

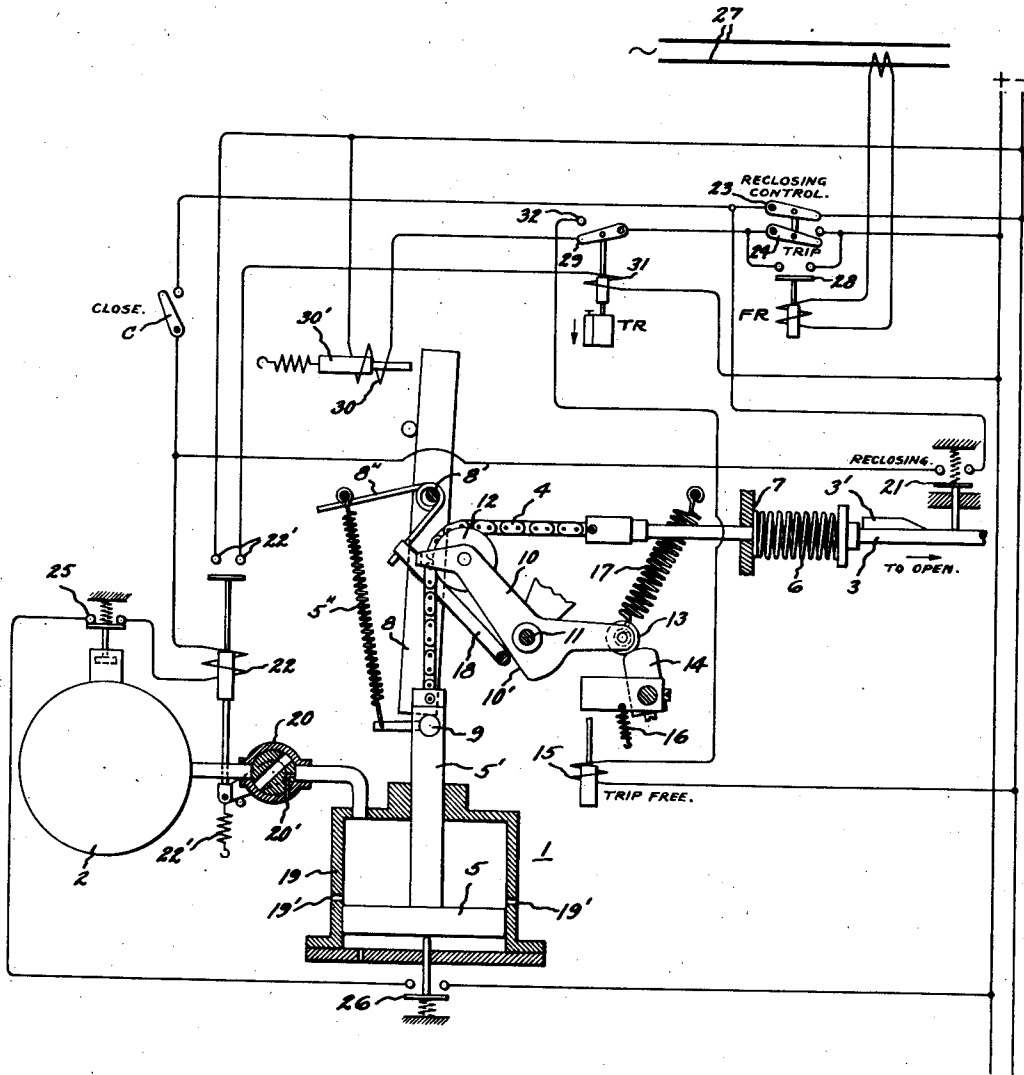
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CIRCUIT BREAKER OPERATING SYSTEM

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CIRCUIT BREAKER OPERATING SYSTEM

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My invention relates to circuit breaker operating systems, more particularly to pneumatic 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 in 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.

In electric distribution systems where continuity of service is a very important factor, means have been provided for quickly reclosing an electric circuit breaker one or more times after automatic opening in response to a fault on the assumption that a very large percentage of faults, such as surges due to lightning, for example, are of a temporary nature. In synchronized circuits, however, such 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.

My invention will be more fully set forth in the following description referring to the accompanying drawing, 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 drawing, the single figure thereof is a partly diagrammatic layout of a high speed automatic circuit breaker operating and reclosing system embodying the present invention.

The pneumatic operating mechanism illustrated by way of example 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 any suitable type, the specific chain linkage arrangement herein shown being of the character 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 to bias it toward its upper or reset position. The piston 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 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 link-

age 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 5 can now move to its upper position for producing more slack in the chain 4 allowing complete opening of the breaker and permitting 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.

To initiate the closing operation of this type mechanism, gas under pressure is admitted to the cylinder 19 by a control valve 20 for moving the piston 5 downward. 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 continued closing movement of the piston 5.

The operating mechanism so far described is adapted for the normal circuit closing and opening operations wherein the breaker operating member is moved throughout its full stroke for each operation. In the case of high speed reclosing however, 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 to its fully closed position. The cylinder 19 furthermore is so vented that the space at the working side of the piston still contains gas under reduced pressure so that the fresh charge of gas can act with maximum speed on the piston 5. That is, since the cylinder space is not com-

pletely exhausted, as in the case prior to a normal closing operation, 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 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 through the reclosing control switch 23, reclosing switch 21, source pressure control switch 25, and limit or cutoff switch 26. 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 the piston 5 completes its working stroke and reaches the 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 and the reclosing control switch 23 is 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 transfer relay TR, the tripping solenoid 30. This tripping solenoid 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 5 and permit opening movement of the breaker under influence of the breaker spring 6.

The breaker is now free to move toward open circuit position notwithstanding the fact that the crank 10 is still latched in at 14. Initial high speed opening of the breaker is facilitated by the cylinder vents 19', this initial opening movement causing closing of the limit switch 26 and subsequent increase in the pressure of the gas on the working side of the piston as the piston closes the vents 19' notwithstanding the bleed vent at 20' provided in the valve 20. 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. Immediately upon opening of the valve, the piston 5 is driven back through a partial working stroke to the position shown, 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 already filled with gas when the reclosing operation is initiated.

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 associated contacts at 22' are closed so as to complete a circuit for energizing the coil 31 of the transfer relay TR. The transfer relay as a result switches the tripping circuit from contact 29 to contact 32 so that the tripping solenoid 15 is now in the tripping circuit instead of the tripping solenoid 30. The circuit is maintained at contact 32 by a suitable dashpot device for a time sufficient to permit exhaust of gas from the cylinder 19 after the reclosing operation. A transfer relay system of this character is disclosed and claimed in a copending application Serial No. 192,782, filed February 26, 1938 by C. Thumim for "High speed reclosing mechanism" and assigned to the same assignee as the present invention. 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 resetting of the mechanism then takes place in the manner above described, the piston spring 5' raising the piston 5 as the gas in the cylinder space is vented through the valve controlled opening 20', and the spring 17 of the crank 10 taking 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 to latch the piston at the lower limit of its 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.

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, a source of fluid under pressure, a control valve for admitting said fluid to said motor for operating the circuit breaker to closed circuit position, tripping means for causing opening of said circuit breaker, and means operative in response to predetermined circuit opening movement of said circuit breaker for opening said valve and causing reclosing of said circuit breaker by means of a partial working stroke of said breaker prior to completion of the full opening stroke of said breaker.

2. An automatic reclosing circuit breaker system comprising a fluid motor for operating 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, a source of fluid under 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 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 interconnecting the circuit breaker and said piston including trip-free means, a spring for biasing said circuit breaker toward open circuit position, a source of fluid under pressure for operating said piston so as to cause closing movement of said circuit breaker against the bias of said spring, a control valve between said source and piston, a second tripping means independent of said first-named tripping means for releasing said spring and causing opening movement of both said piston and 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 reversal of said piston 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 operatively relating said piston to said circuit breaker, a spring arranged to bias said circuit breaker toward open circuit position, a source of fluid under pressure for driving said piston in a direction 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 piston and 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 the movement of said piston is instantly reversed 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 an operating cylinder and piston, a trip-free connection between said piston and the circuit breaker, a spring for biasing said circuit breaker toward open circuit position, a source of gas under pressure for operating said piston so as to cause closing movement of said circuit breaker against the bias of said spring, a control valve between said source and cylinder for selectively admitting gas to and venting said cylinder, a second tripping means for releasing said spring and causing opening movement of both said piston and said circuit breaker, the aforesaid valve venting means being restricted so that gas in said cylinder is retained during said piston opening movement, and means operable in accordance with predetermined opening movement of said circuit breaker for causing opening of said valve and reversal of said piston under source gas pressure to reclose said

circuit breaker prior to completion of the opening stroke thereof.

6. An automatic reclosing circuit breaker system comprising a source of gas under pressure, a fluid motor having a cylinder and piston, a control valve between said source and cylinder, means operatively connecting said piston and the circuit breaker, spring means arranged to bias said circuit breaker and also said piston 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 said piston, said cylinder being vented to exhaust approximately at the end of the piston closing stroke whereby reverse initial opening movement of said piston can also take place at high speed, said control valve in the closed position thereof also arranged to vent said cylinder through a restricted opening, and means for opening said valve at a predetermined intermediate point in the opening stroke of said breaker for admitting gas under source pressure to the aforesaid vented cylinder space for reclosing said circuit breaker prior to completion of the opening stroke thereof.

7. An automatic reclosing circuit breaker system comprising a source of gas under pressure, a fluid motor having a cylinder and piston, means operatively connecting said piston to the circuit breaker, valve means for controlling admission of gas from said source to said cylinder to cause closing of said circuit breaker, fault responsive means for causing opening of said circuit breaker and reverse movement of said piston, said piston after initial high speed opening movement thereof causing closing of cylinder venting means, the cylinder working space thereupon being vented through said valve means, and means operable in response to predetermined circuit opening movement of said breaker to cause closing of the valve vent and opening of said valve for admitting gas under source pressure directly to said cylinder working space whereby the opening movement of said piston is instantly reversed and said circuit breaker is reclosed prior to completion of its opening stroke.

8. An automatic reclosing circuit breaker system comprising a source of gas under pressure, a fluid motor having a cylinder and piston, means operatively connecting said piston to the circuit breaker, a solenoid-operated valve for controlling admission of gas from said source to said cylinder to cause closing of said circuit breaker, latching means for holding said circuit breaker and piston in closed circuit position against an opening spring bias, fault responsive means coacting with said latching means for causing opening of said circuit breaker and reverse movement of said piston, the cylinder working space being vented for initial high speed opening movement of said piston, and electroresponsive means operable upon predetermined circuit opening movement of said breaker to cause opening of said valve for admitting gas under source pressure directly to said cylinder working space whereby the opening movement of said piston is instantly reversed and said circuit breaker is reclosed prior to completion of its opening stroke.

9. An automatic reclosing circuit breaker system comprising a source of gas under pressure, a fluid motor having a cylinder and piston, means operatively connecting said piston to the circuit breaker, valve means for controlling admission of gas from said source to said cylinder to cause closing of said circuit breaker, fault responsive means for causing opening of said circuit breaker and reverse movement of said piston, means for facilitating high speed opening movement of said piston including a venting passage for the cylinder working space controlled by said valve means, and means operable in response to predetermined circuit opening movement of said breaker to cause closing of the valve controlled vent and opening of said valve for admitting gas under source pressure directly to said cylinder working space whereby the opening movement of said piston is instantly reversed and said circuit breaker is reclosed prior to completion of its opening stroke.

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