April 6, 1948. W. E. PAUL 2,439,264

ELECTRIC SWITCH

Filed June 7, 1945

Fig. 1.

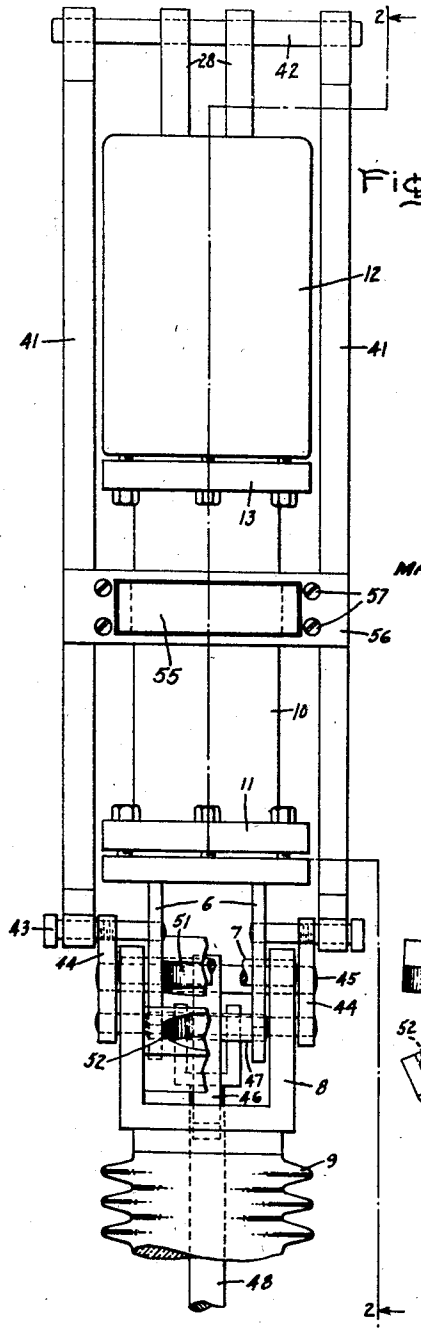


Fig. 2.

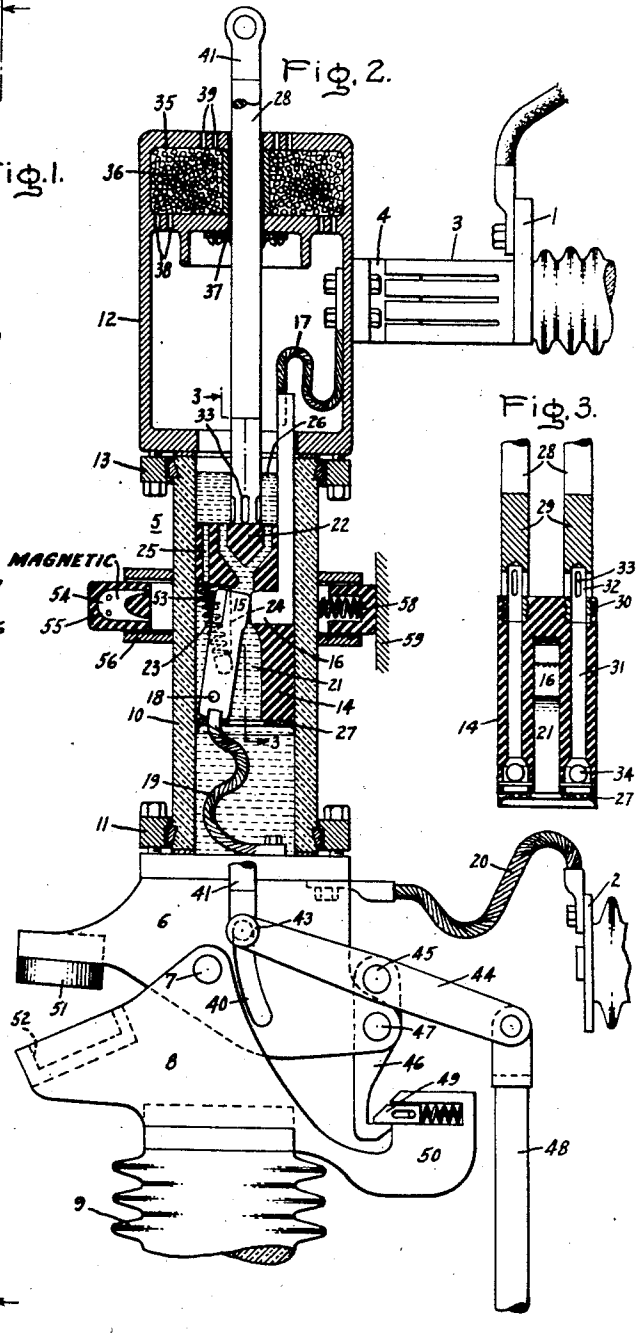


Fig. 3.

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Patented Apr. 6, 1948

2,439,264

UNITED STATES PATENT OFFICE

2,439,264

ELECTRIC SWITCH

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Application June 7, 1945, Serial No. 598,041

9 Claims. (Cl. 200—146)

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My invention relates to electric switches, and more particularly to those of the load break switch type wherein means are provided for interrupting load power currents as well as for carrying the normal load current and disconnecting the circuit.

The problem of both interrupting and disconnecting a high voltage circuit at points where conventional power circuit breakers are impractical or uneconomical involves a number of difficulties including those associated with the usual requirements for simplicity and ruggedness in structure, compactness, economical construction and operation and electrical efficiency, in both interrupting the load power arc and disconnecting the circuit. It would be desirable to have a load break switch which could be used anywhere, either indoors or outdoors, and which could also be used for taking power from transmission lines or distribution lines for farm power or other small installations along power lines.

It is an object of my invention, therefore, to provide an improved load break switch that is simple and inexpensive in construction, that is capable of efficiently interrupting line charging currents and moderate load currents in high voltage power circuits and disconnecting the power circuits.

It is another object of my invention to provide a new and improved load break switch in which the interruption of the circuit is accomplished before any movement of the isolating portion of the load break switch occurs.

Still another object of my invention is the provision of a new and improved load break switch having a very high interrupting capacity with little or no maintenance required.

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 is a front elevational view with certain portions cut away, of an electric switch embodying my invention; Fig. 2 is a view taken on line 2—2 of Fig. 1, and Fig. 3 is a sectional view taken on line 3—3 of Fig. 2.

Referring now to the drawing, the load break switch of my invention comprises a pair of relatively fixed terminals 1 and 2 which are suitably mounted on insulators or an insulating supporting panel, or the like. The terminal 1, which

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forms the upper terminal of the switch of my invention has integrally formed therewith a contact 3 comprising a plurality of contact fingers adapted to electrically engage with a cooperating contact 4 forming a part of the current-carrying contact structure of my switch generally designated at 5. Preferably, the contact structure 5 comprises a pivotal supporting member 6 pivotally mounted at 7 to a stationary supporting member 8 supported on a suitable insulator 9.

The current-carrying contact structure 5, in addition to the pivotal support 6, includes a tubular member or housing 10 of insulating material which is mounted in sealed relationship to pivotal member 6, as by a clamping ring 11. The other end of insulating tube 10 is connected to an exhaust chamber 12 and is held in sealed relationship therewith by means of a clamping ring 13. Contact 4, adapted to cooperate with the contact 3, is mechanically supported from exhaust chamber 12. From the above, it will be understood that the current-carrying contact structure 5, hinged about pin 7 of the stationary support 8, constitutes a generally cylindrical disconnecting "blade" of the load break switch of my invention.

Tubular insulating member, or housing, 10 forms a cylinder within which is disposed for reciprocal movement therein a movable support shown in the form of a long piston generally indicated at 14. Mounted within piston 14 are a pair of relatively movable arcing contacts 15 and 16, contact 16 being indicated as a stationary contact with respect to piston 14 and electrically connected by a flexible lead 17 with contact 4 to permit free piston movement in cylinder 10. Contact 15 is indicated as a hinge type contact pivotally mounted at 18 to the lower part of piston 14 and electrically connected by flexible lead 19 with pivotal supporting member 6, which in turn is electrically connected by means of a conductor 20 to fixed terminal 2. Movable contact 15 is mounted in a slot-like fluid blast passageway 21 provided within piston 14 and, in the closed position of contact 15 as indicated in Fig. 2, this fluid blast passageway 21 is closed, gate-like, by contact 15 bearing against contact 16. Immediately above contacts 15 and 16 the oil blast passageway divides into two branches so as to define an arc dividing member 22. A suitable spring 23 supported in a recess 24 in contact 15 and engaging an abutment within piston 14 biases contact 15 to the closed position. As will be explained in more detail later, piston 14 and the contacts 15 and 16 contained therein are caused

to move downward within cylinder 10 at the commencement of the switch opening operation, whereby gate contact 15 is caused automatically to pivot counterclockwise about pivot 18. In order that contact 15 may not be unduly retarded during this opening movement, a venting passage 25 is provided in the upper portion of piston 14 for relieving the fluid from behind contact 15 in fluid passage 16.

Tubular housing 10 is adapted to be filled with a suitable arc extinguishing fluid 26 to the level indicated in Fig. 2. In the illustrated embodiment this fluid is shown as a liquid such as oil, for example. A suitable packing ring 27 is provided which constitutes the lower face of piston 14 so that upon downward movement thereof the fluid is displaced effectively through blast passageway 21 thereby causing relative separation of contacts 15 and 16 to draw an arc therebetween. The blast of fluid extends the arc against arc dividing member 22 and interposes a stream of fresh dielectric between the separated contacts to cause rapid extinguishment of the arc and interrupt the circuit.

Movable piston 14 must be connected to external means for operating the same within cylinder 10 and to this end I have provided a pair of piston rods 28, preferably formed of insulating material for a substantial portion thereof and having a lower metal portion 29 adapted to be threadedly mounted as indicated at 30 to piston 14 as best shown in Fig. 3. As already noted, downward movement of piston 14 will cause the fluid in housing 10 to be displaced and moved relatively upward through piston 14 via passageway 21. Upon return of piston 14 to its initial position it is desirable that this fluid may rapidly return to the lower part of housing 10. Vent pasageway 25 is insufficient for this purpose and to this end, as shown by Fig. 3, I provide through piston 14 a plurality of passageways 31, the upper ends of which register with a bore 32 in the lower metal ends 29 of piston rods 28 which bores 32 communicate to the fluid space in the upper end of tubular housing 10 through openings 33 in the metal portions 29 of rods 28. In order that the main fluid blast is prevented from going through passageways 31 upon downward movement of piston 14, a suitable check valve, such as a ball 34, is provided at the lower end of each passageway 31.

The exhaust gases from a circuit interrupting operation are driven upwardly into exhaust chamber 12 which includes a gas cooling portion specifically indicated as a chamber 35 filled with gravel, or other suitable gas cooling material, generally indicated at 36. A suitable packing material 37 is provided where operating rods 28 pass through exhaust chamber 12 to prevent oil or exhaust gases from escaping to atmosphere in that manner. Cooling chamber 35 is connected to exhaust chamber 12 through suitable ports 38 and to atmosphere through suitable ports 39. Any oil which might be blasted into chamber 35 is collected on cooling material 36 and is returned to housing 10 through ports 38.

One of the objects of my invention, as was mentioned earlier, is to interrupt the circuit in the arc extinguishing structure comprising piston 14 or the like reciprocable within housing 10 before any pivotal movement of the hinged current-carrying contact structure 5 occurs, or more specifically, before any separation between contacts 3 and 4 occurs. Accordingly I provide an operating mechanism which causes piston 14, during an interrupting operation, to be moved downwardly in housing 10 from the position shown in Fig. 2 to interrupt the current flowing between terminals 1 and 2 before any separation between contacts 3 and 4, or even relative movement of contacts 3 and 4 occurs. Pivotal supporting member 6, which is a U-shaped member as indicated in Fig. 1, is provided with a curved or arcuate slot 40 in each arm of the U. A pair of side operating rods 41 connected at their upper ends to piston rods 28 by means of a common cross-head pin 42, are each provided with a pin 43 at the lower end thereof adapted to move in arcuate slots 40. Pins 43 are also connected to a pair of levers 44 pivotally mounted as indicated at 45 to a latch 46, which latch 46 is in turn pivoted as indicated at 47 to pivotal support 6. The other end of lever 44 is preferably connected as by an operating rod 48 to suitable means for operating the switch to the open and closed positions. Such means might comprise spring opening means with either manual or solenoid means for closing the switch and charging the spring opening means. In the closed position of the switch shown in Fig. 2 latching member 46 is adapted to engage a spring biased plunger 49 mounted in an extension 50 of stationary supporting member 8. Upward opening force applied to levers 44 by the operating rod 48 will be approximately equal to the downward force exerted on rods 41 at pins 43 since the portions of levers 44 on either side of pivot 45 are not greatly different in length. The moment tending to rotate the blade clockwise about pivot 7 is made up of a downward force exerted on rods 41 at pins 43 and the distance between pivot 7 and the line of action of the downward force at pins 43. Since this distance is relatively short, the clockwise moment is relatively small. The moment tending to rotate the blade counterclockwise is made up of an upward force, substantially equal to the above downward force, which is exerted by rod 48 and the distance between pin 7 and the line of action of the force applied on levers 44 by rod 48. Since this latter distance is relatively large, the counter-clockwise moment applied to the blade would greatly overbalance the above clockwise moment, and the net effect is a moment tending to rotate structure 5 in the counter-clockwise direction. The same result will be reached if the counterclockwise moment be regarded as made up of a relatively large upward force applied to pin 47 and the distance between pivot 7 and the line of action of such upward force. When an upward opening force is applied to the operating rod 48 a strong downward thrust is exerted on piston 14 by piston rods 28 through the tensioned operating rods 41 and the lever 44 pivoted at 45, but because of the resistance to movement of the piston 14 by the fluid below it in the cylinder 10 a strong overturning moment is applied about the pivot 7 to the whole current-carrying contact structure 5 (hereinafter to be termed the "blade" for convenience) tending to rotate it counterclockwise so as to separate contacts 3 and 4. However, the latch 46, held by plunger catch 49, prevents such disconnecting swing of the "blade" so that at this time lever 44 can only pivot about 45 with pins 43 moving downwardly in slots 40 accompanied by the corresponding downward movement of piston 14 by which interruption of the circuit is achieved by separation of the arcing contacts 15 and 16 as already described. It wil be observed that I arrange the

arcuate slots 40 of supporting member 6 in eccentric relationship with respect to pivot 45 so that, in the closed position as shown, the lower ends of slots 40 are closer to pivot 45 than their upper ends; consequently, as lever 44 rotates, its floating fulcrum 45 is forced to the right in planetary relationship to pivot 47 by the cam action of the eccentrically arranged slots 40 upon the pins 43. Because the planetary movement of pin 45 about pivot 47 is effected by the latch 46 it will be obvious that this clockwise rotation of the latch will result in its eventual disengagement from the restraining plunger catch 49. Coincident with the freeing of latch 46, the above-mentioned overturning movement about fixed pivot 7 will now be effective to swing the "blade" outwardly for disconnecting the isolating contacts 3 and 4. In the embodiment shown, this disconnecting swing of the "blade" is further augmented by the thrust of spring means 58 biased against a cooperating fixed surface 59, although this spring arrangement performs another function as will be explained later. I proportion the eccentricity of the slots 40 and the dwell of the coacting latching surfaces so that the latch 46 is released when the piston 14 has moved approximately two thirds of its downward stroke (that is, with the lever 44 rotated so that the pins 43 have moved correspondingly two thirds of their permissible travel in the slots 40; for it will be clear that the length of slots 40 determines the stroke of piston 14) and by which time the circuit will have been interrupted between the separated contacts 15 and 16. In view of the above explanation, it will be understood that, upon disengagement of the latch 46, the upward movement of the operating rod 48 now produces simultaneously (*a*) a local pivotal movement of lever 44 about its floating fulcrum 45 and (*b*) a pivotal movement of the entire "blade" about its fixed pivot 7. Accordingly, while the local pivotal movement of lever 44 is producing a follow-through blast in piston 14 which is effective to maintain contact 15 open after interruption, the pivotal movement of the entire "blade" is causing a progressively widening isolating gap between disconnecting contacts 3 and 4. If it so happens that the pins 43 reach the bottom of the slots 40 toward the end of the opening movement of the "blade," it will be discerned that the lever 44 becomes a positive drive member between the upwardly moving operating rod 48 and the pivotal supporting member 6 without the intervention of the "fluid drive" element constituted by the fluid below piston 14 in cylinder 10.

For establishing an open position for the "blade" with a safe isolating gap between contacts 3 and 4, I provide an extension on the pivotal member 6 and on the fixed supporting member 8, one of which has a dashpot piston as at 51 and the other a shallow cooperating cylinder 52 thereby to cushion the "blade" as it assumes its full open position.

With the arrangement described thus far, spring 23 will close contacts 15 and 16 upon completion of the opening operation so that, upon reverse or downward movement of operating rod 48 to its original closed position as shown in the drawing, the circuit necessarily would be re-established by the reengagement of contacts 3 and 4. It might be desirable in many cases to complete the circuit under the fluid or oil, such as at contacts 15 and 16, rather than at contacts 3 and 4. Accordingly, suitable hold-open means

may be provided to hold contact 15 in the open position once it has opened until contacts 3 and 4 have reengaged. For this purpose I provide a magnetic member 53 on the back of the free end of contact 15. I also provide a magnet 54 mounted in suitable supporting means 55 outside of tubular housing 10 so that when contact 15 is opened it can be magnetically held in the open position by magnet 54 while the switch "blade" is open. The magnet 54 and its supporting means 55 is preferably mounted for lateral movement in a suitable supporting guide means 56 which in turn is fastened to operating rods 41 as by means of clamping screws 57 so that magnet 54 will be properly aligned with respect to magnetic member 53 at all times even when piston 14 and contact 15 reciprocate within and move relative to housing 10. Supporting means 55 for magnet 54 is preferably biased by spring means 58 so that magnet 54 is urged thereby to a position of abutment against the exterior wall of housing 10 and in which position it is capable of holding the contact 15 open after it has been opened and maintained open temporarily by the fluid blast as already described. This hold-open position of the magnet supporting means 55 is only possible while the "blade" at least is partially open, for I provide a fixed stop surface as indicated at 59, in stationary relationship to the supporting structure or panel upon which the switch is mounted, positioned for intercepting the slidable means 55 as the "blade" approaches closed position. Therefore, when the "blade" has fully closed, magnet means 55 will have assumed a position toward the left with respect to cylinder 10, as is clearly shown in Fig. 2, in which position the increased gap produced between magnetic members 53 and 54 renders magnet 54 incapable of holding the contact 15 open. Accordingly, not until the "blade" closes, with disconnecting contacts 3 and 4 in substantial engagement, will contact 15 be released from open position to close against contact 16 under the bias of its spring 23 for re-establishing the circuit between terminals 1 and 2. Hence, it will be understood that when the magnetic arrangement of my invention is employed for holding and releasing contact 15 in the above-described manner, both the interruption and reconnection of the switch circuit are effected by the relatively movable contacts 15 and 16 operating in the fluid contained in cylinder 10; so that the contacts 3 and 4 function solely as disconnecting or isolating contacts which are not subjected to arcing conditions.

In view of the detailed description included above the operation of the load break switch embodying my invention will be obvious to those skilled in the art. With the switch in the position as indicated in the drawing, opening thereof is obtained by upward movement of operating rod 48. This causes a counter-clockwise rotation of lever 44 and a downward movement of pins 43 in arcuate slots 40. This furthermore causes operating rods 41 and piston rods 28 to move piston 14 downwardly in housing 10. Such downward movement of piston 14 compresses the fluid beneath piston or movable support 14 forcing it at high velocity between contacts 15 and 16, with the consequent high speed interruption of the arc drawn therebetween by fluid blast action cooperating with arc dividing member 22. As long as the hinged current-carrying contact structure 5 or blade is closed with respect to contacts 3 and 4, magnet 54 is too far away

from magnet member 53 to hold contact 15 in the open position. However, the fluid blast through passageway 21 maintains contact 15 in the open position. Continued movement of pins 43 in arcuate slots 40 causes latch 46 to rotate free from latching plunger 49. When pins 43 have moved approximately two thirds of the way down arcuate slots 40 latch 46 is released. Pins 43 continue to move downwardly with continued movement of piston 14 and a continued fluid blast between contacts 15 and 16 while, coincidently, the "blade" begins to swing to the left about pivot 7, as viewed in Fig. 2, to provide an isolating gap between contacts 3 and 4. As soon as magnet supporting member 55 is free of fixed member 59 magnet 54 lies abuttingly against cylinder 10 and magnetically holds contact 15 in the open position. The "blade" is cushioned by cushioning means comprising members 51 and 52 and brought to rest in its full open position.

To reclose the switch a downward force is applied to operating rod 48 which immediately moves pins 43 from the bottom to the top of arcuate slots 40 thus resetting piston 14 for another interrupting operation. The fluid above piston 14 can now return freely past valves 36 through passages 31 to its initial position. When pins 43 reach the upper end of arcuate slot 40 a continued downward force on operating rod 48 applies a positive drive to the "blade" to rotate it about pivot 7 to its closed position in Fig. 2 to reclose contacts 3 and 4. As the "blade" reaches its closed position latch 46 moves spring biased plunger 49 to the right until it is beneath plunger 49 whereupon the operating mechanism is in condition for a subsequent closing operation. When magnet supporting member 55 engages stationary member 59 the gap between magnet 54 and magnet member 53 increases sufficiently so that magnet 54 is no longer capable of holding contact 15 in the open position. Thereupon the circuit is finally completed between contacts 15 and 16.

While I have shown and described a particular 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 in its broader aspects 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. An electric switch comprising a pair of relatively fixed terminals, a current-carrying contact structure arranged electrically to bridge said terminals, an arc extinguishing unit disposed in said current-carrying contact structure comprising a piston and a pair of relatively movable contacts mounted within and supported by said piston, means for causing movement of said piston, a fluid arranged so as to be forced between said contacts to cause relative separation thereof and interrupt the current flowing therethrough in response to movement of said piston, and means for moving said current-carrying contact structure from between said terminals while said contacts are in the open position and said fluid is flowing therebetween.

2. An electric switch comprising a pair of relatively fixed terminals, a current-carrying contact structure arranged electrically to bridge said terminals, an arc extinguishing unit disposed in said current-carrying contact structure comprising a piston having an axial opening therein and a pair of relatively movable contacts mounted within and supported by said piston so as to close said opening in said piston when said switch is closed, means for causing movement of said piston, an arc extinguishing liquid arranged so as to be forced through the axial opening in said piston and between said contacts to cause relative separation thereof and interrupt the current flowing therethrough in response to movement of said piston, and means for moving said current-carrying contact structure from between said terminals while said contacts are in the open position and said liquid is flowing therebetween.

3. An electric switch comprising a pair of relatively fixed terminals, a current-carrying contact structure arranged electrically to bridge said terminals comprising a tubular member of insulating material, a body of arc extinguishing fluid in said tubular member, a piston of insulating material reciprocal in said tubular member and having an opening therethrough arranged so that said fluid is forced through said opening in response to movement of said piston, a pair of relatively movable contacts for completing the circuit through said contact structure mounted within and supported by said piston arranged when closed for blocking said opening through said piston, means for causing movement of said piston so as to force said fluid through said opening to separate said contacts and blast the arc drawn therebetween are in the open position and said fluid blast continues between said contacts.

4. An electric switch comprising a pair of relatively fixed terminals, a pivotally mounted current-carrying contact structure arranged electrically to bridge said terminals, an arc extinguishing unit disposed in said contact structure comprising a pair of relatively movable contacts and a movable support carrying said contacts, means for causing movement of said support, a fluid arranged so as to be forced between said contacts to open the same and interrupt the arc drawn therebetween in response to movement of said support, and means for pivoting said current-carrying contact structure out of bridging relationship across said terminals while said contacts are in the open position and said fluid is flowing therebetween.

5. An electric switch comprising a pair of relatively fixed terminals, a current-carrying contact structure arranged electrically to bridge said terminals, an arc extinguishing unit disposed in said current-carrying contact structure comprising a piston and a pair of relatively movable contacts mounted within and supported by said piston, means for causing movement of said piston, a fluid arranged so as to be forced between said contacts to cause relative separation thereof and interrupt the current flowing therethrough in response to movement of said piston, operating means for moving said current-carrying contact structure to cause disconnection and subsequent reconnection of said structure with respect to said terminals, means interconnecting said operating means and said piston moving means to cause separation of said contacts prior to said disconnection, and means for holding said contacts separated after said disconnection until said reconnection has been effected.

6. An electric switch comprising a pair of relatively fixed terminals, a pivotally mounted current-carrying contact structure arranged electrically to bridge said terminals, a tubular housing for said contact structure, an arc extinguish-

ing unit disposed in said housing comprising a pair of relatively movable contacts and a support carrying said contacts movable in said housing, means for causing movement of said support, a fluid in said housing arranged so as to be forced between said contacts to open the same and interrupt the arc drawn therebetween in response to movement of said support, and means for pivoting said current-carrying contact structure out of bridging relationship across said terminals while said contacts are in the open position and said fluid is flowing therebetween.

7. An electric switch comprising a pair of relatively fixed terminals, a pivotally mounted current-carrying contact structure arranged electrically to bridge said terminals, an arc extinguishing unit disposed in said contact structure comprising a pair of relatively movable contacts and a movable support carrying said contacts, means for causing movement of said support, a fluid arranged so as to be forced between said contacts to open the same and interrupt the arc drawn therebetween in response to movement of said support, operating means for pivoting said current-carrying contact structure to cause disconnection and subsequent reconnection of said structure with respect to said terminals, means interconnecting said operating means and said support moving means to cause separation of said contacts prior to said disconnection, holding means for maintaining said contacts separated until said reconnection has been effected, said holding means comprising a magnetic member shiftable between releasing position and holding position in accordance with the disconnecting and reconnecting movements respectively of said structure.

8. An electric switch comprising a pair of terminals, an interrupting unit including a pair of separable arcing contacts provided with means for biasing them into closed position, said unit being arranged in series relationship with respect to said terminals, switching means for isolating said interrupting unit from one of said terminals, means for providing a blast of fluid

for said unit whereby to separate and blast said contacts to extinguish the arc drawn therebetween, means for operating said switching means to disconnecting position following said separation of said contacts and for thereafter reconnecting said switching means, and holding means for maintaining said contacts separated while said switching means remains disconnected from one of said terminals, said holding means comprising a magnetic member shiftable between releasing position and holding position in accordance with the disconnecting and reconnecting movements respectively of said switching means.

9. An electric switch comprising a pair of terminals, an interrupting unit including an elongated chamber and a structure disposed for reciprocal movement therein, said structure having an opening therethrough and a pair of relatively movable contacts for completing a circuit through said unit mounted within and supported by said structure arranged when closed for blocking said opening through said structure, a fluid in said chamber, said interrupting unit being arranged in series relationship with respect to said terminals, switching means for isolating said interrupting unit from one of said terminals, means for actuating said switching means to isolating position, and means for causing movement of said structure so as to force said fluid through said opening whereby to separate said contacts and blast the arc drawn therebetween prior to the isolating movement of said switching means.

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Certificate of Correction

Patent No. 2,439,264. April 6, 1948.

WILLIAM E. PAUL

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Column 8, line 31, claim 3, after "therebetween" insert , *and means for moving said current-carrying contact structure from between said terminals while said contacts*; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 24th day of August, A. D. 1948.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

Certificate of Correction

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Signed and sealed this 24th day of August, A. D. 1948.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.