June 12, 1945. N. H. WESTERVELT 2,378,270

SWITCH OPERATING MECHANISM

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Fig. 1.

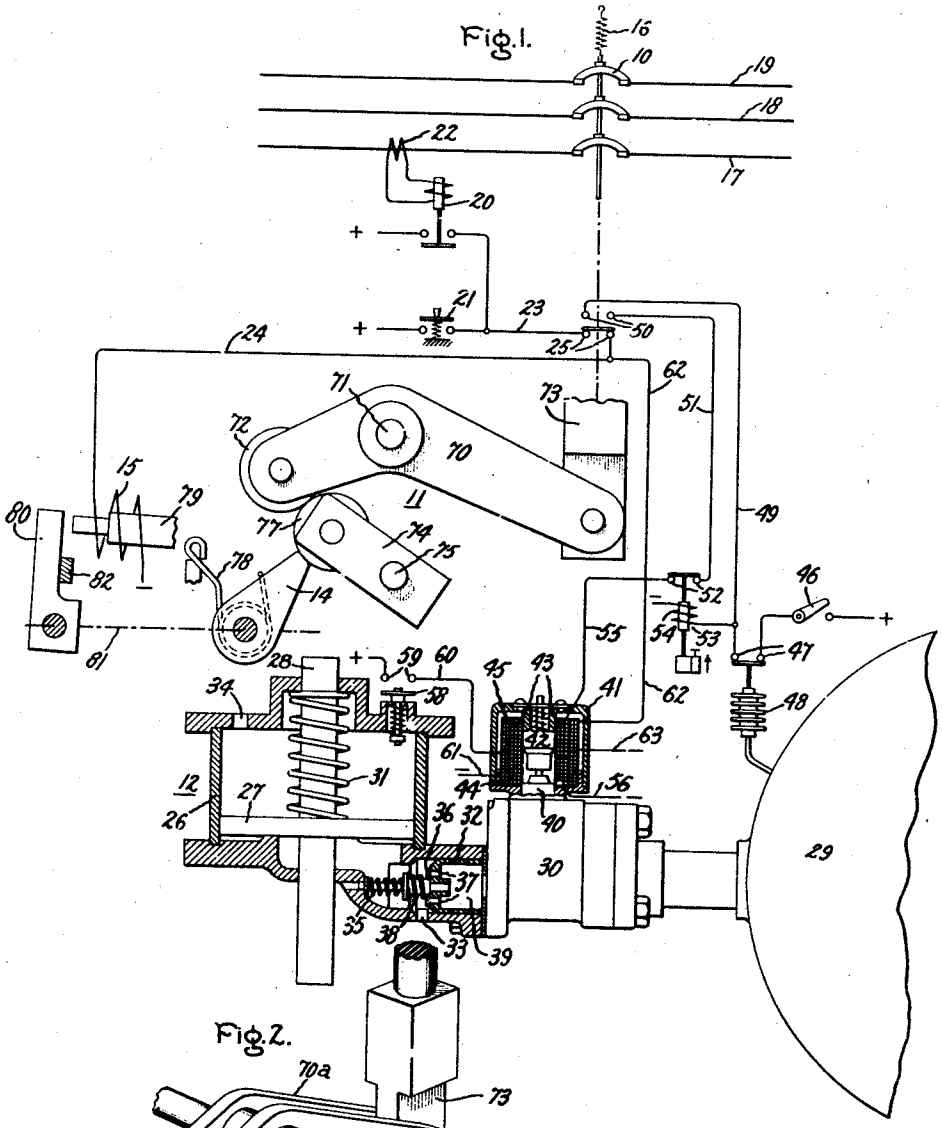
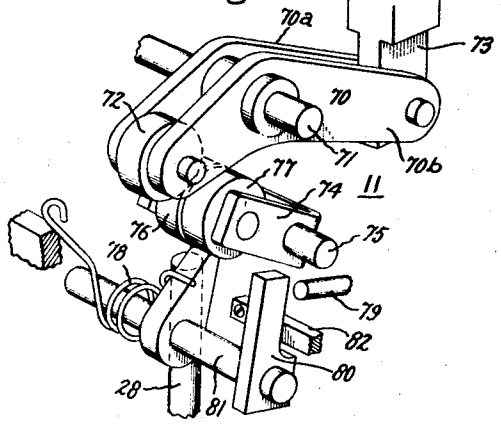


Fig. 2.



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SWITCH OPERATING MECHANISM

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3 Claims. (Cl. 74—516)

My invention relates to operating mechanisms for electric switches, and more particularly to operating mechanisms for power circuit breakers.

Electric switches, such as power circuit breakers, usually comprise a contact structure with actuating means to actuate the circuit breaker to the open or closed positions, or both. For high speed circuit breakers it has often been the practice to bias the contact structure to the open position by suitable spring means. In such an arrangement the actuating means for operating the circuit breaker, which might be a fluid motor, a solenoid, or the like, would, through a suitable operating mechanism, move the contact structure to the closed position against the biasing means, such as springs, thereby charging the springs during the circuit closing operation. It is obvious that suitable latching means must be provided to latch the circuit breaker or switch in the closed position. Opening of the circuit breaker can then be initiated by releasing the latching means. It would be desirable to provide an operating mechanism of the above mentioned type which would act as a force multiplying means near the end of the closing operation so as to take care of a greatly increased force as the energy storage means approaches the fully charged condition. It would further be desirable to provide an arrangement in which the latching means could be released by a very small force and yet wherein the operating mechanism was simple and compact in construction.

It is an object of my invention to provide a new and improved switch operating mechanism.

It is another object of my invention to provide an operating mechanism for an electric switch which is simple and compact in construction and which embodies the desirable features enumerated above.

Further objects and advantages of my invention will become apparent as the following description proceeds 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.

For a better understanding of my invention reference may be had to the accompanying drawing in which Fig. 1 diagrammatically illustrates an electric switch embodying the operating mechanism of my invention; and Fig. 2 is a perspective view of the operating mechanism shown in Fig. 1.

Although my invention is generally applicable to electric switches of the type in which the contact structure is biased to the open position and latched in the closed position against said biasing means, I have chosen to illustrate my invention as applied to a circuit breaker having a contact structure 10 which is operated to the closed position through a suitable operating mechanism 11 by means of an actuating means comprising a fluid motor generally indicated at 12. The operating mechanism 11, which will be described in greater detail hereinafter, includes a latching member or prop 14, which may be moved to its unlatching position by energization of its trip coil 15.

The circuit breaker comprising the contact structure 10 is schematically illustrated as a three-pole switch which is biased to the open circuit position by suitable means indicated as a spring 16. The contact structure 10 of the circuit breaker is arranged to control an electric circuit comprising conductors 17, 18 and 19.

The trip coil 15 of the operating mechanism 11 embodying my invention is arranged to be energized to release the prop or latching means 14 in response to the operation of a protective relay 20, or a tripping control switch 21. The protective relay 20 is illustrated simply as an over-current relay connected to be energized from a current transformer 22 in the circuit conductor 17. It will be understood, of course, that any number of relays may be employed in accordance with the art of circuit protection. Also as shown, the circuit of trip coil or winding 15, which includes the conductors 23 and 24, may also include the contacts 25 of a circuit breaker *a* auxiliary switch which is closed when the circuit breaker is closed and open when the circuit breaker is open.

For actuating the operating mechanism 11 to close the contact structure 10 of the circuit breaker, there is provided the fluid pressure actuated means or fluid motor 12 comprising a cylinder 26 within which is reciprocally and slidably mounted a piston 27, carrying a piston rod 28. This piston rod 28 is adapted to engage with the operating means 11 as will be described hereinafter to move the circuit breaker to the closed position so that latching means 14 may become effective to hold the circuit breaker in closed position against the force of spring 16. While any suitable fluid may be provided to raise the piston 27 it is usual to use air under the desired pressure which may be contained in a suitable source or tank 29, from which it is supplied to cylinder 26 through control valve means 30. On the upstroke of the piston 27 suitable energy storing means, such as spring 31, is compressed to effect the down or return stroke of the piston 27 to the lower position shown. This down stroke operation follows

the cutting off of the air supply by the control valve 30 so that the air in the cylinder 26 can be quickly exhausted to atmosphere through the medium of a dump valve 32 which uncovers exhaust ports 33. In order to avoid pressure above the piston 27 on the up stroke and also to have it return freely under the bias of spring 31, the cylinder 26 is provided with one or more suitably located ports 34. When the control valve 30 is open, air under pressure is admitted from source or tank 29 through the valve 30 to the back of the dump valve 32. This valve 32 moves to the left against the bias of a spring 35 and closes the exhaust ports 33. Coincidentally with the closing of the dump valve 32 the air under pressure opens an admission valve 36 mounted in the head of the dump valve 32 to uncover ports 37 therein for admission of air to the cylinder 26. The admission valve 36 is biased to the closed position by a spring 38 which becomes so compressed that when air is subsequently exhausted from the space 39 on the source side of dump valve 32 the valve 36 quickly closes the ports 37 whereby the dump valve 32 more effectively moves to uncover the ports 33. This construction of the dump valve is not my invention but is disclosed and claimed in a copening application, Serial No. 512,180, filed concurrently herewith upon an application of Thellwell R. Coggeshall, and assigned to the same assignee as the present application.

The control valve 30 may comprise any suitable form of electromagnetically actuated control valve but is preferably of the pilot differential type such as is disclosed in the copending Coggeshall application referred to above, or as is disclosed and claimed in Coggeshall application, Serial No. 512,179, filed concurrently herewith and assigned to the same assignee as the present application. In accordance with the last-mentioned Coggeshall application, electromagnetically actuated valve 30 includes an armature 40, a magnetic housing 41, a pole piece 42 and a valve opening winding 43. The electromagnetic actuated means also includes two independent valve closing windings 44 and 45.

For closing the circuit breaker comprising contact structure 10, there is provided a closing control system for the valve opening winding 43. As shown, this circuit includes a closing control switch 46, the contacts 47 of a minimum pressure switch 48 which opens when the pressure in the tank 29 falls below a predetermined minimum value, a conductor 49, *b* auxiliary switch contacts 50 of the circuit breaker comprising contact structure 10, a conductor 51, the contacts 52 of a short time delay circuit opening relay 53 whose winding 54 is energized upon closure of the closing control switch 46, a conductor 55, the valve opening winding 43, and a conductor 56. The opening of the circuit breaker closing control circuit by the slightly delayed contacts 52 of the relay 53 insures a positive opening of the control valve 30 in response to energization of its opening winding 43 and also prevents reclosure of the circuit breaker as long as the control switch 46 is kept closed. In other words, with a single closure of the control switch 46, only one closure of the circuit breaker comprising contact structure 10 can be effected.

The valve closing winding 44 is provided for quickly returning the piston 27 to the down or normal position. The operating mechanism 11, although inherently trip-free as will become apparent hereinafter, cannot move to the open circuit position as long as air pressure below the piston 27 keeps the piston rod 28 in other than its lowermost position. Valve closing winding 44 is so wound and connected to be energized that its polarity is opposite to the polarity of the valve opening winding 43 and is such as to neutralize the holding flux thereby to release the plunger or armature 40 for the valve closing movement. In order to insure the energization of the valve closing winding 44 at the proper moment, the circuit of this winding is controlled by a limit switch 58 which is actuated to the closed position in response to the movement of the piston 27 so as to close its contacts 59 in the circuit of the winding 44 when the circuit breaker is fully closed. As shown, the circuit of the valve closing winding 44 includes the contacts 59 of the cutoff or limit switch 58, the conductor 60, the valve closing winding 44 and the conductor 61.

The valve closing winding 45 is provided in order to insure a fast or early opening of the contact structure 10 when it is closed during an abnormal circuit condition. Means are provided for simultaneously tripping the circuit breaker and effecting the closing of the valve means 30. Valve closing winding 45 is independent of valve closing winding 44 and it is wound and connected to be energized so as to release the armature 40 to close the valve 30. A parallel trip circuit comprising the trip coil 15 of the operating mechanism 11 is also provided. The circuit for the valve opening winding 45 includes the contacts of protective relay 20 and the trip switch 21 in parallel, the conductor 23, the circuit breaker *a* auxiliary switch contacts 25, a conductor 62, the valve closing or neutralizing winding 45 and a conductor 63.

The control arrangement described thus far is not my invention but is disclosed and claimed in the above mentioned Coggeshall application, Serial No. 512,179.

In accordance with my invention the operating mechanism 11, also shown in perspective in Fig. 2, comprises an output bell crank 70 pivotally mounted about a fixed pivot 71. Crank 70 actually comprises two levers 70*a* and 70*b* spaced apart from one another but united to form a single member. At one end of crank 70 there is mounted a roller 72 which is inserted between the levers 70*a* and 70*b*. A circuit breaker operating rod 73 is suitably fastened between the members 70*a* and 70*b* at the other end of crank 70. Circuit breaker operating rod 73 is directly connected to the contact structure 10 of the circuit breaker for closing the same.

Instead of transmitting the force from piston rod 28 directly to the roller 72 fastened to crank 70, I provide an independently pivoted lever 74 having one end thereof pivoted about a fixed pivot 75. The other end of lever 74 is provided with a pair of rollers 76 and 77. As best shown in Fig. 2 the lever 74 is actually a U-shaped member with the rollers 76 and 77 rotatably mounted within the open end of the U. The roller 76 transmits force from piston rod 28 to roller 72. The lever 74 is so arranged with reference to piston 28 and crank 70 as to effectively form a toggle arranged to act as a force-multiplying means. The effective toggle so formed comprises the link 74 as one link thereof while the rollers 72 and 77, which maintain the distance between the pivots about which these rollers rotate constant, form the other link of the effective toggle. Actually the pivots of rollers 72 and 77 might be interconnected by a link and the rollers 72 and 77 dispensed with, in which case an actual toggle

would be provided. By providing the rollers 72 and 77 the effectiveness of the arrangement which acts as an effective toggle is not impaired and friction is greatly reduced. With this arrangement it is obvious that as the contact structure 10 of the circuit breaker approaches the closed position as indicated in Fig. 1, when the greatest closing force is required, the lever 74 and the roller 72 of crank 70 and the roller 77 as mentioned above effectively provide a force-multiplying toggle arrangement which for a given force from plunger or piston rod 28 produces a much larger force on circuit breaker operating rod 73 at the end of the closing stroke when it is most needed. During this closing operation the roller 76 directly engages the roller 72 associated with crank 70.

When, during a closing stroke of a circuit breaker, the operating mechanism 11 approaches the position indicated in Fig. 1 the latching means or prop 14 biased to rotate in a clockwise direction by virtue of spring means 78 engages the roller 77 to hold the contact structure 10 of the circuit breaker in a closed position after the piston 27 returns to its normal position shown in Fig. 1. It will be observed that with the arrangement shown in Fig. 1 a comparatively small force is exerted on latching means or prop 14 and the bulk of the energy stored in spring 16 in the form of back force exerted through circuit breaker operating rod 73 is counteracted by lever 74. Furthermore, by providing a separate roller 77 for the latching means 14 friction is greatly reduced and a much smaller tripping force for latch 14 is required. It will be obvious from Figs. 1 and 2 that the operating mechanism 11 is free to collapse upon a predetermined counterclockwise movement of the latching means or prop 14 and thereby to allow the opening of the circuit breaker providing there is no support or force against the roller 76 to hold it in the illustrated position when the prop 14 is moved out of holding engagement with roller 77.

For actuating the latching means or prop 14 in the tripping direction as illustrated, a suitable tripping solenoid including the trip coil 15 and a plunger 79, is provided. Whenever trip coil 15 is energized by virtue of operation of protective relay 20 or actuation of manual trip switch 21, plunger 79 engages with a lever 80 mounted on the shaft 81 also supporting latching means 14. A suitable stop 82 limits the clockwise rotation of lever 80 and prop 14.

In view of the detailed description given above, the operation of the operating mechanism embodying my invention will be more or less obvious to those skilled in the art. Whenever protective relay 20 is energized or the control switch 21 is actuated, trip coil 15 is energized to move latching means or prop 14 to the releasing position. By virtue of the separate roller 77 and the arrangement of lever 74 a very small force is required to release latching means 14. The circuit breaker comprising contact structure 10 is then opened by the bias of spring 16 and is of course free to open without opposition from the piston 27 which returned to its lower position at the end of the preceding closing operation. At the same time the trip coil 15 is energized, the valve closing winding 45 of valve 30 is also energized but since valve 30 is already closed nothing happens as a consequence of this energization.

Upon the opening of the circuit breaker the auxiliary switch contacts 25 are opened and the auxiliary switch contacts 50 are closed. When it is desired to close the circuit breaker the closing control switch 46 is moved to the closed position and if the pressure in tank 29 is sufficient, then the valve opening winding 43 is completed and will be maintained until a short time delay circuit opening relay 53 opens its contacts 52. The energization of winding 43 opens valve 30 and the released pressure gas causes the piston 27 to move upwardly to move the operating mechanism 11 to the position indicated in Fig. 1 whereupon the latch 14 is caused under the bias of spring 78 to move under roller 77 and maintain the circuit breaker in the closed position. As soon as the piston 27 reaches the end of its up stroke with the breaker fully closed, the limit switch 58 closes its contacts 59 thereby energizing the valve closing or neutralizing winding 44 to cause immediate closing of valve 30 which permits the quick return of piston 27 by virtue of the operation of dump valve 32. In the event that the circuit breaker is closed upon a fault, the operation of the protective relay 20 is immediately effective to cause the opening of the circuit breaker through energization of the valve closing winding 45.

It will be observed that I have provided an operating mechanism which is simple and compact and yet which provides a greatly increased force at the end of the closing stroke when increased force is desired. Furthermore, with my improved arrangement a minimum tripping force is required for releasing the operating mechanism.

While I have described what I at present consider the preferred embodiment of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from my invention and I therefore aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

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

1. In a switch operating mechanism, a reciprocally movable actuating means, means to be actuated comprising a lever pivoted about a fixed pivot and having a roller at one end thereof, an independent force transmitting member mounted on a fixed pivot and having a roller mounted on the free end thereof adapted to transmit force between said actuating means and said roller on said means to be actauted, said independent member and said lever roller effectively forming a toggle arranged to act as a force-multiplying means and provide a greatly increased force near the end of the closing operation of said switch mechanism.

2. In a switch operating mechanism, a reciprocally movable actuating means, means to be actuated comprising a lever pivoted about a fixed pivot and having a roller at one end thereof, an independent force transmitting member mounted on a fixed pivot and adapted to transmit force between said actuating means and said roller on said means to be actuated, said independent member and said lever roller effectively forming a toggle arranged to act as a force-multiplying means and provide a greatly increased force near the end of the closing operation of said switch mechanism.

3. In a switch operating mechanism, a reciprocally movable actuating means, means to be actuated comprising a lever pivoted about a fixed pivot and having a roller at one end thereof, an independent force transmitting member mounted

on a fixed pivot and having a pair of rollers mounted on the free end thereof, one of said rollers being adapted to transmit force between said actuating means and said roller on said means to be actuated, said independent member and said lever roller effectively forming a toggle arranged to act as a force-multiplying means and provide a greatly increased force near the end of the closing operation of said switch mechanism, and a latch engaging the other of said pair of rollers for holding said mechanism in a predetermined position.

NELSON H. WESTERVELT.