

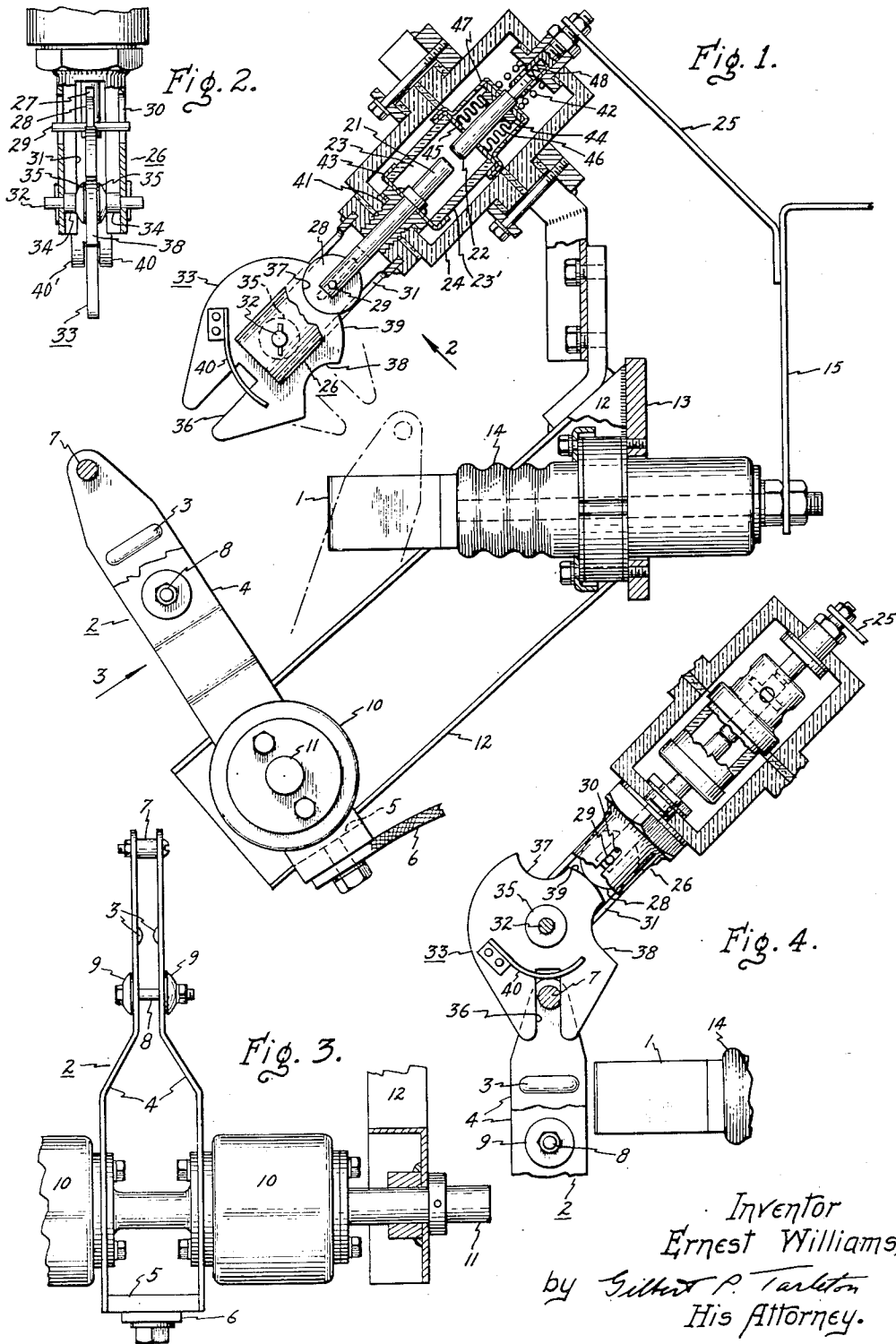
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ELECTRIC SWITCH

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## ELECTRIC SWITCH

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This invention relates to an electric switch, and more particularly, to an electric switch having a shunt path around the switch whereby the switching duty is transferred from the contacts of the switch to an auxiliary switching device.

Electrical switches having a shunt path thereabout for transferring the switching duty from the contacts of the switch to an auxiliary device during making and breaking of the load circuit are well known in the art. In one prior art form of said electrical switches the shunt path comprises a vacuum switch device at which the load circuit is made and broken. However, this form of electrical switch has the disadvantage in that the vacuum switch device continues to carry part of the load current after the contacts of the switch are fully closed. That is, the vacuum switch device is subjected to the additional duty of carrying part of the load current after the contacts of the switch are fully closed aside from the duty of making and breaking the load. This additional duty requires that the vacuum switch device be larger and more costly than would be the case if it carried no load current after full closure of the contacts of the switch and performed the duty of only making or breaking load current.

It is an object of this invention to provide an electric switch having a shunt device for making and breaking the load circuit or current wherein after the circuit is closed the shunt device carries no part of the load current.

It is a further object of this invention to provide in a main electrical switch a shunt electrical switch for making and breaking the load current whereby after the main switch is closed the shunt switch is automatically opened.

It is a further object of this invention to provide in a main electrical switch having a shunt electrical switch thereabout an operating mechanism therebetween for transferring the duty of making and breaking the load current from the main switch to the shunt switch and for ensuring that the shunt switch is opened after the main switch is closed.

It is a further object of this invention to provide an uncomplicated, reliable, and low cost switching arrangement comprising a main switch and an auxiliary switch and an operating mechanism for transferring the duty of making and breaking the load current from said main switch to said auxiliary switch.

My invention comprises an electrical apparatus having a main electrical switch and a switching duty shunt switch together with an operating mechanism for said switches for automatically opening said shunt switch when said main switch is in closed position.

My invention further comprises a switch operating mechanism including a switch arm having one end thereof movable through an arc, a pivoted cam having a notch formed therein, said notch disposed in said arc and adapted to receive a portion of said arm's one end to cause rotation of said cam as said arm is moved, said cam having two spaced concave surfaces separated by a convex surface, and a cam follower engageable with said concave and convex surfaces to impart closing and open-

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ing movement to a movable contact member as said arm is moved.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing.

In the drawing, Fig. 1 is a partly broken away side elevation view of a preferred form of my invention in the full open position. Fig. 2 is a partly broken away bottom view of part of the operating mechanism of Fig. 1 when viewed in the direction of arrow 2 of Fig. 1. Fig. 3 is a partly broken away front view of another part of the operating mechanism of Fig. 1 when viewed in the direction of arrow 3 of Fig. 1. Fig. 4 is a partly broken away side elevation view similar to that of Fig. 1 except in an intermediate position wherein the auxiliary shunt contacts are closed while the main contacts are open. Like reference numerals will be used throughout the various figures to indicate like parts.

Referring now particularly to Fig. 1, shown therein is a main electrical switch comprising a fixed main contact 1 and a movable switch blade or arm 2 carrying movable main contacts 3. As better seen in Fig. 3, blade or arm 2 comprises a pair of identical oppositely positioned and spaced elongated strips 4. At their lower ends the strips 4 are interconnected by a bridge 5 having a terminal connected thereto for connecting a line 6 thereto. At their upper ends the strips 4 are interconnected by a pair of spaced pins 7 and 8. The contacts 3 are formed on the inner facing sides of the strips 4 between the pins 7 and 8 and a pair of spring elements 9 cooperate with the pin 8 to permit the upper ends of strips 4 to be spread somewhat when receiving the fixed main contact 1 therebetween.

The arm 2 is pivotally mounted adjacent its lower end through a pair of insulating coupling members 10 and operating rods 11 between a pair of support brackets 12. The upper ends of support brackets 12 are connected together by a bridge 13 and fixed contact 1 is insulatingly mounted on said bridge 13 by virtue of an insulating bushing 14. The right-hand end of bushing 14 has a terminal thereon for connection of a conducting strip 15 thereto. When the arm 2 is in its illustrated broken line closed position of Fig. 1 an electrical circuit is completed from line 6, bridge 5, strips 4, contacts 3, contact 1, through bushing 14 to conducting strip 15.

Positioned above the main electrical switch in fixed spaced relationship on the support brackets 12 is a shunt or auxiliary switch such as a vacuum switch device. The vacuum switch per se constitutes no part of my invention and comprises a movable spring urged lower contact or rod 21 and a relatively fixed spring urged upper contact or rod 22. The opposite ends of rods 21 and 22 are positioned in a movable vacuum chamber 23 defined in part by an insulating material jacket 23' which in turn is enclosed in an outer support jacket 24. The lower contact 21 is slidable within a bushing 41 threaded into the lower end of jacket 24, and is biased toward bushing 41 by a spring 42. Also, the lower contact 21 is sealed to an end closure cap 43 of jacket 23' as by brazing. The upper contact 22 is sealed to a collar 44 as by brazing, and sealed or brazed to the collar 44 and an apertured cap 45 of the upper end of jacket 23' is an accordion or bellows-like metallic member 46. Thus, the lower end of jacket 23' is made vacuum tight by brazed parts 21 and 43, and the upper end of jacket 23' is made vacuum tight by brazed parts 45, 46, 44 and 22. Another apertured cap 47 is superposed over cap 45, and is slidable with respect to the contact 22 while contact 22 is biased to

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its Fig. 1 illustrated position by a spring 43. When the contact 21 is initially moved inward of jacket 24 the parts 43, 21, 23', 45 and 47 are raised, and parts 46 and 42 are compressed until contact 21 engages contact 22. During initial closing movement of contact 21 contact 22 and collar 44 will not move since spring 43 is stronger than spring 42. However, after contact 21 engages contact 22 it can simultaneously raise contact 22 with its fixed collar 44 against the biasing action of spring 43.

The upper end of jacket 24 has a terminal thereon which is in electrical contact with rod 22 as well as a conducting strip 25 which is electrically connected to conducting strip 15. The lower end of jacket 24 has a hollow cylindrical cam carrying member 26 protruding therefrom. The lower end of rod 21 extends into the cylinder 26 and has a slot 27 formed therein. In the slot 27 is positioned a circular rotary cam follower 28. Cam follower 28 is rotatable about a pin 29 passing through opposite sides of rod 21 across slot 27. The extreme outer ends of pin 29 are guided in a pair of lengthwise extending slots 30 formed in the upper end of cylinder 26.

Extending lengthwise of the cylinder 26 about 90° removed from slots 30 from the lower end thereof to the upper end thereof are another pair of slots 31. A pin 32 extending parallel to the pin 29 and disposed in the same plane as the two slots 30 passes through opposite sides of the cylinder 26 adjacent the lower end thereof. A rotary cam 33 is mounted on pin 32 between opposite sides of cylinder 26 within slots 31. The pin 32 has a pair of collars 34 thereon which abut the opposite inner surfaces of the opposite sides of cylinder 26 and between collars 34 and cam 33 are positioned a pair of spring elements 35.

The front edge of cam 33 protrudes beyond the lower end of cylinder 26 and has a notch or slot 36 formed therein, and in the rear and bottom edges of cam 33 are formed generally semicircular concave notches or slots 37 and 38 respectively which have radii generally equal to the radius of circular cam 28. The central portions of notches 37 and 38 are removed from each other by about 90° and are separated from each other by a convex curved edge 39.

When the arm 2 is pivoted clockwise the pin 7 describes an arc whose radius is generally equal to the distance between pin 7 and the pivotal axis of arm 2. The outer portion of slot 36 is disposed in this arc so that the pin 7 will enter and ride up and out of slot 36 and thereby rotate cam 33 counterclockwise about 90° in the manner illustrated in Fig. 4. During counterclockwise rotation of cam 33 circular cam 28 will ride out of concave notch 37 up on the convex edge 39 whereby rod 21 is moved into contact with rod 22. In the Fig. 4 position of the apparatus the load circuit has been made within the vacuum switch but the main contacts 3 and 1 are not yet closed. That is, a shunt path has been completed around contacts 3 and 1 from line 6, bridge 5, strips 4, pin 7, cam 33, cam 28, rods 21 and 22, to conducting strips 25 and 15. A pair of spring elements 40 and 40' disposed on opposite sides of cam 33 ensure against arcing between pin 7 and the inner surfaces of slot 36, due to the fact that slot 36 is at least slightly greater in width than the diameter of pin 7, by bearing down on the upper end tips of strips 4 whenever the vacuum switch is in closed position. Upon additional clockwise movement of arm 2 the contact 1 will engage the contacts 3 while cam 28 is still riding on convex edge 39 during which parallel paths are provided between line 6 and conducting strip 15 through the main electrical switch and through the vacuum switch. However, on still further clockwise movement of the arm 2 to full closed position the pin 7 will cause additional counterclockwise movement of cam 33 to permit cam 28 to ride from convex edge 39 into concave edge 38 after which pin 7 will leave slot 36 entirely as indicated in broken line outline in Fig. 1.

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When the cam 28 enters notch 38 the rods 21 and 22 are separated so that the shunt path through the vacuum switch device is automatically opened when the main contacts 3 and 1 are finally moved to their full closed position.

In breaking the load circuit the operation is the reverse of that for making the load circuit. That is, referring to the broken line outline position of arm 2 and cam 33 of Fig. 1, the slot 36 is now positioned 90° from its location during the open position of the main switch but the slot 36 is still disposed in the arc described by pin 7 during counterclockwise rotation of arm 2. Before the contacts 3 will have left the contact 1 the cam 28 will have left the edge 38 and have traveled a sufficient distance up on edge 39 to close rod contacts 21 and 22 as will be clear from an inspection of Fig. 4 assuming that arm 2 has been moving in a counterclockwise direction. Further counterclockwise movement of arm 2 will cause separation of contacts 3 and 1, riding of cam 28 into edge 37 to cause interruption of the load current between separated rod contacts 21 and 22, and withdrawal of pin 7 from slot 36.

As mentioned heretofore, the prior practice has been to leave the shunt arcing duty switch in the closed position after the main switch has been closed. This means that the shunt arcing duty switch has been required to continuously carry a portion of the load current. Apparatus of the type illustrated in the drawing has been constructed wherein the main switch had a current carrying capacity or rating of 600 amperes, and the vacuum switch had a continuous current carrying capacity or rating of 100 amperes, and a current interrupting capacity or rating of 600 amperes. At such ratings, assuming that the full load current is just under 600 amperes and that the vacuum switch is not opened after the main switch is closed, the ratio of the resistance of the vacuum switch to the resistance of the main switch should not be less than 5:1. That is, at a ratio of 5:1 the vacuum switch is continuously carrying just less than 100 amperes, and at a ratio of less than 5:1 the vacuum switch would be required to continuously carry more than 100 amperes which is greater than its continuous current carrying rating. When the continuous current carrying rating of the vacuum switch is exceeded the vacuum switch becomes overheated which causes destruction of or damage to the brazed seals thereof whereby the high vacuum is lost. The ratio of the resistance of the vacuum switch to the resistance of the main switch can drop below 5:1 due to accumulation of dirt on the main switch or looseness between the contacts thereof. For instance, at the time of installation in the example given the ratio of the resistance of the vacuum switch to the resistance of the main switch was about 10:1 whereby at full load current of just under 600 amperes the vacuum switch continuously carries about 55 amperes of current, assuming the vacuum switch is not opened after the main switch is closed. However, if the dirt collects on the main switch contacts or there is looseness between the main switch contacts the resistance of the main switch may increase to more than twice its initial value. This means that the ratio of the resistance of the vacuum switch to the resistance of the main switch will drop to below 5:1 whereby the vacuum switch continuously carries more than 100 amperes and becomes overheated. Such overheating can be avoided by making the current carrying parts of the vacuum switch larger. However, such expedient increases the cost of the vacuum switch. Accordingly, in my invention the shunt arcing duty switch is opened after the main switch is closed so as to avoid the possibility of overloading of the shunt switch in the event a fault develops in the main switch. During the process of opening and closing the main switch there is an instant during which the vacuum switch is required to carry part of the load current since two parallel paths for the load current are provided at said instant. Also, during the instant of making or breaking of the full load

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current by the shunt switch the current therethrough will be substantially greater than the continuous current carrying rating of the shunt switch. However, these instances are of such short durations that insufficient time elapses for the shunt switch to become overheated.

The example given above is illustrative only, since it is believed that my invention is applicable to a wide current range of switches. Also, though my invention is illustrated in its preferred form in connection with a shunt arcing duty vacuum switch, it is believed that my invention is applicable to other types of shunt arcing duty switches. However, my invention is more important with respect to vacuum switches than other types of switches since small vacuum switches having very high current interruption ratings but low continuous current carrying ratings can be made whereas in other types of switches the difference between intercepting rating and continuous current carrying rating is not as great as in vacuum switches.

While there has been shown and described a particular embodiment of the invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention, and therefore it is intended by the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

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

1. An operating mechanism for an electrical apparatus comprising a pivotally mounted switch arm, one end of said arm having a pin thereon movable through an arc when said arm is pivoted, a pivotally mounted cam, an open sided slot in said cam, the open side of said slot disposed in said arc, said pin engageable with said slot to cause pivotal movement of said cam, and two concave surfaces in said cam separated by a convex surface for imparting reciprocating motion to another member.

2. A switch operating mechanism comprising a pivotally mounted arm, an outer end of said arm movable

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through an arc when said arm is pivoted, a flat pivotally mounted cam having a notch formed in a peripheral edge portion thereof, said notch disposed in said arc and adapted to receive a portion of said arm outer end to cause pivotal movement of said cam, another peripheral edge portion of said cam having a pair of concave surfaces formed therein separated by a convex surface, and a cam follower engageable with said concave and convex surfaces for imparting reciprocating motion to another member as said arm is pivoted.

3. In an electrical apparatus comprising a main electrical switch and a switching duty shunt switch, mechanism for first closing said shunt switch as said main switch is actuated to closed position but before said main switch has reached closed position and then opening said shunt switch after said main switch has reached closed position comprising a pivotally mounted switch arm of said main switch, an outer end of said arm movable through an arc as said arm is pivoted, a pivotally mounted cam having a notch formed in a peripheral edge portion thereof, a portion of said notch disposed in said arc and adapted to receive a portion of said arm outer end as said arm is pivoted to cause pivotal movement of said cam, a pair of spaced concave surfaces formed in another peripheral edge portion of said cam separated by a convex surface of said another peripheral edge portion, and a cam follower engageable with said concave and convex surfaces for imparting closing and opening movement to a movable contact member of said shunt switch as said arm is pivoted from open to closed position.

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