Jan. 14, 1958 R. H. MILLER ET AL 2,820,119

CONTROL ARRANGEMENT FOR A STORED-ENERGY TYPE OF CIRCUIT BREAKER OPERATING MECHANISM

Filed Sept. 25, 1956 2 Sheets-Sheet 1

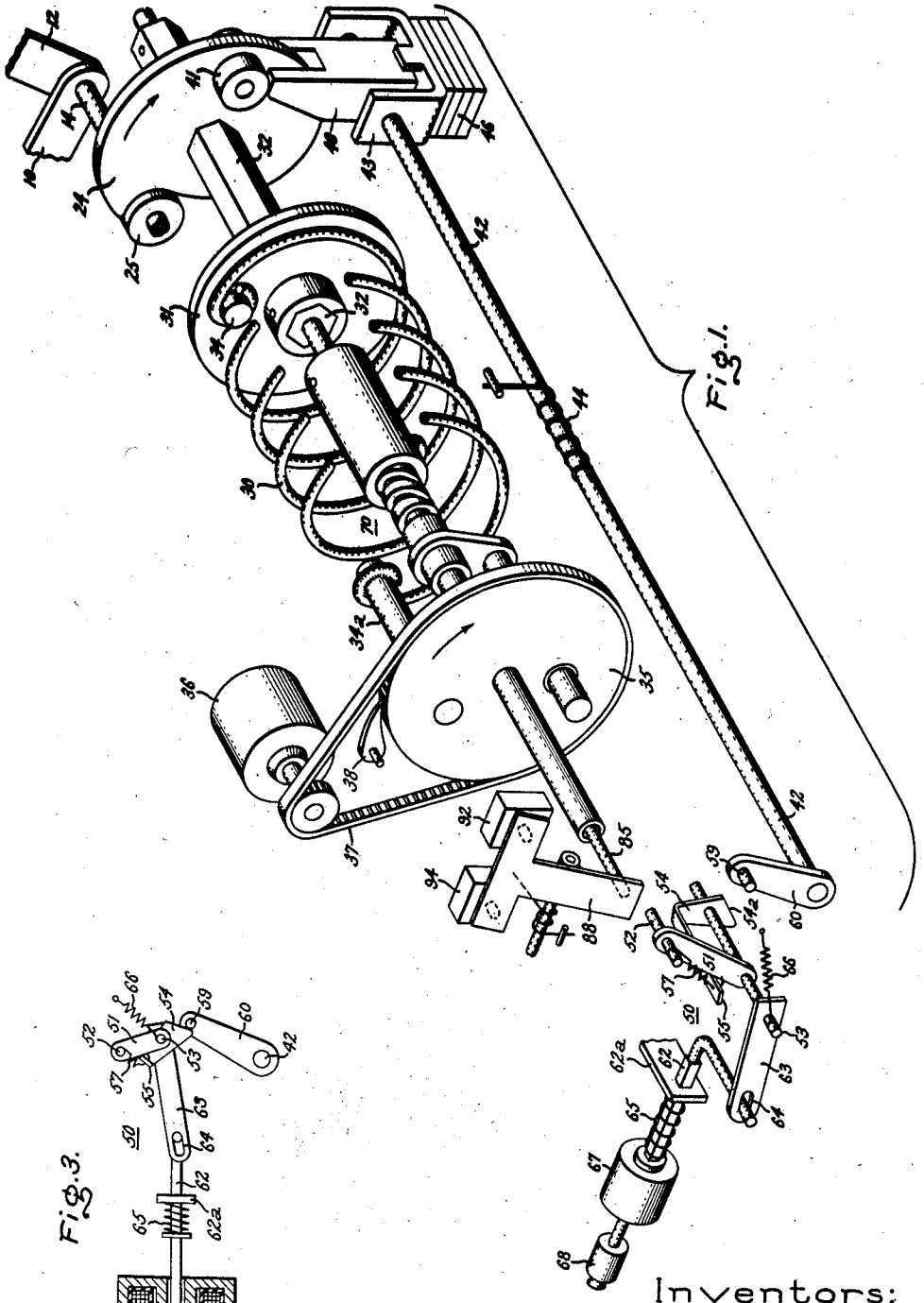


Fig. 1.

Fig. 3.

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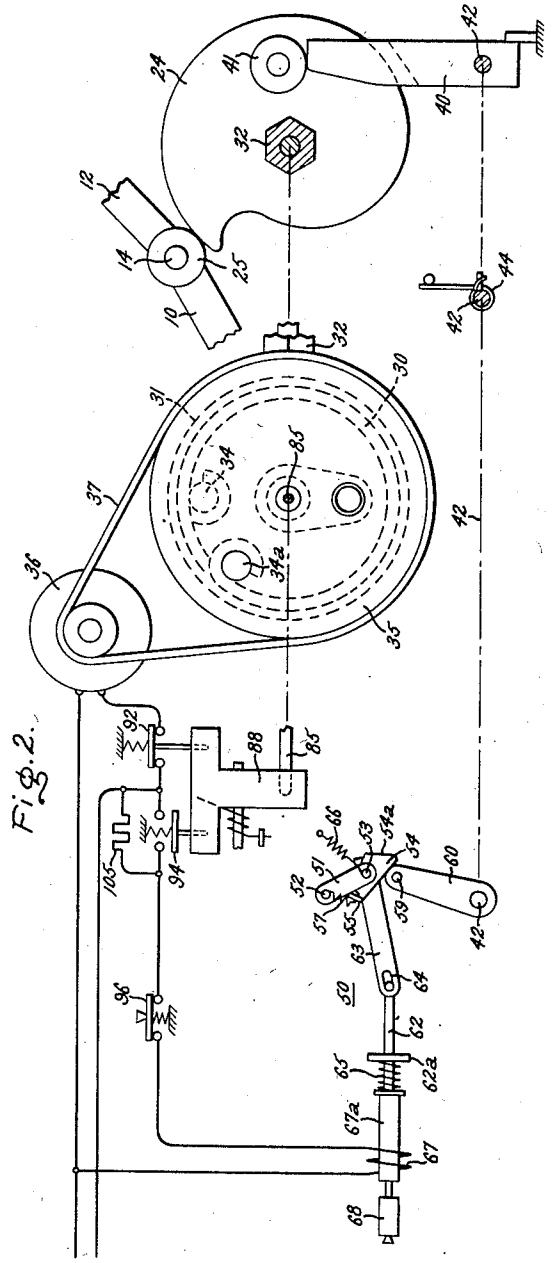


Fig. 2.

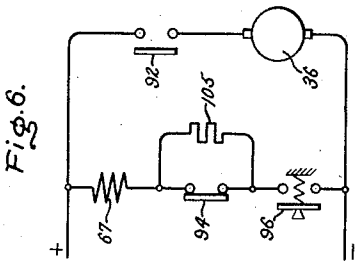


Fig. 6.

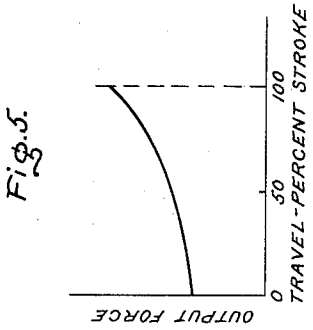


Fig. 5.

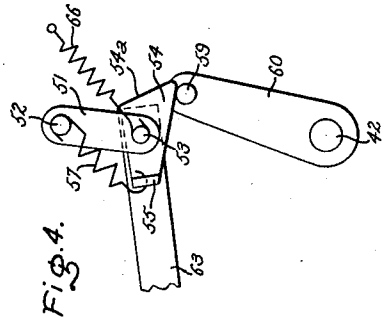


Fig. 4.

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2,820,119

CONTROL ARRANGEMENT FOR A STORED-ENERGY TYPE OF CIRCUIT BREAKER OPERATING MECHANISM

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Application September 25, 1956, Serial No. 612,007

6 Claims. (Cl. 200—89)

This invention relates to a stored-energy type of operating mechanism for an electric circuit breaker and, more particularly, to a control arrangement for controlling the operation of such a mechanism.

The invention has particular application to a circuit breaker closing-mechanism of the type which comprises energy-storing means, such as a spring, which is held in a charged condition by suitable restraining means which can be released to permit the spring to discharge and drive the breaker toward closed position.

A general object of the invention is to produce such releasing action by means of a simple and inexpensive device which operates to prevent circuit breaker "pumping," i. e., repeated reclosing operations in the event that the breaker is closed on a fault and fails to remain closed.

Another object is to construct the releasing device in such a manner that it can be successfully operated by a solenoid of minimum size and force output.

In carrying out our invention in one form, we hold the stored-energy closing device in a charged condition by restraining means which can be moved from a holding position to a releasing position to permit discharge of the stored-energy device. For releasing the restraining means, we provide an actuating member which moves through a first predetermined travel to drive the restraining means from its holding to its releasing position. Thereafter, the actuating member is moved through further travel into a position free of the restraining means, thus permitting the restraining means to be returned to its holding position under the influence of suitable biasing means. The actuating member is driven through said first predetermined travel by the action of a solenoid driving its armature through a full operating stroke. The actuating member is then driven through said further travel by means of a spring which is permitted to move the actuating member independently of the solenoid armature. By utilizing the spring, instead of the solenoid, for producing this further travel, we are able to more efficiently utilize the solenoid, especially during the final portion of its stroke when its force output is relatively high.

For a better understanding of our invention, reference may be had to the following specification taken in connection with the accompanying drawings, wherein:

Fig. 1 is a schematic perspective view of a closing mechanism constructed in accordance with our invention with the parts thereof shown in the charged breaker-open position.

Fig. 2 is a schematic exploded view of the mechanism of Fig. 1 shown in a discharged breaker-closed position.

Fig. 3 is an enlarged view of a releasing device which is included as a portion of Fig. 1. Fig. 3 shows the releasing device in an intermediate position through which it passes when moved from the position of Fig. 1 to that of Fig. 2.

Fig. 4 illustrates the releasing device during a resetting operation.

Fig. 5 is a force-travel diagram for the solenoid which is utilized for operating the releasing device.

Fig. 6 is a schematic circuit diagram illustrating certain electrical relationships during the time the mechanism is in the charged breaker-open position of Fig. 1.

Referring now to Fig. 1, the operating mechanism shown therein comprises a toggle **10**, **12** pivotally joined together at a knee **14**. This toggle **10**, **12** is part of a conventional trip-free linkage which is coupled to the movable contact (not shown) of the circuit breaker. Since this linkage forms no part of the present invention and is described in detail in application S. N. 512,638, Coggeshall et al., filed June 2, 1955, now Patent No. 2,769,874, dated Nov. 6, 1956, and assigned to the assignee of the present application, it has not been shown in the present application. It is believed sufficient merely to understand that when the knee **14** is lifted from the position shown in Fig. 1, the toggle **10**, **12** is extended and drives the movable contact of the breaker toward closed position against the bias of a suitable opening spring (also not shown).

This lifting of the knee **14** is accomplished by the action of a rotatable cam **24** cooperating with the usual roller **25** which is mounted at the knee **14**. When the cam **24** is rotated clockwise through a complete revolution by means soon to be described, it moves from the position of Fig. 1 to the position of Fig. 2 and lifts the knee **14**, thereby extending the toggle **10**, **12** and closing the breaker. Fig. 2 shows this toggle portion of the breaker mechanism in closed position, where it is held by the force of the cam acting through the knee **14** to maintain the toggle **10**, **12** extended.

For rotating the cam **24** to drive the circuit breaker closed, we have provided a stored-energy closing device which comprises a torsion spring **30** suitably coupled at one end to the cam **24**. As shown in Fig. 1, this coupling comprises a disc **31** attached to the hexagonal cam shaft **32** and carrying a boss **34** to which the forward end of the spring is suitably anchored. The rear end of the spring is anchored by a suitable boss **34***a* to a rotatable sprocket **35**.

Charging of the spring **30** is accomplished by rotating the sprocket **35** in a clockwise direction by means of a suitable charging motor **36** coupled to the sprocket **35** by means of a conventional chain drive **37**. The manner in which this charging motor is controlled will appear more clearly hereinafter. Unwinding of the spring **30** at its rear end by possible back-tracking of the sprocket **35** is prevented by means of a suitable holding pawl **38**.

For controlling the rotation of the cam **24** there is provided a latch or closing-release prop **40** which cooperates with an abutment such as the roller **41** suitably secured to the cam **24**. This prop **40** is keyed to an actuating shaft **42** which is journaled within a U-shaped bracket **43**. The prop is biased into its holding position shown in Fig. 1 by means of a prop-resetting spring **44** surrounding the shaft **42**. When the prop **40** is released, i. e., moved clockwise out of the path of the abutment **41**, the main spring **30** is free to drive the cam **24** clockwise at high speed from the breaker-open position of Fig. 1. The prop **40** is reset to its holding position immediately and in ample time to arrest the movement of the cam **24** after it has rotated through a complete revolution to drive the breaker into the closed position shown in Fig. 2. The forces produced by the abutment **41** impacting against the prop **40** during this arresting action are effectively absorbed by a stack of yieldable buffers **46** mounted beneath the prop-supporting bracket **43**.

For releasing the prop **40** to effect closing of breaker, as described above, we provide a releasing device **50** which is constructed in accordance with one form of the present invention. This releasing device **50** comprises a

guide link 51 mounted for pivotal movement about a fixed pivot 52 and carrying at its lower end a transversely-extending actuating pin 53. Pivotally mounted on this pin 53 is an actuating pawl 54, which has a transversely projecting portion 55 contacting the rear side of the guide link 51. The projecting portion 55 is releasably held in this position by a spring 57 which allows the pawl to rotate counterclockwise about the pin 53 of Fig. 1 under certain conditions, which will soon be described. The actuating pawl 54 cooperates with a pin 59 carried by an input crank 60 secured to the prop actuating shaft 42. When the actuating pin 53 is moved in a counterclockwise direction about its pivot 52 from the position of Fig. 1, the actuating pawl, with its lower surface 54*a* acting through the crankpin 59, rotates the input crank 60 in a clockwise direction and thereby releases the prop 40. At the instant that the prop 40 is released, the parts of releasing device are passing through the approximate position shown in Fig. 3 with the actuating pawl 54 still engaging, or capable of engaging, the crankpin 59. By allowing for this continued engagement of the pawl 54 and crankpin 59 after prop-release, we are able to insure that the pawl 54 will not have moved out of driving-relationship with the crankpin 59 before producing prop release. As soon as prop-release does occur, the pawl 54 is moved from the position of Fig. 3 into the position of Fig. 2 in a manner which will soon be described in greater detail. This movement of the pawl 54 from the position of Fig. 3 to the position of Fig. 2 moves the pawl surface 54*a* free of the crankpin 59 and permits the input crank 60 to be returned to its original position shown in Fig. 2 by means of the prop resetting spring 44. This results in the prop being immediately reset in time to arrest the movement of the main cam 24 after it had been spring-driven through a complete revolution to effect breaker-closing. The parts of the releasing device would occupy the position shown in Fig. 2 immediately after the prop had been released and had reset.

The above-described prop-releasing action of the pawl 54 is produced by means of a slidable L-shaped operating rod 62 which is suitably guided in the frame 62*a* and which is coupled to the actuating pin 53 by means of a connecting link 63. This connecting link 63 at one end is pivotally mounted on the actuating pin 53 and at its other end has a lost-motion slot 64 which receives the outer leg of the L-shaped operating rod. A compression spring 65 acting through the operating rod 62 maintains the parts of the releasing device in the normal or neutral position of Fig. 1 against the opposing bias of a weaker tension spring 66, which tends to move the actuating pin 53 counterclockwise about its pivot 52. The operating rod 62 can be operated either electrically, as by a suitable closing-release solenoid 67, or manually, as by applying a force to a plunger 68 secured to its outer end.

In case of either manual or electrical operation, if the operating rod 62, with the aid of the spring 66, is moved through its normal stroke to the right from its neutral position shown in Fig. 1, it acts through the connecting link 63 to move the actuating pin 53 counterclockwise about its pivot 52. This drives the pawl surface 54*a* into engagement with the crankpin 59 and produces the prop-releasing action described above. After release, the prop 40 immediately resets, as described above, and the parts are then in the position of Fig. 2. When the operating rod 62 is thereafter released, the releasing device 50 resets under the influence of its spring 65, and the parts thereof are restored to their position of Fig. 1. During prop-releasing action, the pawl 54 acts against the pin 59 in an essentially unyielding manner due to engagement between the projection 55 and the guide link 51 as the actuating pin 53 moves counterclockwise. When the releasing device is reset from the position of Fig. 2, however, the pawl yields when it engages the crankpin 59, since the crankpin is then on an opposite side of the pawl. This yielding action, which is best shown in Fig. 4, continues until near the end of the resetting stroke, at which time the pawl has been dragged clear of the crankpin 59 and is free to reset under the influence of its own spring 57.

It should be apparent from Fig. 1 that considerable force is required in order to release the prop 40 from the roller 41 inasmuch as the charged main spring 30, acting through the roller 41, creates considerable friction tending to resist such prop-releasing action. Once the prop has been released, however, these spring-produced friction forces are no longer present, and, as a result, very little force is required in order to further move the actuating pawl 54, i. e., from the position of Fig. 3 to that of Fig. 2 so as to free the prop 40 for resetting. If the pawl 54 had been permitted to remain in the position of Fig. 3 instead of being subsequently driven into the position of Fig. 2, then the pawl, acting through the crankpin 59, would block return of the prop 40 to its holding position of Fig. 1.

As shown in the force-travel diagram of Fig. 5, the solenoid 67 delivers its maximum force output near the end of its stroke. To utilize this final portion of the stroke for performing the relatively easy job of moving the pawl 54 free of the crankpin 59 (i. e., from the position of Fig. 3 to that of Fig. 2) would require that an intermediate portion of the solenoid stroke be used for the actual prop-releasing action. Since the force output from the solenoid is relatively low during this intermediate portion of the stroke, an unduly large solenoid would be needed in order to derive the necessary prop-releasing forces from this intermediate portion of the stroke.

We have obviated the need for such an unduly large solenoid by utilizing the spring 66, rather than the solenoid 67, for moving the pawl 54 free of the crank 59 after prop-release has occurred. This enables us to rely upon the final portion of the solenoid stroke, rather than an intermediate portion thereof, for effecting prop-releasing action, thus making available maximum force output when the retarding forces are at their maximum.

For a better understanding of this latter feature, reference may be had to Fig. 3 where the parts are shown at about the instant that prop-release has occurred. It will be observed from Fig. 3 that the solenoid armature 67*a* is then at the end of its stroke positioned against the pole piece 67*b*, thus indicating that the final portion of the solenoid stroke was utilized for prop-releasing action. During this prop-releasing action, the outer leg of the operating rod 62 had acted against the right hand end of the slot 64 to drive the actuating pawl 54 and the crankpin 59 into their respective prop-releasing positions of Fig. 3. Since further movement of the solenoid armature is then blocked by the pole piece 67*b*, it will be apparent that movement of the pawl 54 from the position of Fig. 3 to that of Fig. 2 is produced primarily by the action of spring 66. The lost motion slot 64 permits the pawl 54 to be carried into the position of Fig. 2 independently of the then-blocked solenoid armature 67*a*. Motion of the pawl 54 is terminated when the rear end of the slot 64 encounters the outer leg of the operating rod 62.

The lost-motion slot 64 and the spring 66 also contribute to the effectiveness of the solenoid 67 in producing initial prop-releasing forces. For example, when the solenoid armature 67*a* is initially driven to the right from the position of Fig. 1, it can quickly attain a relatively high speed because it is required only to overcome the resetting spring 65 inasmuch as the other movable parts of the releasing device are initially driven by the spring 66. In this regard, the spring 66 simply moves the linkage 51—57, 63 to the right in follow-up relationship to the operating rod 62 until the pawl surface 54*a* contacts the crankpin 59. Thereafter, the operating rod is rapidly driven across the lost-motion slot 64 and into engagement with the right-hand end of the slot. This produces a hammer-like impact which is most effective in overcoming initial resistance of the prop 40 to movement

out of its holding position of Fig. 1. Further movement of the solenoid armature **67***a* completes the prop-releasing operation in the manner previously described.

For controlling the charging motor **36**, we provide a control switch **92** connected in series with the motor **36** across a suitable source of control voltage, as shown in Fig. 2 and Fig. 6. This switch **92** is controlled by a controlling-arrangement **70, 85, 88** which is described and claimed in application S. N. 611,331, Miller et al., filed September 21, 1956, assigned to the assignee of the present invention. For the purpose of the present explanation, it is believed sufficient to understand merely that the controlling arrangement closes the switch **92** to produce spring-charging operation of the motor **36** whenever the main spring **30** discharges below a predetermined energy level and opens the switch **92** to terminate the charging operation whenever the spring is charged above a predetermined safe energy level. As will be apparent from Fig. 6, the switch **92**, in closing, completes an energizing circuit for the motor, and in opening, interrupts this energizing circuit.

For preventing operation of the releasing device **50** before the main spring is charged to a predetermined safe energy level, another control switch **94** is provided. As shown in Figs. 2 and 6 this control switch **94** is connected in series with the coil of solenoid **67** and also in series with a manually-operable switch **96**. Like the other control switch **92**, switch **94** is also controlled by the controlling arrangement **70, 85, 88** in a manner described in detail in application S. N. 611,331. For the purposes of the present explanation, it is believed sufficient merely to understand that the controlling arrangement **70, 85, 88** operates to close this switch **94** whenever the spring **30** is charged to a safe energy level and operates to open the switch **94** whenever the energy level of the spring is below a safe level. Referring to Fig. 6, if the switch **94** is closed, indicating that the spring **30** is safely charged, the manually-operated switch **96** can then be closed to energize and operate solenoid **67**, thereby causing the releasing device **50** to release the prop **40**. If the switch **94** is open, which indicates that the energy-level of the spring is below a safe value, then operation of the manually-operable switch **96** will be ineffective to produce operation of the solenoid **67**. This is the case because the resistor **105**, which is connected in shunt with switch **94**, limits the current flowing through the solenoid coil to a value which is insufficient to cause pick-up of the solenoid. The resistor **105** is of such a value, however, that when the control switch **94** is open, the resistor allows sufficient current to flow through the solenoid coil to maintain its armature **67***a* sealed-in, i. e., against the pole piece **67***b*, should it then be in this operated position. This sealed-in relationship, which is illustrated in Fig 2, prevents the releasing device **50** from resetting under the influence of its spring **65** during the time the spring **30** is being recharged after having been released, or in other words, during the time that switch **94** is open. Thus, if an operator seeking to close the breaker, closes the control switch **96** and holds it closed, the solenoid **67** will initially pick-up and remain picked-up even though the spring cut-off switch **94** is temporarily opened as a result of the main spring **30** being temporarily in a discharged condition.

Since the releasing device **50** remains in its position of Fig. 2 so long as the manually-operable switch **96** is held closed, it should be apparent that the releasing device **50** operates to prevent circuit breaker "pumping," i. e., repeated closures of the breaker in the event that it is closed and fails to remain closed. This is the case because with the releasing device **50** held in its position of Fig. 2, it is incapable of again actuating the input crank **60** until reset to its normal position of Fig. 1. Thus, should the releasing device **50** be initially operated as above-described to close the breaker and should the breaker fail to remain closed, no further closures will take place until the switch **96** is released to permit the releasing device **50** to reset from its position of Fig. 2 to that of Fig. 1.

Circuit breakers are commonly provided with a "b" switch to prevent attempted closure whenever the circuit breaker is already closed. Such switches are customarily actuated by the circuit breaker operating mechanism and are open when the breaker is closed and closed when the breaker is open. This "b" switch is not shown in our disclosed circuit breaker, but, as explained in application S. N. 610,736, Coggeshall et al., assigned to the assignee of present invention, such a switch can be electrically connected in series with the control switch **94** and in shunt with the resistor **105** without affecting the anti-pump characteristics of our releasing device **50**.

While we have shown and described a particular embodiment of our invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from our invention in its broader aspects, and we, therefore, intend in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of our invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. In an electric circuit breaker comprising stored-energy operating means dischargeable to produce operation of the breaker, restraining means operable in a holding position to hold said stored-energy means in a charged condition and movable from said holding position to a releasing position to permit discharge of said stored-energy means, biasing means tending to return said restraining means to its holding position, an actuating member movable through a first predetermined travel to drive said restraining means from its holding to its releasing position, the position of said actuating member at the end of said first travel being such as to block return of said restraining means to its holding position, spring means biasing said actuating member through further travel into a position free of said restraining means to permit said restraining means to be returned to its holding position by its biasing means, a solenoid having an armature movable through an operating stroke to drive said actuating member through said first predetermined travel, and a force-transmitting linkage interconnecting said armature and said actuating member for transmitting operating forces from said armature to said actuating member, the force-transmitting linkage including a lost motion connection which permits said spring means to move said actuating member through said further travel independently of said armature.

2. In an electric circuit breaker comprising stored-energy closing means dischargeable to effect closing of the breaker, restraining means operable in a holding position to hold said stored-energy means in a charged condition and movable from said holding position to a releasing position to permit discharge of said stored-energy means, biasing means tending to return said restraining means to its holding position, an actuating member movable through a first predetermined travel to drive said restraining means from its holding to its releasing position, the position of said actuating member after said first travel being such as to block return of said restraining means to its holding position, a solenoid having an armature, means interconnecting said armature and said actuating member for driving said actuating member through said predetermined first travel in response to driving movement of said armature through an operating stroke, and means for driving said actuating member through further travel independently of said armature into a position free of said restraining means to permit said restraining means to be returned to its holding position by its biasing means.

3. In a closing mechanism for an electric circuit breaker comprising stored-energy means dischargeable to effect closing of the breaker, restraining means operable in a

holding position to hold said stored-energy means in a charged condition and movable from said holding position to a releasing position to permit discharge of said stored-energy means, biasing means tending to return said restraining means to its holding position, an actuating member movable through a first predetermined travel to drive said restraining means from its holding to its releasing position, the position of said actuating member after said first travel being such as to block return of said restraining means to its holding position, a solenoid having an armature and a force output which progressively increases as said armature is driven through its operating stroke, means interconnecting said armature and said actuating member for driving said actuating member through said predetermined first travel in response to said armature being driven through its operating stroke, and means for driving said actuating member through continued further travel independently of said armature into a position free of said restraining means whereby to permit said restraining means to be returned to its holding position by its biasing means.

4. In an electric circuit breaker comprising stored-energy closing means dischargeable to effect closing of the breaker, a holding member operable in a holder position to hold said stored-energy means in a charged condition and movable from said holding position to a releasing position to permit discharge of said stored energy means, biasing means tending to return said holding member to its holding position when displaced therefrom, means including a pivotally mounted input member for transmitting operating forces to said holding member, an actuating member mounted for angular movement about a pivot axis spaced from that of said input member, said actuating member being movable through a first predetermined travel to transmit through said input member operating forces which drive said holding member from its holding position into its releasing position, said actuating member then being in a position to act through said input member to block return of said holding member to its holding position, means for carrying said actuating member through continued further travel into a position free of said input member to permit said holding member to be returned to its holding position by its biasing means, a solenoid having an armature, means interconnecting said armature and said actuating member for driving said actuating member through said predetermined first travel in response to driving movement of said armature through an operating stroke, and means for driving said actuating member through said further travel independently of said armature.

5. In an electric circuit breaker comprising stored-energy operating means dischargeable to produce operation of the breaker, restraining means operable in a holding position to hold said stored-energy means in a charged condition and movable from said holding position to a releasing position to permit discharge of said stored-energy means, an actuating member for releasably engaging a portion of said restraining means and movable from a first to a second position to drive said restraining means from its holding to its releasing position, means including a one-way driving connection for operating said actuating member from its first to its second position, biasing means operable when said actuating member nears said second position to return said restraining means to its holding position, means for thereafter returning said actuating member to its first position from said second position, said restraining means being disposed in the path of return movement of said actuating member, said one-way driving connection yielding during said return movement of the actuating member to permit said actuating member to move into said first position without being blocked by said restraining means.

6. In an electric circuit breaker comprising stored-energy operating means dischargeable to produce operation of the breaker, a holding member normally holding said stored-energy means in a charged condition and releasable to permit discharge of said stored-energy means, means including an input member for transmitting operating forces to said holding member, an actuating member adapted to releasably engage said input member in force-transmitting relationship and having a normal position located behind said input member, means including a one-way driving connection for driving said actuating member out of its normal position into force-transmitting engagement with said input member to release said holding member, means for continuing movement of said actuating member in a releasing direction to move said actuating member clear of said input member, biasing means operable upon movement of said actuating member clear of said input member to return said input member to its initial position which is then located behind said actuating member, means for thereafter returning said actuating member to its normal position, said one-way driving connection yielding during said return movement of said actuating member to allow said actuating member to move into said normal position without being blocked by said input member.

No references cited.