May 11, 1943. B. W. JONES 2,319,000

ELECTRIC SWITCH

Filed Sept. 10, 1941

Fig. 1.

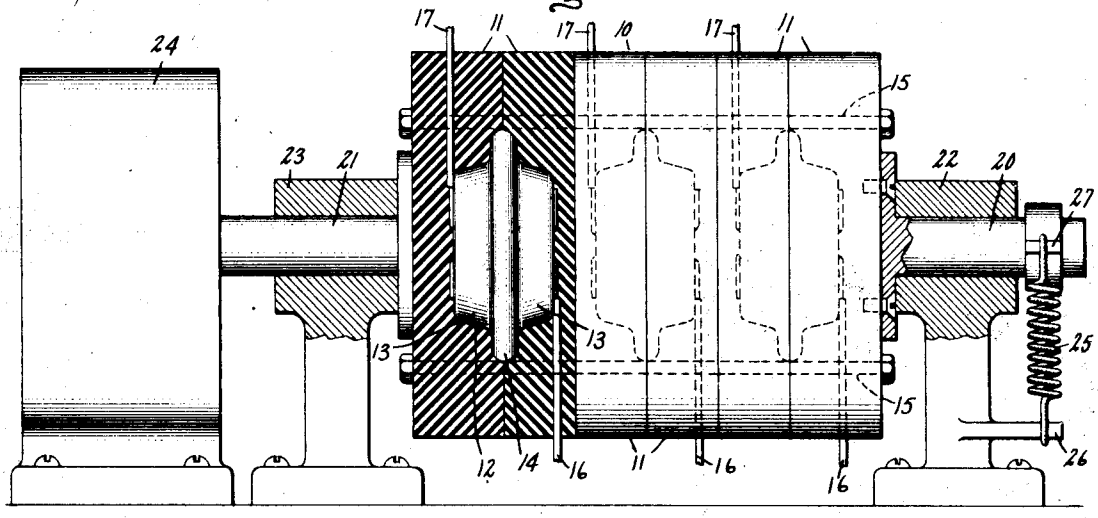


Fig. 2.

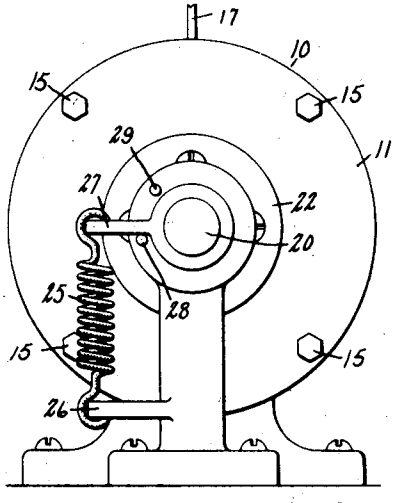


Fig. 4.

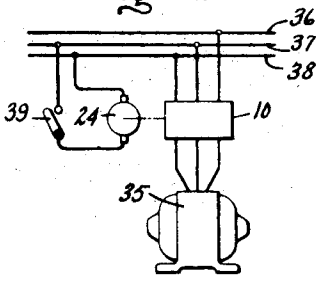
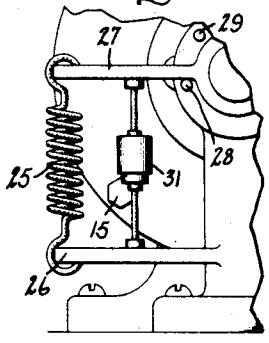


Fig. 3.



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Patented May 11, 1943 2,319,000

UNITED STATES PATENT OFFICE

2,319,000

ELECTRIC SWITCH

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Application September 10, 1941, Serial No. 410,237

4 Claims. (Cl. 200—92)

My invention relates to electric switches, and particularly to line switches for controlling relatively large amounts of power while also providing undervoltage protection for a connected load. For example, my invention finds particular application to the starting and protection of relatively large motors in industrial application, such as steel mills and the like.

For many years it has been customary, and indeed it is still the present practice, to use clapper type operating electromagnets and relatively movable butt contact switches for motor starters and other relatively large line contactors. While such devices are capable of making and breaking the line current in the desired manner, the larger sizes of such devices become objectionable because of the considerable noise incident to their operation. Clapper type contactors of a suitable size for controlling currents of the order of 100 to 1000 amperes at voltages up to 600 volts or more are noisy because of the impact of large metal parts, and are also dangerous due to the presence of large exposed arcs. For a long time there has existed among those skilled in the art an incipient demand for a line starter or power circuit breaker capable of operation without appreciable noise and without exposed arcing.

It is therefore an object of my invention to provide an automatic circuit breaker of the line contactor type which shall be quiet in its operation and capable of controlling relatively large amounts of power.

It is a further object of my invention to provide an automatic circuit.breaker which shall be particularly suitable as a line contactor for the control of relatively large motors and which shall provide undervoltage protection for such motors.

It is a still further object of my invention to provide a power circuit breaker which shall operate essentially without noise or exposed arcing.

According to my invention the above objects are obtained and the long-felt demand of the art is satisfied by providing an enclosed fluid contact type of circuit interrupter with special slow speed rotatable operating means in the form of an inherently slow speed alternating current torque motor. A slow speed operator is necessary in order to provide satisfactory action of a liquid contact type of interrupting unit, while the ability to stall the motor with the electric supply circuit connected thereto and thereby maintain the breaker in switch closing position permits an extremely simple construction in which complicated gear and latch mechanisms are rendered unnecessary. My invention is also particularly characterized in that the slow speed of operation is inherent in the form of motor used. While it is possible to reduce the speed of any motor by means of gears, a large gear reduction would preclude undervoltage protection in a switch of the type described. For example, the gear ratio necessary for the operation of a liquid type contactor by means of a 1725 R. P. M. motor would be in the neighborhood of 20 to 1. In a gear reduction of this magnitude so much gear friction is introduced that the switch operating shaft could be reversely rotated only by reverse energization of the motor; that is, it would be impossible to return the switch to any predetermined position by a biasing force applied to the low speed shaft.

In order to obtain a more complete understanding of my invention and its mode of application and a further appreciation of its many objects and advantages, reference should now be had to the following detailed specification taken in conjunction with the accompany drawing, in which Fig. 1 is a side elevation, partly in section, of a circuit breaker embodying my invention; Fig. 2 is an end view of the breaker shown in Fig. 1; Fig. 3 is a fragmentary end view of a switch showing my invention in a modified form; and Fig. 4 is a schematic circuit diagram of connections showing a circuit breaker according to my invention applied as a line starter for a three-phase alternating current motor, the circuit breaker being illustrated diagrammatically.

Referring now to the drawing in greater detail, and particularly to Figs. 1 and 2, I have shown a line circuit breaker comprising a base or support 10 comprising a plurality of similarly recessed disk-like sections 11. The disks 11 are preferably formed of a suitable moulded insulating compound, many examples of which are well known to those skilled in the art, and are provided with circular recesses which, when placed in opposing relationship, form a unitary cylindrical support for a plurality of fluid contact interrupting devices 12. In the form shown, each fluid contact interrupting device 12 comprises a pair of oppositely positioned metallic conducting cups 13, mechanically connected together but electrically insulated from each other by an annular glass bead 14 to form a chamber which is partially filled with mercury. An annular, disk-shaped, apertured insulating baffle between the cups provides means for making and breaking an electric circuit formed therebetween by the enclosed mercury.

A fluid contact device of the above type is commonly known as a mercury button and is fully described and claimed in Patents 2,101,092 and 2,101,093, issued to John H. Payne on December 7, 1937. While I have shown rotatable mercury buttons of the type described in the above Payne patents by way of illustration, I wish to have it understood that my invention is not limited thereto, but may be used in connection with other suitable types of fluid contact interrupters, such as, for example, that shown in Patent 1,897,454, issued to Warren R. Walker on February 14, 1933.

The disk-like sections 11 are clamped together to form a unitary cylindrical switch base 10 by means of a plurality of longitudinally extending bolts 15. Each mercury button is provided with a pair of terminal conductors 16, 17 for connection of the button in series circuit relation with a line conductor. The terminal conductors 16, 17 pass into the insulating base 10 and are electrically connected to the metallic cups 13.

In order to rotatably support the base 10 for tilting movement between switch opening and switch closing positions, the opposite ends of the cylindrical base are provided with axially aligned shaft portions 20 and 21 which are supported upon bearings 22 and 23, respectively. The shafts 20 and 21 constitute both a rotatable supporting means and an operating shaft for the switch base 10.

A slow speed alternating current torque motor 24 is connected in a substantially 1 to 1 driving relation with the shaft 21. In the form shown in the drawing, the motor is connected directly to the shaft. One form of inherently slow speed alternating current electric motor which is particularly suitable for use in connection with my line circuit breaker is that shown in Patent 2,105,513, issued to Alfred F. Welsh on January 18, 1938. As described in the Welsh patent, the particular exemplary modification is provided with a number and arrangement of stator and rotor teeth which will produce a speed of 78.26 R. P. M. when the split-phased field is energized at 60 cycles. Such a speed, being of the order of 100 R. P. M., is ideally suited to the operation in a 1 to 1 driving relation therewith of the base 10 and its liquid contact interrupting unit such as I contemplate in connection with my invention. More rapid operation tends to produce violent agitation and splashing of the mercury in the interrupting unit, while operation at too slow a speed causes an undesirable persistence of the electric arc with consequent damage to the interrupters. Furthermore, the motor of the Welsh patent is of a type which may be stalled with the electric supply circuit connected thereto, thereby to provide a torque motor capable of holding the interrupting units in switch closing position against a biasing force.

As has been previously pointed out, a motor having an inherently slow speed, such as the motor of the Welsh patent, may be used without the interposition of a high ratio gearing unit. As shown in the drawing the motor 24 of this type has its rotor directly connected in a 1 to 1 driving relation with the shaft 21. It will therefore be immediately apparent that the rotor of a motor thus connected to its load may be reversed by an externally applied biasing force applied to the load. According to my invention undervoltage protection is provided by means of a tension spring 25 which exerts a biasing force constantly tending to rotate the interrupting units to their switch opening position. As shown at Figs. 1 and 2, the tension spring 25 is connected between a bracket 26, formed upon the base of the bearing 22 and a radially extending arm 27 attached to the outer end of the shaft 20. In order to limit the movement of the interrupting unit to the relatively small are necessary to make and break the circuits through the various mercury buttons, a pair of spaced stop pins 28 and 29 are attached to the bearing 22 and project longitudinally along the shaft 20 to engage the projecting arm 27 thereby to determine the switch opening and switch closing positions of the breaker.

According to the modification of Figs. 1 and 2, the speed of movement attained by the switch in the reverse direction at the moment the circuit is opened is limited by the inertia of the interrupting unit and of the rotor of the motor 24. Thus the spring 25 and the mass of the various parts are preferably so proportioned that the switch opening velocity under the influence of the spring is of the order of 100 R. P. M., that is, substantially the same as its closing velocity under the influence of the motor 24.

At Fig. 3 I have shown a modified form of my invention in which the velocity of the switch in the reverse or opening direction is limited primarily by a dash pot 31 connected between the arm 27 and the bracket 26. This form of the invention is preferable where the inertia of the parts is insufficient to limit the opening velocity to the desired value.

In Fig. 4 I have shown a schematic diagram of connections for applying my power breaker as a line starter for a three-phase alternating current motor 35. As shown, the motor is connected to conductors 36, 37 and 38 of a three-phase alternating current line through three interrupting units 12 mounted in a common base 10, while the slow speed operating motor 24 is energized across a single phase of the same alternating current line through a control switch 39.

It is believed that the operation of my line starter will be sufficiently clear from the above description. In brief, however, it will be observed that when the motor 24 is de-energized, the biasing spring 25 retains the arm 27 against the stop 28 in such a position that the circuits through the mercury buttons 12 are interrupted. When the motor 24 is energized, as by closing the switch 39 the motor rotates the operating shaft 21 and cylindrical switch base 10 clockwise through a small arc as viewed in Fig. 2, until the radially extending arm 27 engages the stop 29. Engagement of the arm 27 with the stop 29 determines the switch closing position of the interrupting unit and the units are retained in this position by the motor 24 acting as a torque motor as long as the motor remains energized. Undervoltage protection is provided by proportioning the spring 25 so that it will reverse the motor 24 and bring the arm 27 against the stop 28 whenever the energization of the motor, i. e., voltage applied to it, is substantially diminished to a predetermined value, as well as when the motor is completely de-energized.

While I have shown and described but one modification of my invention by way of illustration, many other modifications will occur to those skilled in the art, and I therefore wish to have it understood that I intend by the appended claims to cover all such modifications as fall within the true scope and spirit of my invention.

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

1. An automatic circuit breaker of the line contactor type providing undervoltage protection for a multiple conductor line comprising a plurality of tiltable fluid contact interrupting units, each of said interrupting units having terminals for connecting said unit in series circuit relation with one of said conductors, an operating shaft providing means for rotatably mounting all of said interrupting units for simultaneous movement between open and closed circuit positions, fixed stop means for limiting the rotation of said units thereby to determine said open and closed circuit positions, spring means engaging said operating shaft for biasing said units to said open circuit position, a slow speed electromagnetic torque motor having a speed of the order of 100 R. P. M. connected to said operating shaft in a substantially 1 to 1 driving relation therewith for rotating said unit to said closed circuit position in opposition to said spring means, said motor being so constructed and arranged that it offers substantially no frictional resistance to reverse rotation under the influence of said spring, said spring being operable automatically to reverse said motor and to return said interrupting units to said open circuit position upon deenergization of said motor or upon substantial diminution in the energization of said motor to a predetermined value, and means cooperating with said operating shaft for limiting the speed of said reverse rotation under the influence of said spring, said speeds of rotation of said interrupting units in the circuit closing direction by said motor and in the circuit opening direction by said spring being sufficiently low to avoid detrimental splashing of the fluid in said interrupting units and sufficiently high to avoid damaging arcing in said fluid interrupting units.

2. An automatic line starter for connecting an electric translating device to a multiple conductor source of electric supply and providing undervoltage protection for said device comprising a tiltable fluid contact interrupting unit connected in series circuit relation with each of said conductors, an insulating base formed to provide a common support for all of said interrupting units, means for rotatably mounting said base for movement between open and closed circuit positions of said interrupting units, said means comprising an operating shaft having a radially projecting arm, stop means arranged to engage said arm thereby to limit the rotation of said base and determine said open and closed circuit positions, a spring connected to said arm to bias said base to said open circuit position, a slow speed electromagnetic torque motor connected directly to said operating shaft in a 1 to 1 driving relation therewith for rotating said base to said closed circuit position in opposition to the force of said spring, said motor being so constructed and arranged that when de-energized it offers substantially no frictional resistance to reverse rotation under the influence of said spring, said spring being operable to reverse said motor and to return said interrupting units to said open circuit position upon deenergization of said motor and also upon substantial diminution in the energization of said motor to a predetermined value, and means for limiting the speed of said return opening movement of said interrupting units to a predetermined low speed, said speeds of operation of said interrupting units in the circuit closing direction by said motor and in the circuit opening direction by said spring being sufficiently low to avoid detrimental splashing of the fluid in said interrupting units and sufficiently high to avoid damaging arcing in said fluid interrupting units.

3. A switch for connecting an electric translating device to a source of electric supply comprising a base, supporting means pivotally mounting said base, a plurality of mercury switches mounted on said base in positions relative to said base and to each other to be tilted simultaneously between open and closed circuit positions by a predetermined angular movement of said base, stop means for limiting said angular movement of said base to movement between said open and closed circuit positions, spring means for biasing said base to said open circuit position, a rotatable torque motor having a speed on the order of 100 R. P. M. connected to said base in a substantially 1 to 1 driving relation therewith, said torque motor being arranged when energized to turn said base at a speed on the order of 100 R. P. M. to said closed circuit position against the force applied thereto by said spring and hold said base in said closed circuit position while said motor remains substantially fully energized, said spring being arranged to return said motor and said base to said open circuit position when said motor is deenergized or the energization of said motor is substantially diminished, and means for limiting to a predetermined low speed said return opening movement of said base to said circuit opening position, said speeds of operation of said base in the circuit closing direction by said motor and in the circuit opening direction by said spring being sufficiently low to avoid detrimental splashing of the fluid in said mercury switches and sufficiently high to avoid damaging arcing in said mercury switches.

4. A switch for connecting an electric motor to a source of electric supply comprising a support, operating shaft for rotatably mounting said support, a plurality of mercury switches mounted on said support in positions relative to said support and to each other to be tilted simultaneously between open and closed circuit positions by a predetermined angular movement of said support on said shaft, stop means for limiting said angular movement of said support to movement between said open and closed circuit positions, spring means for biasing said support in said open circuit position, a rotatable alternating current synchronous torque motor having a speed on the order of 100 R. P. M. connected to said shaft in a substantially 1 to 1 driving relation therewith, said torque motor being arranged when energized to turn said support at a speed on the order of 100 R. P. M. to said closed circuit position against the force applied thereto by said spring and hold said support in said closed circuit position while said motor remains substantially fully energized, said spring being arranged to return said motor and said support to said open circuit position when said motor is deenergized or the energization of said motor is substantially diminished, and means for limiting the speed of said return movement of said motor and said support by said spring to a speed on the order of 100 R. P. M., said speeds of operation of said switches and support in the circuit closing direction by said motor and in the circuit opening direction by said spring being sufficiently low to avoid detrimental splashing of the fluid in said switches and sufficiently high to avoid damaging arcing in said switches.

BENJAMIN W. JONES.