nuts **179, 181** on the outer ends of the rods **171, 173** respectively. Another pair of springs **185, 187** are mounted on the rods **171, 173** and supported between the plate **169** and a pair of nuts **189, 191** respectively that are secured to the rods **171, 173**, respectively. A pair of generally U-shaped brackets **195, 197** are threadedly mounted on the ends of the rods **171, 173** and locked in position by a pair of nuts **201, 203** respectively. Each of the brackets **195, 197** is connected to the associated operating handle **145** of the associated circuit breaker by means of a pin that extends through an opening in the associated handle **145**, and is secured to the opposite legs of the associated bracket. As shown in FIG. **2**, the handle **145** of the circuit breaker A is in the open position and the handle **145** of the circuit breaker B is in the closed position. The circuit breakers A and B are supported in reverse positions from each other so that movement to the left of the rods **171, 173** will move the circuit breaker A

to the closed position and the circuit breaker B to the open position. Movement to the right of the rods 171, 173 will move the circuit breaker A to the open position and the circuit breaker B to the closed position. The springs 175, 177, 185 and 187 provide resilient connections between the plate 169 and the circuit breaker handles 145 to prevent damage to the circuit breaker handles 145 during operation of the motor operated circuit breaker 5. The nuts 179, 181, 189, 191 can be loosened and threadedly adjusted on the rods 171, 173 to provide adjustment for proper operation of the circuit breakers A and B during operation of the motor operated circuit breaker 5. The limit switch circuit breaker B is adjusted to go to its closed position just before the handle structure 21 reaches its closed position. The limit switch circuit breaker A should go to its open position just before the handle structure 21 reaches its closed position. The limit switch circuit breaker A should go to its closed position just before the handle-structure 21 goes to its open position. The limit switch circuit breaker B should go to its open position just before the handle-structure 21 goes to its reset position. When the handle structure 21 is electrically operated to open the breaker, the handle structure 21 is driven to the limit by the inertia of the moving parts so that the handle structure always goes to the reset position during electrical opening operations. When the handle structure 21 is manually operated to open the breaker however, the handle structure 21 will stop in the open position unless the operator makes a special effort to drive the handle structure to the reset position. With the above-mentioned adjustments of the circuit breakers A and B, both of the breakers A and B are closed following a manual operation to the open position. Thus, following a manual opening operation, an operator can electrically operate the handle structure to either the reset or closed position merely by pushing the selected push button PB1 or PB2 (FIG. 6). After the adjustments of the circuit breakers A and B are made, the nuts 179, 181, 189, 191 are locked in place with a suitable cement.

Each of the relays X and Y is a four-pole electro-magnetic relay of the type more specifically described in the patent to G. Jakel, U.S. Pat. No. 3,088,058 patented Apr. 30, 1963.

The electric control for operating the circuit breaker 7 is shown schematically in FIG. 6. As can be understood with reference to FIG. 6, the line L1 and L2 are connectable to a suitable power source for energizing the motor 75 to operate to the circuit breaker 7. The parts are shown in FIG. 6 with the circuit breaker 7 in the open position and the relays X and Y in the deenergized condition. Two push button switches PB1 and PB2, which may be mounted on the cover 66 (FIG. 1) for external operation, are momentary push buttons which automatically return to the open position upon release thereof by the operator. As can be seen in FIG. 6, with the circuit breaker 7 open, the circuit breaker A is closed and the circuit breaker B is open. With the X relay deenergized the X relay contacts X1 and X2 are normally open and the X relay contacts X3 and X4 are normally closed. With the Y relay deenergized, the Y relay contacts Y1 and Y2 are normally open and the Y relay contacts Y3 and Y4 are normally closed. The push button PB1 is manually closed momentarily to electrically open the circuit breaker 7. Upon closing of the push button PB1 the X relay coil XC is energized from the line L1 through the push button PB1, the circuit breaker A, the normally closed Y relay contact Y3, the relay coil XC to the line L2. Upon energization of the X relay coil XC the relay picks up closing contacts X1 and X2, and opening the contacts X3 and X4. Upon closing of the contacts X1, a seal-in circuit is is established from the line L1 through the contact X1, the circuit breaker A, the contact Y3, the relay coil XC to the line L2 so that upon release of the push button PB1 the relay coil XC will remain energized until the circuit breaker A is opened. With the relay coil XC energized, a winding of the reversible motor 75 is energized through the contact X2. This circuit is established from the line L1 through the relay contact X1, the circuit breaker A, the relay contact X2, the winding of the motor 75 to the line L2. With the reversible established 75 energized, the motor drive structure is operated to move the handle structure 21 of the circuit breaker 7 to the closed position to close the contacts 25, 27 of the circuit breaker in the same manner as was hereinbefore described. Just before the handle structure 21 reaches the closed position, the circuit breaker B is operated to its closed position and the circuit breaker A is operated to its open position. The contacts X3 and Y3 of the relays X and Y operate as an electrical interlock to prevent simultaneous energization of the relay coils XC and YC. Just before the handle structure 21 reaches the closed position of the motor circuit 75 is interrupted through the contacts of the circuit breaker A. This is the circuit from the line L1 through the relay contact X1, the circuit breaker A, the relay contact X2, the winding of the motor 75 to the line L2. Opening the circuit breaker A also opens the seal-in circuit from the line L1 through the contact X1, the circuit breaker A, the contact Y3, the coil XC to the line L2 to thereby deenergize the coil XC and drop out the relay X opening the contacts X1 and X2 and closing the contacts X3 and X4. By using the circuit breaker A to open the motor current, the contacts of the X relay are protected allowing the use of a smaller and lower cost relay particularly for DC operation. When the X relay drops out closing the contacts X4, a direct short circuit is established from line L2 through the motor winding, the contact X4, the contact Y4 to the line L2 to provide dynamic braking which brakes the motor, and the parts operated by the motor, to a stopped condition.

With the circuit breaker 7 closed, the motor 75 deenergized, the relay coils XC and YC deenergized, the circuit breaker A opened and the circuit breaker B closed, the motor operated circuit breaker 5 is electrically operated to the open position by momentary closing of the push button contact PB2. Closing of the contact PB2 energizes the Y relay coil from the line L1 through the contact PB2, the closed circuit breaker B, the contact X3, the Y relay coil YC, to the line L2. Upon energization of the coil YC, the Y relay picks up the closing normally open contacts Y1 and Y2, and opening the normally closed contacts Y3 and Y4. Upon closing of the contact Y1, a seal-in circuit is established from the line L1 through the contact Y1, the circuit breaker B, the contact X3, the relay coil YC to line L2 sealing in the picked up Y relay which will remain energized upon release of the momentary push button PB2 until the circuit breaker B is opened. When the Y relay is picked up, a circuit is established energizing another winding of the reversible motor 75 from the line L1 through the contact Y1, the circuit breaker B, the contact Y2, the winding of the motor 75, to the line L2 energizing the reversible motor 75 to operate the motor operated circuit breaker 5 from the closed position to the open position in the manner hereinbefore described. Just before the handle structure 21 reaches the open position, the circuit breaker A will be operated to its closed position; and the circuit breaker B will be operated to its open position just before the handle structure reaches its reset position. As was hereinbefore described, the contacts X3, Y3 prevent simultaneous energization of the relay coils XC and YC. When the circuit breaker B opens, the energizing circuit for the motor 75 is interrupted through the contacts of the circuit breaker B which also open the seal-in circuit to deenergize the relay coil YC. By interrupting the motor circuit with the circuit breaker B, the contacts of the Y relay are protected allowing the use of a smaller and a lower cost relay particularly for DC operation. When the seal-in circuit through the contact Y1 is interrupted the relay coil YC is deenergized and the Y relay drops out closing the contact Y4 to establish a short circuit from the line L2, through the motor winding, the contact X4, the contact Y4, to the line L2 to dyn amically brake the motor 75 to bring the motor and the parts driven by the motor to a stopped condition.

If an automatic reset is desirable, an auxiliary switch can be operated to automatically reset the circuit breaker 7 by means of the motor drive structure 63 following a tripping operation of the circuit breaker 7. A well known type of auxiliary switch can be mounted inside the circuit breaker in a normally open

position to be automatically closed by movement of the trip member 43 (FIG. 1) to the tripped position and automatically opened when the tripped member 43 is moved to the relatched reset position. The contacts of the automatic reset switch are wired to bypass the push button PB2 as shown at AR in FIG. 6. When the automatic reset is utilized the contact AR will be automatically closed by movement of the trip member 43 (FIG. 1) to the tripped position. Closing of the contact AR will energize the reversible motor 75 in the manner hereinbefore described to automatically provide an electrical operation of the handle operator 21, (FIG. 1) to the reset position, and when the handle operator 21 reaches the reset position the circuit breaker B will be opened to interrupt the motor current and to drop out the Y relay in the manner hereinbefore described with the automatic reset contact AR being opened by movement of the trip member 43 to the reset position.

We claim

1. A motor operating device for operating a circuit breaker having a pair of breaker contacts and a handle structure movable to open and close said breaker contacts;

said motor operating device comprising an electric reversible motor; and operating structure for operatively connecting said reversible motor with said handle structure;

a closing relay comprising a closing relay coil and operable when said closing relay coil is energized to energize said reversible motor to operate said handle structure to close said breaker contacts; an opening relay comprising an opening relay coil and operable when said opening relay coil is energized to energize said reversible motor to operate said handle structure to open said breaker contacts; a first limit switch contact structure and a second limit switch contact structure; said first limit switch contact being in a first series circuit with said closing relay coil and a power source; said first limit switch contact structure being in a second series circuit with a normally open contact of said closing relay, a first winding of said reversible motor and a power source; said second limit switch contact structure being in a third series circuit with said opening relay coil and a power source; said second limit switch contact structure being in a fourth series circuit with a normally open contact of said opening relay, a second winding of said reversible motor and a power source; closing control contact means for closing said first and second series circuits; opening control contact means for closing said third and fourth series circuits;

and means automatically operating to open said first limit switch contact structure and close said second limit switch contact structure when said handle structure is electrically operated to close said breaker contacts and automatically closing said first limit switch contact structure and opening said second limit switch contact structure when said handle structure is electrically operated to open said breaker contacts.

2. A motor operating device according to claim 1; a first limit circuit breaker and a second limit circuit breaker; said first limit switch contact structure being a contact structure in said first limit circuit breaker and said second limit switch contact structure being a contact structure in said second limit circuit breaker.

3. A motor operating device according to claim 1; and each of said relays comprising a normally open seal-in contact bypassing the associated control contact means in parallel with the associated control contact means for sealing in the energized relay until the associated limit switch contact structure is opened.

4. A motor operating device according to claim 3; each of said relays comprising an interlock contact cooperable with an interlock contact of the other relay to provide an electrical interlock for preventing simultaneous energization of said relays.

5. A motor operating device according to claim 4; and each of said relays comprising a braking contact in series with a braking contact of the other relay to provide a short circuit through the winding of said motor to provide dynamic braking when both of said relays are deenergized.

6. A motor operating device according to claim 1; and each of said relays comprising a braking contact in series with a braking contact of the other relay to provide a short circuit through the winding of said motor to provide dynamic braking when both of said relays are deenergized.

7. In combination, a circuit breaker and a motor operating mechanism for operating said circuit breaker,

said circuit breaker comprising a circuit breaker mechanism, said circuit breaker mechanism comprising a pair of breaker contacts and a handle structure, said circuit breaker mechanism being movable to a tripped position to automatically open said breaker contacts and to a reset position to permit closing an opening of said breaker contacts by operation of said handle structure, said handle structure being movable in a first direction to a closed position to close said breaker contacts, said handle structure being movable in a second direction from said closed position to an open position to open said breaker contacts, said handle structure being movable in said second direction to a reset position past said open position to open said breaker contacts if said breaker contacts are closed and to reset said circuit breaker mechanism if said circuit breaker mechanism is in the tripped position,

said motor operating mechanism comprising a reversible motor and an operating structure operatively connecting said reversible motor with said handle structure of said circuit breaker, control means for operating said reversible motor,

said control means comprising a closing relay energizable to effect energization of said motor in one direction to move said handle structure to said closed position, an opening relay energizable to effect energization of said motor in another direction to move said handle structure to said reset position, limit switch means comprising a first limit switch contact structure in series with said closing relay and said motor, and a second limit switch contact structure in series with said opening relay and said motor,

limit switch actuating means automatically operable to open said first limit switch contact structure and close said second limit switch contact structure to deenergize said motor when said motor is energized to move said handle structure to the closed position, said limit switch actuating means being automatically operable to open said second limit switch contact structure and close said first limit switch contact structure to deenergize said motor when said motor is energized to move said handle structure to the reset position,

said handle structure being manually operable from said closed position to said open position without disconnection from said operating structure of said motor operating mechanism, and said limit switch actuating means automatically positioning both of said first and second limit switch contact structures in the closed position when said handle structure has been manually moved from the closed position to the open position whereby said control is automatically prepared for an electrical operation to the closed position and also for an electrical operation to the reset position following a manual operation to the open position.

8. A combination according to claim 7, a pair of insulating-housing type circuit breakers, and each of said limit switch contact structure being a contact structure in a separate one of said insulating-housing type circuit breakers.

9. A combination according to claim 8, each of said insulating-housing type circuit breakers comprising an externally operable handle for operating the associated limit switch contact structure, and resilient connecting means operatively connecting said operating structure with said handles of said insulating-housing type circuit breakers.

10. A motor operating device for operating a circuit breaker having a pair of breaker contacts and a handle structure movable to open and close said breaker contacts;

said motor operating device comprising an electric reversible motor; an operating structure for operatively connecting said reversible motor with said handle structure;

a closing relay comprising a closing relay coil and a first normally open contact;

a first limit switch contact structure in a first series circuit with said closing relay coil and a power source; said first limit switch contact structure being in a second series circuit with said first normally open contact, a first winding of said reversible motor and a power source;

closing control contact means for closing said first and second series circuits;

an opening relay comprising an opening relay coil and a second normally open contact;

a second limit switch contact structure in a third series circuit with said opening relay coil and a power source; said second limit switch contact structure being in a forth series circuit with said second normally open contact, a second winding of said reversible motor and a power source; opening control contact means for closing said third and fourth series circuits;

interlock means interlocking said first and second limit switch contact structures;

with said first limit switch contact structure closed and said second limit switch contact structure open said closing control contact means being closable to close said breaker contacts; upon closing of said closing control contact means said closing relay coil being energized to thereby close said first normally open contact to thereby close said second series circuit to energize said first winding whereupon said operating structure is operated to move said handle structure to close said breaker contacts whereupon said interlock means is automatically operated to open said first limit switch contact structure and close said second limit switch contact structure;

with said first limit switch contact structure open and second second limit switch contact closed said opening control contact means being closable to open said breaker contacts; upon closing of said opening control contact means said opening relay coil being energized to thereby close said second normally open contact to thereby close said fourth series circuit to energize said second winding whereupon said operating structure is operated to move said handle structure to open said breaker contacts whereupon said interlock means is automatically operated to open said second limit switch contact structure and close said first limit switch contact structure.

11. A motor operating device according to claim 10; and each of said relays comprising a normally open seal-in contact bypassing the associated control contact means in parallel with the associated control contact means for sealing in the energized relay until the associated limit switch contact structure is opened.

12. A motor operating device according to claim 11; each of said relays comprising an interlock contact cooperable with an interlock contact of the other relay to provide an electrical interlock for preventing simultaneous energization of said relays.

13. A motor operating device according to claim 12; and each of said relays comprising a braking contact in series with a braking contact of the other relay to provide a short circuit through the winding of said motor to provide dynamic braking when both of said relays are deenergized.

14. A motor operating device according to claim 10; and each of said relays comprising a braking contact in series with a braking contact of the other relay to provide a short circuit through the winding of said motor to provide dynamic braking when both of said relays are deenergized.

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