Jan. 17, 1961 R. C. INGWERSEN 2,968,709

ELECTRIC SWITCH INCORPORATING CIRCUIT BREAKER

Filed March 18, 1957 2 Sheets-Sheet 1

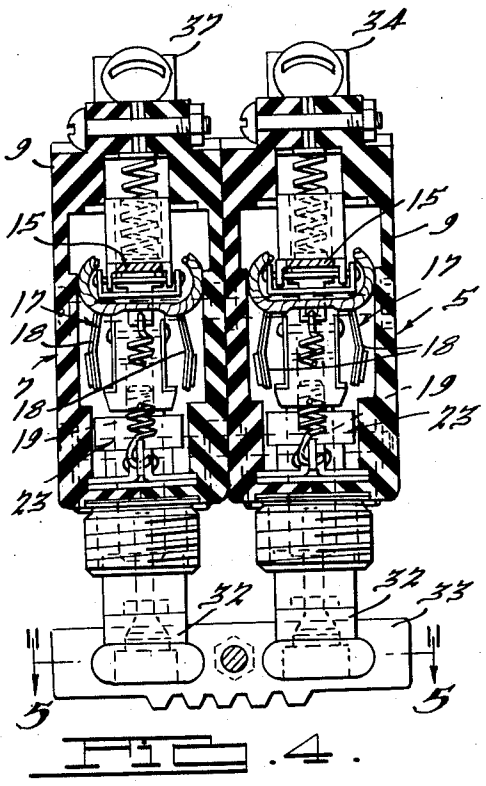


FIG. 4.

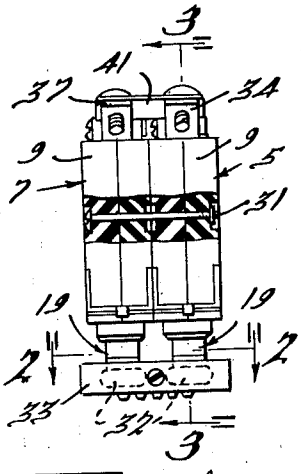


FIG. 1.

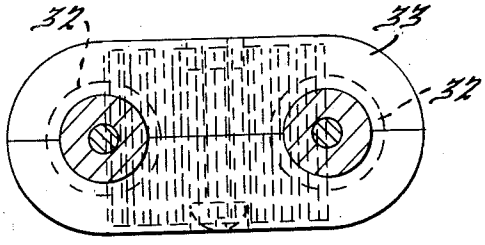


FIG. 2.

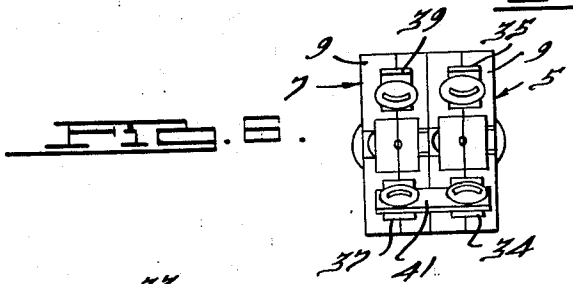


FIG. 6.

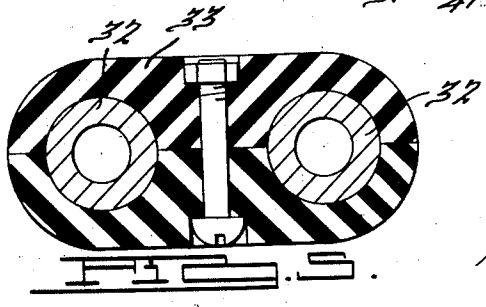


FIG. 5.

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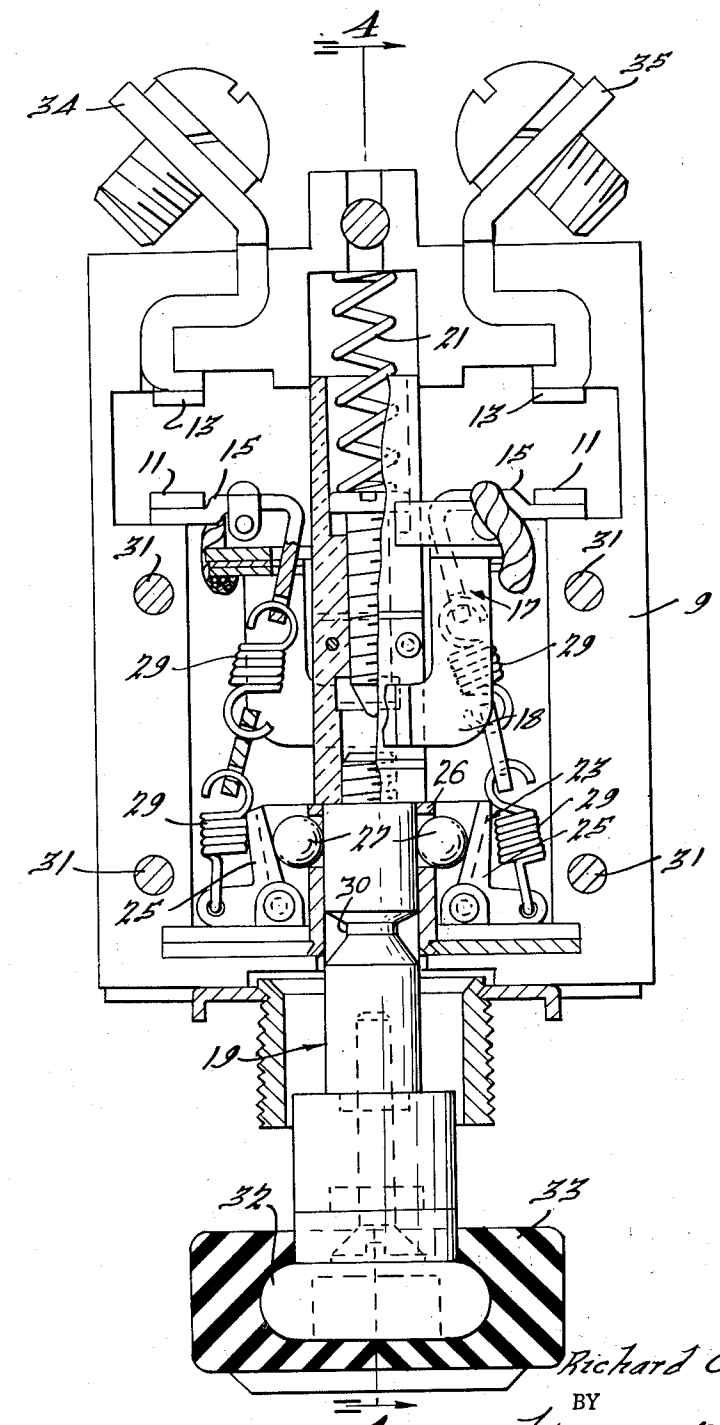


FIG. 3.

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2,968,709

ELECTRIC SWITCH INCORPORATING CIRCUIT BREAKER

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3 Claims. (Cl. 200—116)

This invention relates generally to electric switches and more particularly to a manual off-on switch incorporating an automatic circuit breaker to automatically protect an electric circuit against an overload current in excess of a predetermined rating.

Circuit breaker type switches of the aforementioned type have been in wide use particularly in aircraft, and while such switches have been adapted to automatically interrupt a wide range of electrical currents they are unsatisfactory for use in relatively high voltage circuits. Circuit breaker type switches of the aforementioned type normally include fixed contacts and contacts which move into and out of engagement with the fixed contacts to open or close a circuit through the switch. Circuit breaker type switches must be compact and as small as possible, so that even when the moveable contacts move out of engagement with the fixed contacts, there can only be provided a relatively small air gap between the contacts. Thus, if conventional circuit breakers or switches are used in high voltage electrical systems, the electric current can jump the air gap between the open contacts, thus rendering the switch or circuit breaker useless for interrupting the circuit. It is known, for example, that 20,000 volts will jump a one inch air gap and this is indicative of the necessity of providing, for use in high voltage systems, switches or circuit breakers in which the air gap between the open contacts is greater than can be provided in known switches of this type.

It is, therefore, an object of this invention to provide an electric circuit breaker type switch which will interrupt currents at higher voltages than has been heretofore possible with similar devices and which are useable in "wild frequency" electrical systems, such as are present in jet aircraft or the like. The so called "wild frequency" system is one wherein the alternator is driven directly from the turbine so that when the aircraft takes off the frequency and voltage goes very high in comparison with the frequency and voltage at normal operating speeds of the alternator.

These improved results are obtained with the construction of this invention by interconnecting, as a single operating unit, two or more circuit breaker type electric switches which are electrically connected in series relationship and both of which will open simultaneously upon the occurrence of a predetermined current overload, so that a unit is provided which is capable of interrupting currents at higher voltages because the total air gap between the stationary and moveable contacts is at least doubled when compared to a single circuit breaker type switch.

It is a still further object of this invention to provide an improved circuit breaker type switch of the aforementioned type which is relatively inexpensive to manufacture, compact in construction, light in weight and exceptionally durable in use.

These and other objects of this invention will become apparent from the following detailed description taken

in conjunction with the accompanying drawings in which:

Figure 1 is a side view, partly in section and partly in elevation, of the improved circuit breaker type switch of this invention;

Fig. 2 is an enlarged sectional view of the structure illustrated in Fig. 1 taken along the line 2—2 thereof;

Fig. 3 is an enlarged sectional view of the structure illustrated in Fig. 1 taken along the line 3—3 thereof;

Fig. 4 is a reduced sectional view of the structure illustrated in Fig. 3, taken along the line 4—4 thereof;

Fig. 5 is a sectional view of the structure illustrated in Fig. 4, taken along the line 5—5 thereof, and

Fig. 6 is a plan view of the structure illustrated in Fig. 1.

Referring now to the drawings, it will be seen that a pair of circuit breaker type electric switches 5 and 7 are illustrated as being disposed in a side by side adjacent relationship. Each of the switches 5 and 7 is substantially identical in construction and may be of any suitable construction, such as, for example, illustrated in the copending patent application of Richard C. Ingwersen and R. L. Hamill, filed March 5, 1956, Serial No. 569,375, now Patent No. 2,831,086 and entitled Electric Switch Incorporating an Automatic Circuit Breaker. As will clearly be understood in reference to the aforementioned copending patent application, each of the switches 5 and 7 includes a hollow housing 9 made of electrically nonconductive or insulation material and including therein moveable contacts 11 and fixed contacts 13. The moveable contacts 11 are adapted to engage the contacts 13, when the elements of the switch are in an "on" or closed position and the contacts 11 are carried on the outer ends of contact arms 15 which in turn are pivotally supported, intermediate their ends, on a current responsive latch element 17.

While various types of current responsive latch elements may be used in the switches, the element 17 illustrated is of a bimetallic thermostat type having spaced apart generally U-shaped leg portions 18 which are interconnected adjacent their upper ends. The lower edges of the legs 18 of the latch element 17 normally engage abutment elements carried by actuator means in the form of an electrically non-conductive plunger 19 which is supported in the housing 9 for "in" and "out" movement. The current responsive element 17 is in effect sleeved on the plunger 19 so as to be moveable both with and relative to the plunger. While the plunger is illustrated as being supported in the casing for "in" and "out" movement, between open and closed positions, it is obvious that the actuator means could be supported for movement in other directions without departing from the scope of this invention.

When the latch element 17 is in engagement with the abutment elements on the plunger 19, it will be appreciated that the latch element and the contacts 11 will move as a unit with the plunger 19 as the same moves between its "in" and "out," or closed and open positions; however, if an overload current condition occurs, so as to cause the legs of the thermostat element 17 to expand or move outwardly out of engagement with the abutment elements on the plunger 19, the current responsive latch element and contacts 11 will move as a unit relative to the plunger 19 so as to open or disengage contacts 11 and 13. A coil spring 21 acts against the plunger 19 to urge the same to its "out" or contact open position but is normally restrained from doing so by a mechanical latch mechanism generally indicated at 23 which mechanism acts to retain the plunger in either its "in" or its "out" position.

The mechanical latch which is shown, for purposes of illustration only, is of the type embodying lever like members 25 which are pivotally supported in the housing 9

and engage balls 27 which in turn are supported in openings in a stationary sleeve 26, surrounding the plunger adjacent the bottom of the housing 9. The balls 27 are normally urged against the plunger 19 by means of springs 29 which are connected with each lever and with the contact arms 15 so that when the plunger is in its "in" position and the contacts 11 and 13 are in engagement, the springs 29 will be tensioned so as to apply a load against the balls 27 and move the same into engagement with a detent like groove 30 in plunger 19, thereby retaining the plunger in its "in" position, against the action of spring 21. However, when the current responsive latch 17 moves out of engagement with the abutments on plunger 19, due to current overload, springs 29 pull the latch and contacts 11 downwardly and at the same time the tension on the springs 29 is relaxed so that the spring 21 can push the plunger to its "out" position by camming the balls 27 and levers 25 outwardly out of the way.

The contacts 11 may be moved back into engagement with the contacts 13 by pushing inwardly on plunger 19 and if the legs of the latch element 17 have returned to their normal position they will again engage the abutments on the plunger and the mechanical latch unit will retain the plunger in its "in" position with the contacts closed.

The contacts 11 and 13 may be moved out of engagement manually by merely pulling outwardly on the exteriorly disposed plunger knob 32 with sufficient force to cam the balls 27 and levers 25 out of the way, so that the current responsive latch 17 and the contacts 11 will move with the plunger and away from contacts 13. Subsequently, the contacts 11 and 13 can be re-engaged by merely pushing the plunger inwardly until the balls 27 engage the detent groove on the plunger 19.

With the construction of this invention, at least two switches 5 and 7 are secured together in side by side relationship, by suitable fastening means such as bolts and nuts 31 and the plungers 19 are secured together by a rigid tie bar construction 33 so that the plungers will move outwardly and inwardly together as a unit. The tie bar 33 is shown as formed of two interconnected plastic sections, locked to the plunger knobs 32. The switch 5 includes a pair of terminals 34 and 35 while the switch 7 includes a pair of terminals 37 and 39. A portion of each terminal is disposed exteriorly of the housing 9 of each switch and a portion of each terminal is electrically connected with a fixed contact 13. Two of the terminals, illustrated as being terminals 34 and 37 are electrically interconnected by suitable conduit means or a conductor bar 41 while the other two terminals, namely 35 and 39 are adapted to be connected in an electric circuit in which the switch of this invention is employed. It will thus be seen that the two switches 5 and 7 are electrically interconnected in a series arrangement so that the current will flow, for example, into terminal 35 to one of the fixed contacts 13, through the moveable contacts 11 and the current responsive latch 17 to the other fixed contact thence through terminal 34, bar 41, terminal 37, through the fixed contacts of switch 7, the moveable contacts 11, latch element 17 and out through terminal 39 into the circuit.

The current responsive latch element 17 of both switches 5 and 7 are substantially identical so that both will respond similarly to current overload and will move away from the plunger abutment elements simultaneously, thus causing the contacts 11 and plungers 19 to move to the open position as previously described. However, if one of the current responsive elements responded ahead of the other element, the entire unit would move to contact open position, because of the manner in which the switches are tied together to operate as a single unit. The contacts in both switches can be closed by manually pressing inwardly on the tie bar 33. The unit is, therefore, manually actuatable between contact open and contact closed positions by exerting a manual force on the tie bar, and both switches 5 and 7 will respond as a single unit.

It will thus be appreciated that the air gap between the fixed and moveable contacts 11 and 13 is at least doubled as compared with the air gap in a single switch and that, therefore, the single operating unit of this invention, composed of two or more interconnected switches can interrupt currents at higher voltage than a single switch. For example, it has been found that a single switch 5 can interrupt a current at a voltage of approximately 208 volts while a unit composed of the two switches 5 and 7, interconnected in series, can interrupt a current at a voltage of approximately 350 volts.

Furthermore, by the use of two current responsive latch elements 17, the resistance of the switch unit thus provided is doubled and the switch acts more efficiently as a current limiter and, furthermore, by employing two housings of electrically nonconductive material, arcing problems between the adjacent sets of contacts are eliminated, which problem might occur if all of the contacts were in a single housing.

The circuit breaker type switch of this invention thus has many operating advantages over a single circuit breaker or switch, and is useable in electrical systems where a single switch would not suffice and the construction thus provided is exceptionally durable, is very compact and is relatively light in weight which, of course, is extremely important in aircraft installations.

While the switch illustrated in the drawings is composed of only two side by side circuit breaker type switches, it will be appreciated that a plurality of such switches may be provided in a similar arrangement and connected together in series to interrupt currents at even high voltages.

What is claimed is:

1. An electrical circuit breaker unit comprising a plurality of electric circuit breakers secured together in an adjacent relationship, each of said circuit breakers including a housing, relatively moveable contact means in each housing moveable into and out of engagement so as to be capable of opening or closing a circuit through said unit, trip means in each housing responsive to a predetermined current overload so as to automatically move said contact means out of engagement, each of said circuit breaker housings having walls of electrical insulating material which separate the contact means in one housing from the contact means of the adjacent housing so as to provide an electrical barrier which will prevent arcing between the contact means of said circuit breakers, each of said circuit breakers having a pair of terminals electrically connected with the contact means thereof, conduit means electrically interconnecting certain of said terminals of said unit so that said circuit breakers are electrically connected in series relationship, at least two of said terminals of said unit being connectible in an electrical circuit, and means mechanically interconnecting said circuit breakers so that actuation of any one of said trip means is operative to trip all of said circuit breakers.

2. A single-pole electrical circuit breaker unit comprising a plurality of electric circuit breakers secured together in an adjacent relationship to provide a single operating unit, said unit including housing means enclosing said circuit breakers, each of said circuit breakers including relatively movable contact means movable into and out of engagement so as to be capable of opening or closing a circuit through said unit, each of said circuit breakers including means responsive to a predetermined current overload to automatically move said contact means out of engagement, each of said circuit breakers including a manually actuatable member projecting exteriorly of said housing means and connected with said contact means so that said contact means can be moved into and out of engagement by actuation of said member, means rigidly interconnecting said manually actuatable members so that the same will move together as

a unit upon actuation of any one thereof, each of said circuit breakers having a pair of terminals electrically connected with the contact means thereof, conduit means electrically interconnecting certain of said terminals so that said circuit breakers are electrically interconnected in a series relationship, at least a pair of said terminals of said unit being connectible in an electric circuit, and an electric barrier disposed in said housing means between the adjacent circuit breakers so as to prevent arcing between the contact means of the adjacent circuit breaker.

3. A manually actuatable switch having automatic current overload protection and including a pair of side-by-side switches, each of which includes a housing formed of electrical insulating material, means rigidly interconnecting said housings in said side-by-side relationship, a pair of stationary contacts in each of said housings, a pair of interconnected contacts in each of said housings movable as a unit into and out of engagement with said stationary contacts, a manually actuatable member operatively connected with said movable contacts in each of said housings and manually movable between a position to engage said movable and stationary contacts and a position to disengage said movable and stationary contacts, rigid means interconnecting said manually actuatable members so that both of said members will be simultaneously actuated upon manual actuation of one of the same, substantially identical current responsive means in each of said housings operatively connected

with the movable contacts so that upon the occurrence of a predetermined current overload the movable contacts in both of said housings will move out of engagement with said fixed contacts, a pair of terminal members electrically connected with the fixed contacts in each housing, and conduit means electrically connecting one terminal member of one housing with a terminal member in the other housing so that the contacts in the housings are electrically connected in series relationship, the other terminals of said housings being connectible in a circuit so that current will flow through the contacts in both housings, said switch housings having walls of electrical insulating material which separate the contacts of one switch from the contacts of the adjacent switch so as to provide an electrical barrier which will prevent arcing between the contacts of said switches.

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