United States Patent

Davies

[15] **3,652,815**

[45] **Mar. 28, 1972**

[54] CIRCUIT INTERRUPTER WITH MOTOR OPERATED SPRING CHARGING MEANS INCLUDING TWO RATCHETS AND TWO PAWLS

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

[22] Filed: **Jan. 14, 1971**

[21] Appl. No.: **106,330**

[52] **U.S. Cl.** .....**200/153 SC**, 74/118, 185/40 R, 335/76

[51] **Int. Cl.** **H01h 3/30**, H01h 3/34

[58] **Field of Search** .....200/153 SC, 153 P; 185/40 R; 335/68, 76, 77, 171, 140, 73; 74/118, 143

[56] **References Cited**

UNITED STATES PATENTS

3,235,044 2/1966 Rodeseike .....200/153 SC X

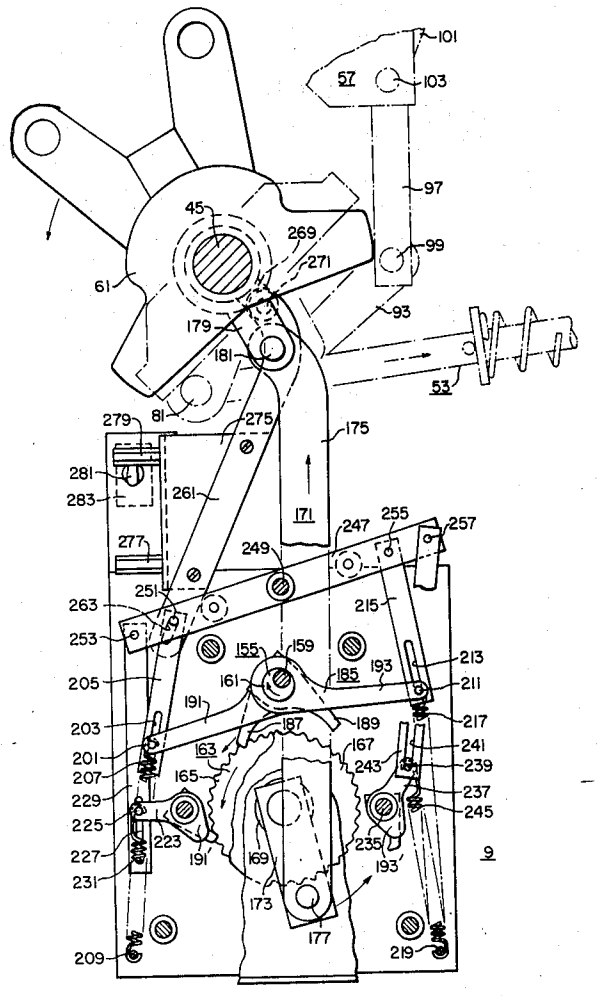
3,475,981 11/1969 Gerard 74/143

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Assistant Examiner—Robert A. Vanderhye
Attorney—A. T. Stratton, C. L. McHale and W. A. Elchik

[57] **ABSTRACT**

A motor operated circuit interrupter comprises an overcenter spring structure operable to a spring-charged closed position to prepare the circuit interrupter for a spring opening operation and to a spring-charged open position to prepare the circuit interrupter for a spring closing operation. Releasable latch means latches the overcenter spring structure in both of the spring charged positions. A motor operating mechanism comprises ratchet means operated by a motor and operable to operate the circuit interrupter to both of the spring-charged positions. The ratchet means comprises two ratchets and two pawls, one pawl and ratchet set engageable to charge the spring in one position, and the other pawl and ratchet set engageable to charge it in its other position.

11 Claims, 14 Drawing Figures



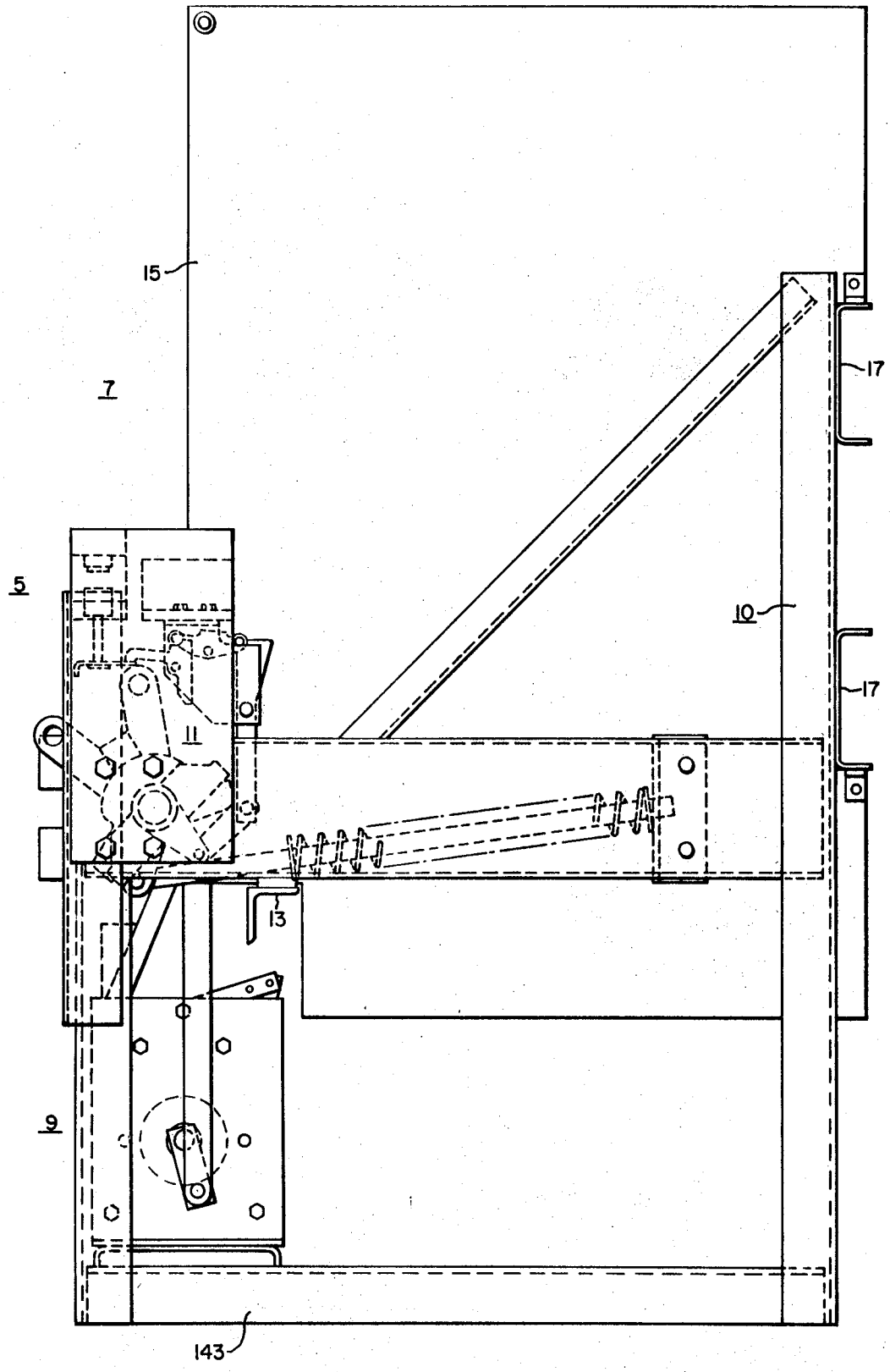


FIG. 1.

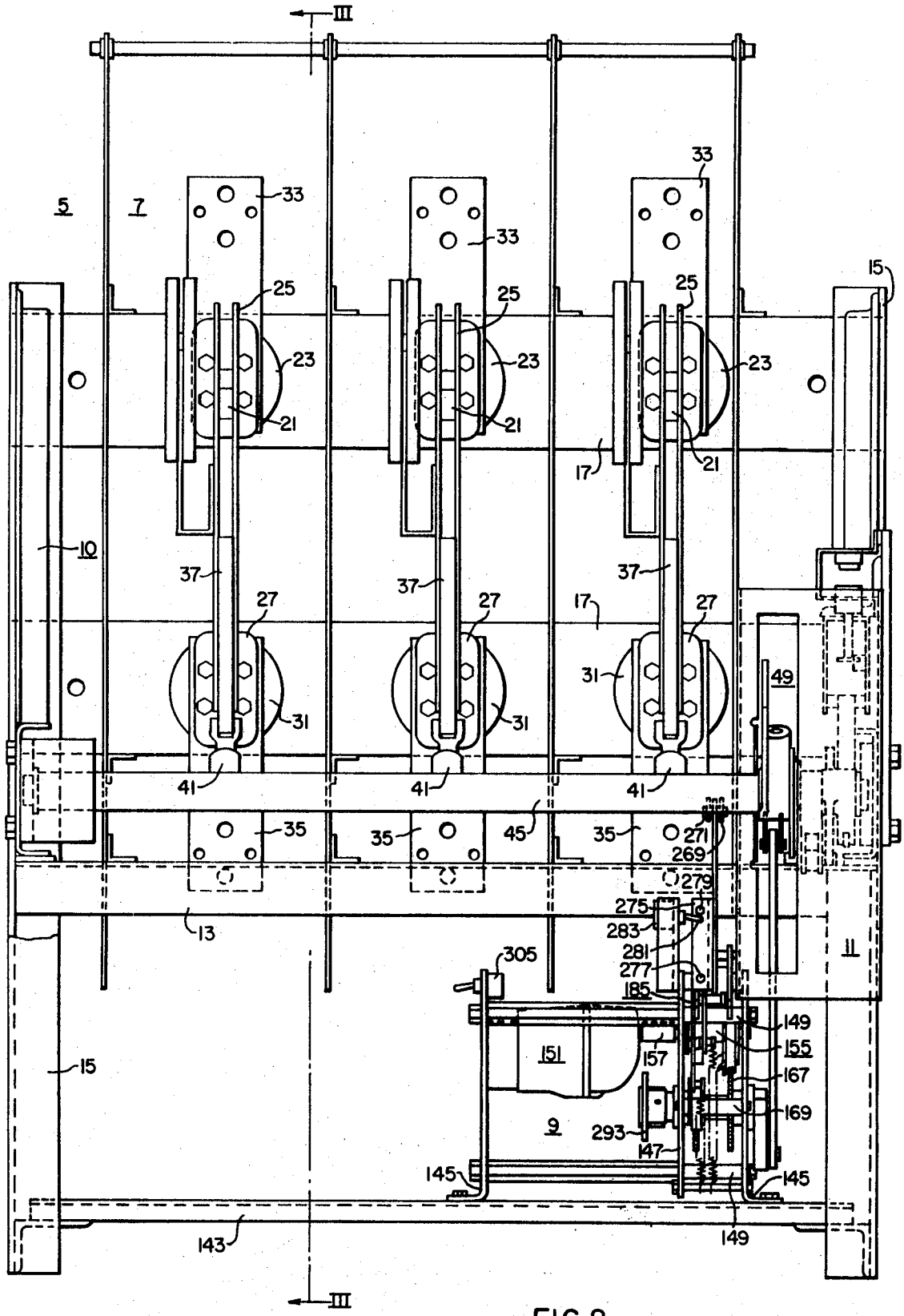

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FIG. 2.

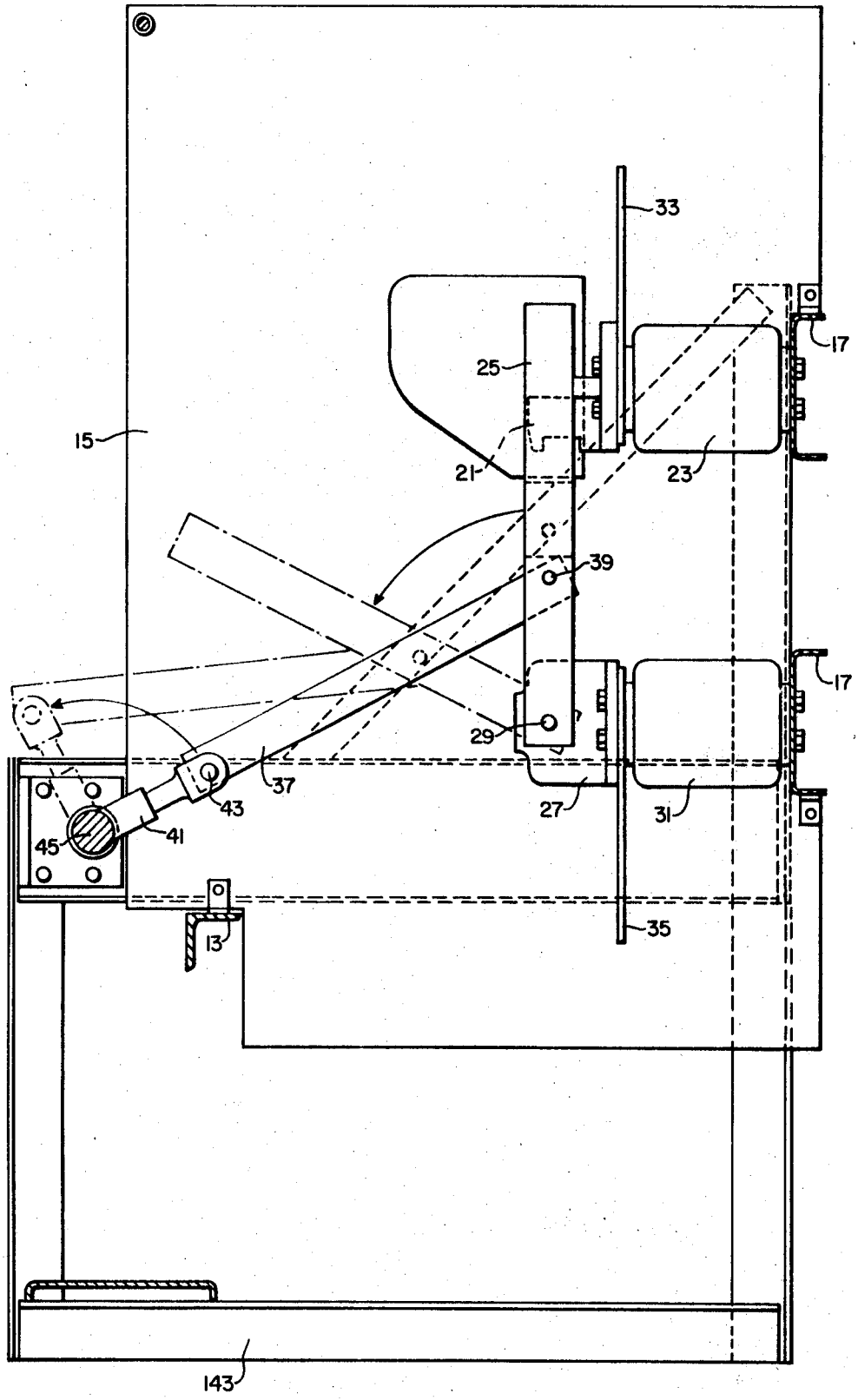


FIG. 3.

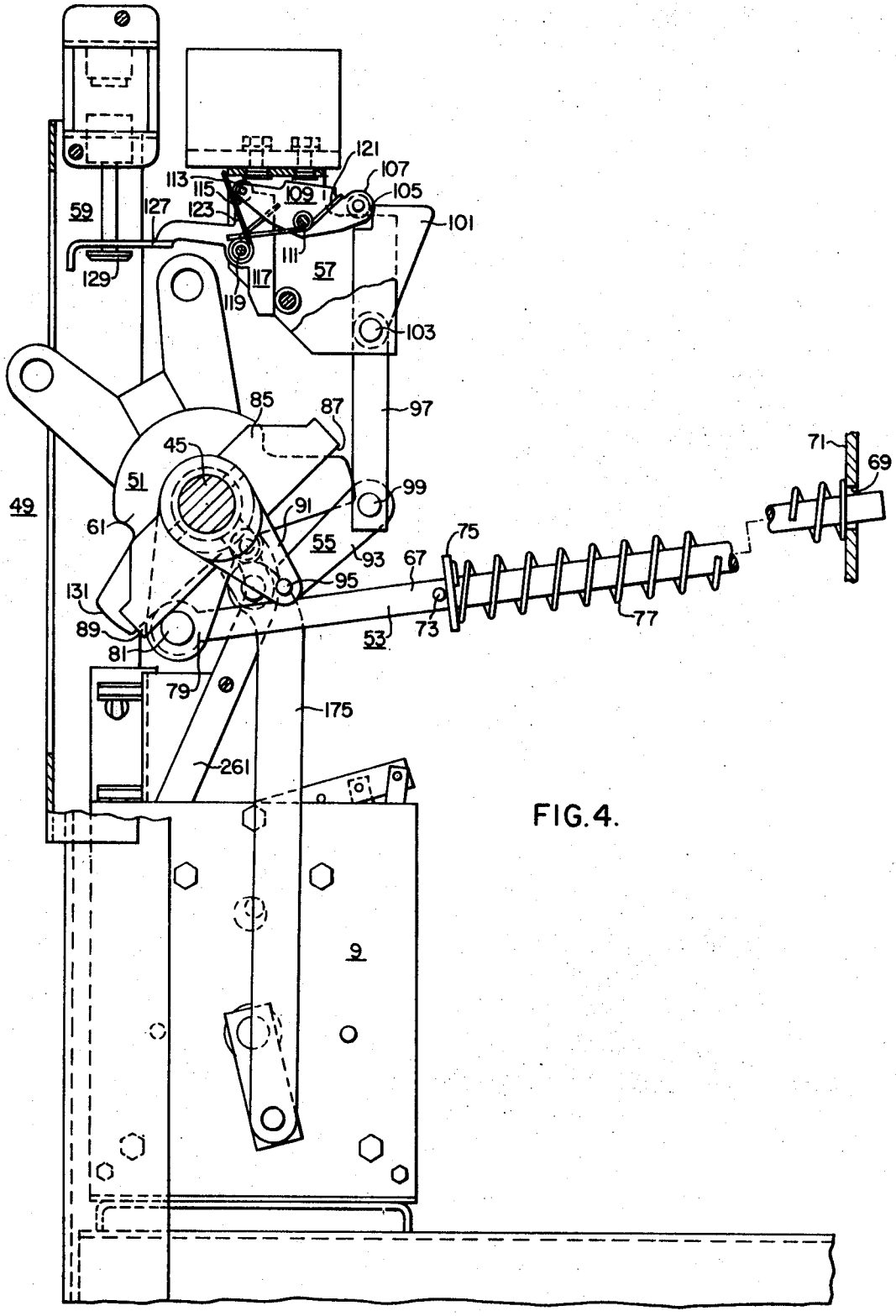

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FIG. 4.

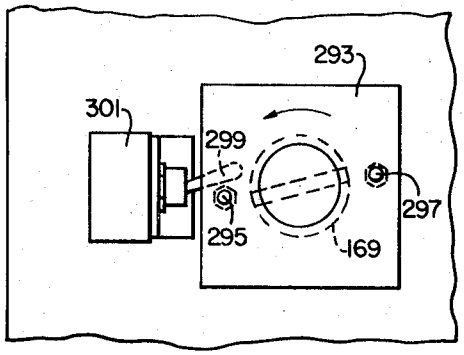

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FIG.6.

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FIG. 5.

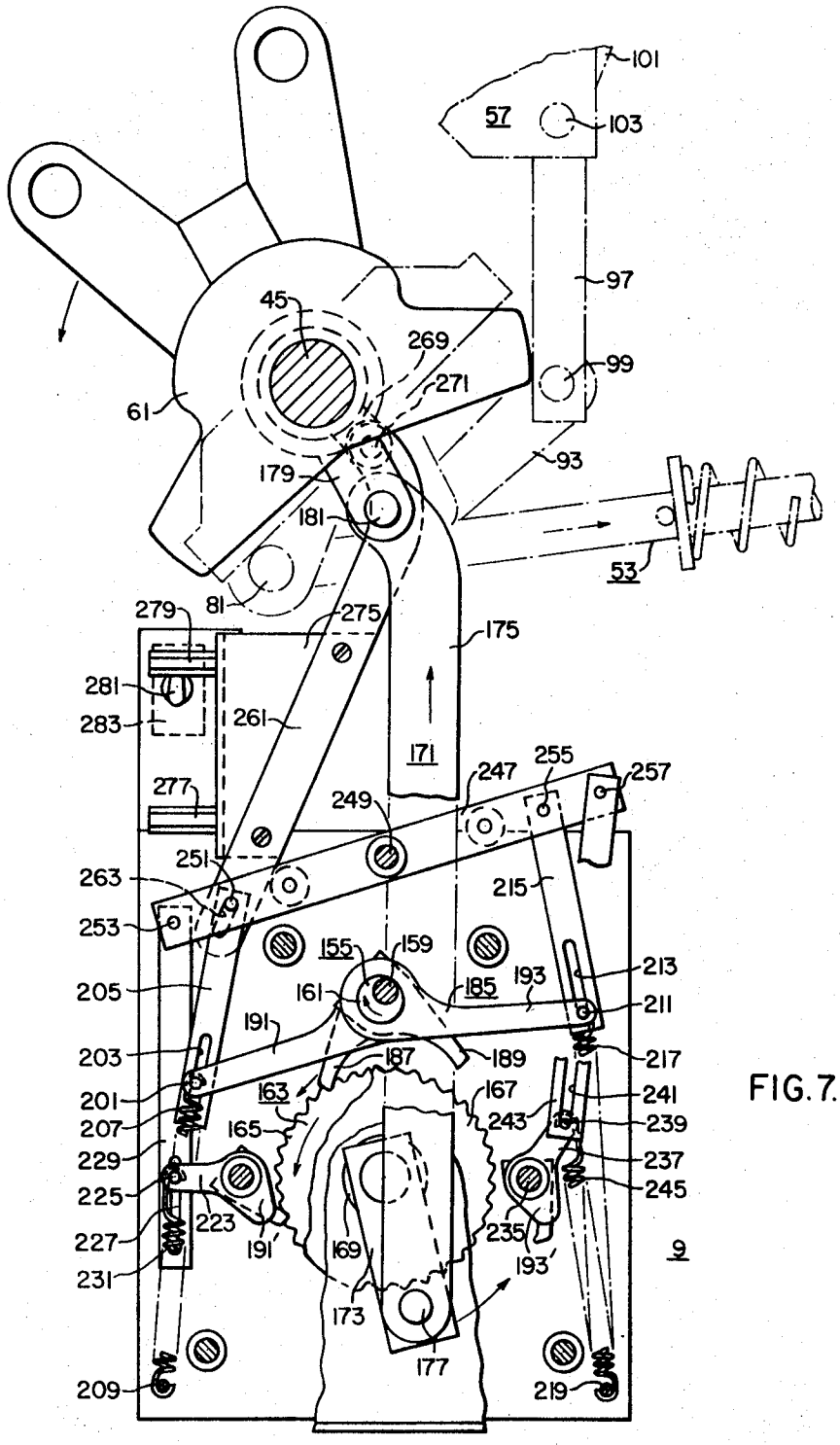

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FIG. 7.

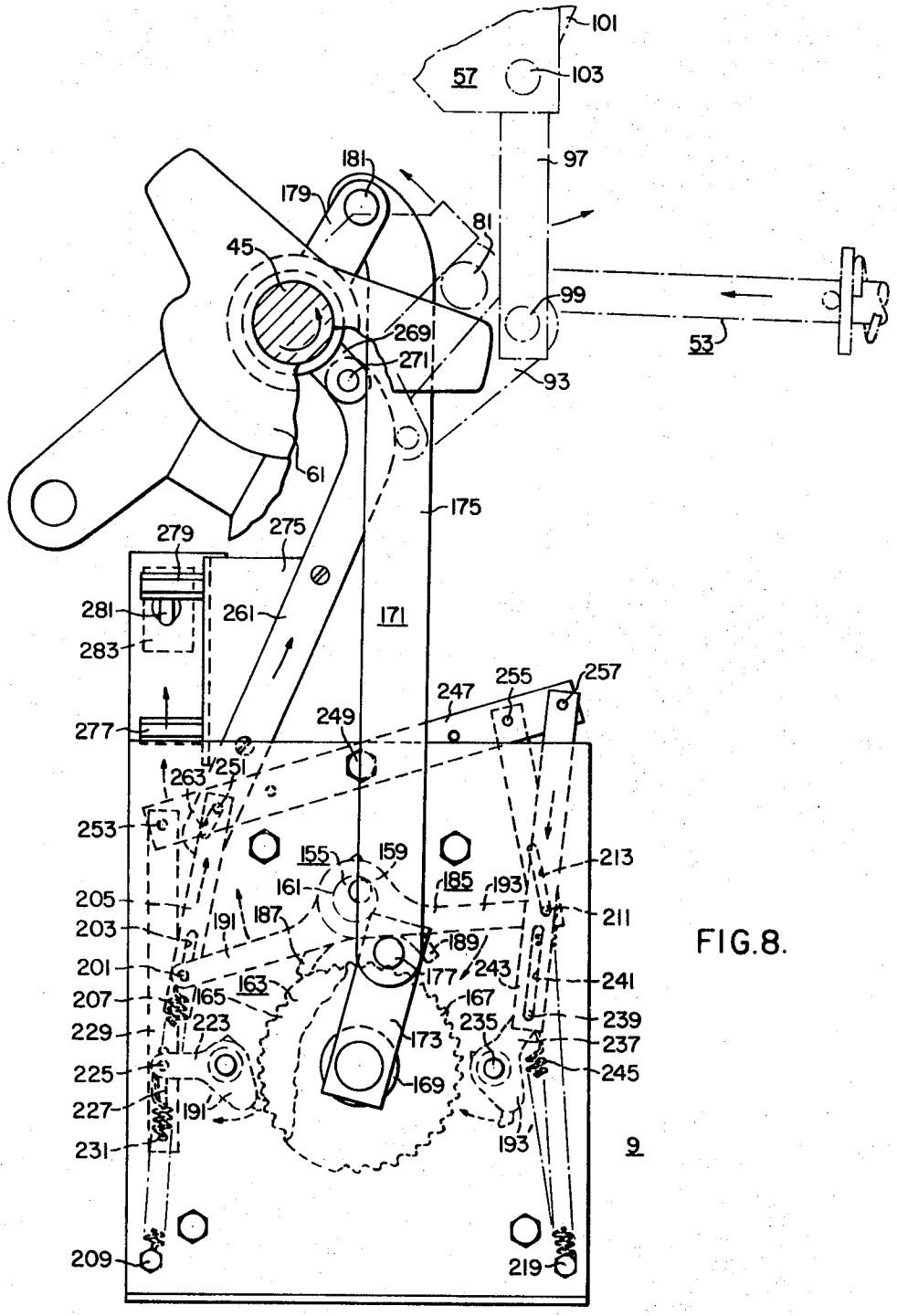

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FIG.8.

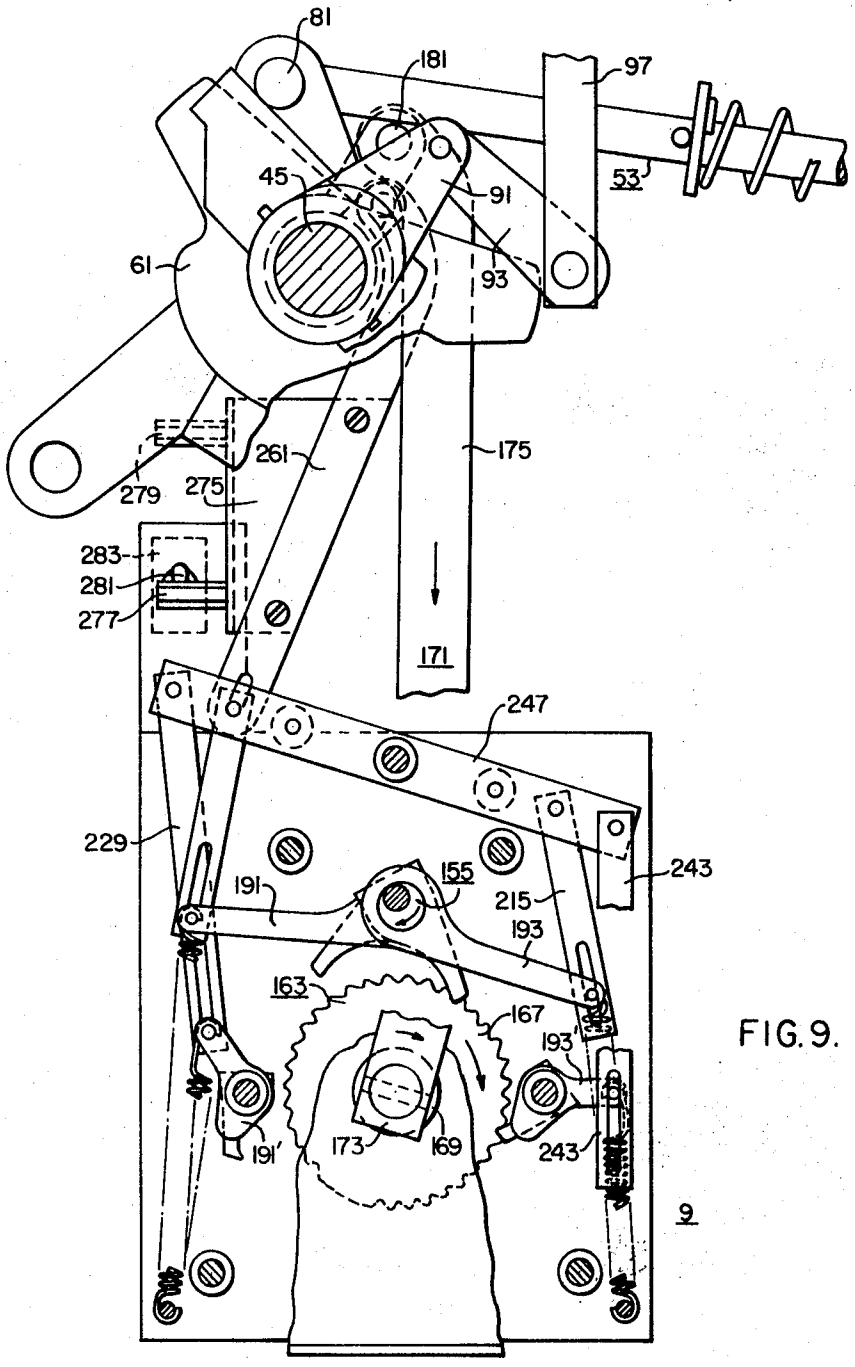

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FIG. 9.

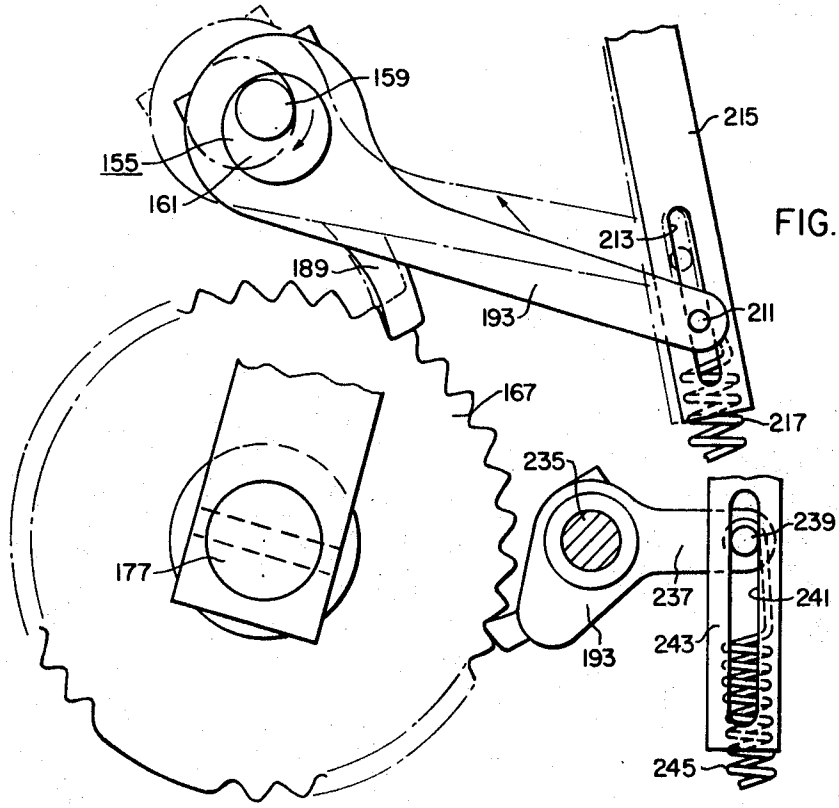
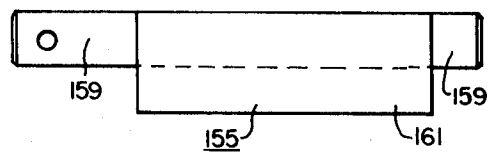


FIG. 12.

FIG. 10.



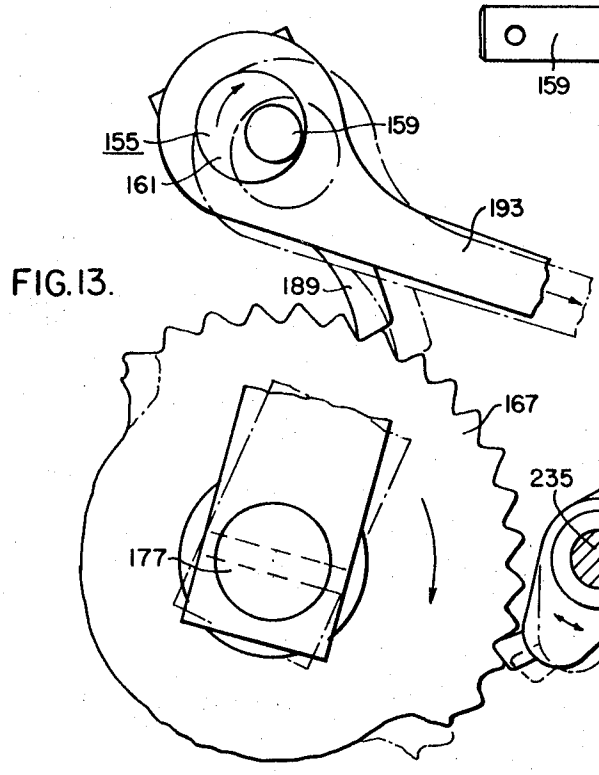


FIG. 13.

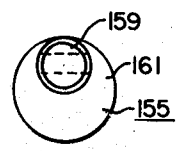


FIG. 11.

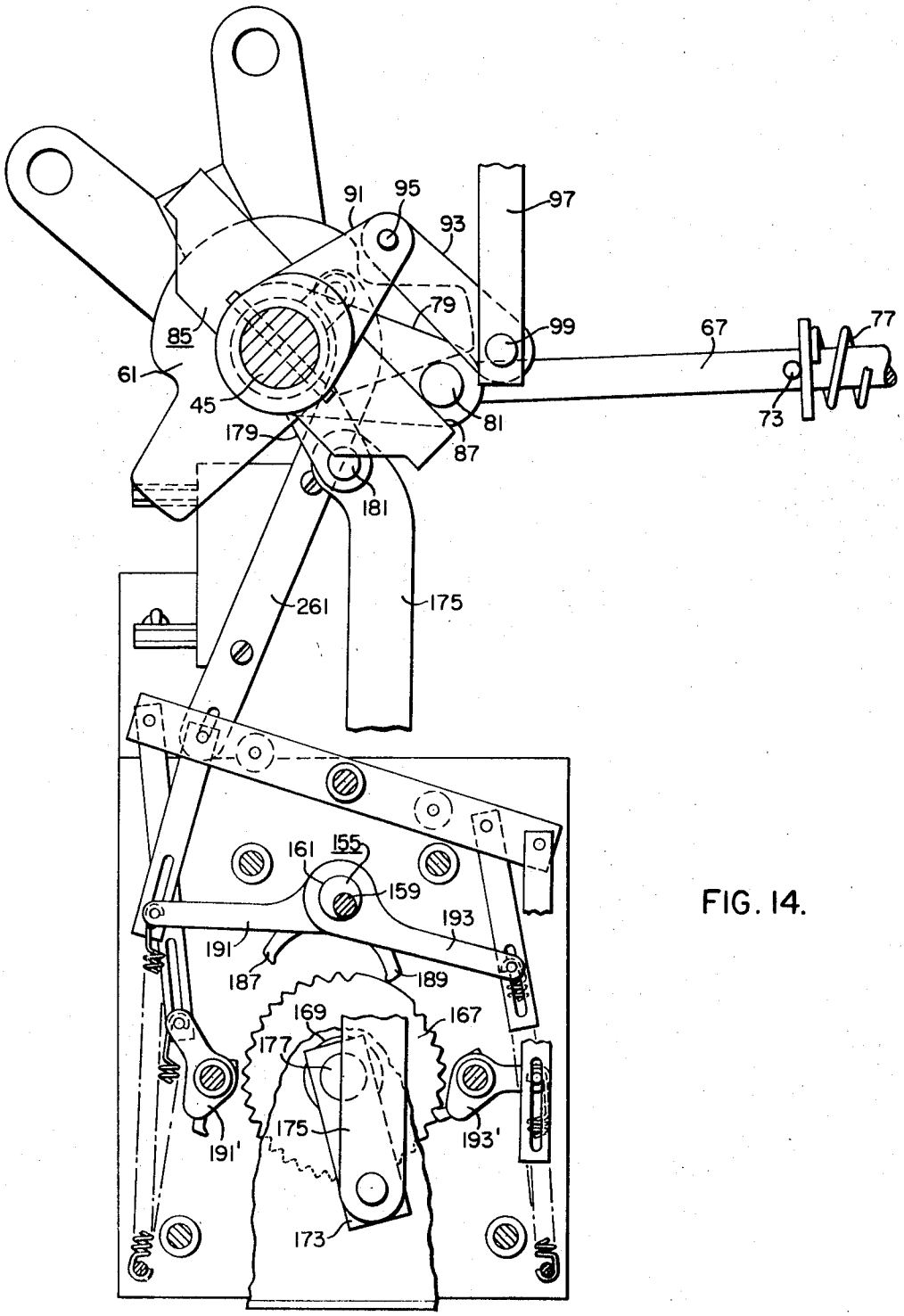

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FIG. 14.

CIRCUIT INTERRUPTER WITH MOTOR OPERATED SPRING CHARGING MEANS INCLUDING TWO RATCHETS AND TWO PAWLS

CROSS-REFERENCE TO RELATED APPLICATION

The herein-disclosed circuit interrupter is disclosed in the copending patent application, of Norman Davies, Ser. No. 106,328, filed Jan. 14, 1971.

BACKGROUND OF THE INVENTION

1. Field of the Invention

Stored-energy spring operated circuit interrupters of the type comprising a motor energizable to charge an operating spring structure.

2. Description of the Prior Art

In the patent to Gerard, U.S. Pat. No. 3,475,981, there is disclosed a motor operated switch comprising a motor operating mechanism operable to drive a pair of ratchet wheels in opposite directions in order to charge an overcenter spring structure to thereby operate a switch between open and closed positions. This invention is an improvement over prior art of the type disclosed in the Gerard patent in that the circuit interrupter of this invention comprises latch means for latching the overcenter spring structure in both of the stored energy positions, and the ratchet means of the motor operating mechanism comprises missing-tooth portions on the ratchet wheels which enable the motor to overrun when the circuit interrupter reaches the stored energy positions. The motor operating mechanism also comprises improved means for shifting driving and holding pawls to provide that the unidirectional motor will operate the ratchet means in the desired direction.

SUMMARY OF THE INVENTION

A motor operated circuit interrupter comprises a circuit interrupter structure and a motor operating mechanism. The circuit interrupter structure comprises a pair of contacts and an operating shaft movable between open and closed positions to open and close the contacts. An overcenter spring structure is movable to an overcenter spring-charged closed position to prepare for an opening operation and to an overcenter spring charged open position to prepare for a closing operation. Releasable latch means is provided for latching the overcenter spring structure in both of the spring-charged positions. Upon release of the latch means when the overcenter spring structure is in the spring charged closed position the overcenter spring structure will operate the operating shaft to the open position, and upon release of the latch means when the overcenter spring structure is in the spring-charged open position the overcenter spring structure will operate the operating shaft to the closed position.

The motor operating mechanism comprises a ratchet structure comprising an opening ratchet and a closing ratchet. An opening driving pawl is provided for driving the opening ratchet and an opening holding pawl is provided for holding the opening ratchet in the advanced position as the driving pawl is operated. A closing driving pawl is provided for driving the closing ratchet and a closing holding pawl is provided for holding the closing ratchet in the advanced position as the closing driving pawl is operated. A motor comprises an output shaft operatively connected to the driving pawls. A first link means connects the ratchet structure with the overcenter spring structure and a second link means connects the pawls with the operating shaft. With the circuit interrupter in the closed position, the second link means maintains the pawls in a position wherein the opening driving pawl and the opening holding pawl are positioned to operate the opening ratchet. Upon energization of the motor, the output shaft operates an eccentric to reciprocate the opening driving pawl against the opening ratchet to thereby operate the first link means to move the overcenter spring structure to the spring-charged closed position. The opening ratchet is provided with a missing tooth portion and when the overcenter spring structure reaches the spring-charged closed position continued operation of the motor will operate the opening driving pawl against the missing tooth portion without applying damaging forces to the ratchet structure. Suitable limit switch means is provided for deenergizing the motor when the overcenter spring structure reaches the spring-charged closed position. With the overcenter spring structure in the spring charged closed position the latch means can be released and the overcenter spring structure will operate to drive the operating shaft to the open position.

Upon operation of the operating shaft to the open position the second link means operates automatically to move the opening driving pawl and opening holding pawl out of cooperative engagement with the opening ratchet and to move the closing driving pawl and closing holding pawl into cooperative engagement with the closing ratchet. With the circuit interrupter in the open position, the motor, upon energization thereof, will drive the eccentric to reciprocate the closing driving pawl against the closing ratchet to advance the ratchet means in the opposite direction during which movement the first link means operates the overcenter spring structure to the spring-charged open position. When the overcenter spring structure reaches the spring charged open position the latch means automatically latches the overcenter spring structure in the closing spring-charged position, and the closing ratchet is positioned such that the closing driving pawl operates against a missing tooth portion of the closing ratchet so that continued operation of the motor will not apply damaging forces on the ratchet structure. A limit switch is operated to automatically deenergize the motor when the overcenter spring structure reaches the spring-charged open position. With the overcenter spring structure in the spring-charged open position the latch means is releasable whereupon the overcenter spring structure operates to drive the operating shaft in the closing direction to the closed position. Upon operation of the operating shaft to the closed position the second link means operates automatically to move the closing driving pawl and closing holding pawl out of cooperative engagement with the closing ratchet and to move the opening driving pawl and opening holding pawl into cooperative engagement with the opening ratchet.

Upon operation of the operating shaft to both the closed and open position a limit switch is operated to prepare the motor circuit for a subsequent operation. The motor, which is a unidirectional motor, operates both the closing driving pawl and the opening driving pawl to operate the ratchet means. An improved linkage is provided for shifting the pawl means into the proper operating condition upon operation of the operating shaft.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of a motor operated multipole circuit interrupter constructed in accordance with principles of this invention;

FIG. 2 is a front view of the circuit interrupter disclosed in FIG. 1;

FIG. 3 is a sectional view taken generally along the line III—III OF FIG. 2 with the open position of the circuit interrupter being shown in broken lines;

FIG. 4 is a side view with parts broken away to better illustrate part of the operating mechanism;

FIG. 5 is a front view, with parts broken away, of the mechanism illustrated in FIG. 4;

FIG. 6 is a view taken generally along the line VI—VI of FIG. 5;

FIG. 7 is a side view, with parts broken away of part of the mechanism seen in FIG. 4 in the spring discharged closed position with an arrow-type illustration of the direction of movement of various parts;

FIG. 8 is a view similar to FIG. 7 illustrating the spring-charged closed position;

FIG. 9 is a view similar to FIG. 7 with the circuit interrupter in the spring discharged open position with an arrow-type illustration of the direction of movement of various parts;

FIG. 10 is an elevational view of the eccentric seen in FIG. 5;

FIG. 11 is a side view of the eccentric seen in FIG. 10;

FIGS. 12 and 13 are views illustrating the operation of the eccentric in driving closing ratchet; and

FIG. 14 is a view illustrating the spring-charged open position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, there is shown, in FIGS. 1 and 2, a motor operated circuit interrupter 5 comprising a circuit interrupter 7 and a motor operating mechanism 9. The circuit interrupter 7 is more specifically shown and described in the copending patent application of Norman Davies, Ser. No. 106,328 filed Jan. 14, 1971.

The circuit interrupter 7 comprises support means 10 and a circuit-interrupter structure 11 supported on the support means 10. The support means 10 comprises a backplate means 13 and a pair of side plate means 15, connected to the backplate 13. A pair of elongated channel members 17 are supported on the side plate means 15 for supporting the terminal of the circuit interrupter.

The circuit-interrupter structure 11 comprises three stationary contacts 21 (FIGS. 2 and 3) supported on three spaced insulating members 23 that are supported on one of the back support channel members 17. A separate movable contact arm 25 is provided to cooperate with each of the stationary contacts 21. Each of the contact arms 25 comprises a pair of spaced contact members (FIG. 2) that comprise contact portions that engage the opposite sides of the associated stationary contact 21 in the closed position of the contacts. Each of the contact arms 25 is supported for pivotal movement on a separate conducting terminal 27 by means of a pivot pin 29. Each of the terminals 27 is supported on an insulating support 31 that is in turn supported on one of the channel support members 17. In each pole unit a terminal plate 33 is connected to the contact 21 and a terminal plate 35 is connected to the terminal 27 to enable connection of the pole unit in an electric circuit.

In each pole unit an elongated link 37 (FIG. 3) is pivotally connected at one end thereof, to the movable contact arm 25 by means of a pivot pin 39 and at the other end thereof to a member 41 by means of a pivot pin 43. Each of the members 41 is an integral part of an elongated operating shaft 45. As can be understood with reference to FIGS. 2 and 3, the operating shaft 45 is supported on the side plate means 15 for rotational movement about the elongated axis thereof. The circuit interrupter is shown in full lines in FIG. 3 in the closed position. Upon counterclockwise movement of the operating shaft 45 to the open position shown in broken lines, the three links 37 of the three pole units are moved to move the contact arms 25 to the open position shown in broken lines. Reverse or clockwise movement of the operating shaft 45 from the position shown in broken lines operates through the links 37 to move the three contact arms 25 from the open position shown in broken lines to the closed position in full lines.

An operating mechanism 49 (FIGS. 2, 4 and 5) is provided for operating the operating shaft 45 between the closed and open positions. The operating mechanism 49 comprises drive means 51, an overcenter spring structure 53, a latch linkage 55, a latch structure 57 and a trip device 59.

The drive means 51 comprises a drive member 61 supported on the operating shaft 45 for rotational movement relative to the operating shaft 45. The drive member 61 is provided with an opening 63 for receiving a crank rod that can be placed into the opening 63 in order to crank the drive member 61 between the open and closed positions.

The overcenter spring structure 53 comprises an elongated rod 67 (FIG. 4) that extends at one end thereof through an opening 69 in a stationary plate 71 that is connected on the side plate means 15. A pin 73 and washer 75 are supported on the rod 67. An overcenter spring 77 is supported on the rod 67 between the washer 75 and the plate 71. The rod 67 is pivotally connected at the other end thereof to an intermediate member 79 by means of a pin 81. As can be understood with reference to FIG. 5, the pin 81 extends out through opposite sides of the member 79. The member 79 is supported on the operating shaft 45 for rotational movement relative to the operating shaft 45. A member 85 is fixedly secured to the operating shaft 45. The member 85 is provided with an extension 87 at one side of the operating shaft and an extension 89 at the other side of the operating shaft 45. The member 85 is also provided with an integral extension or toggle link 91 that serves as one link of a toggle of the latch linkage 55 in a manner to be hereinafter described. The other toggle link is a member 93 that is pivotally connected at one end thereof to the part 91 by means of a pivot pin 95 and at the other end thereof to an elongated link 97 by means of a pivot pin 99. The link 97 is pivotally supported, intermediate the ends thereof, on a stationary support bracket 101 by means of a pin 103. The support bracket 101 is suitably secured to the side plate means 15. The link 97 is provided with a notch 105 at the upper end thereof that engages a roller 107 of a roller latch 109. The roller latch 109 is pivotally supported on the bracket 101 by means of a pin 111. The roller latch 109 is provided with a roller 113 at the other end thereof that engages in a notch 115 of a latch member 117 that is pivotally supported on the bracket 101 by means of a pivot pin 119. A torsion spring 121 biases the roller latch 109 in a clockwise direction to the latching position seen in FIG. 5, and a torsion spring 123 biases the latch 117 in a counterclockwise direction to the latching position seen in FIG. 5. The latch 117 is provided with an extension 127 that can be manually moved to pivot the latch 117 in a clockwise direction in order to operate the interrupter in a manner to be hereinafter described. The extension 127 may also be actuated by the electromagnetic trip 59 that comprises a plunger 129 that is raised when the electromagnet 59 is energized to thereby automatically move the latch 117 in a clockwise (FIG. 4) direction to the actuated position.

The circuit interrupter is shown in the spring discharged closed position in FIGS. 1–5. The circuit interrupter is operated to the open position by automatic operation of the motor operating mechanism 9, in a manner to be hereinafter described, that moves the drive member 61 counterclockwise (FIG. 4). During this movement, an extended part 131 of the drive member 61 engages the pin 81 (FIGS. 4 and 5) to drive the intermediate member 79 and spring rod 67 from the spring discharged closed position seen in FIG. 5 to the overcenter spring-charged closed position indicated in FIG. 8. During this movement, the spring 77 is charged and near the end of this movement, the spring rod 67 passes overcenter relative to the axis of the operating shaft 45 whereupon the spring 77 starts to discharge driving the pin 81 against the extended part 87 of the member 85 to bias the member 85 and the operating shaft 45, to which the member 85 is secured, in a counterclockwise (FIG. 6) direction toward the spring discharged open position indicated in FIG. 9. The overcenter spring structure 53 is latched in this spring-charged closed position (FIG. 8) by the latch linkage 55 (FIG. 4) which prevents counterclockwise rotation of the operation shaft 45 and by the latch structure 57 which latches the latch linkage 55 in the closed latch position seen in FIG. 5. In this position, it is noted that a toggle 91, 93 of the latch linkage 55 is underset or collapsed in a downward (FIG. 5) direction. When the interrupter reaches the spring-charged closed position the motor operating mechanism 9 is automatically deenergized in a manner to be hereinafter described. The parts will remain in the spring-charged closed position until release of the latch linkage 55. Thus, energy is stored for a closing operation. In order to close the circuit interrupter with the spring 77 in the spring charged closed position, the latch member 117 (FIG. 4) is pivoted in a clockwise

direction manually, by lifting the part 127, or electromagnetically by operation of the electromagnet 59 to move the plunger 129 upward to lift the part 127. During this movement, the latch 117 moves to release the roller 113 from the notch 115 permitting the roller latch 109 to rotate in a counterclockwise direction about the pin 111. This movement permits the roller 107 to move out of the notch 105 permitting the elongated link 97 to pivot in a counterclockwise direction about the pivot pin 103. This movement releases the toggle 91, 93 to release the operating shaft 45 whereupon the charged spring 77 discharges driving the rod 67 from the spring-charged closed position indicated in FIG. 8 to the spring discharged open position indicated in FIG. 9 with the pin 81 operating against the extended part 87 of the member 85 to drive the member 85, and the operating shaft 45 to which the member 85 is secured, in a counterclockwise direction from the spring-charged closed position to the spring discharged open position. During this movement, the operating shaft 45 rotates from the closed position seen in full lines in FIG. 3 to the open position seen in broken lines in FIG. 3 moving the links 37 of the three pole units to the position seen in broken lines in FIG. 3 to thereby move the three contact arms 25 to the open position seen in broken lines in FIG. 3. Upon movement of the parts from the spring-charged closed position indicated in FIG. 8 to the spring discharged open position indicated in FIG. 9, the toggle 91, 93 is moved from the collapsed or downward underset position indicated in FIG. 8 to the collapsed or upward underset position indicated in FIG. 9 during which movement the link 97 is moved first in a counterclockwise direction as the toggle 91, 93 moves to the erected position and then in a clockwise direction as the toggle 91, 93 collapses to the upward underset position indicated in FIG. 9. This movement automatically resets the toggle link 97 in the latching position and the springs 121, 123 automatically reset the latches 109, 117 respectively in the latching position.

In order to operate the circuit interrupter from the spring discharged open position indicated in FIG. 9 to the spring discharged closed position seen in FIG. 4, the circuit interrupter is first operated to a spring-charged open position seen in FIG. 14. With the circuit interrupter in the position indicated in FIG. 9, the motor operating mechanism 9 is automatically energized, in a manner to be hereinafter described, to drive the drive member 61 clockwise. During this movement, the projecting portion 133 of the drive member 61 operates against the pin 81 to drive the member 79 and the rod 67 from the spring discharged open position indicated in FIG. 9 to the spring-charged open position indicated in FIG. 14. During this movement, the rod 67 goes overcenter relative to the axis of the operating shaft 45 and the spring 77, which is charged during the early part of this movement, starts to discharge forcing the rod 67 and member 79 in a counterclockwise direction. This movement is limited by the engagement of the pin 81 with the projecting part 89 of the member 85, that is secured to the operating shaft 45, and with the latch linkage 55 latched by means of the latch structure 57, the parts are latched in the stored-energy spring-charged open position seen in FIG. 14. When the parts reach the spring charged open position the motor operating mechanism 9 is automatically deenergized in a manner to be hereinafter described. In order to release the stored energy and close the circuit breaker, the part 127 of the latch member 117 is lifted, either manually or electromagnetically, to rotate the latch 117 in a counterclockwise direction to release the roller 113 from the notch 115 to release the roller latch member 109 permitting counterclockwise movement of the roller latch member 109. Upon release of the roller latch member 109 the roller 107 moves out of the notch 105 of the link 97 to permit counterclockwise movement of the link 97. This movement permits the toggle 91, 93 to move from the upward underset position seen in FIG. 14 to thereby permit clockwise movement of the operating shaft 45. The spring 77 discharges moving the rod 67 from the spring-charged open position indicated in FIG. 14 to the spring discharged closed position seen in FIG. 4. During this movement the pin 81, operating against the part 89 of the member 85, drives the member 85 and operating shaft 45 from the spring-charged open position seen in FIG. 14 to the spring discharged closed position seen in FIG. 5. During this movement, the operating shaft 45 rotates in a clockwise (FIG. 3) direction to move the links 37 and the three contact arms 25 from the open position seen in broken lines in FIG. 3 to the closed position seen in full lines in FIG. 3. During this movement to the closed position, the movement of the operating shaft 45, operating through the toggle 91, 93, first moves the link 97 in a counterclockwise direction as the toggle 91, 93 moves to the erected position and then the link 97 is moved in a clockwise direction as the toggle 91, 93 moves to the downward underset position seen in FIG. 4. This movement moves the link 97 to the latching position seen in FIG. 4, and the springs 121, 123 operate to automatically reset the roller latch member 109 and latch member 117 in the latched position seen in FIG. 5. The circuit interrupter may then be operated to the spring-charged closed position seen in FIG. 6 and to the spring discharged open position seen in FIG. 7 in the same manner as was hereinbefore described. As was hereinbefore set forth, the operation of the circuit interrupter is more specifically disclosed in the copending application of Norman Davies, Ser. No. 106,328 filed Jan. 14, 1971.

The motor operating mechanism 9 comprises another back plate means 143 (FIGS. 1–5) supported between the side plate means 15, and a pair of additional supporting plates 145 (FIG. 5) supported on the backplate means 143. An additional supporting plate 147 is supported between the side plates 145 by support rods 149 that also space the side plates 145. A unidirectional motor 151, supported on one of the side plates 145, comprises an output shaft 153 that is connected to an eccentric member 155 by means of an intermediate connecting member 157 (FIG. 5). The eccentric member 155 (FIGS. 10 and 11) comprises a pair of bearing parts 159 at the opposite ends thereof and an eccentric intermediate part 161. The member 155 is supported for movement about the elongated axis of the parts 159 on the plate 147 and the one side plate 145 (FIG. 5). Ratchet means 163 (FIGS. 5 and 7) comprising an opening ratchet wheel 165 and a closing ratchet wheel 167, is supported on a shaft 169 that is supported for rotation on the plates 147, 145 (FIGS. 5 and 7). As can be understood with reference to the drawings the direction of the teeth of the opening ratchet wheel 165 is reversed from the direction of the teeth of the closing ratchet wheel 167. A linkage 171 connects the shaft 169 with the drive member 61. The linkage 171 comprises a first link 173 supported on the shaft 169 to move with the shaft 169 and an elongated link 175 pivotally connected at the lower end thereof to the link 173 by means of a pivot pin 177 and at the upper end thereof to a link 179 by means of a pivot pin 181. The link 179 is an integral extension part of the drive member 61.

Pawl means 185 (FIG. 7) is provided for driving the ratchet means 163. The pawl means 185 comprises an opening driving pawl 187, a closing driving pawl 189, an opening holding pawl 191 and a closing holding pawl 193. Each of the driving pawls 187, 189 is provided with a circular opening therein that receives the circular eccentric part 161 of the eccentric member 155. The opening driving pawl 187 is provided with an elongated extension 191 and the closing driving pawl 189 is provided with an elongated extension 193. A pin 201 on the end portion 191 of the opening driving pawl 187 is positioned in a slot 203 of an elongated link member 205. A spring 207 is connected to the pin 201 at one end thereof and to a stationary pin 209 at the other end thereof to bias the opening driving pawl 187 generally counterclockwise on the eccentric member 155. A pin 211 on the part 193 of the closing driving pawl 189 is positioned in a slot 213 of a link member 215. An elongated spring 217 is connected at the upper end thereof to the pin 211 and at the lower end thereof to a stationary pin 219 to bias the closing driving pawl 189 generally clockwise

about the eccentric member 155. The opening holding pawl 191 is pivotally supported on a stationary pin 221. A leg portion 223 of the pawl 191 supports a pin 225 which is positioned in a slot 227 of a link 229. A spring 231 is supported between the pin 225 and the stationary pin 209 to bias the opening holding pawl 191 in a counterclockwise direction about the pin 221. The closing holding pawl 193 is pivotally supported on a stationary pin 235. The closing holding pawl 193 comprises an extension 237 that supports a pin 239 that moves in a slot 241 of a link member 243. An elongated spring 245 is connected at the upper end thereof to the pin 239 and at the lower end thereof to the stationary pin 219 to bias the closing holding pawl 193 in a clockwise direction about the pin 235. An elongated link 247 is pivotally supported intermediate the ends thereof on a stationary pin 249 that is supported between the plates 147, 145. The link 205 is pivotally connected to the link 247 by means of a pin 251. The link 229 is pivotally connected to the link 247 by means of a pin 253. The link 215 is pivotally connected to the link 247 by means of a pin 255. The link 243 is pivotally connected to the link 247 by means of a pin 257. An elongated link 261 is provided with a slot 263 in the lower end thereof which receives the pin 251 to connect the link 261 to the link 247. The link 261, at the upper end thereof, is pivotally connected to a part 269 of the operating shaft 245 by means of a pin 271 (FIGS. 5 and 7).

A bracket 275, which is secured to the link 261, comprises a pair of extensions 277, 279 that operate a toggle 281 of a limit switch 283.

A plate 293 (FIGS. 5 and 6), which is connected to rotate with the ratchet shaft 169, comprises a pair of pins 295, 297 that operate a toggle 299 of a limit switch 301.

A switch 305 is provided for cutting off power to the motor 151 for repairs and inspection purposes.

The parts are shown in FIG. 7 in the position reached just at the expiration of a closing operation of the circuit interrupter. During the closing operation, the operating shaft 45 moved counterclockwise to the position seen in FIG. 7 to move the link 261 downward which movement operated the link 247 in the counterclockwise position to the position seen in FIG. 7. During this movement, the spring 207 moved the opening driving pawl 187 counterclockwise into cooperative engagement with the teeth of the opening ratchet wheel 165, and the spring 231 moved the opening holding pawl 191 counterclockwise into cooperative engagement with the teeth of the opening ratchet wheel 165. This counterclockwise movement of the link 247 also operated to pull the closing driving pawl 189 and the closing holding pawl 193 out of cooperative engagement with the closing ratchet wheel 167 (FIG. 7). This downward movement of the link 261 has also moved the projection 279 downward to operate the toggle 281 of the limit switch 283 to energize the motor 151 (FIG. 5). Upon energization of the motor 151, the output shaft is rotated to rotate the eccentric 155 clockwise (FIG. 7) about the axis of the bearing parts 159 to reciprocate the opening driving pawl 187. Upon each revolution of the member 155, the opening driving pawl 187 advances the ratchet wheel 165 counterclockwise one tooth and the holding pawl 191 holds the ratchet wheel 165 in the advanced position until the driving pawl 187 advances the ratchet wheel 169 upon the next revolution of the member 155. This movement rotates the shaft 169 counterclockwise (FIG. 7). As the shaft 169 rotates counterclockwise the link 173 moves the link 175 to operate through the pin 181 to drive the drive member 51 counterclockwise (FIG. 7) from the spring discharged closed position (FIG. 7) to the spring-charged closed position (FIG. 8). As was hereinbefore described, the overcenter spring structure 53 reaches an over-toggle or overcenter spring-charged opening position and the latch linkage 55 and latch structure 57 latch the mechanism in the overcenter spring charged closed position. When the parts reach the overcenter spring-charged closed position a missing tooth portion 307 on the opening ratchet wheel 165 is adjacent the opening driving pawl 187 so that continued operation of the motor 151 will not apply damaging forces to the ratchet wheel 165. At this time, the pin 297 (FIG. 6), rotating with the ratchet shaft 169, operates the toggle 299 of the switch 301 to deenergize the motor and the motor is braked to a stop condition by the inertia of the parts thereof. The motor operated circuit interrupter then remains in the spring charged closed position, with the motor 151 deenergized, until the latch member 117 is moved to the unlatching or tripping position to effect an opening operation in the manner that was hereinbefore described.

Upon tripping movement of the latch 117, the overcenter spring structure 53 operates the circuit interrupter to the open position seen in broken lines in FIG. 3 in the manner hereinbefore described. During this movement, the operating shaft 45 (FIG. 7) is rotated counterclockwise to the spring discharged open position seen in FIG. 9. During this movement the link 261 is moved upward to the position seen in FIG. 9 to pivot the link 247 clockwise. During this movement, the links 205, 209 are drawn upward to disengage the opening driving pawl 187 and the opening holding pawl 191, and the links 215, 243 are moved downward to permit the springs 217, 245 to engage the closing driving pawl 189 and the closing holding pawl 193. During this upward movement of the link 261, the projection 277 is moved up to operate the toggle 281 of the switch 283 to thereby energize the motor 151. Upon energization of the motor 151, the eccentric 159 is rotated counterclockwise (FIG. 9) to reciprocate the opening driving pawl 189 in the manner illustrated in FIGS. 12 and 13. During each revolution of the member 155, the closing driving pawl 189 is reciprocated to advance the closing ratchet wheel 167 one tooth with the closing holding pawl 193 holding the ratchet wheel 167 in the advanced position.

It can be understood with reference to FIGS. 7, 9, 12 and 13 that the unidirectional motor 151 rotates the eccentric 155 clockwise for both the spring charging operations, When the opening driving pawl 187 operates the opening ratchet wheel 165, the ratchet shaft 169 is rotated counterclockwise and when the closing driving pawl 189 operates the closing ratchet wheel 167 the ratchet shaft 169 is rotated in clockwise.

As the closing ratchet wheel 167 is rotated clockwise (FIG. 9) the shaft 169 is rotated clockwise to move the link 173 to thereby move the link 175 downward to thereby move the drive member 61 in a clockwise direction. This movement moves the overcenter spring structure 53 from the spring discharged open position seen in FIG. 9 to the overcenter spring-charged open position (FIG. 14). The latch linkage 55 and latch structure 57 latch the overcenter spring structure 53 in the spring charged open position in the same manner as was hereinbefore described. When the ratchet wheel 167 reaches the spring charged open position, a missing tooth portion 309 thereon is adjacent the closing driving pawl 189 so that continued operation of the motor 151 will not apply damaging forces to the ratchet wheel 167. When the parts have reached the spring-charged open position, the projection 295 (FIG. 6) on the plate 293 engages the toggle 299 of the limit switch 301 to deenergize the motor 151 and the inertia of the parts brings the motor to a stopped condition. The circuit interrupter will remain in the spring charged open position until the latch 117 is moved to the tripping position. Upon movement of the latch 117 to the tripping position, the overcenter spring structure 53 will drive the operating shaft 45 clockwise from open position seen in broken lines in FIG. 3 to the closed position seen in full lines in FIG. 3 to thereby close the contacts of the circuit interrupter with the parts moving to the spring discharged closed position (FIG. 7) in the same manner as was hereinbefore described. During this movement, the link 261 is moved downward to pivot the link 247 counterclockwise to disengage the driving pawl 189 and holding pawl 193, and to engage the driving pawl 187 and holding pawl 191 (FIG. 7). During this movement, the projection 279 moves down to engage and actuate the toggle 281 of the switch 283 to energize the motor 151 to thereby operate the overcenter spring structure from the spring discharged closed position (FIG. 7) to the spring-charged closed position (FIG. 8) in the same manner as was hereinbefore described.

I claim as my invention:

1. A motor operated circuit interrupter comprising a circuit interrupter and a motor operating mechanism;

said circuit interrupter comprising a pair of contacts and an operating shaft movable between open and closed positions to open and close said contacts, an overcenter spring structure movable from a spring discharged closed position to a spring-charged closed position to prepare for an opening operation and from a spring discharged open position to a spring charged open position to prepare for a closing operation, releasable latch means for latching said overcenter spring structure in said spring-charged closed position and in said spring charged open position,

a motor operating mechanism for operating said overcenter spring structure to said spring-charged closed position and to said spring-charged open position, said motor operating mechanism comprising a ratchet structure, a first link means connecting said ratchet structure with said overcenter spring structure, pawl means comprising an opening driving pawl a closing driving pawl an opening holding pawl and a closing holding pawl, a motor comprising an output shaft operatively connected to said opening driving pawl and to said closing driving pawl, a second link means operatively connecting said pawl means with said operating shaft,

with said circuit interrupter in the spring discharged closed position said second link means maintaining said pawl means in an opening position wherein said opening driving pawl and said opening holding pawl are in cooperative engagement with said ratchet structure and wherein said closing driving pawl and said closing holding pawl are disengaged from said ratchet structure,

upon energization of said motor with said circuit interrupter in the spring discharged closed position and said pawl means in the opening position said output shaft rotating to reciprocate said opening driving pawl against said ratchet structure to thereby operate said first link means to move said overcenter spring structure from said spring discharged closed position to said spring-charged closed position, said ratchet structure comprising a first missing tooth portion automatically positioned adjacent said opening driving pawl when said overcenter spring structure reaches said spring charged closed position, a first switch means automatically deenergizing said motor when said overcenter spring structure reaches said spring charged closed position,

upon release of said releasable latch means with said overcenter spring structure in said spring-charged closed position said overcenter spring structure moving to a spring discharged open position to drive said operating shaft from said closed position to said open position, upon movement of said operating shaft from said closed position to said open position said second link means being automatically operated to move said pawl means to a closing position wherein said closing driving pawl and said closing holding pawl are in cooperative engagement with said ratchet structure and wherein said opening driving pawl and said opening holding pawl are disengaged from said ratchet structure,

upon energization of said motor with said circuit interrupter in the spring discharged open position and said pawl means in the closing position said output shaft rotating to reciprocate said closing driving pawl against said ratchet structure to thereby operate said first link means to move said overcenter spring structure from said spring discharged open position to said spring-charged open position, said ratchet structure comprising a second missing tooth portion automatically positioned adjacent said closing driving pawl when said overcenter spring structure reaches said spring-charged open position, said first switch means automatically deenergizing said motor when said overcenter spring structure reaches said spring-charged open position,

upon release of said latch means with said overcenter spring structure in said spring-charged open position said overcenter spring structure moving to said spring discharged closed position to drive said operating shaft from said open position to said closed position and upon operation of said operating shaft from said open position to said closed position said second link means being automatically operated to move said pawl means to said opening position.

2. A motor operated circuit interrupter according to claim 1, a second limit switch means, and upon operation of said output shaft to said open position and to said closed position means automatically operating said second limit switch means to energize said motor.

3. A motor operated circuit interrupter according to claim 1, said motor being a unidirectional motor, and said means operatively connecting said output shaft of said unidirectional motor with said opening driving pawl and with said closing driving pawl comprising an eccentric means for reciprocating said opening driving pawl and said closing driving pawl.

4. A motor operated circuit interrupter according to claim 1, said second link means comprising an elongated link pivotally supported intermediate the ends thereof, a pair of links on a first side of the pivot of said elongated link connecting said elongated link with said holding driving pawl and said opening driving pawl, a second pair of links on the opposite side of said elongated link connecting said elongated link with said closing driving pawl and said closing holding pawl, an operating link connecting said elongated link with said operating shaft to pivot said elongated link upon operation of said operating shaft between the open and closed positions, upon operation of said operating shaft to the open position said elongated link pivoting to effect movement of said pawl means to said closing position and upon operation of said operating shaft to the closed position said elongated link pivoting to effect movement of said pawl means to said opening position.

5. A circuit interrupter according to claim 4, a second limit switch means, and means on said second link means automatically operating said second limit switch means to energize said motor upon operation of said operating shaft to said open position and upon operation of said operating shaft to said closed position.

6. A circuit interrupter according to claim 5, said motor being a unidirectional motor, and said means connecting said output shaft with said opening driving pawl and with said closing driving pawl comprising an eccentric for reciprocating said opening driving pawl and said closing driving pawl.

7. A circuit interrupter according to claim 1, said ratchet structure comprising an opening ratchet wheel and a closing ratchet wheel, a rotatable ratchet shaft connected to said opening ratchet wheel and said closing ratchet wheel, said first link means connecting said ratchet shaft with said overcenter spring structure, in said opening position of said pawl means said opening driving pawl and said opening holding pawl being in cooperative engagement with said opening ratchet wheel and said closing driving pawl and said closing holding pawl being disengaged from said closing ratchet wheel, in the closing position of said pawl means said closing driving pawl and said closing holding pawl being in cooperative engagement with said closing ratchet wheel and said opening holding pawl and said opening driving pawl being disengaged from said opening ratchet wheel, said first missing tooth portion being a part of said opening ratchet wheel and said second missing tooth portion being a part of said closing ratchet wheel.

8. A circuit interrupter according to claim 7, a second limit switch means, upon operation of said operating shaft to said open position means automatically operating said second limit switch means to energize said motor, and upon operation of said operating shaft to said closed position means automatically operating said second limit switch means to energize said motor.

9. A circuit interrupter according to claim 1, said motor being a unidirectional motor, an eccentric connected to said

output shaft of said motor, said opening driving pawl having an opening therein receiving said eccentric, said closing driving pawl having an opening therein receiving said eccentric, with said pawl means in said opening position said eccentric reciprocating said opening driving pawl against said ratchet structure upon rotation of said output shaft, and with said pawl means in said closing position said eccentric reciprocating said closing driving pawl against said ratchet structure upon rotation of said output shaft.

10. A circuit interrupter according to claim **9**, a ratchet shaft supported for rotation, said ratchet structure comprising an opening ratchet wheel mounted on said ratchet shaft and a closing ratchet wheel mounted on said ratchet shaft, said first link means connecting said ratchet shaft with said overcenter spring structure, with said pawl means in the opening position said opening driving pawl and said opening holding pawl engaging said opening ratchet wheel to drive said ratchet shaft in a first direction upon energization of said motor, with said pawl means in said closing position said closing driving pawl and said closing holding pawl engaging said closing ratchet wheel to drive said ratchet shaft in a second direction opposite said first direction upon energization of said motor.

11. A circuit interrupter according to claim **9**, a second limit switch means, upon operation of said operating shaft to said open position means automatically operating said second limit switch means to energize said motor, and upon operation of said operating shaft to the closed position, means automatically operating said second limit switch means to energize said motor.

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