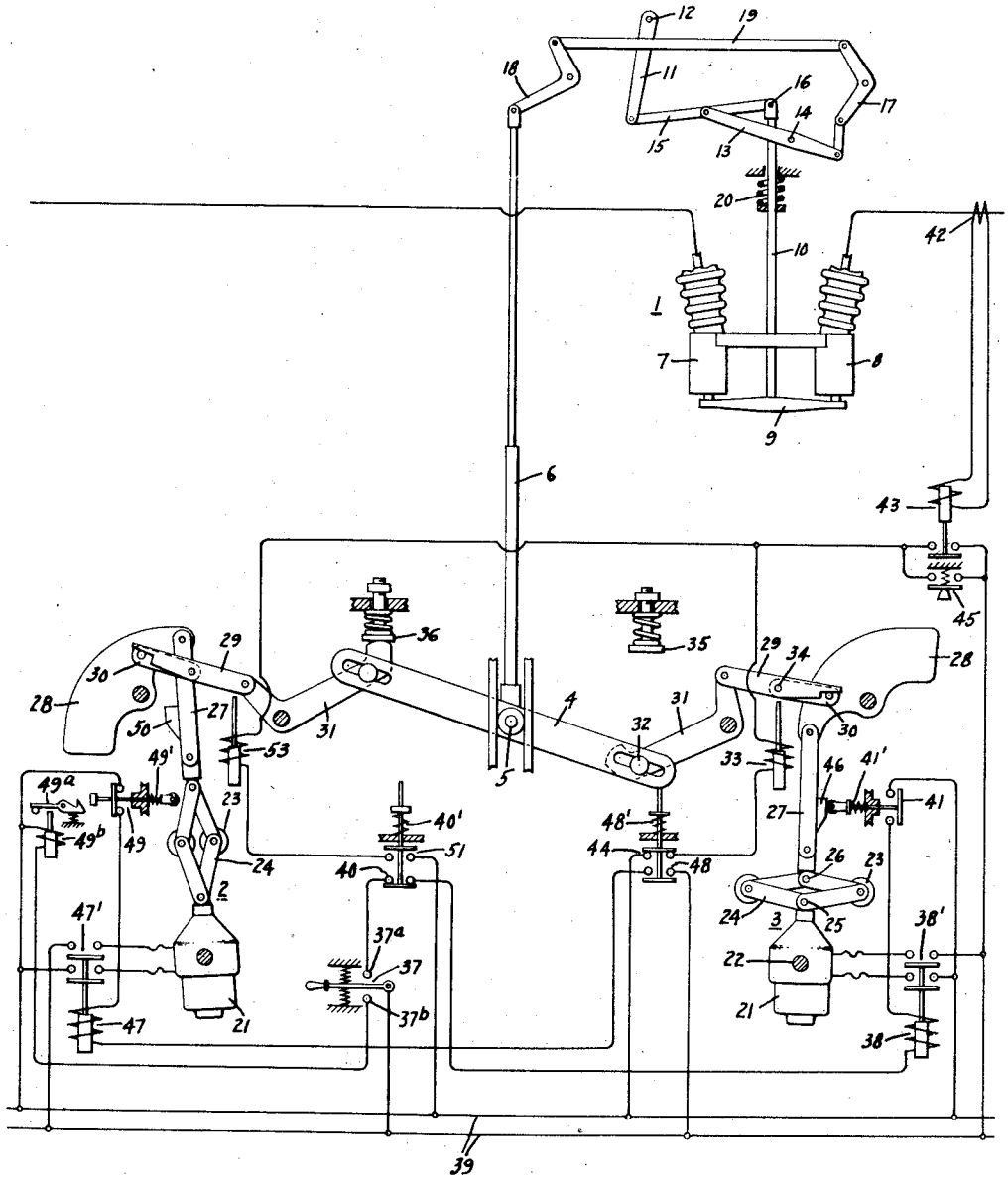
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HIGH SPEED RECLOSING MECHANISM

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HIGH SPEED RECLOSING MECHANISM

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My invention relates to high speed reclosing mechanisms for apparatus operable between two positions, such as, for example, an electric circuit breaker operable between closed and open circuit positions.

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 on the assumption that most faults are of a temporary nature, such as surges due to lightning for example. However, the means heretofore employed for effecting quick reclosure have either been quite expensive, such as for example an arrangement using a pair of circuit breakers one of which is to be closed when the other is tripped open, or have failed to take advantage of the comparatively brief existence of the fault.

From the standpoint of service continuity, the ideal condition is that the breaker be reclosed instantly after clearing of the fault by the breaker. A well designed breaker can clear a fault within a few inches of breaker travel. In connection with this operation, however, it should be borne in mind that the function of a circuit breaker is not only to open a circuit and clear faults, but also to maintain the circuit clear under adverse voltage conditions. That is, the length of stroke of the circuit breaker must be sufficient to prevent restriking of the arc even when the line voltage is several times that of normal. Accordingly, where standard opening and closing mechanisms are employed reclosure does not actually start until the full opening stroke has been completed.

It will, therefore, be apparent that when the design factors, such as required length of stroke, mass and inertia of the moving parts, etc., of a conventional oil circuit breaker of high interrupting capacity are taken into account, the problem of rapidly reclosing the circuit breaker involves many difficulties.

A principal object of my invention is the provision of an improved high speed reclosing mechanism for apparatus such as a circuit breaker which is effective to initiate the reclosing operation during and prior to completion of the opening operation.

In accordance with my invention, the comparatively short travel necessary for arc interruption terminates the opening operation and the reclosing operation is initiated at that point.

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 illustration of a high speed reclosing mechanism for an electric circuit breaker embodying the present invention.

The high speed reclosing mechanism is shown as applied to a conventional oil circuit breaker generally indicated at 1, although it should be understood that the mechanism may be as readily applied to apparatus operable between two positions wherein quick return or reclosing to one of said positions is desired. The actuating means comprises in the present instance a pair of centrifugal devices of the well known flyball type, generally indicated at 2 and 3, the devices being operatively interconnected by a floating lever 4 which is in turn connected at a vertically guided point 5 intermediate said devices to the operating rod 6 of the circuit breaker.

The circuit breaker as shown is in the closed circuit position, the fixed contact and arc extinguishing structures 7 and 8 being bridged by the movable contact structure 9. The lift rod 10 for operating the bridging contact 9 is connected through suitable linkage structure to the operating rod 6. The linkage structure is of the straight-line type, a link 11 having a fixed pivot at 12 and a lever 13 having a fixed pivot at 14 being interconnected by a link 15 so as to impart to the lift rod at 16 substantially straight-line motion. The lever 13 is interconnected through a pair of bellcranks 17, 18 and a link 19 to the operating rod 6. Accordingly, when the rod 6 is free to move upwards, the bridging contact 9, under the influence of spring 20, moves downwards to the open circuit position. Conversely, downward movement of the operating rod 6 causes closing of the bridging member against the bias of spring 20.

Each of the centrifugal devices 2, 3 comprises an electric motor 21 pivotally supported at 22 and arranged to rotate a pair of flyballs 23, the flyball linkage 24 being connected at 25 to the motor shaft and at 26 to a connecting link member 27. The link 27 is in turn connected to a pivoted weighted member 28 which tends to reset the flyball linkage, as indicated by the position of the centrifugal device 2. A collapsible thrust-transmitting linkage including an overset toggle 29—30 and a bellcrank 31 having a pin and slot connection at 32 with one end of the floating lever 4 is connected to the member 28.

The operation of the centrifugal device is believed to be apparent from the above description, energization of the motor 21 of device 3, for example, to spin the flyballs causing extension of the flyball linkage so as to cause counter-clockwise rotation of the resetting weight 28, and counter-clockwise rotation of the bellcrank 31 through the thrust-transmitting toggle 29—30. In device 2, extension of the flyballs causes clockwise rotation of weight 28 and crank 31.

A tripping solenoid 33 is associated with the toggle 29—30 so as to cause movement of the toggle knee 34 beyond the line of centers for buckling the toggle. Accordingly, the mechanism is trip-free in operation since buckling of the toggle at any point during the operation of the centrifugal device permits reverse movement of the bellcrank 31.

Assuming now that the circuit breaker is in the open circuit position and that both centrifugal devices are deenergized and reset similar to device 2, the floating lever 4 would then be in a horizontal position adjacent the fixed spring buffers 35 and 36. The buffers 35 and 36 are adapted to be engaged, respectively, by the bellcranks 31 for both cushioning the shock of an opening operation and for providing a pivot for the lever 4. In this initial position, auxiliary switch 48 would be closed under bias of its spring 48' and switch 49 would be held open by latch 49a.

If the circuit breaker is simply to be used for normal opening and closing operation, that is, reclosing under the direction of an operative after an opening operation, the manually controlled switch at 37 is closed on contact 37a, thereby energizing the motor contactor coil 38 from the control source 39.

This control circuit also includes auxiliary switches 40 and 41. Since the centrifugal device 3 in the open circuit position of the breaker is in the same position as device 2, the auxiliary switch 41 will be closed under the bias of spring 41'. Also, the auxiliary switch 40 which is normally biased closed by its spring 40' will be closed.

When the motor contactor contacts close at 38', the motor 21 will be energized from the control source and the floating lever 4 will be rotated clockwise through the flyball linkage and thrust-transmitting structure of device 3 above described. During operation of the linkage a cam 46 carried thereby causes opening of the auxiliary cutoff switch 41 thereby opening the motor contactor 38 and deenergizing the motor.

The circuit breaker is now closed and the mechanism remains in the position shown until the breaker is tripped. The tripping may be accomplished in a conventional manner by a current transformer at 42 associated with the main power circuit controlled by the breaker 1, and a relay 43 for completing the circuit of the trip coil 33. An auxiliary switch 44, normally closed by the lever 4 when the breaker is closed, prevents operation of the trip coil 33 when the breaker is open. For manual tripping a push button switch 45 is connected across the relay 43.

Assuming now that a fault occurs on the line, the relay 43 will be actuated to energize the trip coil 33 from source 39 to cause collapse of the toggle 29—30. This results in counter-clockwise rotation of lever 4 to the original horizontal position due to the bias of breaker spring 20 and opening of the breaker. The operative may then, if he desires, reclose the breaker by closing switch 37 on contact 37a, thereby restarting the above described cycle.

Where automatic reclosing is desired, an auxiliary or cutoff switch in the motor control circuit of the reclosing device 2 is closed, this switch being opened and latched in open position in accordance with the reclosing operation for the purpose of preventing "pumping" or reclosing indefinitely.

To this end, after the breaker has been closed by centrifugal device 3, the operative's switch 37 is thrown from contact 37a to contact 37b. This energizes the latch coil 49b for releasing latch 49a and permitting closing of cutoff switch 49 by its biasing spring 49'. If now the breaker is tripped open, the auxiliary switch 48, which is held open in the closed position of the breaker by the lever 4, is closed by its biasing spring 48'. The motor contactor coil 47 for the device 2 is thereby energized from the control source 39.

Energization of the motor circuit through the contactor contacts 47' causes extension of the flyball linkage of device 2 and counter-clockwise rotation of the lever 4 with respect to the buffer 35 for closing the circuit breaker. The devices 2 and 3 will now be in positions opposite to those shown in the drawing. In moving to the closed position, device 2 through the cam member 50, which is moved downwards by the flyball movement, causes opening of the auxiliary or cutoff switch 49 to deenergize the contactor coil and open the motor circuit. The cutoff switch 49 is then held open by latch 49a. Also, lever 4 in moving counter-clockwise causes closing of the auxiliary contacts at 51.

In this position actuation of the tripping relay 43 causes energization of the tripping solenoid 53, thereby causing buckling of the toggle 29—30, clockwise rotation of the lever 4 and opening of the breaker by the breaker spring 20.

Accordingly, when the operative's switch 37 is held closed on contact 37a until the breaker is closed and then is closed on contact 37b to release and close the auxiliary switch 49, an automatic reclosing cycle is prepared so that in response to a line disturbance the breaker is tripped open, reclosed, and if the fault persists is again tripped open (being trip-free). The mechanism remains in this position until the operative performs another control operation, namely manual closing of switch 37 on contact 37a and then on contact 37b, to prepare for another automatic reclosing cycle.

In addition to providing an electric interlock between the motors of the devices 2 and 3, the auxiliary or reclosing switches 40 and 48 serve to cause initiation of the operation of the centrifugal device for reclosing the breaker during and prior to completion of the circuit opening movement. That is, assuming that the operative's switch 37 is closed on contact 37b for automatic operation and the circuit breaker has been previously closed as above described, the tripping operation will cause rotation of lever 4 towards the buffer 35. Since the lever 4 in the position shown holds the switch 48 open, immediately upon tripping the switch 48 will close causing energization of the motor contactor coil 47 and actuation of the device 2. This operation is so rapid that the device 2 starts lowering its end of the lever 4 before the opposite end of the lever reaches the buffer 35. In other words, there is an intermediate point in the operation where the circuit breaker operating rod 6 is retarded in its opening movement. By reason of the floating

relation of the lever 4 to the operating mechanisms and breaker rod 6, the right end (as viewed) of the lever is moving down at the same time the left end is moving up resulting in a rapid but gradual and smooth retardation of and change in direction of motion of the breaker rod 6. There is therefore no shock or impact as would be the case were the reclosing force directly to oppose the moving mass to effect reclosure.

This retardation or dashpot effect, which is applied before completion of the breaker opening stroke, is particularly advantageous since the inertia of the moving parts is rapidly overcome and the device 2 is thereby more effective rapidly to reverse the operation of the rod 6 and reclose the breaker. It will, therefore, be seen that the reclosing operation is actually in progress before completion of the opening operation.

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. A high speed circuit breaker reclosing system comprising a circuit breaker having relatively movable contact structure, means for actuating said contact structure toward closed circuit position, means actuated independently of the operation of said actuating means for tripping and causing opening movement of said contact structure, and means operated subsequent to said tripping means and prior to completion of the opening stroke of said contact structure to initiate the operation of said actuating means to reclose said contact structure within a fraction of the time required for a full stroke opening and reclosing cycle.

2. A high speed reclosing mechanism for an electric circuit breaker comprising two separate operating means, means controlling one of said operating means for closing said circuit breaker, means for causing a circuit opening operation of said circuit breaker, and means responsive to said opening operation for controlling the other of said operating means so as to cause initiation of a reclosing operation of said circuit breaker prior to completion of said circuit opening operation.

3. A high speed reclosing mechanism for an electric circuit breaker comprising a pair of separately actuated operating means, means interconnecting said operating means and said circuit breaker, tripping means selectively associated with each of said operating means for causing opening of said circuit breaker, and means responsive to a tripping operation at one of said operating means for initiating the operation of the other operating means to reclose said circuit breaker prior to completion of the circuit opening movement.

4. A high speed circuit breaker reclosing system comprising a circuit breaker having relatively movable contact structure, means for biasing said contact structure through a full stroke to open circuit position, means for actuating said contact structure toward closed circuit position, and means actuated by and in accordance with movement of said contact structure through a fractional part of said opening stroke for instantly initiating the operation of said actuating means prematurely to check the opening stroke of said circuit breaker and to reclose said circuit breaker within a reclosing time cycle that is materially less than a full stroke opening and reclosing cycle.

5. A high speed reclosing mechanism for an electric circuit breaker comprising a pair of separate operating means, a floating lever operatively interconnecting said operating means, said lever being connected at an intermediate point to said circuit breaker, latching and tripping means selectively associated with each of said operating means for holding and causing release respectively of the corresponding end of said lever and circuit opening movement of said breaker, and control means responsive to a tripping operation at one end of said lever for initiating the operation of the operating means at the other end of said lever prior to completion of the circuit opening movement for reclosing said circuit breaker.

6. An automatic reclosing mechanism for apparatus operative between open and closed positions comprising actuating means for closing said apparatus, a relay for controlling said actuating means, tripping means for causing opening of said apparatus, and control means actuated in accordance with said opening operation for positively causing initiation of the operation of said relay for controlling said actuating means prior to completion of said opening operation whereby said actuating means effects retardation of the final opening movement during said initial operation.

7. A high speed reclosing mechanism for an electric circuit breaker comprising two separately operated motive means, structure common to said motive means for operatively connecting the same to said circuit breaker, said structure arranged so that said circuit breaker can be closed by selective operation of said motive means, tripping means selectively associated with each of said motive means for causing opening of said circuit breaker, and control means responsive to operation of one of said tripping means for causing initiation of the operation of the motive means associated with the other of said tripping means to reclose said circuit breaker, said last-named motive means being related to said structure so as to cause retarding of the circuit breaker final opening movement during said initial operation.

8. A high speed reclosing mechanism for an electric circuit breaker comprising a pair of separately actuated centrifugal operating devices, a floating lever interconnecting said devices, said circuit breaker being operatively connected to said lever at a point intermediate said devices, each of said devices being operatively connected to said lever through collapsible thrust-transmitting structure, tripping means associated with said structure, means for actuating one of said centrifugal devices for rotating said lever to cause closing of said circuit breaker, actuation of the tripping means associated with said last-named device causing opening of said circuit breaker, and a control switch arranged to close in accordance with said opening movement for energizing the other of said centrifugal devices thereby initiating counter-rotation of said floating lever and reclosing of said circuit breaker.

9. A high speed circuit breaker reclosing system comprising a circuit breaker having relatively movable contact structure, an actuating device for moving said contact structure to closed circuit position, a second actuating device includ-

ing tripping means for causing movement of said contact structure toward open circuit position, a third actuating device for effecting reclosing movement of said contact structure, and means actuated by and in accordance with movement of said contact structure toward open circuit position for initiating the operation of said third actuating device to reclose said circuit breaker prior to completion of the full circuit opening stroke of said contact structure.

10. A high speed reclosing mechanism for a circuit interrupter comprising an operating member movable to open and to closed position, means for actuating said operating member toward closed position, means actuated independently of the operation of said actuating means for tripping and causing opening movement of said operating member, and means operated subsequent to said tripping means and prior to completion of the opening stroke of said operating member to initiate the operation of said actuating means to reclose said operating member within a fraction of the time required for a full stroke opening and reclosing cycle.

11. A high speed circuit breaker reclosing system comprising a circuit breaker having relatively movable contact structure, tripping means for causing opening of said contact structure, means for causing high speed reclosure of said contact structure in response to the opening operation thereof, trip-free means associated with said reclosing means, a circuit controlling means responsive to the opening of said contact structure for rendering inoperative said tripping means, and a second circuit controlling means also responsive to the operation of said contact structure for transferring the tripping control to said trip-free means during reclosure of said circuit breaker.

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