July 10, 1956 J. A. FAVRE 2,754,387

CIRCUIT BREAKER OPERATING MECHANISM

Filed April 30, 1954 3 Sheets-Sheet 1

Fig. 1.

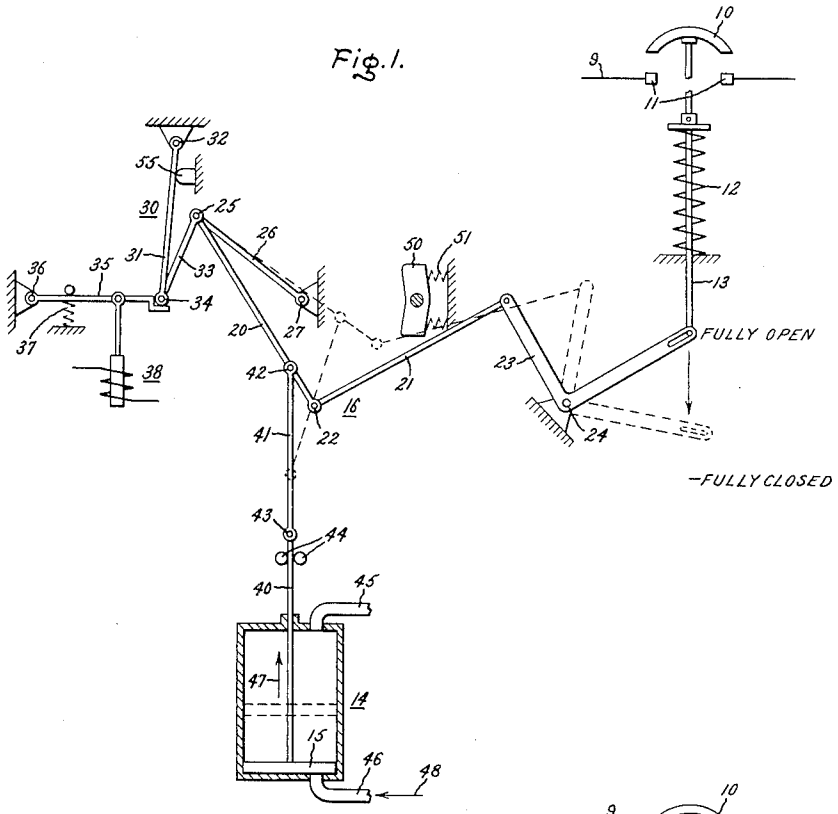
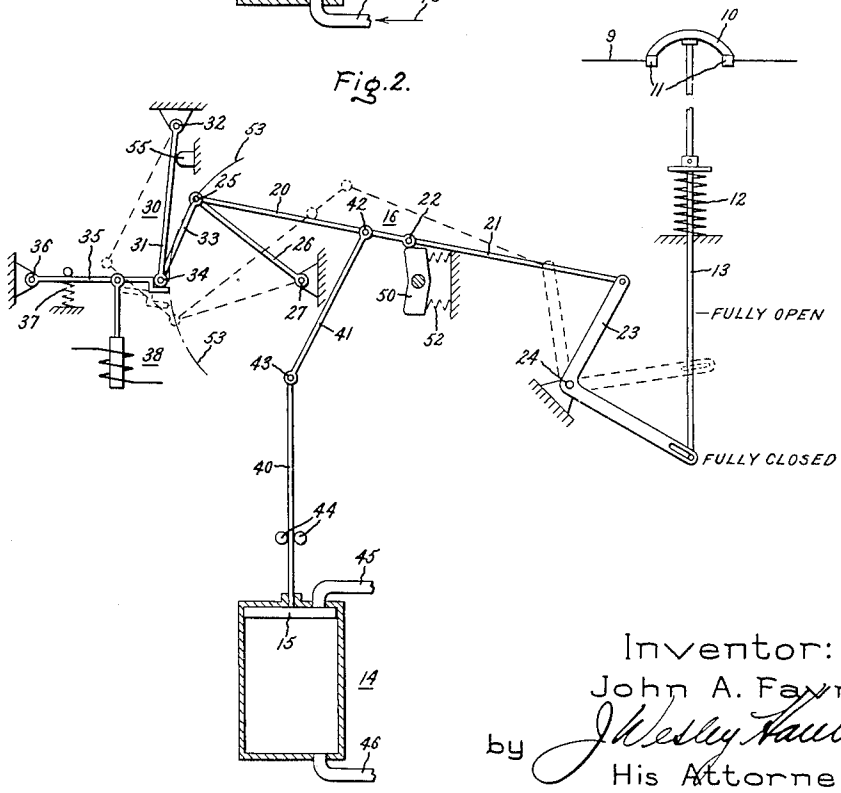


Fig. 2.



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Fig. 3.

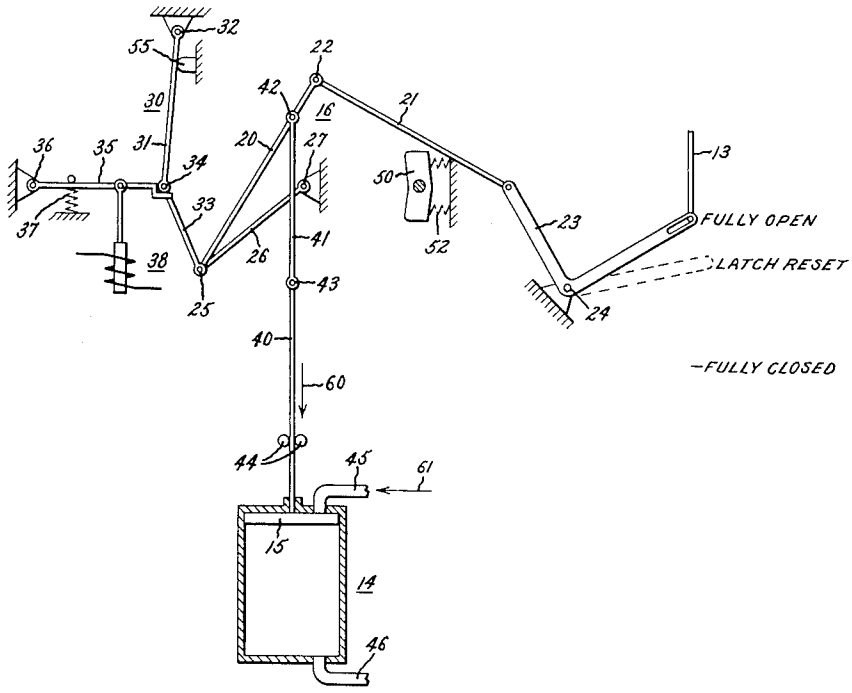
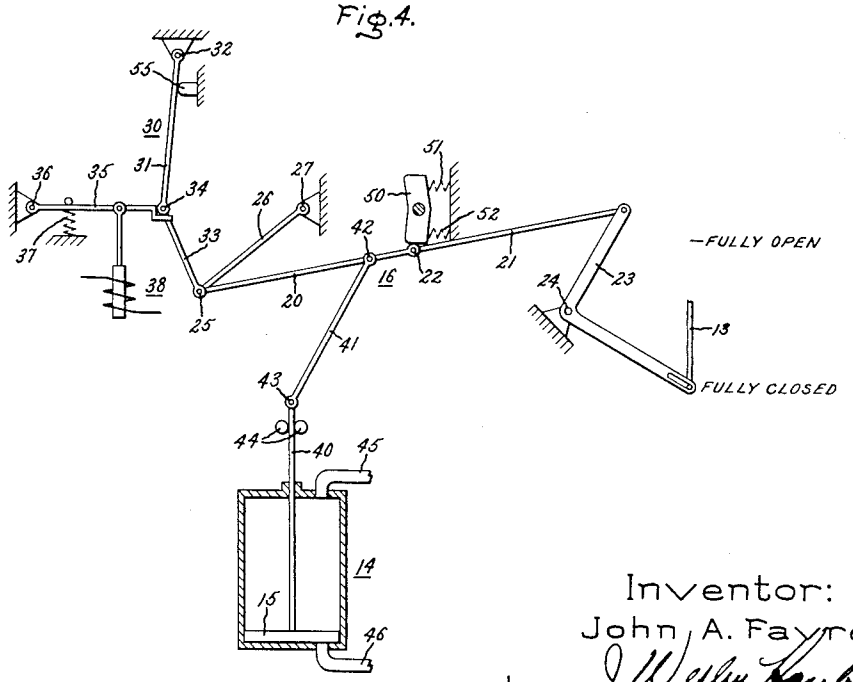


Fig. 4.



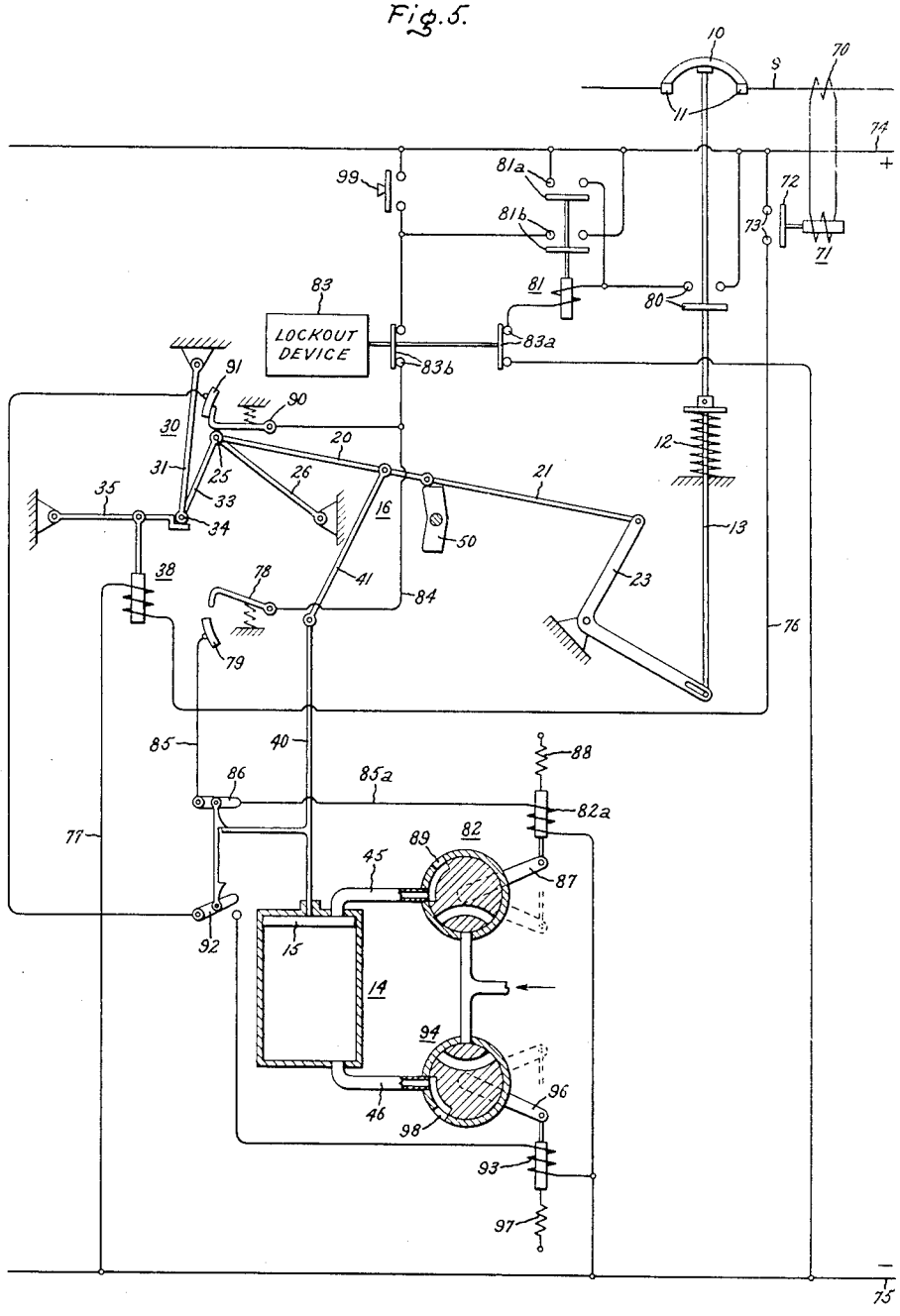
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CIRCUIT BREAKER OPERATING MECHANISM

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Fig. 5.



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2,754,387

CIRCUIT BREAKER OPERATING MECHANISM

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Application April 30, 1954, Serial No. 426,662

21 Claims. (Cl. 200—82)

This invention relates to an operating mechanism for circuit breaker, and more particularly to a mechanically trip-free operating mechanism which is capable of producing high speed reclosure of the circuit breaker upon opening thereof.

An important requirement for most circuit breakers is that the circuit breaker contacts should be capable of tripping, or moving toward open position, even while a thrust is being applied by the closing device of the breaker. To meet this requirement, it is conventional to provide the circuit breaker with a mechanically trip-free operating mechanism. The mechanically trip-free mechanism usually comprises a collapsible linkage which is maintained in thrust-transmitting relationship by a trip-free latch. If the closing device drives the mechanism in a direction to close the contacts of the circuit breaker while a fault is present on the line, the latch will be tripped at or near the end of the closing stroke, and as a result, the mechanism will be rendered incapable of transmitting continued thrust from the closing device to the contacts. Accordingly, the usual springs, which normally urge the contacts toward open position, will then immediately become effective to collapse the mechanism, to uncouple it from the closing device, and to open the contacts. Such a conventional trip-free switch closing mechanism is described in U. S. Patent 1,827,626 issued to Carl Thumin and assigned to the assignee of the present invention.

Before the usual mechanically trip-free mechanism can be reclosed, it is necessary that the operating linkage and the trip-free latch be reset, and it is further necessary that the closing device be returned at least partially to its original retracted position. Only after this resetting and retraction has occurred, are the usual linkage and closing device again in a condition to transmit closing thrust to the contacts. In prior mechanically trip-free circuit breakers this resetting of the linkage and retraction of the closing device has required an appreciable period of time. This period of time is highly undesirable where rapid reclosing of the circuit breaker is necessary in order to maintain continuity of service on the circuit.

To shorten the delay required for complete resetting of the circuit breaker mechanism and closing device, certain prior arrangements have been devised, but these arrangements have often been rather complex and costly. For example, it is common in a pneumatically-operated circuit breaker to provide a dump valve for quickly evacuating the pressurized air beneath the circuit breaker closing-piston in order to permit rapid reversal or retraction of the piston without undue impedence from the residual pressurized air. In such arrangements only when the piston is retracted, may the circuit breaker then be reclosed. An example of such an arrangement is shown and claimed in U. S. Patent 2,479,315 issued to TR Coggeshall and assigned to the assignee of this application. Since the required dump valves are rather

costly, it obviously would be desirable if rapid reclosing could be achieved without the need for dump valves.

Other attempts have been made to shorten the delay required for resetting by providing a mechanism which utilizes a pair of latches, one a non-trip-free latch and the other a trip-free latch. An example of such a mechanism is shown in U. S. Patent 2,282,348, issued to Carl Thumin and assigned to the assignee of the present invention. In such a mechanism the presence of more than one latch requires that complex means must be utilized for transferring control from one latch to the other.

Accordingly, it is an object of my invention to provide a new and improved mechanically trip-free operating mechanism which requires only a single latch in order to provide for rapid reclosing.

It is a further object of my invention to provide a mechanically trip-free linkage which may be driven toward closed position by a closing device which requires no subsequent retraction prior to again reclosing the linkage after a subsequent tripping. This feature permits a rapidly-reclosing, pneumatically-operated circuit breaker to be constructed without dump valves since a return of the operating piston back to its initial position is no longer a necessary pre-requisite to a subsequent closing operation.

A further object of my invention is to construct the mechanically trip-free mechanism in such a manner that the closing device remains coupled to the mechanism at all times, even during a trip-free operation. Hence, as soon as the trip-free latch is reset, the closing device is prepared to drive the circuit breaker toward its reclosed position.

A further object is to construct the mechanism in such a manner that the application of reclosing power to the tripped mechanism prior to full latch-resetting is effective to accelerate the latch resetting action and thereby reduce the reclosing time to a minimum.

In accordance with one form of my invention, the circuit breaker comprises a movable switch member and a collapsible toggle coupled to said switch member. The toggle has a knee movable toward toggle center on one side of said center to close said switch member and movable away from toggle center on the other side thereof to open the switch member. For moving the knee toward toggle center on one side thereof whereby to close the switch member, there is provided a source of motive power having a driving member coupled to the knee. Cooperating with the toggle, there is provided trip-free latch means which may be tripped to render the toggle ineffective to drive or hold the switch member closed. Normally ineffective toggle-collapsing means is rendered effective by tripping of the latch means to move the knee away from toggle center on said other side of said center whereby to effect opening movement of the switch member. The latch means has a pair of different latched positions in which it is effective to maintain the toggle operative to transmit closing thrust to the switch member. When the circuit breaker is tripped by moving the latch means out of one of its latched positions, the latch means resets into its other latched position before the completion of the opening stroke by the circuit breaker. Reclosing power applied to the toggle before the latch has completely reset is effective to accelerate the latch resetting process. As soon as the latch resets, this reclosing power becomes effective to immediately reverse the then-opening circuit breaker and to return it to its closed position.

My invention will be better understood from the following description when considered with the accompanying sheets of drawings, and its scope will be pointed out in the appended claims.

Referring to the drawings, Fig. 1 is a partially schematic view of a circuit breaker having a fluid-motor actuated operating mechanism constructed in accordance with the present invention. By the solid lines of Fig. 1 the breaker is shown in open position with the piston to the fluid motor in a lowered position. The dotted lines of Fig. 1 illustrate an intermediate position through which the mechanism will move as the piston is elevated toward its upper circuit breaker closed position.

Fig. 2, by solid lines, shows the circuit breaker of Fig. 1 in a fully closed position with the piston in its fully elevated position. The dotted lines illustrate an intermediate position through which the mechanism would move after having been tripped from the solid line position of Fig. 2.

Fig. 3 illustrates the circuit breaker of Fig. 1 in open position with the piston of the fluid motor in an elevated position.

Fig. 4 illustrates the circuit breaker of Fig. 1 in another closed position, but with its actuating piston in a lowered position.

Fig. 5 is a diagrammatic layout of a circuit breaker operating system embodying the mechanism of Fig. 1.

Referring more specifically to Fig. 1, the circuit breaker embodying my invention comprises a pair of relatively-movable contacts **10**, **11** separable to interrupt the current flowing through power circuit **9**. These contacts are biased toward open position by a compression spring **12** acting through a reciprocable circuit breaker operating rod **13** of insulating material connected to contact **10**. For moving the contact **10** toward closed position, I have provided a fluid motor **14** having a reciprocable piston **15**, which is coupled to the operating rod **13** by means of the mechanically trip-free operating mechanism generally indicated at **16**.

The operating mechanism **16** includes a primary toggle links **20** and **21** which are pivotally joined by means of a pin forming a toggle knee **22**. For coupling the inner end of toggle link **21** to contact operating rod **13**, there is provided an output crank **23** supported on a fixed pivot **24**. The arms of the crank are respectively pivotally joined to the toggle link **21** and the operating rod **13**. For guiding and supporting the outer end of link **20**, there is provided a carrier element **26**, which is pivotally supported on a fixed pivot pin **27** and is pivotally joined to toggle link **20** by a toggle support pin **25**.

As will appear more clearly hereinafter, the carrier element **26** can be latched in either an upper or a lower position. In Fig. 1 the carrier element **26** is shown latched in its upper position. For carrying out this latching function, there is provided a trip-free latch means including a secondary toggle **30** comprising a first link **31** pivotally supported on a fixed pivot pin **32** and a second link **33** pivotally joined to the support pin **25** of the primary toggle **16**. Secondary toggle links **31** and **33** are pivotally joined to each other by a pin forming a knee **34** for the secondary toggle. For latching the knee **34** in a predetermined fixed position, there is provided a trip-free latch member **35** pivotally supported on fixed pivot **36** and biased counterclockwise about this pivot into the latching position shown in Fig. 1 by means of a resetting spring **37**. For tripping, or unlatching, the latch member **35** in response to predetermined electrical conditions, there is provided a tripping solenoid **38**, which when activated, moves latch member **35** clockwise against the bias of resetting spring **37**. As will appear hereinafter, especially from Fig. 5, this tripping solenoid **38** may be activated in response to a predetermined electrical condition in circuit **9**. The operation of this electroresponsive latch structure is described in greater detail hereinafter.

The fluid motor **14**, which provides a source of motive power for closing the breaker, has its piston **15** coupled to toggle link **20** by means of a piston rod **40** and a connecting link **41** pivotally joined at **42** and **43** to the toggle link **20** and the piston rod **40**, respectively. The piston rod **40** is guided for linear movement by suitable guide rollers **44**. For reasons which will soon be apparent, the fluid motor **14** is double-acting. That is, by selectively admitting pressurized fluid, preferably air, to either side of the piston **15** by means of conduits **45** and **46**, the piston may be selectively driven either upwardly or downwardly, depending upon its initial position in the cylinder of the motor.

A cycle of operation for the mechanism will now be described. Assume, first, that the circuit breaker is in the solid-line open position of Fig. 1 with the driving piston **15** in its lower position. So long as the trip-free latch member **35** remains in its latched position, the toggle supporting pivot pin **25** remains fixed and the collapsible primary toggle **20—22** is capable of transmitting closing thrust from the driving piston **15** to the operating rod **13** of the circuit breaker. Assume, then, that the latch member **35** remains latched as the piston **15** is driven upwardly from its lowered position of Fig. 1, as indicated by arrow **47**. To drive the piston upwardly, pressurized fluid is admitted to the space beneath piston **15** by means of conduit **46**, as shown by the arrow **48** in Fig. 1. As the piston is driven upwardly, it moves the mechanism through the dotted-line, partially-closed, position of Fig. 1, and finally, when the upward stroke of the piston is completed, into the solid line, fully-closed, position shown in Fig. 2. It will be apparent that this upward movement of the piston moves the knee **22** of the primary toggle toward the toggle center and into the substantially toggle-center position shown in Fig. 2, in which position the knee has encountered and is maintained by a pivotally-mounted prop member **50**, which is biased toward a stable supporting position, underneath the knee by a suitable spring **51**.

A circuit breaker opening, or tripping, operation will be now described by referring to Figs. 2 and 3. When the tripping solenoid **38** is energized to move the latch member **35** clockwise toward the dotted line position shown in Fig. 2, the knee **34** of the then-contracted secondary toggle is immediately freed from the latch member **35** and is moved rapidly outward toward the dotted line position of Fig. 2 by the bias of opening spring **12** discharging through the operating mechanism **16**. As the secondary toggle **34** extends toward its dotted line position, the toggle supporting pin **25** swings rapidly downward along an arc **53** having its center at **27**. This downward arcuate movement of the support pin causes the primary toggle **20**, **21** to collapse generally upwardly toward its dotted line position of Fig. 2. Initiation of this upward collapsing movement of the primary toggle is promoted by the fact that the prop **50** and the piston-connected linkage **40**, **41** provide an upward force component which acts through the knee **22** when the toggle-supporting pin **25** moves arcuately downwardly. Obviously, this upward component of force acting through the toggle knee **22** buckles the toggle **20**, **21** in an upward direction and causes toggle collapsing movement toward the dotted line position of Fig. 2. As the primary toggle **20**, **21** continue in its collapsing movement and as the toggle-supporting pin **25** continues in its downward arcuate movement the secondary toggle continues to extend, and as a result the knee **34** of the secondary toggle begins to return toward its latched position. This return movement of the knee **34** continues until the link **31** engages a buffer or stop **55**, as shown in Fig. 3. When this engagement occurs the knee **34** has been returned to its original position, wherein it is latched by the latching member **35**, which has reset to its normal holding position of Fig. 3 under the bias of latch reset spring **37**. This resetting of the latch member **35** is completed at an intermediate point in the contact opening stroke substantially prior to completion of the full opening stroke. If no reclosing power is being applied to the piston **15** when

the latch becomes reset, the contact **10** continues to move upwardly toward its fully open position.

That the mechanism is mechanically trip-free is demonstrated by the fact that during the above-described tripping operation of the breaker from the position of Fig. 2 toward the position of Fig. 3, the position of the piston **15** at the upper end of the cylinder can remain unchanged. Thus, the breaker is capable of tripping free of the piston **15** even if closing power is being applied to the lower side of piston **15** at the instant of tripping.

If it is unnecessary to provide for rapid reclosing duty, then closing power may be applied to the piston **15** at any desired time after completion of the above-described opening stroke. For example, to reclose the circuit breaker from the open position of Fig. 3, it is necessary merely to drive the piston **15** downwardly as indicated by arrow **60**. This may be accomplished by supplying pressurized fluid through conduit **45**, as indicated by arrow **61**. Since the latch member **35** is reset in the position of Fig. 3, the toggle support pin **25** is fixed and, accordingly, the primary toggle **20**, **21** is capable of transmitting closing thrust from piston **15** to the contact operating rod **13**. Accordingly, downward movement of piston **15** extends the primary toggle **20**, **21** into the position of Fig. 4 thereby to move the operating rod **13** toward contact-closed position. As the primary toggle moves into its extended position of Fig. 4 its knee **22** first displaces and then moves under the lower surface of prop member **50**, where it is maintained by the prop against the bias of the opening spring **12**. A prop biasing spring **52** urges the prop into a position to maintain the toggle extended so long as the latch member **35** is in its latched position.

It will be apparent from the above described cycle of operation, that if the circuit breaker is tripped after the driving piston **15** has moved the breaker toward closed position, it is unnecessary to retract the piston and repeat the upward piston closing stroke in order to again reclose the breaker, as is necessary in the usual breaker. My invention makes it possible to utilize the piston retracting movement to reclose the breaker. No additional piston movement is required. For example, if the circuit breaker is tripped into the position of Fig. 3 after the driving piston **15** has moved upwardly to drive the breaker from the open position of Fig. 1 toward the closed position of Fig. 2, it is unnecessary to subsequently lower the piston **15** prior to initiating a reclosing operation. This reclosing may be carried out simply by driving the piston downwardly from the elevated position (of Fig. 2) that it has assumed in originally closing the breaker. No further movement of the piston is required. This reversibly-acting, closing characteristic of the piston and operating linkage is an important feature of the present invention which permits extremely rapid reclosing of the circuit breaker when it is used for automatic reclosing duty. This may be illustrated by the following description of trip-free close-open operation followed by a rapid reclosing operation; this being a type of duty desired, or required, in certain circuit breaker applications. Assume that as the piston moves upwardly to close the breaker (as from Fig. 1 to Fig. 2), a fault is present on the line. As soon as the fault current flows between contacts **10** and **11**, the fault sensitive latch member **35** immediately trips, thereby causing the primary toggle to collapse and become incapable of transmitting continued closing thrust to the contact **10**. Since the toggle collapses upwardly as indicated by the dotted lines of Fig. 2, the driving piston **15** can remain in its upper position. But, if rapid reclosing is desired, a downward reclosing force may be applied to the piston even before the latch member **35** has reset into the solid-line latched position of Fig. 3. As will be explained in greater detail hereinafter, this downward reclosing force is immediately transmitted to the secondary toggle **30** and performs the very desirable function of accelerating the return of the secondary knee

34 to its latched position. Obviously, this acceleration shortens the time for latch resetting and permits reclosure to be initiated more rapidly. As pointed out previously, once the latch member **35** is reset, the toggle supporting pin **25** becomes a fixed reaction point and, as a result, the primary toggle is again capable of transmitting closing force. Thus, at the instant the latch resets into the position of Fig. 3, the toggle supporting pin **25** again becomes a fixed point in its alternate lower position and the driving piston which is then moving downwardly under reclosing power, instantaneously reverses the upward collapsing direction of movement of the tripped primary knee **22** and begins moving the knee downward toward toggle center. This reversal of primary toggle knee **22** is immediately transmitted to the contact operating rod **13** and is effective to immediately initiate reversal, or reclosing, of the contacts **10**, **11**.

It will be apparent from this description of a rapid close-open-reclose cycle that by utilizing the downward, or return, movement of the driving piston **15** to effect reclosing, after its first upward closing movement, several highly advantageous results are obtained. First, it is unnecessary to reset, or retract, the driving piston prior to initiation of a reclosing stroke, and, as a result, no time is consumed in piston resetting. Second, the downward, or return, movement of the piston actually accelerates latch resetting and, accordingly, shortens the delay normally required to permit latch resetting.

An important feature of applicant's linkage which contributes to the above-described ability of the piston to close the breaker by moving in either of two mutually reverse directions in that closing movement of the breaker is effected by moving the primary toggle knee **22** toward toggle center on one side of toggle center, whereas a subsequent opening of the breaker results in movement of the toggle knee **22** away from center but on the other side of center. This may be illustrated by comparing the position of the primary toggle knee **22** in the dotted line closing position of Fig. 1 with the position of the knee in the dotted line opening position of Fig. 2. In these dotted line positions, the primary toggle knee **22** is on the opposite sides of toggle center. Since closing of the breaker may be effected only by moving the knee toward toggle center, it is apparent that movement of the knee into positions on opposite sides of toggle center in response to successive opening operations permits the breaker to be reclosed successively by moving the knee in reverse direction toward toggle center. Accordingly, the piston is capable of carrying out a closing and a subsequent reclosing action simply by moving through one stroke and then returning to its original position.

Another feature which contributes to the abiilty of the circuit breaker to rapidly reclose is that the latch means **30—35**, after having been tripped out of one latched position, resets to another latched position before the full opening stroke is completed. As a result, the primary toggle is rendered capable of transmitting a reclosing thrust to the contacts prior to completion of full opening stroke. This characteristic has been illustrated by the legends applied to the positions of the output crank **23** in Fig. 3, which show that the latch may be reset before completion of a full opening stroke. Since reclosing power from the driving piston accelerates latch resetting, as described above, it will be apparent that the point of latch resetting may be varied by varying the instant at which reclosing power is applied to piston **15**.

The manner in which reclosing power from the driving piston accelerates the latch resetting process may be more specifically explained by considering the condition of primary toggle link **20** after the mechanism has been tripped. For example, consider the condition of link **20** after the mechanism has been tripped from the solid line position of Fig. 2 and at the instant it passes through the dotted line position of this same figure. At this instant, the link **20** is floating with respect to link **21**

and, accordingly, is free to pivot counterclockwise at any desired speed about the upwardly moving primary knee 22. Obviously, accelerating such counterclockwise movement of the link 20 will accelerate the downward arcuate travel of toggle support pin 25 along arc 52 and accordingly will accelerate the latch resetting process. Since the piston 15 is coupled to link 20 at a point 42 which is spaced from the toggle knee 22, it will be apparent that downward movement of the piston 15 acting through the movement arm between 42 and 22 will accelerate the above-described downward arcuate movement of toggle support pin 25 and, accordingly, will accelerate latch resetting.

Another feature which is apparent from the above description of a close-open-reclose operation is that the piston 15, through linkage 40, 41, remains coupled to the primary toggle 20, 21 at all times, even during a trip-free close-open operation. The pivotally-mounted connecting link 41 permits independent movement of the primary toggle 20, 21 with respect to the piston but positively transmits motion from the piston to the toggle for both directions of piston movement. Thus, the piston 15 is not required to move with the toggle 20, 21 during tripping, but because of its permanently coupled relationship with the toggle, is capable of applying a reclosing force to the toggle at any desirable instant after circuit interruption, even while the breaker parts are still moving toward their fully-open position.

The schematic layout of Fig. 5 illustrates a control system for automatically producing rapid reclosing operation of the circuit breaker of Figs. 1–4. This layout of Fig. 5 has been shown in simplified form in order to facilitate an understanding of the control system. In this figure, the circuit breaker is shown in closed position with the piston 15 elevated and the latch means 30, 35 in its upper latched position, in the same manner as shown in Fig. 2. For initiating a tripping operation there is provided a current transformer 70 and a relay 71 in circuit therewith. For illustrative purposes, the relay 71 is shown as an overcurrent relay having normally-open contacts 72, 73 which are closable in response to overcurrent in power circuit 9, as sensed by current transformer 70. Closing of the contacts of relay 71 established a tripping circuit across the opposed terminals 74 and 75 of a D. C. control power source. This tripping circuit includes the series combination of contacts 72, 73, conductor 76, tripping solenoid 33 and conductor 77. Thus, when contacts 72, 73 close in response to overcurrent in circuit 9, the tripping solenoid 33 will be energized to unlatch latch member 35, thereby freeing the secondary toggle knee 34 so that the mechanism may be collapsed toward the dotted line position shown in Fig. 2 by the then-freed contact opening spring 12. At some intermediate point prior to complete resetting of the latch means 30, 35 into its lower holding position shown in Fig. 3, the toggle support pin 25 strikes a movable biased-open auxiliary contact 78 (Fig. 5) which is driven into extended wiping engagement with a cooperating fixed contact 79. Immediately prior to this intermediate point, the auxiliary contacts 80 on the then-opening circuit breaker operating rod 13 will have closed thereby closing a reclosing relay 81, which seals itself closed through seal-in contacts 81*a*. Thus, it will be apparent that as soon as the latch-controlled contacts 78 and 79 close, a reclosing circuit is established through the valve control coil 82*a* of a closing control valve 82. This reclosing circuit extends from supply line 74 through the then-closed contacts 81*b* of relay 81, the contacts 83*b* of a lockout device 83, conductor 84, the then-closed contacts 78, 79, conductor 85, limit switch 86, conductor 85*a*, valve control coil 82*a* and then to the opposite supply line 75. The lockout device 83 is shown schematically since it may be a conventional construction which locks out in response to a predetermined number of closely-spaced circuit reclosures. Upon lockout, it functions to lock open its contacts 83*b* so as to prevent more than said predetermined number of closely-spaced circuit reclosures. Additionally, lockout of the device 83 opens the contacts 83*a* to effect opening of the then sealed-in reclosing relay 81. Assuming now that the contacts of the lockout device are closed, completion of the above reclosing circuit at contacts 78, 79 immediately opens valve 82 by moving its operator 87 into the dotted line position, thereby permitting pressurized fluid to flow from a reservoir (not shown), through header 87*a*, and then through valve 82 to the top side of the driving piston 15 whereby to apply reclosing power to piston 15. It will be apparent that by varying the point at which the latch-controlled switch 78, 79 closes, the instant at which reclosing power is applied to piston 15 may be varied. If the piston 15 has begun its downward reclosing movement at the instant the latch means 30, 35 resets into its lower position (of Fig. 3), continued downward movement of the piston 15 will be effective to immediately return the contact operating rod 13 toward its closed position of Fig. 4. When the piston reaches a point adjacent its lower limit of movement it opens the previously-closed limit switch 86, thereby permitting valve 82, under the bias of spring 88, to cut off fluid flow into the motor and to vent the residual pressure in the motor through port 89, whereby to remove closing power from the piston 15.

The operation of the system follows substantially the same pattern if the latch and piston occupy their respective lower positions at the time of tripping. Under such conditions, the toggle support pin 25 would move upwardly during the tripping-open operation to close the then-open upper auxiliary contacts 90, 91 (which correspond to the lower auxiliary contacts 78, 79 thereby completing a second reclosing circuit through the then-closed limit switch 92 and coil 93 of the lower closing control valve 94. Energization of coil 93 would raise the lower valve operator 96 into the dotted line position whereby to supply pressurized reclosing fluid to the lower side of the then-lowered piston 15. This application of reclosing power would continue until the piston was elevated into its upper position where it effects opening of the limit switch 92, thereby permitting the valve 94, under the bias of spring 97 to cut off the flow of fluid into the cylinder and to vent through port 98.

It will be understood that any desired number of successive open-close operations may be performed by the trip-free mechanism of my invention. With the aid of a conventional timer (not shown) suitably connected in the energizing circuit for the fault responsive relay 71, the time interval between these successive operations may advantageously be made as short or as long as desired.

For manually initiating a closing operation, I have provided a push-button switch 99 which, when closed, establishes an energizing circuit for the proper closing control valve 82 or 94.

It should be understood that my invention is not limited to the specific construction illustrated herein, and that changes and modifications may occur to one skilled in the art without departing from the spirit of my invention. For example, although I have shown a fluid motor as the source of motive power for closing the illustrated circuit breaker, it will be apparent that any suitable source of motive power having a driving member capable of applying power in reverse direction may be used without departing from the present invention.

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

1. In combination, a switch member movable between open and closed positions, collapsible toggle mechanism coupled to said switch member and having a knee movable between positions on opposite sides of toggle center, a source of motive power having a movable driving member connected to move said knee toward toggle center on one side of said center thereby to move said

means effective in a pair of alternate latched positions to maintain said toggle mechanism operative to transmit closing thrust to said switch member, said toggle mechanism having a knee movable in one direction to effect closing movement of said switch member when said latch means is in one of its latched positions, said knee being movable in a generally opposite direction to effect closing movement of said switch member when said latch means is in its other latched position, means responsive to tripping of said latch means out of one of its latched positions for moving said toggle knee relative to toggle center and in the same general direction as the direction in which the knee was moved during the closing movement which immediately preceded tripping of said latch means whereby to effect opening movement of the switch member, a fluid motor having a piston reversibly movable to reversibly drive said knee in either of said directions toward switch closed position, and a linkage coupling said piston to said toggle mechanism during movement of said piston and during tripping of said trip-free latch means.

21. In combination, a switch member movable between

open and closed positions, a thrust toggle linkage coupled to said member, means for applying force in one direction for driving said toggle linkage to a first generally dead-central position for closing said switch member, holding means for supporting one end of said toggle linkage during said application of force and trippable to free said toggle linkage to permit said switch member to open, means for shifting said one end of said toggle linkage coincident with the tripping movement of said holding means whereby to establish a second dead-central position for said toggle linkage, and means for applying an alternate closing force in a direction generally opposite to said one direction for driving said toggle linkage to said second central toggle position, whereby to reclose said switch member.

References Cited in the file of this patent

UNITED STATES PATENTS

1,848,902	Paxton et al.	Mar. 8, 1932
2,307,567	Coggeshall et al.	Jan. 5, 1943