United States Patent

[11] **3,600,540**

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Pittsburgh, Pa.

[54] **MOTOR-OPERATED SPRING-CLOSING CIRCUIT BREAKER**
5 Claims, 4 Drawing Figs.

[52] U.S. Cl. **200/153,** 200/50
[51] **Int. Cl.** **H01h 3/00**
[50] **Field of Search** 335/68, 76; 200/153.23, 153; 74/2, 575

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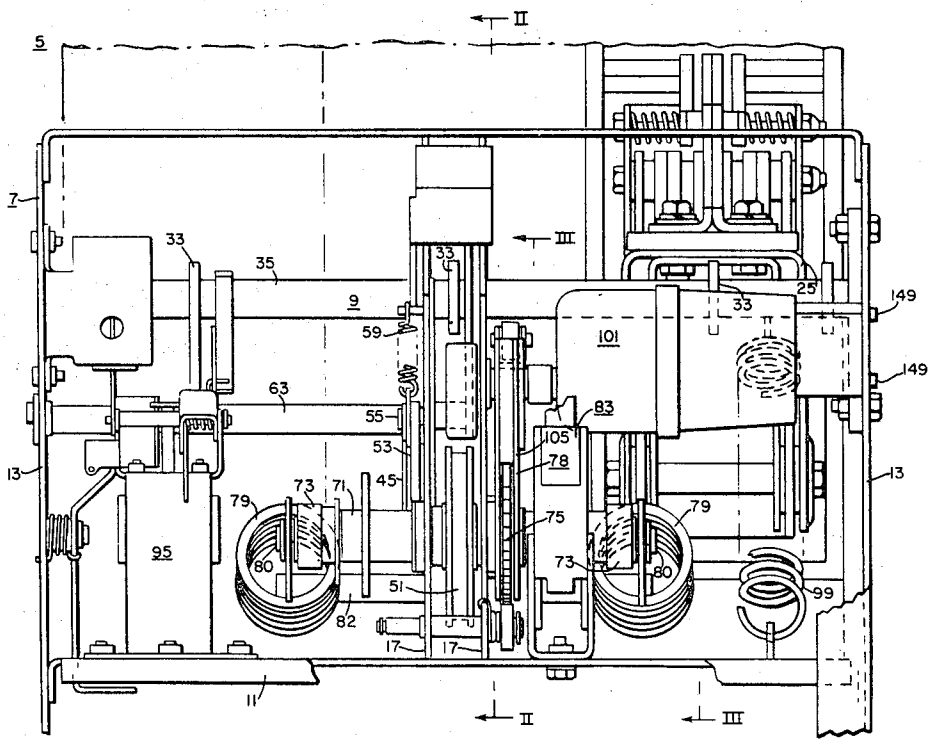
ABSTRACT: A circuit breaker comprises spring closing means and a motor drive structure for charging the spring-closing means with improved means supporting the motor drive structure in a cooperating relationship with the spring closing means.



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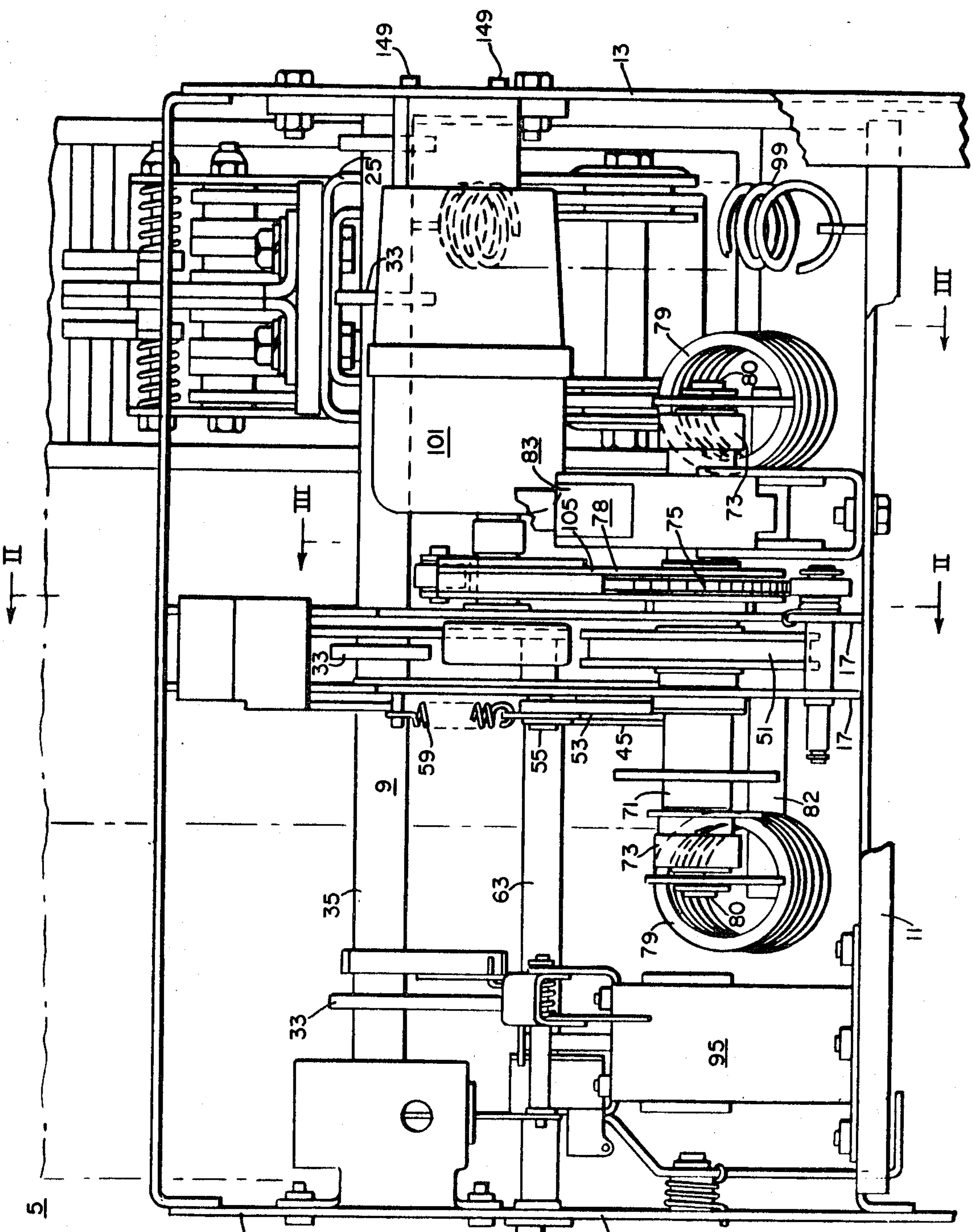

FIG. 1

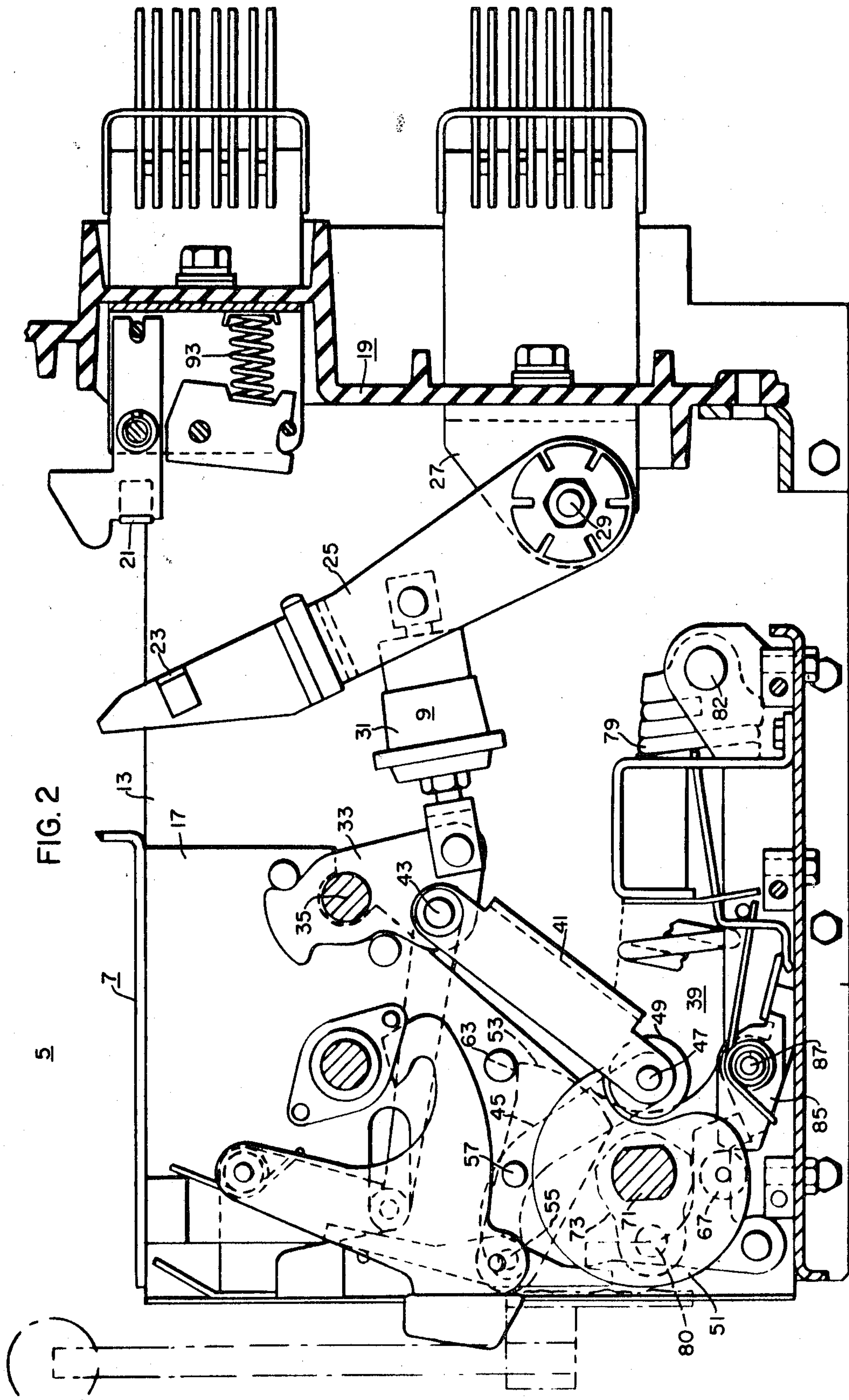
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FIG. 2

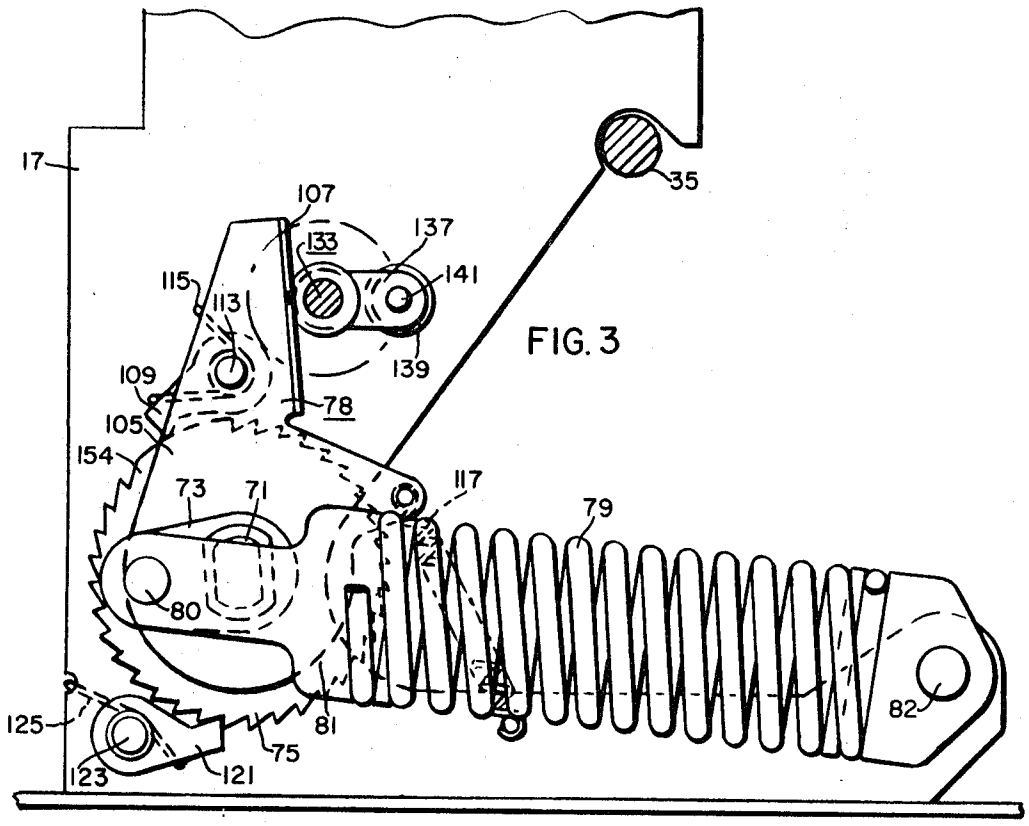
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FIG. 3

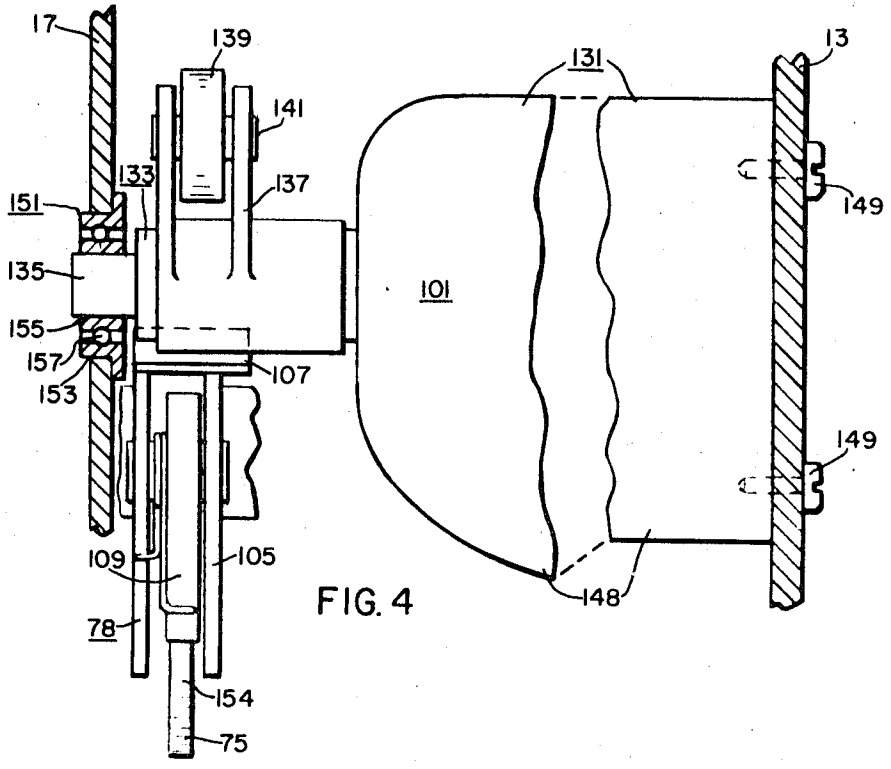
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FIG. 4

MOTOR-OPERATED SPRING-CLOSING CIRCUIT BREAKER

CROSS-REFERENCES TO RELATED APPLICATIONS

The applications of Fred Bould et al., Ser. No. 770,296 filed Oct. 24, 1968, and of Fred Bould, Ser. No. 836,313 filed June 25, 1969 are related to the present application in a manner that will be hereinafter set forth under the description of the prior art.

BACKGROUND OF THE INVENTION

1. Field of the Invention

Motor-operated spring-closing circuit breaker.

2. Description of the Prior Art

In the above-mentioned application of Fred Bould et al., Ser. No. 770,296, there is disclosed a spring-closing mechanism for closing a circuit breaker, with manual means for charging the spring-closing mechanism. In the above-mentioned application of Fred Bould, Ser. No. 836,313 there is disclosed a motor-operated spring-closing circuit breaker. The present invention is an improvement over both of the above-mentioned applications in that the present invention provides an improved motor-operated spring-closing circuit breaker with improved means supporting the motor drive structure in a cooperating relationship with the spring-closing means. The improved supporting or mounting means provides a precise location of the motor roller arm preventing undesirable deflections of the roller arm under load conditions and keeping the loads on the motor housing within safe limits. The mounting is such as to facilitate assembly and removal of the motor drive structure and a standard drill-type motor body can be utilized in the combination.

SUMMARY OF THE INVENTION

A circuit breaker comprises spring-closing means and a motor drive structure for charging the spring-closing means, with improved means supporting the motor drive structure for operating the spring-closing means. The circuit breaker comprises a metallic housing structure comprising a baseplate and a pair of spaced generally parallel sideplates connected to the baseplate with a pair of spaced generally parallel center plates connected to the base plate within the widthwise dimension of the sideplates. The center plates support a crankshaft that is rotatable about an axis to charge a pair of closing springs, and a ratchet is connected to the crankshaft. The sideplates and center plates support a jackshaft that is movable to operate the movable contacts of the breaker. A reciprocating pawl structure is supported to advance the ratchet to thereby charge the closing springs. The motor drive structure comprises a main body motor part and a rotatable output shaft structure extending from and supported on the main body motor part. The main body motor part is supported on one of the breaker sideplates and the nose or end part of the output shaft structure is supported on a bearing support that is supported on one of the center plates. Upon energization of the motor and rotation of the output shaft structure, a cam part or roller arm on the output shaft structure between the nose and the main body motor part rotates and operates against the reciprocating pawl structure to advance the ratchet wheel to thereby charge the closing springs. By supporting both the main body part and the end part of the motor drive structure, the roller arm is maintained in the operative position under operating loads and the loads on the body of the motor are kept within safe limits. A standard drill-type motor, including an aluminum motor housing, can be utilized in the combination. The motor drive structure is readily assembled in available space between one of the sideplates and one of the center plates of the breaker support structure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an end view, with parts broken away and with certain parts left out for the purpose of clarity, of a circuit breaker constructed in accordance with principles of this invention;

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

FIG. 3 is a partial sectional view taken generally along the line III–III of FIG. 1 with the crankshaft and closing spring being shown in side elevation; and

FIG. 4 is a partial sectional view, with parts broken away and with parts left out for the purpose of clarity, looking down on the motor drive structure and reciprocating pawl structure to illustrate the support of the motor drive structure on the one center plate and one sideplate.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, there is shown in FIGS. 1 and 2 a three-pole circuit breaker 5 comprising a support structure or housing structure 7 and a circuit breaker structure 9 supported on the housing structure 7. The housing structure 7 comprises a metallic baseplate 11, a pair of spaced metallic side plates 13 fixedly secured to flanges of the base plate 11, a pair of metallic center plates 17 fixedly mounted on the base plate 11 and a backwall structure indicated generally at 19.

The circuit breaker structure 9 is a three-pole structure comprising a stationary contact 21 (FIG. 2) and a movable contact 23 for each pole unit. Each of the movable contacts 23 is supported on a conducting contact arm 25 that is pivotally supported on a terminal conductor 27 by means of a pivotal support means 29. In each pole unit, a separate insulating connecting member 31 is pivotally connected at one end thereof to the contact arm 25 and at the other end thereof to a lever 33 that is welded to a common jackshaft 35 that extends across all of the poles of the circuit breaker. There is a separate lever 33 for each pole unit welded to the common jackshaft 35. Only one of the contact structures is shown in FIG. 1. The contact structures for the center pole and for the left-hand (FIG. 1) pole are left out of the drawing in FIG. 1 merely for the purpose of clarity. It can be understood that the contact structures for all three-pole units are the same as the one contact structure shown in FIGS. 1 and 2.

The jackshaft 35 is supported for pivotal movement, about the elongated axis thereof, on the sideplates 13 and center plates 17. The connecting member 31, levers 33 and jackshaft 35 are part of a stored-energy spring-closing mechanism 39 that is operable to close the contacts 23, 21. The mechanism 39 comprises a link 41 that is pivotally connected, at one end thereof, to the lever 33 of the center pole by means of a pin 43. The link 41 is pivotally connected at the other end thereof, to a link 45 by means of a knee pivot pin 47. A roller member 49, that serves as a cam follower, is mounted on the pin 47 to cooperate with a closing cam 51. The link 45 is pivotally connected at the other end thereof to a latch member 53 by means of a pin 55. The latch member 53 is mounted for pivotal movement about a fixed pivot pin 57 that is supported on the left-hand (FIG. 1) center plate 17. A tension spring 59 is connected to the pin 55 to reset the linkage following a tripping operation of the circuit breaker. The latch member 53 engages the periphery of a trip shaft 63 in proximity to a cutout portion of the shaft 63, which cutout portion is provided so that when the trip shaft 63 is rotated in a counterclockwise direction the latch member 53 will be free to move in the cutout portion to the tripped position. The trip shaft 63 is supported for pivotal movement about the elongated axis thereof between one of the center plates 17 and one of the sideplates 13.

A roller latch 67 (FIG. 2) is rotatably supported on and between the twin plates of the closing cam 51. The closing cam 51 is fixedly secured to a crankshaft 71 that is rotatably supported on suitable bearings that are secured to the center plates 17. A pair of crank arms 73 are fixedly mounted on the

crankshaft 71 at the opposite ends of the crankshaft 71. A ratchet member 75 is fixedly mounted on the crankshaft 71. A reciprocating pawl structure 78 (FIGS. 1 and 3) is supported on the crankshaft 71 for pivotal reciprocating movement relative to the crankshaft 71 to cooperate with the ratchet 75. A separate tension spring 79 is operatively connected at the end of each of the crank arms 73 by means of a pivot pin 80. Each of the springs 79 is connected to a spring support 81 that is pivotally connected to the associated arm 73 by means of the associated pivot pin 80. Each of the tension springs 79 is connected, at the other end thereof, to a rod 82 that is secured to the center plate 17. A manual operating mechanism, indicated generally at 83 (FIG. 1), is provided for manually charging the closing springs 79. A latch member 85 (FIG. 2) is pivotally mounted on a pin 87 and biased in a clockwise (FIG. 2) direction to the latching position wherein the latch 85 engages the roller 67 to latch the closing cam 51 and crank shaft 71 to prevent counterclockwise movement of the closing cam 51 and crank shaft 71.

The circuit breaker is shown in FIG. 2 in the contact open position with the stored energy closing springs 79 in the charged condition. As is shown in FIG. 2, the spring support pins 80 of the tension springs 79 are below a line between the center of the spring support rod 82 and the center or axis of the crank or shaft 71 so that the charged tension springs 79 are operating to bias the crankshaft 71 in a counterclockwise direction. Counterclockwise movement of the crankshaft 71 is prevented by the engagement of the latch member 85 with the latch roller 67 that is mounted on the closing cam 51. The latch member 85 is operated to the unlatching position to close the circuit breaker in a manner described in the above-mentioned application of Fred Bould et al., Ser. No. 770,296. When it is desired to close the breaker, the latch 85 is pivoted in a counterclockwise (FIG. 2) direction to thereby release the roller 67. When the roller 67 is released, the closing cam 51 and the crank shaft 71 are free to rotate in a counterclockwise direction, and the closing springs 79, operating on the crank arms 73, operate to rotate the crank shaft 71 in a counterclockwise direction as the springs 79 discharge. During this movement, the closing cam 51 will force the roller 49, and the link 41, to the closed position. During this closing movement of the link 41, of the lever 33 (FIG. 2) of the center pole unit is forced in a counterclockwise direction to rotate the jackshaft e5 counterclockwise to simultaneously move the three contact arms 25 in a clockwise direction about the pivots 29 to the closed position. In the closed position, the engagement of the closing cam 51 with the roller 49 serves to prop the link member 41 in the closed position to thereby maintain the jackshaft 35 and contacts 23 in the closed position.

With the contacts in the closed position and the closing spring discharged, the circuit breaker may be automatically tripped open, in response to an overload above a predetermined value in any of the pole units, by operation of the trip shaft 63 in a manner described in the patent application of Nagar J. Patel, Ser. No. 770,236, filed Oct. 24, 1968. During the tripping operation, the trip shaft 63 is rotated in a counterclockwise (FIG. 2) direction. When the trip shaft 63 is rotated counterclockwise, the trip shaft moves to permit the latch member 53 to move in the cutout portion of the trip shaft 63 thereby permitting the latch member 53 to move in a counterclockwise direction about the pivot 57 to the tripped position. The compressed contact springs 93 (FIG. 2) and an opening spring 99 (FIG. 1) then operate to move the contact arms 25 toward the open position which movement occurs because the pivot 55 is free to move so that the link 45 can move to the tripped position with the toggle 45, 41 collapsing to permit the lever 33 and jack shaft 35 to move in a clockwise direction to the tripped open position. Thus, movement of the trip shaft 63 to the tripped position permits the members 41, 45, 53 to move to the tripped position wherein the roller 49 and link 41 no longer restrain the lever 33 in the closed position, and the springs 93, 99 operate to move the jackshaft 35 and the three contact arms 25 to the tripped open position.

With the circuit breaker in the tripped open position, the breaker is reset and the closing springs 79 are charged by operation of the motordrive structure 101 in a manner to be hereinafter more specifically described. In order to reset the circuit breaker and charge the closing springs 79, the crankshaft 71 is rotated through an angle of more than 180° of the spring charged operating position seen in FIG. 2. As the crankshaft 71 moves to the position seen in FIG. 2, the roller 49 rides off of the peak of the cam 51 into the depression seen in FIG. 2. When the roller 49 is free to move into the depression of the cam 51, the spring 59 (FIG. 1) biases the latch 53 clockwise (FIG. 2) to move the latch 53 to the reset position pulling links 45, 41 and the roller 49 to the reset position wherein the roller 49 is positioned in the depression of the cam 51 (FIG. 2). When the latch 53 moves out of the notch of the trip shaft 63, suitable spring means operates to rotate the trip shaft 63 clockwise to the latching position wherein the periphery of the trip shaft 63 again latches the latch member 53 to latch the parts in the reset position seen in FIG. 2. As the crankshaft 71 moves more than 180° to the position seen in FIG. 2, the springs 79, which are moved overcenter, take over to bias the crankshaft 71 in a counterclockwise (FIG. 2) direction, and the roller 67 engages the latch 85 to latch the crankshaft 71 in the charged position seen in FIG. 2, and the circuit breaker is prepared for another closing operation.

When the circuit breaker is in the contact closed position with the stored energy closing springs 97 discharged the spring closed means is operated to the charged position by operation of the motor drive structure 101 (FIGS. 1, 3 and 4) to rotate the crankshaft 71 through an angle of slightly more than 180° (approximately 184°) to charge the springs 79 during which movement the roller 49 rides on a fixed radius of the cam 51 to a position just short of the peak of the cam surface of the cam member 51. This charging movement of the cam 51 is more specifically described in the above-mentioned application Ser. No. 770,296.

With the parts in the contact closed spring charged position, the following sequence of operations can occur.

Upon the occurrence of an overload above a predetermined value, the trip means indicated generally at 95 (FIG. 1) is automatically operated to rotate the trip shaft 63 to release the latch member 53 and permit the toggle 41, 45 to effect an opening operation in the same manner as was hereinbefore described. With the toggle 41, 45 collapsed, the spring 59 operates to draw the roller 49 into the depression of the cam 51 resetting the linkages 53, 41, 45 and the trip shaft 63 is moved by spring means into the latching reset position seen in FIG. 2. The parts at the end of this tripping operation will be in the position seen in FIG. 2 wherein the mechanism is reset and relatched, and wherein the roller member 49 is in the depression of the cam 51 so that the parts are prepared for a closing operation. When the closing springs 79 are charged an operator can immediately operate the closing latch 85 (FIG. 2) to release the roller 67 whereupon the circuit breaker is operated to the closed position in the same manner as was hereinbefore described. With the parts in the closed position, if an overload above the predetermined value occurs the trip mans 95 will be automatically operated to rotate the trip shaft 63 to the tripped position to effect a tripping operation in the same manner as mentioned before described. With the parts in the tripped position and the closing springs 79 discharged, another charging operation of the closing springs 79 will be required in order to provide another closing operation. Thus, when the circuit breaker is in the contact closed spring charged position, the circuit breaker can be tripped and then closed and then tripped again in rapid sequence.

The reciprocating pawl structure 78 (FIG. 3) comprises a reciprocating member 105 that comprises a pair of spaced twin plates, that straddle the ratchet wheel 75, and a bight portion 107 connecting the twin plates. The reciprocating member 105 is mounted on the crank shaft 71 for movement relative to the crank shaft 71 about the axis of the crank shaft 71. A driving pawl 109 is pivotally mounted on the reciprocating member 105 between the twin plates of the member 105

by means of a pin **113**, and a torsion spring **115** biases the pawl **109** in a counterclockwise direction about the pin **113** into engagement with the ratchet wheel **75**. A tension spring member **117** biases the reciprocating member **105** in a clockwise direction about the crankshaft **71**. A holding pawl **121** is pivotally mounted on one of the center plates **17** by means of a pin **123** and biased in a counterclockwise direction, by means of a torsion spring **125**, into engagement with the ratchet wheel **75**.

The motor drive structure **101** comprises a main body motor part **131** and an output shaft structure **133** supported on the main body motor part **131**. The output shaft structure **133** comprises an end part or nose part **135** and a roller arm **137** intermediate the end part **135** and the main body motor part **131**. A roller member **139** is rotatably mounted on a pin **141** that is supported on the roller arm **137**. The main body motor part **131** comprises a motor housing **148** and an electric motor structure supported within the motor housing **148**. A standard aluminum housing drill-type motor has been successfully used in the combination with the back handle of the motor removed and with the two screws **149**, that formerly secured back handle of the drill-type motor to the motor housing **148**, being used to secure the motor housing **148** to the one sideplate **13**. The screws **149** support the motor drive structure **101** on the sideplate **13**, and an additional bearing support **151** is supported on one of the center plates to provide additional support for the end part **135** of the output shaft structure **133** to prevent undesirable deflection of the output shaft structure under operating load conditions and to keep the loads on the motor housing within safe limits. With the improved mounting means of this invention a standard aluminum housing drill-type motor can be utilized in the combination with the roller arm being positively located and with the overall support means keeping the loads on the motor housing within safe limits.

As can be understood with reference to FIG. **4**, the bearing support **151** is a roller bearing comprising a race **153** fixedly supported in an opening on the one center plate **17**, a journal **155** that receives the end part **135** of the output shaft structure **133** and a plurality of ball bearings **157** disposed around the journal between the journal and race to permit the journal and end part **135** to freely rotate relative to the race **153** and plate **17** while supporting the end part **135** against radial movement.

As can be seen in FIG. **3**, the closing springs **79** are in the charged position with the closing latch **85** (FIG. **2**) engaging the roller **67** of the cam **51** to latch the crankshaft **71** release of the latch **85**, the springs **79** discharge rotating the crankshaft **71** approximately 180° to close the circuit breaker in a manner hereinbefore described. Upon discharge of the closing springs **79** suitable limit switch means is actuated in a well-known manner by the breaker mechanism to energize the motor drive structure **101**. Upon energization of the motor drive structure **101**, the output shaft structure **133** is rotated in a clockwise (FIG. **3**) direction about the axis thereof. Upon clockwise (FIG. **3**) rotation of the output shaft structure **133** the roller arm **137** is rotated and during each revolution of the output shaft structure **133** the roller **139**, operating against the bight part **107** of the reciprocating pawl structure **78** moves the reciprocating pawl structure **78** in a counterclockwise direction during which movement the driving pawl of **109** operates against one of the teeth of the ratchet **75** to advance the ratchet **75** and crankshaft **71**. As the roller arm **137** moves 180° from the position seen in FIG. **3**, the reciprocating pawl structure **78** will advance the ratchet **75** and crankshaft **71** in a counterclockwise direction, and as the roller arm **137** moves the remaining 180° of a 360° revolution, the spring **117** will return the reciprocating pawl structure **78** to the position seen in FIG. **3** with the holding pawl **121** holding the ratchet **75** and crankshaft **71** in the advanced position. Thus, as the output shaft structure **133** rotates, the ratchet **75** is advanced by the driving pawl **109** and alternately held by the holding pawl **121** until the crankshaft **71** moves more than 180° to an overcenter position wherein the charged closing springs **79** again bias the crankshaft **71** in a counterclockwise direction with the ratchet **75** and crankshaft **71** becoming latched from closing movement by the latch member **85** (FIG. **2**) which engages the roller **67** on the cam **51** that is fixed to the crankshaft **71**. When the closing springs **79** reach the fully charged position, the driving pawl **109** is adjacent a missing tooth portion **154** (FIG. **3**) of the ratchet **75** so that continued rotation of the motor will not operate against the teeth of the ratchet **75**, and the motor can be brought to a stopped condition without damaging the parts and without putting undue forces on the parts. The motor **101** is automatically deenergized by suitable limit switch means in a manner well known in the art.

I claim as my invention:

1. A circuit breaker comprising a support structure, a circuit breaker mechanism supported on said support structure, said support structure comprising a baseplate and a pair of spaced generally parallel sideplates connected to said baseplate, a pair of spaced generally parallel center plates connected to said baseplate within the dimension between said sideplates and supported in a generally parallel relationship with respect to said sideplates, said circuit breaker mechanism comprising a closing spring means and a motor drive structure operable to charge said closing spring means, said closing spring means comprising a crankshaft supported for rotation on said center plates and a pair of closing springs connected to said crankshaft, a ratchet wheel connected to said crankshaft, a reciprocating pawl structure mounted on said crankshaft for movement relative to said crankshaft, said motor drive structure comprising a main body motor part and a rotatable output shaft structure extending from said main body motor part, said rotatable output shaft structure comprising an end part and an intermediate part, said intermediate part being intermediate said end part and said main body motor part, support means supporting said motor drive structure on said support structure, said support means comprising a first support and a second support, said first support fixedly supporting said main body motor part on one of said sideplates, said second support comprising a bearing support supported on one of said center plates and receiving said end part of said output shaft structure therein, said bearing support supporting said end part of said output shaft structure against radial movement with said end part rotating on said bearing support during operation of motor drive structure, and upon energization of said motor drive structure said output shaft rotating and said intermediate part operating against said reciprocating pawl structure to advance said ratchet wheel to thereby rotate said crankshaft to charge said closing spring means.

2. A circuit breaker according to claim **1**, said intermediate part comprising an operating arm movable upon rotation of said output shaft through a first part of a 360° revolution of said output shaft structure to move said reciprocating pawl structure against a tooth of said ratchet wheel to advance said ratchet wheel, and spring means operating to return said reciprocating pawl structure to position said reciprocating pawl structure adjacent another tooth of said ratchet wheel during the second part of said 360° revolution of said output shaft structure.

3. A circuit breaker according to claim **1**, and said intermediate part of said output shaft structure comprising a roller arm part operable against said reciprocating pawl structure upon rotation of said output shaft structure.

4. A circuit breaker according to claim **3**, and said second support comprising a ball bearing support supporting said end part against radial movement during operation of said motor drive structure.

5. A circuit breaker according to claim, said circuit breaker being a multipole circuit breaker, said circuit breaker mechanism comprising an elongated jackshaft common to all of the poles of said circuit breaker, each of said poles comprising a stationary contact and a movable contact, means operatively connecting each of said movable contacts with said

jackshaft, means supporting said jackshaft on said sideplates and said center plates for movement about the elongated axis thereof, a closing cam on said crankshaft between said center plates, link means operatively connecting said closing cam with said jackshaft, said motor drive structure being operable to operate said reciprocating pawl structure to rotate said crankshaft from a spring discharged position to a spring charged position to charge said closing spring means, latch means for latching said crankshaft in the spring charged position, upon release of said latch means said closing spring means rotating said crankshaft and said closing cam operating through said link means and said jackshaft to move said movable contacts to the closed position.