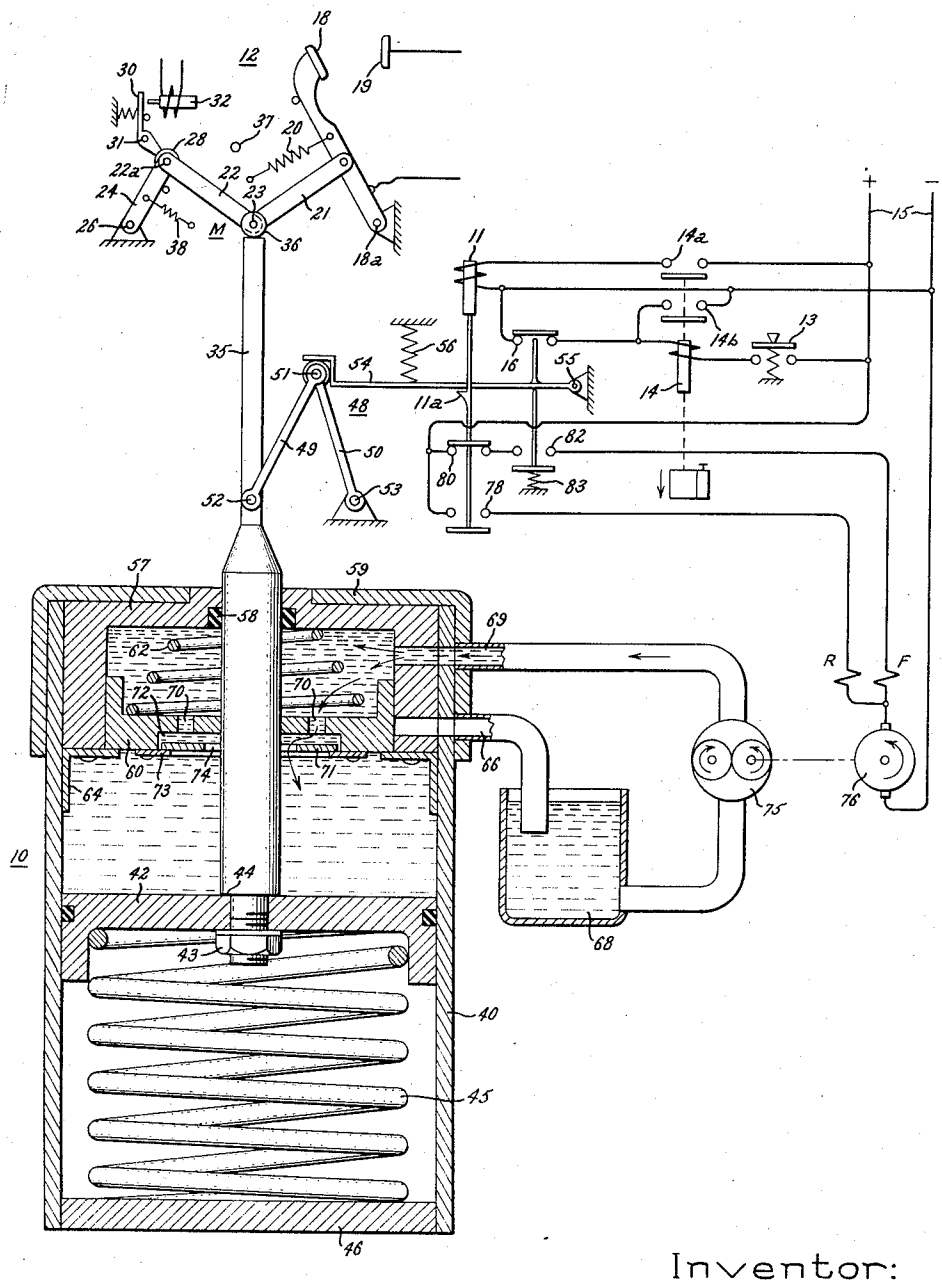
Nov. 18, 1958 J. A. FAVRE 2,861,144

STORED ENERGY TYPE CLOSING DEVICE FOR AN ELECTRIC CIRCUIT BREAKER

Filed July 8, 1957 2 Sheets-Sheet 1

Fig. 1.



Inventor:
John A. Favre,
by J. Wesley Haubner
His Attorney.

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Filed July 8, 1957 2 Sheets-Sheet 2

Fig. 2.

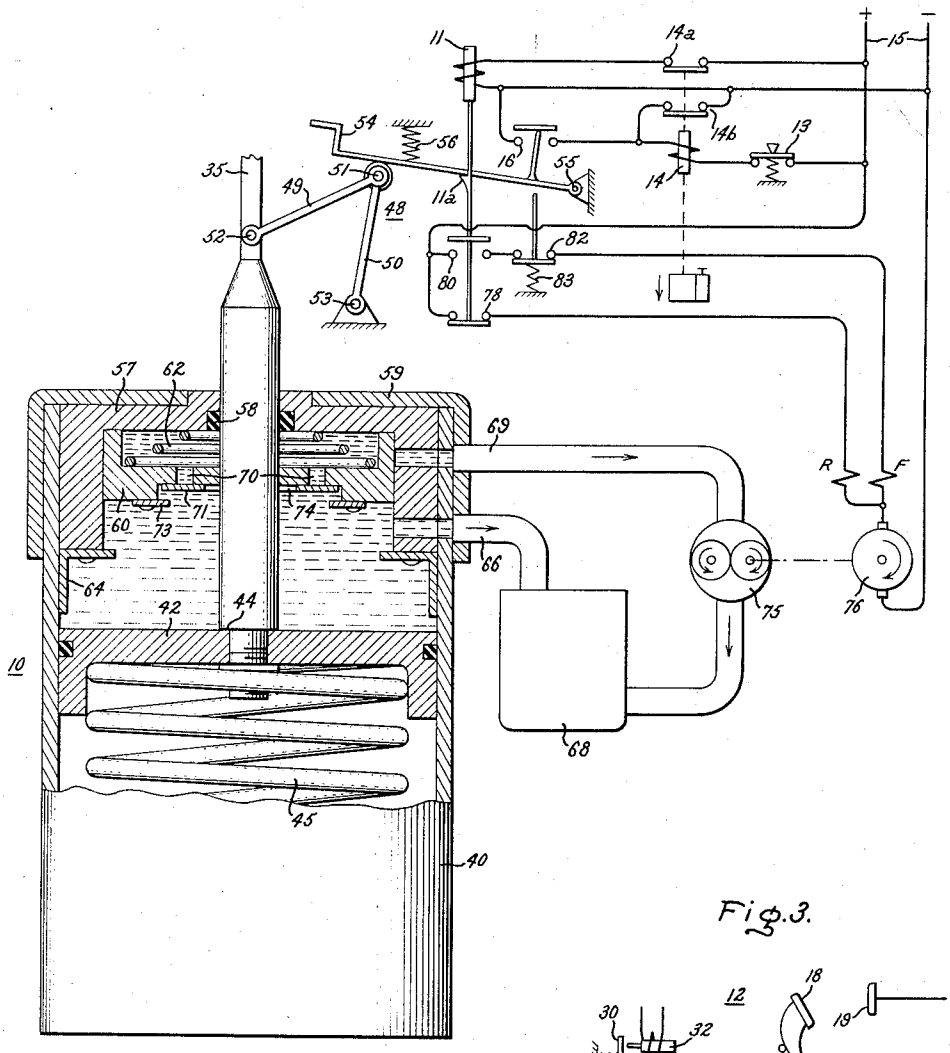


Fig. 3.

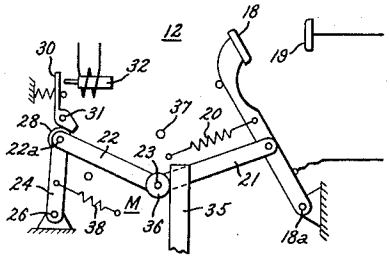
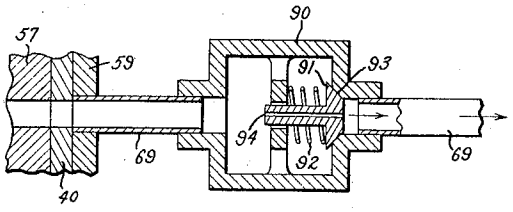


Fig. 4.



Inventor:
John A. Favre,
by J. Wesley Saubrer
His Attorney.

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2,861,144

STORED ENERGY TYPE CLOSING DEVICE FOR AN ELECTRIC CIRCUIT BREAKER

John A. Favre, Bromall, Pa., assignor to General Electric Company, a corporation of New York

Application July 8, 1957, Serial No. 670,404

11 Claims. (Cl. 200—82)

This invention relates to a stored-energy type of closing device for an electric circuit breaker and, more particularly, to a closing device of this general type in which pressurized fluid, preferably liquid, is utilized for charging a spring, which is subsequently released to produce circuit breaker closing.

The use of pressurized liquid for the operation of a circuit breaker has usually required a number of relatively complex control valves and also a relatively expensive accumulator for storing a charge of compressed gas, which provides the energy for closing the breaker.

It is an object of the present invention to provide a simple and inexpensive circuit-breaker closing device which is controlled by pressurized liquid but which requires no accumulator or complex control valves for its proper operation.

Another object of my invention is to provide a simple and reliable closing device in which pressurized fluid is utilized for charging a spring which can be subsequently released to produce circuit breaker closing.

Another object of my invention is to insure that premature operation of the hydraulically-controlled spring-charging means does not interfere with or defeat discharging of the spring during a normal closing operation.

In carrying out my invention in one form, I provide a chargeable spring which is dischargeable at one of its ends to produce closing of the circuit breaker. A movable piston mounted within a cylinder is operatively coupled to said one end of the spring. Pressurized fluid supplied to the cylinder space at one side of the piston acts to drive the piston in a direction to charge the spring. When the spring is charged, a suitable latch holds the piston in a position which maintains the spring charged. Subsequent release of the latch allows the spring to discharge and drive the piston in a direction opposite to the charging direction, and this action is used to produce circuit breaker closing. A dump passage leading from the cylinder space is sealed off during the spring-charging operation, but this dump passage is opened during spring-discharging to allow closing action to take place without appreciable restraint from fluid in the cylinder space.

Control of fluid flow through the dump passage and also through the inlet to the cylinder space is provided by means of a pressure-sensitive movable valve element. During a spring-charging operation, this valve element seals off the dumping passage, but upon spring-discharge this valve element is driven out of sealing relationship with the dumping passage and into a position where it acts to block flow through the inlet. This insures that no fluid will be inadvertently supplied through the inlet to the cylinder during a spring-discharging operation, thus preventing spring discharging from being defeated by any such fluid.

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

Fig. 1 is a schematic view partially in cross-section showing a circuit breaker closing arrangement embodying my invention. The circuit breaker is in open position with the closing device fully charged.

Fig. 2 is a view similar to that of Fig. 1 but with the parts of the closing device in a position through which they would pass near the end of a closing operation.

Fig. 3 is a view illustrating a portion of the circuit breaker mechanism shortly after being tripped to open position.

Fig. 4 is a cross-sectional view illustrating a modification of one portion of the closing arrangement shown in Figs. 1–3.

Referring now to Fig. 1, the stored energy closing device is shown at **10**, and the circuit breaker which it is designed to close is shown at **12**. This circuit breaker **12** can be of any suitable conventional type and is accordingly shown in schematic form only.

As shown in Fig. 1, circuit breaker **12** comprises a pair of relatively movable interrupting contacts **18** and **19**. One of these contacts **18** is pivotally mounted at **18*a*** and is biased to the open circuit position shown by a suitable spring **20**. Closing forces are transmitted to the movable contact **18** by a conventional trip-free operating mechanism M which comprises a pair of toggle links **21** and **22** pivotally joined together by a knee **23**. One of the toggle links **21** is pivotally connected at its opposite end to movable contact **18**, whereas the other of the toggle links **22** is connected by a pivot pin **22*a*** to the upper end of a guide link **24**. This guide link **24** is pivotally supported at its lower end on a fixed fulcrum **26**. The pivot pin **22*a*** carries a latch roller **28** which cooperates with a suitable trip latch **30** pivotally mounted at **31**. So long as the trip latch **30** remains in the latched position shown, the toggle **21**, **22** is capable of transmitting thrust to the movable contact **18**. Thus, when the knee **23** is lifted from the position shown in Fig. 1, the toggle **21**, **22** is extended and drives the movable contact **18** toward the closed circuit position.

This lifting of the knee **23** is accomplished by the action of a suitable plunger **35** cooperating with the usual roller **36** which is mounted at the knee **23**. When this plunger **35** is driven upwardly from its position of Fig. 1, it lifts the knee and produces closing of the circuit breaker in the manner described hereinabove. Preferably, the plunger **35** is arranged to drive the toggle **21**, **22** slightly overcenter and against a stop **37** so that the movable contact will be held in closed circuit position even when the plunger **35** is returned to its original position of Fig. 1.

A suitable solenoid is provided for controlling the trip latch **30**. Energization of this solenoid **32** in response to predetermined electrical conditions causes the solenoid to drive the latch **30** counterclockwise about its pivot **31** to effect tripping open of circuit breaker. Should the latch **30** be tripped when the circuit breaker is closed, or even during the closing stroke, the pivot **22*a*** will be freed by such tripping action, and as a result, the toggle **21**, **22** will be rendered inoperative to transmit thrust to the movable contact **18**. As a result, the opening spring **20** will be free to drive the movable contact to its open position.

The position of the parts of the mechanism after such tripping has occurred is shown in Fig. 3, where the plunger **35** is shown still in its elevated position. A suitable resetting spring **38** connected to the guide link **24** and tending to rotate the guide link clockwise about its fulcrum **26** tends to reset the mechanism M to a latched, thrust-transmitting condition but is incapable of achieving this resetting action so long as the plunger **35** remains out of its normal position of Fig. 1. As shown in Fig. 3, the plunger **35** acts to block such resetting action while in its raised position, and only when it is returned to its position of Fig. 1 is it moved out of interfering relation-

ship with the roller 36 to permit the resetting spring 38 to restore the mechanism 12 to the thrust-transmitting condition of Fig. 1. The importance of this reset-blocking action will soon appear more clearly.

For driving the plunger 35 upwardly to produce the above-described closing of the circuit breaker 12, the stored-energy closing device 10 is relied upon. Referring to Figs. 1 and 2, this closing device 10 comprises a cylinder 40 having a piston 42 slidably mounted therein. The plunger 35 is attached to this piston 42 at its lower end by suitable means, such as by a nut 43 threaded on the plunger and clamping the piston against a shoulder 44 formed on the plunger. The plunger 35 is urged upwardly from the position of Fig. 1 by means of a heavy compression spring 45, hereinafter termed the closing spring, which is interposed between the piston 42 and the lower end wall 46 of the cylinder. In the position shown in Fig. 1, the closing spring 45 is fully charged and is held in this fully charged condition by means of a suitable latching device 48.

The latching device 48 may be of any suitable conventional form but preferably comprises a toggle consisting of a pair of links 49 and 50 pivotally joined together by a knee 51. The link 49 is pivotally connected to the plunger 35 at 52, whereas the link 50 is pivotally mounted on a stationary pivot 53. The knee is restrained in the position shown in Fig. 1 by means of a suitable latch 54 pivoted at 55 and urged into its restraining position by a compression spring 56. When this latch 54 is lifted by means soon to be described, the knee 51 is released, and the plunger 35 is then free to move upwardly. This allows the charged compression spring 45 to quickly discharge and thus drive the plunger 35 rapidly upward to produce the desired closing of the breaker. The position of the parts after the closing spring 45 has completed a major portion of its discharging action is illustrated in Fig. 2.

For lifting the latch 54 to initiate the above-described discharge of the closing spring 45, a solenoid 11 is provided. Referring to Fig. 1, when this solenoid 11 is energized to drive its armature upwardly, a projection 11*a* carried by the armature engages the underside of the latch 54 and carries the latch upwardly into the tripped position, thereby initiating the above-described closing action. This energization of the solenoid is produced by closing a suitable control switch 13, which is connected in series with the coil of a control relay 14 and a normally-closed set of contacts 16 across a source 15 of control power. Closing of the control switch 13 energizes the control relay 14 which responds by immediately closing its contacts 14*a* to complete an energizing circuit for the solenoid 11.

The contacts 16, which are connected in series with the coil of control relay 14, are controlled by the position of latch 54. Tripping of the latch 54 opens these contacts 16, and they remain open until the latch 54 is reset. The purpose of these contacts 16 is to prevent release of the closing spring 45 prior to its being fully charged, as will soon appear more clearly.

The control relay 14 has a time-delay drop-out characteristic. Thus, when the control switch 13 is released after having been closed to initiate a closing operation, the contacts 14*a* remain closed until expiration of a predetermined interval. This interval is set to have sufficient length to insure completion of the circuit breaker closing operation. When the contacts 14*a* open after completion of this interval, they interrupt the energizing circuit for the solenoid 11, thereby allowing the solenoid to drop-out.

For recharging the spring 45 so as to permit additional closing operations, pressurized liquid is supplied to the cylinder space above the piston 42. To provide for this pressurized liquid, the upper end of the cylinder 40 is fitted with a cup-shaped closure 57 acting to seal off this upper end of the cylinder. The plunger 35 extends through a central opening provided in the cup-shaped closure 57, and a suitable seal 58 closely surrounding the plunger prevents any fluid leakage about the plunger. The closure 57 is tightly received within the cylinder 40 and is retained in its position shown by means of a suitable cup-shaped retainer 59 fixed to the cylinder 40.

The cup-shaped closure 57 also serves as the body of a dump valve that is relied upon to control the flow of pressurized liquid into and out of the cylinder 40. This dump valve comprises a movable valve element 60 which is slidably mounted within the cylindrical body of closure 57. The plunger 35 passes through a central opening in the valve element 60, but this opening is of sufficient size to allow free movement of the valve element relative to the plunger. A compression spring 62 interposed between the closure 57 and the movable valve element 60 urges the valve element into its position of Fig. 1, where it is shown seated upon a suitable stop 64. In this seated position of Fig. 1, the outer periphery of the valve element 60 acts to seal off a relatively-large dump passage 66 leading from the interior of cylinder 40 to a suitable sump 68. An inlet passage 69 of lesser size for supplying pressurized liquid to the cylinder 40 (in a manner soon to be described) is located above the seated position of the movable valve element 60 and can therefore supply fluid to the interior of the cylinder 40 without restraint from the valve element 60 so long as the valve element remains in its seated position of Fig. 1.

The movable valve element 60 has a plurality of orifices 70 formed therein for admitting liquid from the upper side of the valve element to the cylinder space at its lower side. A flap valve 71 carried adjacent the lower side of valve element 60 offers no appreciable impediment to such downward flow but acts as a check valve for preventing reverse or upward flow of liquid through the orifices 70. This flap valve 71 is shown loosely mounted within a recess 72 formed in the lower face of the dump valve element 60, and retained within this recess by a suitable retaining ring 73 secured to the dump valve element 60. Downward flow of liquid through the orifices 70 forces the flap valve 71 against the retaining ring 70 and allows fluid to flow freely through the enlarged central opening 74 of the flap valve. However, when fluid tends to flow in an opposite or upward direction, the flap valve 71 is forced upwardly against the underside of the dump valve element 60, where it acts to seal the orifices 70 and block upward flow therethrough.

For supplying pressurized liquid to the cylinder 40 through the inlet passage 69 in order to recharge the closing spring 45, a suitable reversible gear pump 75 is provided. This pump 75 is arranged to be driven by a reversible electric motor 76 which is controlled in a manner soon to be described. When the motor 76 drives the pump 75 in a forward direction, as illustrated in Fig. 1, the pump forces liquid into the space above the valve element 60 and through the orifices 70 into the cylinder space above the piston 42. The pressure within this cylinder space quickly builds up and acts to drive the piston 42 downwardly thereby compressing and recharging the spring 45. Near the end of this downward stroke, the latch 54 moves into place behind the knee 51, thereby rendering the latching device 48 again operative to hold the spring 45 in its charged condition. When this occurs, operation of the pump 75 is terminated by opening of the motor-energizing circuit, and the latching device 48 acts thereafter to hold the closing spring 45 charged. When operation of the pump is terminated, the pressure which had been built up within the cylinder space begins to decay, but the latching device 48 holds the closing spring charged despite this decay in pressure. The position of the various parts shortly after operation of the pump has been terminated is illustrated in Fig. 1.

The reversible motor 76, which controls the pump 75, can be of any suitable conventional form but preferably comprises a pair of field windings F and R, each of which

is shown connected in series with the armature of the motor. Energization of the winding F produces forward operation of the motor, whereas energization of the winding R produces reverse operation.

For properly controlling the motor **76** and the pump **75**, I connect in series with the reverse winding R of the motor a set of normally-open contacts **78** which are controlled by the closure-initiating solenoid **11**. When these contacts **78** are closed, they complete an energizing circuit for the reverse winding R, thereby causing the motor to operate in a reverse direction (for purposes which will soon be apparent).

For controlling the forward winding F, a set of normally-closed contacts **80** are connected in series therewith. These contacts **80** are controlled by the closure-initiating solenoid **11** and are opened by the solenoid when it operates to initiate closure of the circuit breaker. Also connected in series with the forward winding F is another set of contacts **82** which are controlled in accordance with the position of latch **54**. When the latch **54** is in its reset position of Fig. 1, these contacts **82** are open, but when the latch **54** is tripped, these contacts **82** are driven closed by means of a suitable spring **83**. Contacts **82** remain closed until the latch **54** resets.

Assume now that the circuit breaker **12** is open and that it is desired to close the breaker. If the parts of the closing device **10** are in the position shown in Fig. 1, this closing action can be initiated by closing the control switch **13**. As previously described in detail, this causes the solenoid **11** to operate, thereby tripping the latch **54** and freeing the closing spring **45** for discharge. The closing spring responds by driving the piston **42** and the plunger **35** rapidly upward to produce the desired circuit breaker closing action.

This upward closing movement of the piston **42** takes place without appreciable restraint from the liquid above the piston because of the action of the movable dump valve element **60** during this closing period. In this regard, when the spring **45** begins to discharge and force the piston **42** upwardly, it pressurizes the body of liquid between the piston **42** and the movable valve element **60**. As illustrated in Fig. 2, this pressure acting against the underside of the movable valve element **60** forces the valve element upwardly against the bias of spring **62**, thereby uncovering the relatively large dump passage **66**. Thereafter, liquid can flow freely through this dump passage and, accordingly, very little fluid resistance is encountered by the piston as it continues through its upward closing stroke.

When the above-described upward closing movement of the piston **42** was initiated, the pressurized liquid beneath the dump valve element **60** forced the flap valve **71** immediately to seat against the underside of the valve element. This blocked upward flow through the orifices **70**, thus preventing any pressure build-up above the valve element **60** which would undesirably retard upward dumping movement of the valve element **60**.

In the illustrated embodiment of my invention, upward dumping action of the valve element **60** is effected at high speed by relying upon reverse pumping action by the pump **75**. More specifically, when the solenoid **11** operates to trip the closure-initiating latch **54**, it also closes the contacts **78** in the energizing circuit for motor winding R. This causes the motor to drive the pump in the reverse direction illustrated in Fig. 2. Such reverse pumping action quickly withdraws liquid from the space above the dump valve element **60**, thus allowing this valve element **60** to move rapidly upward under the influence of fluid pressure acting against its underside.

In those applications where it is acceptable to initiate closing action at a lower speed than above-described, the gear pump **75** can remain idle, instead of being reversely-driven, during the above-described closing action. In such cases, sufficient leakage takes place through the idle gear pump to permit the valve element **60** to move upwardly under the influence of pressure acting against its underside.

When the upward closing stroke of piston **42** has been completed, pressure beneath the dump valve element **60** is insufficient to hold the valve element in its upper position against the action of spring **62**. As a result, the spring **62** restores the valve element **60** to its lower position, which is depicted in Fig. 1.

Recharging of the closing spring **45** after completion of the above-described closing action takes place as follows. Assume first that the operator had released the control switch **13** immediately after initiating this closing action. After a time interval sufficiently long to insure completion of the closing operation, the relay **14** drops out to open its contacts **14*a***, thereby interrupting the energizing circuit for the solenoid **11**. This causes the solenoid **11** to drop out, thereby closing its contacts **80** and opening its contacts **78**. Opening of the contacts **78** interrupts the energizing circuit for the reverse winding R of the motor **75**, whereas closing of the contacts **80** completes an energizing circuit for the forward winding F of the motor. This terminates the reverse pumping action and initiates forward pumping action. Such forward pumping action forces liquid through the inlet passage **69** and the orifices **70**, as indicated by the arrows in Fig. 1, thus building up fluid pressure above the piston **42**. This pressure build-up drives the piston **42** downwardly to recharge the closing spring **45**. When this downward charging movement of piston **42** has progressed to the stage where latch **54** can reset to its position of Fig. 1, the latch-controlled contacts **82** are opened by the latch, thereby interrupting the motor energizing circuit. This terminates the spring-charging action, and the closing device is once again prepared to produce circuit breaker closing.

For preventing circuit-breaker pumping, i. e., inadvertent repetitive closing operations in the event that the breaker should fail to remain closed while the control switch **13** is held closed, the control relay **14** is provided with a set of seal-in contacts **14*b*** which are operated to closed position when the control relay **14** is picked-up to initiate circuit-breaker closing. Closing of these contacts **14*b*** completes a seal-in circuit through the switch **13**, the coil of relay **14**, and the contacts **14*b***, which holds the relay **14** in an operated position so long as the control switch **13** is held closed. This holds the contacts **14*a*** closed so long as the control switch **13** is held closed, thus maintaining the solenoid **11** energized and its contacts **80** open so long as the control switch **13** is held closed. Since the contacts **80** are relied upon for initiating a recharging operation, so long as they are held open, recharging is prevented. Thus, holding the control switch **13** closed will prevent recharging after a closing operation, and this will prevent additional closing operations until the control switch **13** is released.

It is important that the closing spring **45** be allowed to drive the movable contact **18** of the circuit breaker toward closed position only when sufficient power is stored in the spring to complete such a closing operation. For example, if the spring-charging motor **76** should become accidentally de-energized before the charging operation is completed, say, as a result of loss of control power, then the resulting discharge of the spring **45** should not act to drive the contact **18** toward closed position. This objective is attained in my closing arrangement by preventing the trip-free linkage M from resetting to a thrust-transmitting condition until the spring-charging operation has been completed. For example, referring to Fig. 3, the mechanism resetting spring **38** is incapable of resetting the mechanism until the plunger **35** has been lowered to a position in which the closing spring **45** is fully charged. Thus, if the closing spring **45** should be prematurely allowed to discharge, it would simply drive the plunger **35** upwardly without transmitting closing thrust to the movable contact **18**.

The contacts 16 also aid in preventing release of the closing spring 45 prior to its being fully charged. These contacts 16 remain open so long as the latch 54 is in its tripped position and close only when the latch resets in response to completion of a recharging operation. So long as these contacts 16 remain open, the solenoid 11 is prevented from being again energized as a result of closing the control switch 13. Thus, the solenoid is disabled from initiating a closing action prior to full recharging of the closing spring 45.

Once the closing spring 45 begins discharging to initiate the usual circuit-breaker closing operation, it is important that this operation always be carried through to completion without interference or opposition from operation of the pump 75. For example, if, for any reason, the pump 75 should become prematurely operated in a spring-charging, or forward, direction during the spring-discharging interval, then such operation should not be allowed to oppose the discharging of the spring. This objective is attained in my arrangement by relying upon the movable dump valve element 60 to block flow through the inlet 69 during a spring-discharging operation. For example, during substantially the entire spring-discharging action, the valve element 60 is in its elevated position of Fig. 2 where it seals off the inlet 69 and therefore prevents the flow of liquid from the pump into the cylinder space.

In those applications in which it is desired to effect automatic reclosing of the above-described circuit breaker, the closing control switch 13 is arranged to close automatically in response to a breaker-opening operation, thereby initiating an automatic reclosure. Circuits for providing this desired control over the closing control switch 13 are well known, and reference may be had to Stewart Patent 1,943,096, assigned to the assignee of this application, for an example of such a circuit.

It may be desirable in certain of these reclosing applications to delay the automatic reclosing operation until a predetermined interval of time has elapsed after circuit breaker opening. Such a delay can be readily obtained in my disclosed operating device by providing in the inlet line 69 a valve such as shown at 90 in Fig. 4. This valve 90 comprises a movable element 91 which is biased by means of a light spring 92 into engagement with a suitable seat 93 on the pump or upstream side of the valve. Flow from the pump forces the valve element 91 off of its seat, and fluid from the pump is thereafter able to flow relatively freely about the outer periphery of the element 91 toward the main operating cylinder 40. Thus, the valve offers no appreciable impedance to that flow which is relied upon to charge the main spring 45. However, when flow takes place in a reverse direction through the valve 90, as indicated by the arrows of Fig. 4, element 91 is forced against the seat 93, and any fluid flowing in this reverse direction is required to flow through a restricted orifice 94.

The rate at which this flow in a reverse direction takes place governs the speed at which the previously described dumping movement of the main valve elements 60 takes place and, correspondingly, the rate at which discharge of the closing spring 45 is initiated. The size of the orifice 94 governs this rate of reverse flow. Hence, by a suitable choice of the size of restricted orifice 94, a desired delay in reclosing can be obtained.

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

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

1. In an electric circuit breaker, a chargeable closing spring which is dischargeable to close said breaker, a cylinder, a movable piston mounted within said cylinder and operatively coupled to one end of said spring, means for supplying pressurized fluid to the cylinder space at one side of said piston for driving said piston in a first direction to charge said spring, releasable restraining means for holding said piston in a position to maintain said spring charged, means for subsequently releasing said restraining means to allow said spring to discharge at said one end and drive said piston in a direction opposite to said first direction, means actuated by piston movement in said opposite direction for closing said circuit breaker, a dump passage leading from said cylinder space, a movable valve member blocking flow through said dump passage during charging of said spring, and means operable after completion of said spring-charging operation for moving said valve member out of blocking relationship relative to said dump passage whereby to allow said spring during discharge to drive said piston in said opposite direction without appreciable restraint from fluid in said cylinder space.

2. In an electric circuit breaker, a chargeable closing spring which is dischargeable at one of its ends to close said breaker, a cylinder, a movable piston mounted within said cylinder and operatively coupled to said one end of said spring, means for supplying pressurized fluid to the cylinder space at one side of said piston for driving said piston in a first direction to apply spring-charging force to said one end of said spring, releasable restraining means for holding said piston in a position to maintain said spring charged, means for subsequently releasing said restraining means to allow said spring to discharge at said one end and drive said piston in a direction opposite to said first direction, means actuated by piston movement in said opposite direction for closing said circuit breaker, a dump passage leading from said cylinder space, a movable valve member blocking flow through said dump passage during charging of said spring, and means operable upon release of said restraining means for moving said valve member out of blocking relationship with said dump passage, said valve member being maintained in said non-blocking position during spring-discharge by fluid pressure forces produced by said spring-discharge, and means for returning said valve member to said blocking position upon completion of said spring-discharging action.

3. In an electric circuit breaker, a chargeable closing spring which is dischargeable to close said breaker, a cylinder, a movable piston mounted within said cylinder and operatively coupled to one end of said spring, means for supplying pressurized fluid to the cylinder space at one side of said piston for driving said piston in a first direction to charge said spring, releasable restraining means for holding said piston in a position to maintain said spring charged, means for subsequently releasing said restraining means to allow said spring to discharge at said one end and drive said piston in a direction opposite to said first direction, means actuated by piston movement in said opposite direction for closing said circuit breaker and means for quickly discharging fluid from said cylinder space when the piston moves in said opposite direction whereby to allow circuit-breaker closing to take place without appreciable restraint from fluid in said cylinder space.

4. In an electric circuit breaker, a chargeable spring which is dischargeable at one of its ends to close said breaker, a cylinder, a movable piston mounted within said cylinder and operatively coupled to said one end of said spring, means for supplying pressurized fluid to the cylinder space at one side of said piston for driving said piston in a first direction to charge said spring, releasable restraining means for holding said piston in a position to maintain said spring charged, means for subsequently releasing said restraining means to allow said spring to discharge at said one end and drive said piston in a direction opposite to said first direction, a dump passage leading from said cylinder space, a movable valve member

blocking flow through said dump passage during charging of said spring, and means operable upon release of said restraining means for moving said valve member into a position for blocking flow into said cylinder space and for allowing flow out of said cylinder space through said dump passage.

5. In an electric circuit breaker, a chargeable closing spring which is dischargeable to close said breaker, a cylinder, a movable piston mounted within said cylinder and operatively coupled to said spring, a first passageway leading into the cylinder space at one side of said piston, means for supplying pressurized fluid to said cylinder space through said first passageway to drive said piston in a direction to charge said spring, releasable restraining means for holding said piston in a position to maintain said spring charged, means for subsequently releasing said restraining means to allow said spring to discharge and drive said piston in a direction opposite to said charging direction, means actuated by piston movement in said opposite direction for closing said breaker, a dump passage leading from said cylinder space, a movable valve member blocking flow through said dump passage during the time fluid is flowing through said first passageway to charge said spring, and means operable upon release of said restraining means for moving said valve member out of blocking relationship with said dump passage and into blocking relationship with said first passage.

6. In an electric circuit breaker, a chargeable closing spring which is dischargeable to close said breaker, a cylinder, a movable piston mounted within said cylinder and operatively coupled to said spring, a first passageway leading into the cylinder space at one side of said piston, pumping means for supplying pressurized fluid to said cylinder space through said first passageway for driving said piston in a direction to charge said spring, releasable restraining means for holding said piston in a position to maintain said spring charged, closure-initiating means for subsequently releasing said restraining means to allow said spring to discharge and drive said piston in a direction opposite to said charging direction, means actuated by piston movement in said opposite direction for closing said breaker, a dump passage leading from said cylinder space, a movable valve member blocking flow through said dump passage during the time fluid is flowing through said first passageway to charge said spring, means operable upon release of said restraining means for effecting dumping movement of said valve member out of blocking relationship with said dump passage, and means controlled by said closure-initiating means for causing said pumping means to withdraw from the region of said valve member fluid tending to retard dumping movement of said valve member whereby to accelerate said dumping movement.

7. The combination of claim 6 in which said dumping movement of the valve member positions the valve member in blocking relationship with said first passageway.

8. In an electric circuit breaker, a chargeable spring which is dischargeable to close said breaker, a cylinder, a piston movably mounted within said cylinder and operatively coupled to said spring, reversible pumping means operable in a forward sense to supply pressurized fluid to the cylinder space at one side of said piston for driving said piston in a first direction to charge said spring, releasable restraining means for holding said piston in a position to maintain said spring charged, means for subsequently releasing said restraining means to allow said spring to discharge and drive said piston in a direction opposite to said first direction, a dump passage leading from said cylinder space, a movable valve member blocking flow through said dump passage during charging of said spring, means operable upon release of said restraining means for effecting dumping movement of said valve member out of blocking relationship with said dump passage, and means for accelerating said dumping movement of said valve member by causing said pumping means to operate in a reverse sense and remove liquid from ahead of the valve member during said dumping movement.

9. In an electric circuit breaker, a chargeable closing spring which is dischargeable to close said breaker, a cylinder, a movable piston mounted within said cylinder and operatively coupled to said spring, a first passageway leading into the cylinder space at one side of said piston, means for supplying pressurized fluid in a forward direction through said first passageway to drive said piston in a direction to charge said spring, closure-initiating means for subsequently causing said spring to discharge and drive said piston in a direction opposite to said charging direction, means actuated by piston movement in said opposite direction for closing said breaker, a dump passage leading from said cylinder space, a movable valve member blocking flow through said dump passage during the time fluid is flowing through said first passageway to charge said spring, means responsive to operation of said closure-initiating means for effecting dumping movement of said valve member out of blocking relationship with said dump passage, said first passageway acting as an outlet through which fluid flows reversely from ahead of said valve member during said dumping movement, auxiliary valve means disposed in said passageway for providing a comparatively high impedance to the reverse flow of fluid through said passageway whereby to retard said dumping movement, and means for causing said auxiliary valve to provide a substantially lesser impedance to fluid flowing through said passageway in a forward direction.

10. In an electric circuit breaker having separable contacts, a trip-free linkage coupled to one of said contacts, said linkage being inoperable to transmit closing power to said contact when in a tripped condition and being operable to transmit closing power to said contact when in a reset condition, a chargeable closing spring which is dischargeable to provide said closing power, a cylinder, a movable piston mounted within said cylinder and operatively coupled to one end of said spring, means for supplying pressurized fluid to the cylinder space at one side of said piston for driving said piston in a first direction to charge said spring, means for subsequently allowing said spring to discharge at said one end and supply closing power to said linkage, resetting means tending to reset said linkage after tripping thereof, and means connected to said piston for blocking resetting of said linkage until said piston has been moved through a predetermined charging stroke, said resetting means acting to reset said linkage when said predetermined charging stroke has been completed.

11. In an electric circuit breaker, a chargeable spring which is dischargeable to close said breaker, a cylinder, a piston movably mounted within said cylinder and operatively coupled to said spring, reversible pumping means operable in a forward sense to supply pressurized fluid to the cylinder space at one side of said piston for driving said piston in a first direction to charge said spring, releasable restraining means for holding said piston in a position to maintain said spring charged, means for subsequently releasing said restraining means to allow said spring to discharge and drive said piston in a direction opposite to said first direction, means actuated by piston movement in said opposite direction for closing said circuit breaker, means for operating said pump in a reverse sense to remove fluid from said cylinder space, and means controlled by said reverse operation of the pumping means for controlling the rate at which piston movement in said opposite direction is initiated.

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