May 18, 1943

C. THUMIM

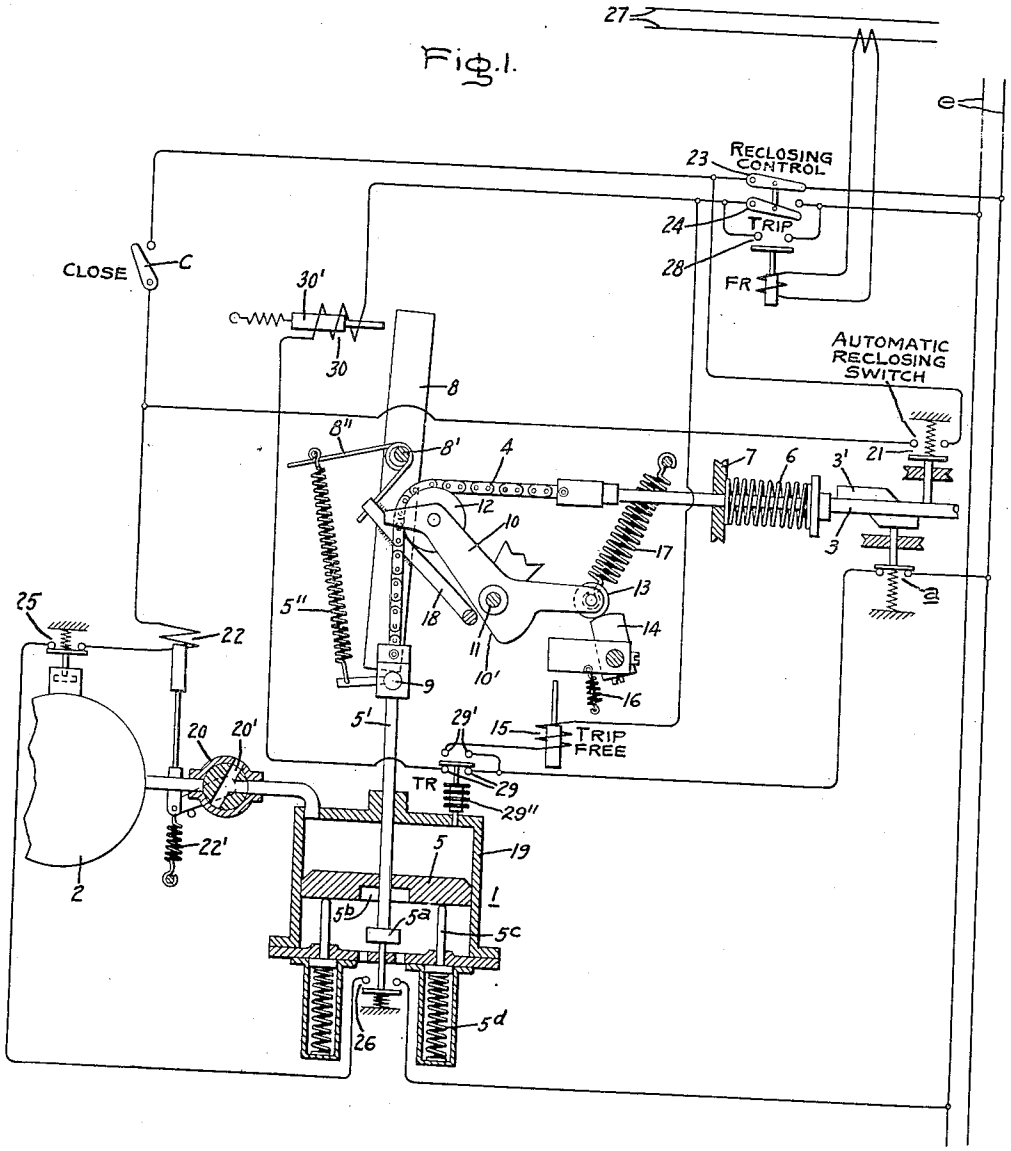
2,319,645

CIRCUIT BREAKER OPERATING SYSTEM

Filed Nov. 29, 1940

2 Sheets-Sheet 1

Fig. 1.



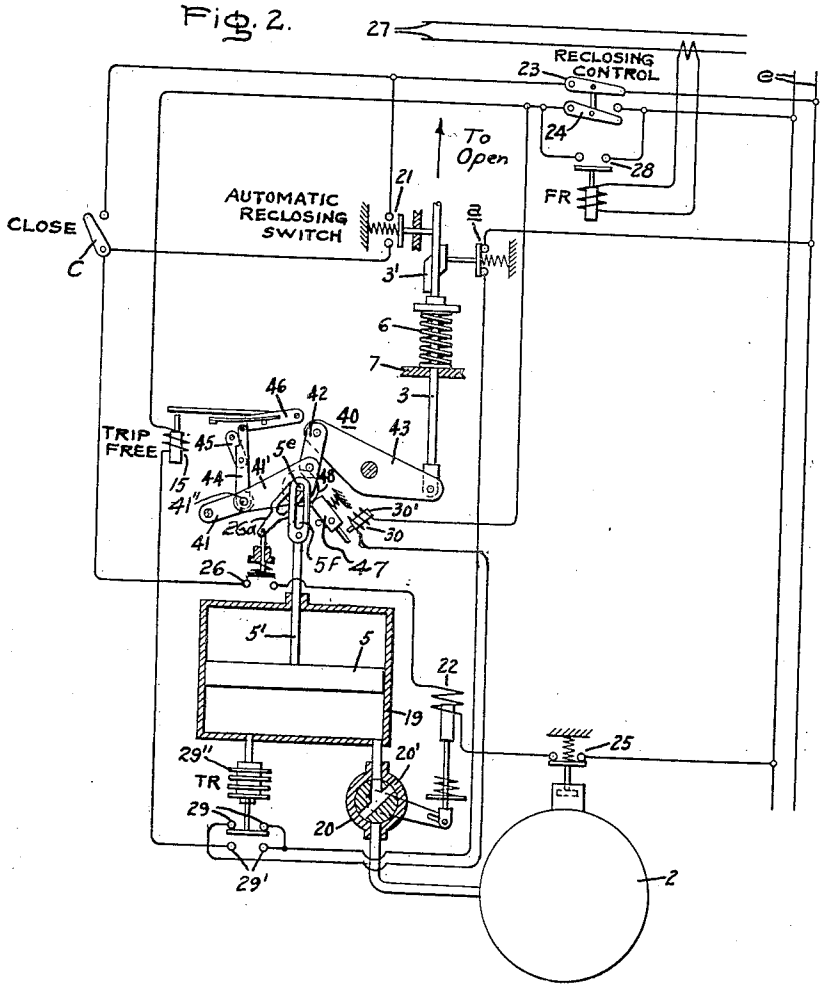
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Fig. 2.



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UNITED STATES PATENT OFFICE

2,319,645

CIRCUIT BREAKER OPERATING SYSTEM

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Application November 29, 1940, Serial No. 367,788

17 Claims. (Cl. 175—294)

My invention relates to circuit breaker operating systems, more particularly to pneumatic operating systems for effecting high speed automatic reclosure of a circuit breaker, and has for its principal object the provision of an improved circuit breaker operating and reclosing system of the aforesaid type that is rapid, positive and efficient, particularly with respect to the reclosing operation, that has low input power rating, and that is applicable to large circuit breakers requiring a considerable closing force.

A further object of my invention is the provision of an improved pneumatic automatic circuit breaker reclosing system that is effective to apply the reclosing force in a positive manner and without delay at a predetermined intermediate point in the breaker opening stroke, and that is automatically preset for high speed reclosing.

Means have been provided for quickly reclosing electric circuit breakers in electric distribution systems where continuity of service is a very important factor, one or more times after automatic opening in response to a fault. This is desirable in view of the fact that a very large percentage of faults, such as short circuits due to lightning, for example, can be cleared by a single breaker operation. In synchronized circuits, however, the circuit reclosures must be made at very high speed if the synchronous load is to be held on the line.

From the standpoint of service continuity, the ideal condition is that the breaker be reclosed instantly after the breaker has cleared the fault, preferably after a very short opening stroke. Accordingly, where standard opening and closing mechanisms are employed, reclosure does not actually start until the full opening stroke has been completed, i. e., an appreciable time after the fault current has been interrupted.

The function of a circuit breaker is not only to open a circuit and clear faults, but also to maintain the circuit clear in the open circuit position under adverse voltage conditions. That is, the length of stroke of the circuit breaker must be sufficient not only to interrupt the heaviest currents for which the breaker is rated, but also to prevent restriking of the arc in case the line voltage is several times that of normal. As contrasted with this isolating function of the breaker, it should be borne in mind that a well designed breaker can actually clear a fault within a few inches of opening stroke.

In accordance with the present invention, a fluid motor, such as a piston and cylinder arranged for example for pneumatic operation, is connected to a source of gas pressure, such as a storage tank for closing a circuit breaker and for rapidly reclosing it after a tripping operation with minimum expenditure of gas energy. To this end, means are provided for initially presetting the fluid motor with respect to the breaker operating mechanism so that no time is lost in initiating the reclosing operation.

My invention will be more fully set forth in the following description referring to the accompanying drawings, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

Referring to the drawings, Figure 1 is a partly diagrammatic layout of a high speed automatic circuit breaker operating and reclosing system in the closed circuit position embodying the present invention, and Figure 2 is a similar view showing the application of the invention to another form of operating mechanism.

The pneumatic operating mechanism illustrated by way of example in Fig. 1 comprises a fluid motor 1 of the piston and cylinder type, a source of compressed gas 2 for operating the motor and a circuit breaker operating member 3 that is operatively connected by a flexible linkage 4 to the piston 5 of the fluid motor. The circuit breaker (not shown) can in the present instance conveniently be of the gas blast type by reason of the source of compressed gas 2, although it will be apparent that any suitable type can be used.

In the position shown, the circuit breaker operating member or rod 3 is held by means hereinafter described in the closed circuit position, a compression spring 6 biasing the breaker and mechanism toward open circuit position. The operating means interconnecting the breaker rod 3 and the piston 5 may be of the chain linkage type as described and claimed in Thumim Patent 2,112,054, granted March 22, 1938, for Operating mechanism.

The breaker rod 3, which is suitably guided for longitudinal reciprocal movement at 7, is directly connected through the flexible chain linkage 4 to the piston rod 5'. A spring 5'' is also connected to the piston rod to bias it toward its upper or reset position. The piston rod 5' is held in the depressed or closed circuit position shown against the bias of springs 5'' and 6 by a prop 8 that is pivotally mounted at 8' and is biased in a counter-clockwise direction by

a spring 8'' so as to ride over and engage a pin 9 secured to the piston rod 5'.

The chain linkage 4 is particularly adapted for applications requiring movement of the circuit breaker operating rod at right angles to the direction of the operating force and is held in operative position by a crank 10 that is pivotally mounted at 11 and is provided with rollers 12 and 13 at the extremities of the crank arms. The roller 12 serves as a rolling guide for the chain linkage 4, and the roller 13 cooperates with a pivoted latch 14 that is in turn associated with a tripping solenoid 15. The latch 14 is spring biased at 16 in counter-clockwise direction so that it can reset beneath the roller 13 and the crank 10 is also biased counter-clockwise by a spring 17 for the purpose of stretching the chain 4 and returning the crank to a reset position with respect to the latch 14. As shown, the crank 10 is held against rotation by the latch 14 so that the linkage 4 is under tension for holding the breaker rod 3 in closed circuit position.

A more detailed description of the chain linkage mechanism is believed to be unnecessary other than to point out that upon clockwise movement of the latch 14 in response to actuation of the tripping solenoid 15, the breaker spring 6 causes rotation of the crank 10 clockwise, taking up slack in the chain 4 and thereby permitting opening movement of the breaker rod. Upon initial clockwise rotation of the crank 10, the prop 8 is also pushed away from the pin roller 9 by reason of a camming action at 10' between the crank 10 and an extension 18 of the prop 8. The piston rod 5' can now move to its upper position, taking with it the piston 5, for producing more slack in the chain 4 so as to allow complete opening of the breaker and to permit resetting of the crank 10 under influence of its spring 17. The breaker is now open and the mechanism reset and in readiness for a closing operation.

It will be noted that there is a lost-motion connection between the piston 5 and its operating rod 5'. This is for the purpose of presetting the piston independently of the piston rod and breaker mechanism after the closing operation so that high speed reclosure can take place unhampered by preliminary piston movement during the opening operation. As shown, the lost-motion connection comprises a collar or stop member 5*a* secured to the piston rod 5' arranged to abut the piston 5 within a recess 5*b* therein. The piston rod otherwise has a sliding connection with the piston. The piston presetting means comprises pins 5c slidably mounted in the lower end of the piston cylinder normally biased by springs 5*d* so as to hold the piston in an intermediate or partial stroke position as shown. This position corresponds approximately to the beginning of the reclosing stroke.

To initiate the normal closing operation of this type mechanism, gas under pressure is admitted to the piston cylinder 19 by a control valve 20 for moving the piston 5 downward, the piston now being in operative engagement with the piston rod collar 5*a* at the upper part of the cylinder. The crank 10, which is now reset and in the position shown, holds the chain linkage taut so that the breaker rod 3 is moved by the piston against the bias of opening spring 6 to the closed circuit position shown. When the piston reaches its lower limit of travel, the prop 8 snaps over the pin roller 9 and holds the breaker in closed circuit position independently of the fluid motor 1.

The normal tripping operation is as above described, that is, energization of the tripping solenoid 15 in response to a fault condition in the circuit, for example, causes release of the latch 14 and collapse of the chain linkage 4 so as to permit opening movement of the breaker.

It will be noted that the operating mechanism above described is trip-free during the closing operation of the breaker. That is, tripping of the latch 14 prior to complete closing of the breaker is effective to cause immediate opening movement of the breaker notwithstanding the fact that the piston 5 is in driving relation to the piston rod 5', and hence the mechanism.

The operating mechanism so far described performs the normal circuit closing and opening operations wherein the breaker operating member is moved throughout its full stroke for each operation. That is, when the breaker opens fully, the mechanism carries the piston 5 upward to the beginning of the stroke, and when the breaker is completely closed the piston moves to the end of the stroke against the bias of resetting springs 5*d*. However, immediately after closing of the breaker and shutting off of the closing force, the presetting means 5*c*—5*d* cause return of the piston, independently of the mechanism and circuit breaker, to the intermediate or preset position shown.

In the case of high speed reclosing, it is essential that the breaker reclosing movement be initiated after but a fraction of the normal opening stroke as previously pointed out. To this end, the fluid motor 1 is controlled by the valve 20 so that a fresh charge of compressed gas is admitted to the cylinder 19 after predetermined opening of the breaker so that the piston 5 is immediately driven back through a partial stroke to its fully closed position. Since the cylinder working space is small as compared with the case of prior types of piston mechanisms, a comparatively small charge of compressed gas under source pressure quickly raises the cylinder pressure to accomplish at high speed the desired reclosing stroke.

The control means for accomplishing high speed reclosing comprise an auxiliary switch 21 arranged to control energization of the valve operating solenoid 22, and means hereinafter described for controlling tripping of the chain linkage mechanism at the latch 14. The auxiliary or reclosing switch 21 is arranged to be engaged by a cam or the like 3' secured to the breaker rod 3 for closing the switch 21 when the breaker rod has moved a predetermined distance toward open circuit position. This distance corresponds to the length of stroke for clearing the fault. The switch 21 is connected so as to be in series with a manual reclosing control switch 23 that is mechanically connected to a tripping switch 24.

When the reclosing cycle is to be used, the switch 23 is put in the position shown and upon opening movement of the breaker the energizing circuit of the valve solenoid 22 is completed from the source of control voltage indicated at *e* through the reclosing control switch 23, automatic reclosing switch 21, source-pressure control switch 25, and a limit or cutoff switch 26 that is spring biased towards closed position. The switch 25 is for the purpose of rendering the system inoperative in case of failure of the gas source pressure at 2, and the switch 26 automatically deenergizes the valve solenoid when it is opened

by the piston 5 at it reaches the lower or closed circuit position. Upon deenergization of the solenoid 22, a biasing spring 22' returns the valve 20 to the closed position shown.

If now it be assumed that the breaker is in the closed circuit position shown with the piston preset at an intermediate position in the stroke and the reclosing control switch 23 closed, energization of the fault relay FR in response to a fault current or overload on the power circuit indicated at 27 causes closing of the fault relay contacts at 28 to energize through the contacts 29 of the pressure operated transfer relay TR, the tripping solenoid 30. The actuator of the relay TR can conveniently be a metallic bellows 29'' connected to the working space of the cylinder 19.

The tripping solenoid 30 is directly associated with the pivoted prop 8 so that upon actuation of the solenoid plunger 30', the prop is kicked in clockwise direction so as to release the piston rod 5' and permit instant opening movement of the breaker under influence of the breaker spring 6. As above pointed out, this initial part of the opening stroke is at high speed by reason of the lost-motion connection between the piston rod and piston.

When the prop latch 8 is tripped, the breaker is free to move toward open circuit position notwithstanding the fact that the crank 10 is still latched in at 14. Initial opening of the breaker causes closing of the limit switch 26 for establishing part of the reclosing circuit. After predetermined initial opening movement of the breaker rod 3, the reclosing switch 21 is closed in the manner previously described to cause energization of the valve solenoid 22 and opening of the valve 20 to the cylinder 19. Immediately upon opening of the valve, the piston 5, which has either been picked up or is about to be picked up by the piston rod is driven back to the closed position, resulting in immediate reclosure of the breaker. As previously pointed out, this action can be very fast since the cylinder space above the piston is limited by reason of the preset position of the piston.

For the purpose of providing trip-free protection during the reclosing operation, the tripping solenoid 15 for controlling the crank 10 is connected in the tripping control circuit in the following manner. When the valve solenoid 22 is energized for the reclosing operation, the working space in cylinder is placed under pressure. Accordingly, the contacts at 29' of pressure operated relay TR are closed so as to complete a circuit for energizing the trip-free coil 15. This control circuit includes a breaker auxiliary switch at *a*, contacts 29', coil 15 and contacts 28 of the fault relay FR.

The pressure operated transfer relay TR as a result switches the tripping circuit from contacts 29 to contacts 29' so that the tripping solenoid 15 is now in the tripping circuit instead of the tripping solenoid 30. The circuit is maintained at contacts 29' as long as predetermined pressure exists in cylinder 19 so that trip-free operation during reclosing is assured. When the breaker is finally closed, the cylinder pressure is vented at the valve opening 20' and the transfer relay TR again closes the contacts at 29 for normal tripping. Since as above pointed out, the tripping solenoid 15 is in the tripping circuit during the reclosing operation, persistence of the fault on the line will cause actuation of the trip-free solenoid at 15 as the fault relay FR closes its contacts at 28. The latch 14 then releases the crank 10 to permit opening of the breaker in the manner previously described.

The full opening of the mechanism then takes place in the manner above described. The piston spring 5'' raises the piston rod 5' as the gas in the cylinder space is vented through the valve controlled opening 20', and the spring 17 of the crank 10 takes up the slack in the chain 4 until the crank roller 13 is latched at 14. The prop 8 lies alongside the left side of the pin 9 as viewed so as to be in readiness again to latch the piston at the end of another closing stroke.

During the reclosing cycle above described, the manual switch C is closed as well as the reclosing control switch 23. With the breaker in the closed circuit position, manual control of tripping is effected merely by closing the tripping switch 24 which automatically causes opening of the switch 23. The circuit breaker is then tripped at the solenoid 30 in the manner previously described. The closing operation is initiated by opening the switch 24 thereby causing closing of switch 23, assuming that the switch C is also closed. The energizing coil 22 of the valve solenoid is then energized through the reclosing control switch 23, switch C and the auxiliary switches 25 and 26.

In Fig. 2 a mechanism of the collapsible linkage type for transmitting the breaker closing force in a vertical direction is disclosed for operating the breaker. In this case the piston 5 and its operating rod 5' are integrally united, but have a lost-motion connection with the comparatively massive linkage mechanism indicated at 40. Accordingly, the piston 5 after completing its opening stroke and opening the limit switch at 26 can preset so as to offer no resistance to the first part of the opening stroke.

Specifically, the lost-motion connection comprises a pin 5*e* connected to the mechanism linkage operable in a slot 5*f* of an extension of the piston rod 5'. In the closed circuit position of the linkage as illustrated, the piston has settled by gravity to the preset position so that the slot 5*f* "takes up" the first part of the breaker opening movement. The mechanism 40 can conveniently be of the type disclosed and claimed in my Patent No. 1,827,626, granted October 13, 1931, for Switch operating mechanism. A holding toggle 41—41' is connected through a link 42 to the breaker operating crank 43. This toggle is in turn connected to a tripping toggle 44—45 controlled by a latch 46. When the trip-free coil 15 is energized to actuate the latch 46, the toggle 44—45 buckles and releases the knee 41'' of the holding or thrust transmitting toggle 41—41'. Since the crank 43 is now free to rotate counterclockwise, the breaker spring 6 immediately acts to cause opening of the circuit breaker.

The breaker is also held closed by a latch 47 acting as a prop for the toggle link 41'. This latch is for normal tripping and slips underneath the toggle roller 48 at the end of the closing stroke. Therefore when the trip coil 30 is energized to actuate the latch 47, the link 41' is free to rotate clockwise, permitting opening of the breaker under the influence of the spring 6 notwithstanding the fact that the latch 46 is in latching position.

Assuming the apparatus to be in the normal closed position shown by Fig. 2, tripping of the latch 47 starts the opening movement of the breaker rod 3. As the pin 5*e* on the linkage drops

down in response to tripping, the slotted link 26*a* interconnecting the linkage and the limit switch 26 also drops down to close the switch 26. When this takes place, the automatic reclosing switch at 21 is closed, as in Fig. 1, for energizing the closing circuit of the valve solenoid 22. Similar auxiliary switches and control means having corresponding reference numbers are used and, since the functions are generally similar, further detailed description of the mechanism and system is unnecessary and the operation will be clear from the following brief description: When the trip coil 30 is energized by the fault relay FR, the mechanism is tripped open. After predetermined opening movement, the valve solenoid 22 is energized through the auxiliary switches 21, 26 and 25, and compressed gas is immediately admitted to the cylinder 19. Since the opening movement so far has simply taken up the lost-motion at 5*f*, the piston is now in instant readiness to reclose the breaker by rotating the link 41' counterclockwise. This reclosing operation is possible since 46 is still latched. Near the end of the piston closing stroke the auxiliary limit switch 26 is opened to deenergize the valve solenoid 22.

If now the fault persists even after reclosing, the trip-free coil 15, which is now in the tripping circuit by means of the pressure operated transfer relay TR, is energized to trip the latch 46 thereby causing immediate reopening of the breaker to the full open position. In this position the piston 5 is at the lower part of the cylinder, the pin 5*e* now being in abutting contact with the piston rod so that upon resetting of the latch 46, the mechanism is in readiness for a new closing operation. With the pin 5*e* in its lower position the limit switch 26 is again closed, thereby placing the control circuit in readiness for the next closing operation when the manual switch at C is closed.

It should be understood that my invention is not limited to specific details of construction and arrangement thereof herein illustrated, and that changes and modifications may occur to one skilled in the art without departing from the spirit of my invention.

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

1. An automatic reclosing circuit breaker system comprising a fluid motor operable through a working stroke to close the circuit breaker, a source of fluid pressure for operating said motor, means for presetting said motor after a working stroke independently of said circuit breaker at an intermediate point in said stroke, a control valve for admitting said fluid to said motor, tripping means for said circuit breaker, and means operative in response to predetermined opening movement of said circuit breaker upon actuation of said tripping means for opening said valve and causing reversal of movement of said motor from said intermediate point to reclose said circuit breaker through a partial working stroke prior to completion of the opening stroke thereof.

2. An automatic reclosing circuit breaker system comprising a fluid motor operable through a working stroke to move the circuit breaker to closed circuit position, spring means arranged to be stressed by said fluid motor for biasing said circuit breaker toward open circuit position, means for presetting said motor after said working stroke at a point corresponding to a partial working stroke, said presetting operation being effected independently of said circuit breaker, a source of fluid pressure for operating said motor, a control valve between said source and motor, tripping means for releasing stored energy in said spring means for causing opening movement of said circuit breaker, and means operable by and in accordance with predetermined opening movement of said circuit breaker for causing opening of said valve and actuation of said fluid motor through the remainder of said stroke to reclose said circuit breaker prior to completion of the opening stroke thereof.

3. An automatic reclosing circuit breaker system comprising an operating piston, means including a lost-motion connection interconnecting the circuit breaker and said piston, tripping means for said circuit breaker, a spring for biasing said circuit breaker toward open circuit position, a source of fluid pressure for operating said piston so as to cause closing movement of said circuit breaker against the bias of said spring, means for presetting said piston independently of said circuit breaker at an intermediate point in its closing stroke through said lost-motion connection, a control valve between said source and piston, and means operable by and in accordance with predetermined opening movement of said circuit breaker for causing opening of said valve and completion of the working stroke of said piston from said intermediate point to reclose said circuit breaker prior to completion of the opening stroke thereof.

4. An automatic reclosing circuit breaker system comprising an operating piston, means including a trip-free connection and a lost-motion connection operatively relating said piston to said circuit breaker, said piston arranged to preset to an intermediate position through said lost-motion connection independently of said circuit breaker after the closing stroke, a spring arranged to bias said circuit breaker toward open circuit position independently of said preset piston, a source of fluid pressure for driving said piston through a working stroke to cause closing movement of said circuit breaker through said trip-free connection, a control valve between said source and piston, a latch for releasing said spring for initiating opening movement of said circuit breaker, reclosing means operable in response to predetermined opening movement of said circuit breaker for opening said valve whereby said piston is instantly started from its preset position and the circuit breaker is reclosed prior to completion of the opening stroke thereof, and means for releasing said trip-free connection for causing opening of said circuit breaker in the event that said reclosing operation is concurrent with a circuit fault.

5. An automatic reclosing circuit breaker system comprising a source of gas pressure, a fluid motor having a cylinder and piston, a control valve between said source and cylinder, means including a lost-motion connection operatively connecting said piston and the circuit breaker arranged so that said piston is effective to close said circuit breaker through a positive working stroke and said circuit breaker is free to open initially a predetermined distance independently of said piston, spring means arranged to bias said circuit breaker toward open circuit position, said spring means being stressed in accordance with the circuit closing movement of said piston, tripping means for causing opening movement of

said circuit breaker, and means for opening said valve upon opening of said breaker said predetermined distance and taking up of said lost-motion connection for admitting gas under source pressure to the cylinder space at the working side of said piston for reclosing said circuit breaker prior to completion of the opening stroke thereof.

6. An automatic reclosing circuit breaker system comprising a source of gas pressure, a fluid motor having a cylinder and piston, means including a lost-motion connection operatively connecting said piston to the circuit breaker, a valve for controlling admission of gas from said source to said cylinder to effect a working stroke of said piston for closing said circuit breaker, said piston being independently movable through said lost-motion connection to preset at an intermediate point in its stroke after said breaker closing, fault responsive means for causing opening of said circuit breaker to take up the lost-motion with said piston, and means operable in response to predetermined circuit opening movement of said breaker to cause opening of said valve for admitting gas under source pressure directly to the cylinder working space whereby said piston is moved from its preset position through the remainder of its working stroke and said circuit breaker is reclosed prior to completion of its opening stroke.

7. An automatic reclosing circuit breaker system comprising a source of gas pressure, a fluid motor, means operatively connecting said motor to the circuit breaker including trip-free means, a valve for controlling admission of gas from said source to said motor to cause closing of said circuit breaker, means for holding said circuit breaker in closed circuit position against an opening bias, fault responsive means coacting with said holding means for causing opening of said circuit breaker, means operable upon predetermined circuit opening movement of said breaker to cause opening of said valve for admitting gas from said source to the working space of said motor whereby said circuit breaker is immediately reversed and reclosed prior to completion of its opening stroke, and pressure responsive means communicating with said motor working space for placing said circuit breaker under control of said trip-free means during the aforesaid closing and reclosing operations.

8. An automatic reclosing circuit breaker system comprising a source of gas pressure, a fluid motor, means operatively relating said motor to the circuit breaker including trip-free means, a valve for controlling admission of gas from said source to said motor to cause closing of said circuit breaker, means for holding said circuit breaker in closed circuit position independently of said motor against an opening bias, fault responsive means coacting with said holding means for causing initial opening of said circuit breaker, means operable upon partial circuit opening movement of said breaker for admitting gas from said source to said motor whereby said circuit breaker is immediately reversed after said partial movement and reclosed, and pressure responsive means operable when said motor is supplied with gas pressure for placing said circuit breaker under control of said trip-free means during the aforesaid reclosing operation.

9. An automatic reclosing circuit breaker system comprising a source of gas pressure, a fluid motor having a piston arranged for reciprocal movement, means operatively connecting the piston rod of said piston to the circuit breaker, a lost-motion connection between said piston and said piston rod corresponding to a partial opening stroke, a valve for controlling admission of gas from said source to said piston to cause closing of said circuit breaker, means for holding said circuit breaker independently of said piston in closed circuit position against an opening bias, means for presetting said piston at a point corresponding to said partial opening stroke, fault responsive means coacting with said holding means for causing initial opening of said circuit breaker independently of said piston to take up said lost-motion, and means operable upon said partial circuit breaker opening movement to cause opening of said valve for admitting gas from said source to said piston whereby said circuit breaker is immediately reversed after said partial movement and reclosed.

10. An automatic reclosing circuit breaker system comprising a source of gas pressure, a fluid motor having a piston arranged for reciprocal movement, means including a mechanical lost-motion connection operatively connecting said piston to the circuit breaker, a valve for controlling admission of gas from said source to said piston to cause closing of said circuit breaker, means for holding said circuit breaker in closed circuit position independently of said piston against an opening bias, said piston thereby being permitted to preset through said lost-motion connection to a partially open position, fault responsive means coacting with said holding means for causing opening of said circuit breaker, said breaker after partial opening movement being in driving relation to said piston, and means operable upon said partial circuit breaker opening movement to cause opening of said valve for admitting gas from said source to said piston whereby said circuit breaker is immediately reversed and reclosed prior to completion of its opening stroke.

11. An automatic reclosing circuit breaker system comprising a source of gas pressure, a fluid motor operable by said pressure, means operatively relating said motor to the circuit breaker for closing said circuit breaker, means for tripping said circuit breaker in response to a fault condition when said circuit breaker is normally closed, trip-free means for also tripping said circuit breaker when it is closed during a fault condition, and pressure-responsive means operable when pressure is applied to said fluid motor for transferring the tripping control from said first-named tripping means to said trip-free means.

12. An automatic reclosing circuit breaker system comprising a fluid motor operable through a working stroke to close the circuit breaker, a source of fluid pressure for operating said motor, means for presetting said motor after a working stroke independently of said circuit breaker at an intermediate point in said stroke, control means for admitting said fluid to said motor, tripping means for said circuit breaker, means operative in responsive to predetermined opening movement of said circuit breaker for admitting fluid to said motor and causing reversal of movement of said motor from said intermediate point to reclose said circuit breaker, and pressure responsive means connected to said motor for controlling said tripping means.

13. An automatic reclosing circuit breaker sys-

tem comprising a source of gas pressure, a fluid motor operable by said pressure, means operatively relating said motor to the circuit breaker for closing said circuit breaker, means for tripping said circuit breaker in response to a fault condition, trip-free means for also tripping said circuit breaker when it is closed during a fault condition, and pressure-responsive means associated with said fluid motor for controlling the tripping of said first-named tripping means and said trip-free means.

14. An automatic reclosing circuit breaker system comprising an operating piston, means including a trip-free connection and a lost-motion connection operatively relating said piston to said circuit breaker, said piston being biased to preset to an intermediate position through said lost-motion connection independently of said circuit breaker after the closing stroke, a source of fluid pressure for driving through said trip-free connection said piston through a working stroke to cause closing movement of said circuit breaker, a control valve between said source and piston, means for initiating opening movement of said circuit breaker independently of said trip-free connection, reclosing means operable in response to predetermined opening movement of said circuit breaker for opening said valve to start said piston from its preset position so that the circuit breaker is reclosed prior to completion of the opening stroke thereof, means for releasing said trip-free connection for causing opening of said circuit breaker in the event that said reclosing operation is concurrent with a circuit fault, and means responsive to fluid pressure at said piston for controlling the aforesaid trip-free connection.

15. An automatic reclosing circuit breaker system comprising a source of gas pressure, a fluid motor having a cylinder and piston, an operating trip-free linkage interposed with respect to said piston and the circuit breaker, a lost-motion connection between said piston and operating linkage, a valve for controlling admission of gas from said source to said cylinder so as to produce a working stroke of said piston for closing said circuit breaker, said piston being biased for independent movement through said lost-motion connection to preset at an intermediate point in said stroke after closing of said breaker, fault responsive means for releasing said linkage and causing opening of said circuit breaker for taking up the lost-motion with said piston, and means operable in response to predetermined circuit opening movement of said breaker to cause opening of said valve for admitting gas under pressure directly to the cylinder working space so that said piston is moved through a fraction of its working stroke and said circuit breaker is reclosed prior to completion of its opening stroke.

16. An automatic reclosing circuit breaker system comprising a source of gas pressure, a fluid motor, means operatively connecting said motor to the circuit breaker including trip-free means, a valve for controlling admission of gas from said source to said motor to cause closing of said circuit breaker, fault responsive means for causing opening of said circuit breaker, means operable upon predetermined circuit opening movement of said breaker to cause opening of said valve for admitting gas to the working space of said motor whereby said circuit breaker is immediately reversed and reclosed prior to completion of its opening stroke, and pressure responsive means communicating with said motor working space for placing said circuit breaker under control of said trip-free means during the aforesaid closing and reclosing operations.

17. An automatic reclosing circuit breaker system comprising a source of gas pressure, a fluid motor having a piston arranged for reciprocal movement, an operating linkage between the piston rod and the circuit breaker, means including a mechanical lost-motion connection interconnecting the piston rod and said linkage, a valve for controlling admission of gas from said source to said piston to cause closing of said circuit breaker, said piston when the breaker is closed being biased to preset through said lost-motion connection to a partially open position, fault responsive means for causing opening of said circuit breaker, said breaker after partial opening movement being in driving relation to said piston, and means operable in response to said partial circuit breaker opening movement to cause opening of said valve for admitting gas from said source to said piston so that said circuit breaker is immediately reversed and reclosed prior to completion of its opening stroke.

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