April 15, 1958 R. C. INGWERSEN ET AL 2,831,086

ELECTRIC SWITCH INCORPORATING AN AUTOMATIC CIRCUIT BREAKER

Filed March 5, 1956 3 Sheets-Sheet 1

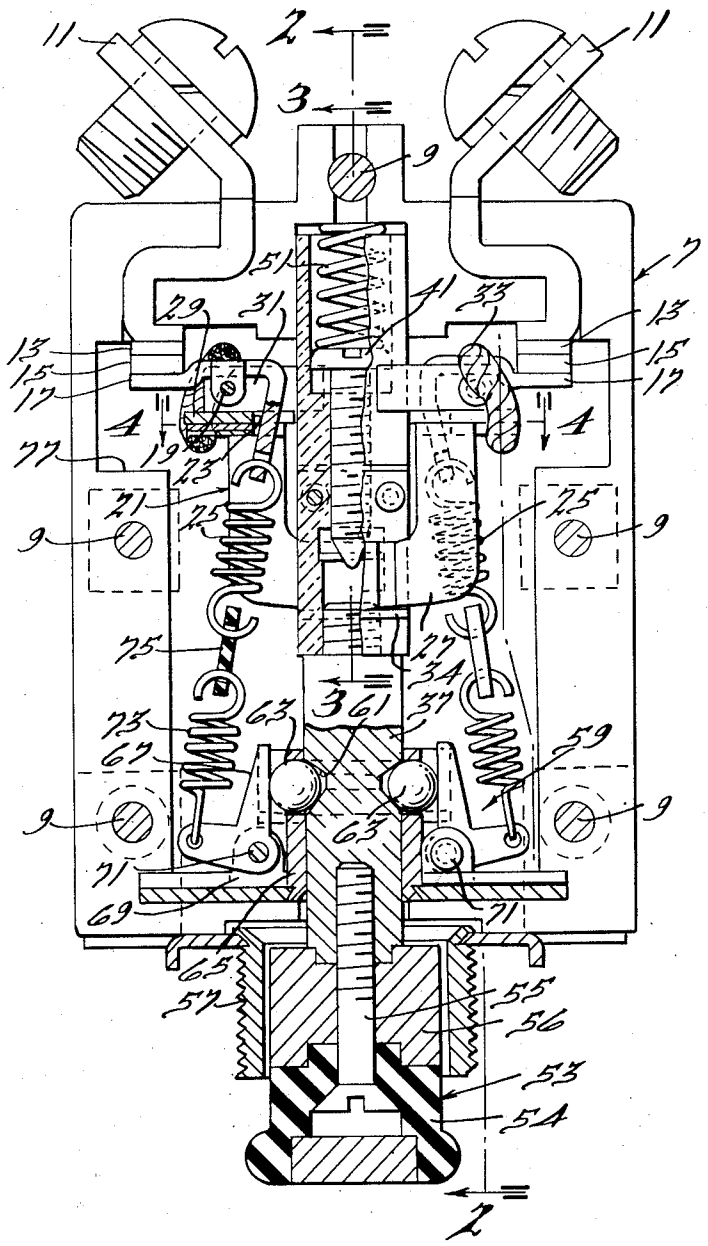


Fig. 1.

INVENTORS.
Richard C. Ingwersen
Raymond A. Hamill
BY
Harness, Dickey & Pierce.
ATTORNEYS.

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Filed March 5, 1956 3 Sheets-Sheet 2

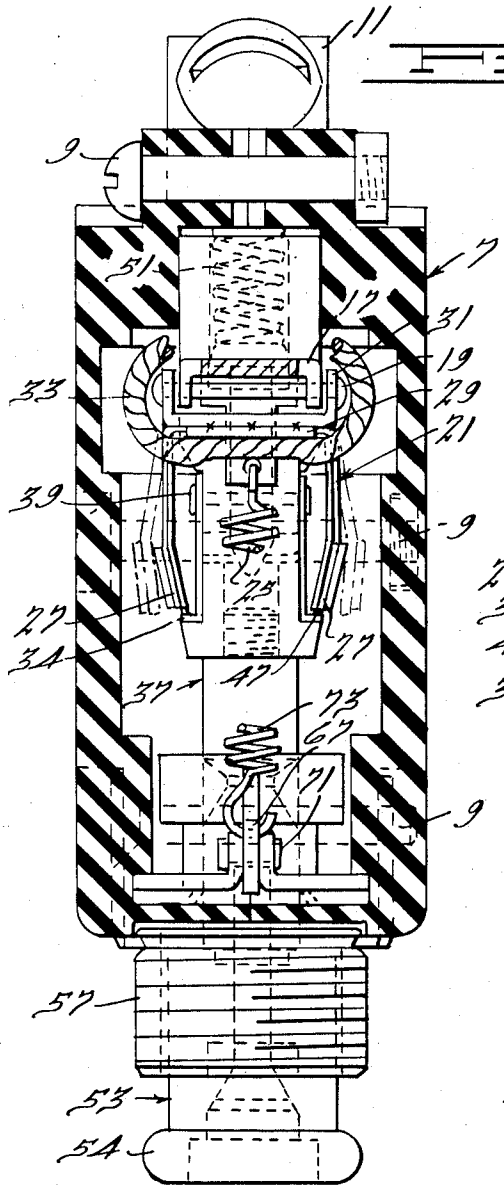


FIG. 2.

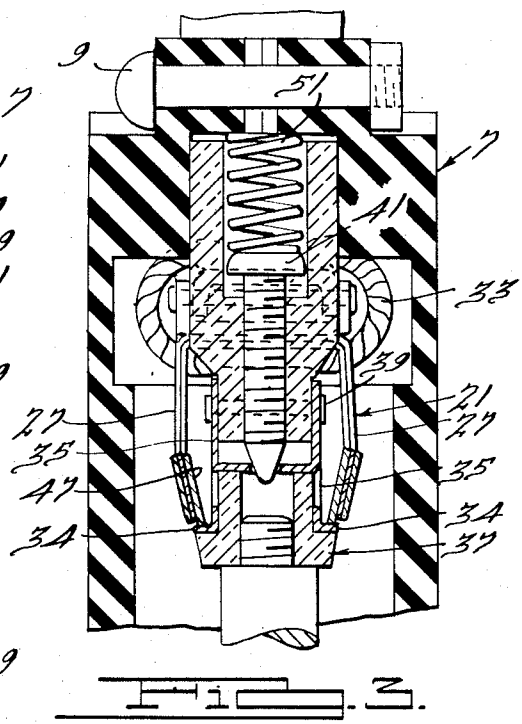


FIG. 3.

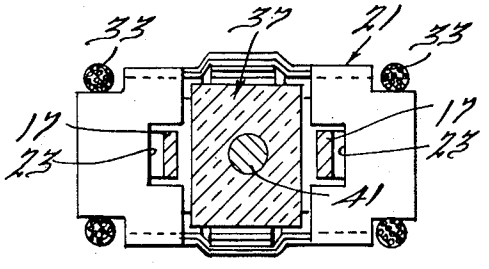


FIG. 4.

INVENTORS
Richard L. Ingwersen
Raymond L. Hamill
BY
Harness, Dickey & Pierce
ATTORNEYS

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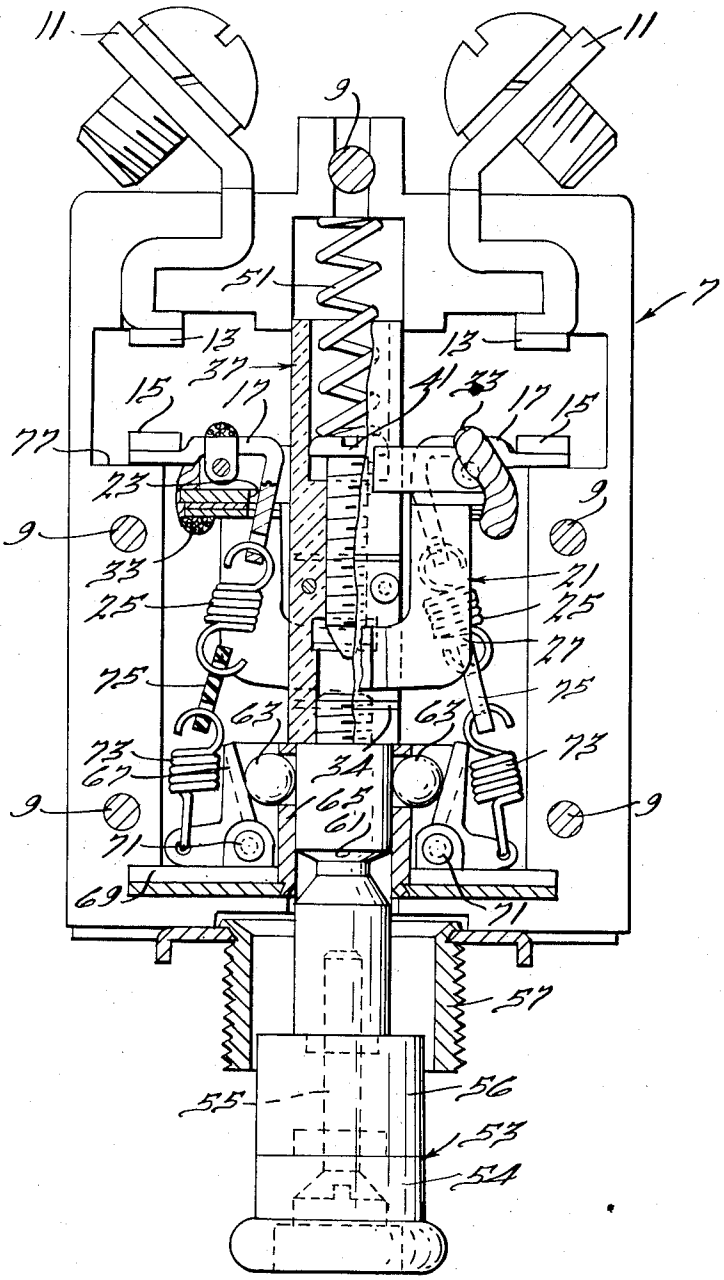


Fig. 5.

INVENTORS.
Richard L. Ingwersen
Raymond L. Hamill
BY
Harness, Dickey & Pierce
ATTORNEYS.

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ELECTRIC SWITCH INCORPORATING AN AUTOMATIC CIRCUIT BREAKER

Richard C. Ingwersen, Jackson, and Raymond L. Hamill, Grass Lake, Mich., assignors to Mechanical Products, Inc., Jackson, Mich., a corporation of Michigan

Application March 5, 1956, Serial No. 569,375

6 Claims. (Cl. 200—116)

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

A requirement of circuit breaker type switches, particularly in the aircraft field, is that they be extremely durable and be capable of being manually actuated between "off" and "on" positions many thousands of times for controlling an electric circuit. Such switches, in order to provide overload current protection, generally include an element which is actuatable in response to current overloading to open switch contacts and interrupt the circuit. Such a current responsive element is generally finely calibrated and in order to protect the same against fatigue and excessive wear, it is desirable that this element not be actuated during manual actuation of the switch between "on" and "off" positions. While circuit breaker type switches have been designed in which the switch may be manually operated between "off" and "on" positions without actuating a current responsive element or the like, these devices have been relatively complicated in construction and relatively expensive to manufacture.

It is, therefore, an object of this invention to provide an improved circuit breaker type switch of the aforementioned type in which manual actuation of the switch can take place without disturbing the setting of a current responsive element or latch, and in which the current responsive latch is subject to current overload actuation to automatically open the switch in the event of excess current in a circuit.

It is a still further object of this invention to provide in a switch of the aforementioned type an improved mechanical or manual latch which may be actuated to permit the switch to be manually moved between open and closed positions and which will be actuated in response to actuation of a current responsive latch to permit the switch to automatically move to open position and thus provide overload current protection.

It is a still further object of this invention to provide a switch of the aforementioned type in which, after the switch has been opened, due to actuation of the current responsive element, all of the elements will automatically assume the proper relative positions to enable the switch to be manually reset or closed, provided the current overload condition no longer exists.

It is a still further object of this invention to provide a switch of the aforementioned type which is simpler in construction comprised of fewer parts and less expensive to manufacture than switches of a similar type heretofore known.

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 longitudinal view partly in section and partly in elevation of the switch of this invention and illustrating the parts in their "on" or closed position;

Fig. 2 is a 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 sectional view of the structure illustrated in Fig. 1 taken along the line 4—4 thereof; and

Fig. 5 is a view similar to Fig. 1 illustrating the switch in its "off" or open position.

Referring now to the drawings, it will be seen that the operating parts of the switch are disposed within a hollow casing 7 which may be formed of two parts secured together by suitable fastening elements 9. Supported within and projecting beyond one end of the casing are spaced apart electrical terminals 11, the inner ends of which are connected to fixed electrical contacts 13. The terminals 11 are, of course, adapted to be connected by a suitable wiring in an electrical circuit so that the switch can control current flow through the circuit. Movable contacts 15 are provided within the casing and are adapted to engage the contacts 13 when the elements of the switch are disposed in an "on" or closed position. The contacts 15 are carried on the outer ends of contact arms 17, which, in turn, are pivotally supported, intermediate their ends, on a current responsive latch element generally indicated at 21. The inner ends of the contact arms 17 are bent to extend through adjacent openings 23 in the current responsive latch element 21, and are connected with a coil spring 25 for reason which will hereinafter appear.

While various types of current responsive latch elements may be used in a circuit breaker type switch of this invention, the element 21 is illustrated herein as being of a bi-metallic or tri-metallic thermostat type having spaced apart, generally U-shaped latch or leg portions 27 which are interconnected adjacent the upper ends thereof, as viewed in Figs. 1 and 2, by bridge portions 29. Arc shields 31 are connected to the bridge portions 29, and the contact arms 17 are pivotally connected at 19 to the shields. Suitable electric connectors, such as pigtails 33, are connected with contact arms 17 and current responsive latch element 21 so that when the contacts 13 and 15 are closed, an electrical circuit between the terminals is completed through the latch element. The contacts 15, contact arms 17, and current responsive latch element 21 comprise a unit adapted for movement within the casing 7.

The lower edges of the current responsive latch element legs 27 normally engage or abut projecting ledges 34 formed on the lower ends of abutment elements 35 carried by actuator means in the form of a non-electrically conductive plunger 37 which is supported in the casing 7 for in and out movement. The current responsive element 21 is in effect sleeved on the plunger 37 so as to be movable both with and relative to the plunger, as will hereinafter appear. While the actuator means 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.

The abutment elements 35 are supported on opposite sides of the plunger by suitable fastening means, such as rivets 39. The upper end of the plunger 37 is recessed and has a threaded screw 41 disposed therein, and the leading end of the screw 41 is tapered at 43 and engages projections 45 on the abutment elements 35 which extend into an opening in the plunger. By adjusting the position of the screw 41 in the plunger 37, the ledges 34 on the lower ends of the abutment elements 35 may be moved

inwardly or outwardly relative to the plunger to control the amount of actuation or expansion of the current responsive latch element legs **27**, which is necessary before disengagement of the latch element from the abutment elements occurs. Thus, the adjusting screw enables the circuit breaker to be finely calibrated.

It will be noted that the current responsive element **21** is of a bi- or tri-metallic type composed of different metals disposed in a laminated relationship so as to be properly responsive to current overload and so as to move outwardly away from the abutment elements **35** when a predetermined current is passing therethrough. In order to prevent or reduce wear of the current responsive element, a stainless steel shoe or plate **47** is provided on the lower ends of each of the latch element legs **27** for engagement with the abutment elements **35**, while the lower ends of the bi-metallic strips or laminations are disposed above the lower end of the stainless steel and do not engage the plunger abutment elements.

When the legs of the latch element **21** are in engagement with the abutment elements **35** it will be seen that the latch element and the contacts **15** will move as a unit with the actuator plunger **37** as the same moves between its "in" and "out" or closed and open positions. However, as will hereinafter appear, if an overload current condition exists so as to cause the legs **27** to expand or move outwardly out of engagement with the abutment elements **35** on the plunger **37**, the current responsive latch element **21** and the contacts **15** will move as a unit relative to the plunger so as to open or disengage the contacts **13** and **15**.

A coil spring **51** is disposed in the recess in the upper end of the actuator plunger **37**, and the lower end of the spring abuts the head of the screw **41**, while the upper end of the spring abuts the casing **7**. The spring is compressed when the switch is disposed in its "on" or contact closed position and resiliently urges the plunger **37** downwardly or to its "off" or contact open position. While the actuator plunger **37** is illustrated as being formed of two threadably interconnected parts for the purposes of this application, whether the plunger is formed of one or more parts is unimportant.

The lower end of the plunger **37** extends through the bottom of the casing **7** and has a button or handle **53** connected therewith by a fastener **55**. The button **53** is composed of an outer part **54** of one color and an inner part **56** of a different color. The button extends through and beyond a boss or sleeve **57** which is connected to the casing, and the sleeve conceals from view the inner button part **56** when the switch is in its closed position. However, when the plunger moves to its "off" or contact open position, the inner part of the button will be moved outwardly beyond the confines of the sleeve so as to visually indicate to the user that the switch is open. The button or handle **53** is, of course, adapted to be grasped by a user to manually actuate the plunger **37** and move the same between its open and closed positions.

In order to releasably retain the actuator plunger in its open or closed positions, a mechanical latch mechanism **59** is provided. While this latch may take various forms, it may be generally referred to as a friction type latch, that is, a latch which engages the actuator plunger so as to retain the same in a set position but the holding force of which may be overcome by the exertion of a predetermined effort or force to move the actuator relative to the casing and to the latch mechanism. In the particular embodiment, a spring-loaded ball and detent type mechanism is provided, and it will be noted that the plunger **37**, adjacent the lower end thereof, has a circumferential groove or detent **61** therein normally engaged by a pair of opposed balls **63** which are supported for movement toward and away from the plunger by means of an apertured cage **65**. The balls **63** are normally urged into engagement with the plunger detent **61** by means of

angle shaped levers **67** which are pivotally supported on the casing. The levers **67** have a portion extending generally parallel to the plunger and a portion extending angularly from the plunger and are pivotally connected at **71**, adjacent the juncture of these portions, to a stationary plate or bracket **69** supported in the casing **7**. A coil spring **73** is connected with each lever **67**, outwardly of the pivots **71**, and the opposite end of each coil spring is connected with the adjacent coil spring **25** through insulator plate **75**. The insulator plates **75** are provided to insulate the contact arms **17** from the levers **67**, but the springs **25** and **73** on each side of the plunger act, from a functional standpoint, as a single coil spring.

When the contacts **15** are in engagement with the contacts **13**, the coil springs **25** and **73** are stretched or tensioned so as to impart a resilient force to the levers **67** to urge the same into engagement with the balls **63** and to resiliently urge the balls into engagement with the detent **61** in the actuator plunger **37** with a sufficient force to retain the plunger in its "on" or contact closed position against the force of the coil spring **51** which is resiliently urging the plunger toward its "out" or contact open position. It will, however, be appreciated that upon the exertion of a predetermined manual pulling effort on the actuator button **53**, the detent **61** will cam the balls **63** outwardly away from the plunger to permit the plunger to move to its "out" or contact open position, thus moving the actuator, the current responsive latch element **21**, the contact arms **17**, and the contacts **15** away from the fixed or stationary contacts **13**.

It will be noted that the casing is provided, below the outer ends of the contact arms **17**, with ledges **77** to limit the downward movement of the contact arms, and it will also be noted that the openings **23** in the current responsive latch element, through which the inner ends of the contact arms extend, are of a size to limit the pivotal movement of the contact arms when the contacts are moved apart.

Thus, in operation, while the actuator plunger may be manually moved between open and closed positions without affecting or actuating the current responsive element or latch, the latter with be actuated if the current flowing through the switch exceeds a predetermined value. When this occurs, the legs **27** of the current responsive element will move outwardly beyond the ledges **34** of the abutment elements **35** so that the element is free to slide on the plunger and the springs **25** and **73** will pull the element, the contact arms **17** and the contacts **15** as a unit away from the stationary contacts **13** thus interrupting current flow through the circuit breaker. Upon the movement of the current responsive unit away from contacts **13** and toward the latch mechanism **59**, the springs **25** and **73** will collapse or return to their unstretched state so that the levers **67** and the balls **63** are no longer resiliently urged into engagement with the detent **61**, thus freeing the actuator plunger **37** for movement to its "out" position under impetus of the expansion of the spring **51**. The springs **25** and **73**, therefore, act in effect as a lever for moving the latch mechanism **59** to its unlatched position upon movement of the current responsive unit relative to the plunger and casing. The spring **51** will thus automatically move the actuator plunger **37** to its "out" position so that the ledge portions **34** of the abutment elements **35** will be disposed below the lower ends of the current responsive element legs **27**, whereby when the legs of the elements have returned to their normal contracted position, and the plunger is pushed inwardly, the plunger abutment elements **35** will engage the element legs **27**. As the plunger is pushed to its "in" position, the current responsive unit will then move therewith and the contacts **15** will again engage the contacts **13**, while the spring **51** will be compressed and the springs **25** and **73** will be stretched or tensioned so that they will releasably retain the plunger in its "in"

or contact closed position. If the current responsive element has not sufficiently cooled or if the current overload condition still exists, the element legs **27** will not engage the abutment ledges **34** and the switch cannot be reset.

It will, therefore, be appreciated that a relatively simple and inexpensive circuit breaker type switch is provided which may be manually actuated between "off" and "on" positions without affecting the current responsive element, but the arrangement is such that the circuit breaker type switch is automatically responsive to a predetermined current overload so as to move to its open or "off" position and may thereafter be properly reset. It, furthermore, will be noted that while the mechanical or manual latch mechanism **59** may be overcome by predetermined manual effort to permit movement of the plunger between "on" and "off" positions, the manual latch mechanism likewise is resonsive to movement of the current responsive latch element and associated contacts to be conditioned so as to permit the spring **51** to automatically move the actuator plunger to its open position for subsequent reset.

What is claimed is:

1. In an electric manual on-off switch having automatic overload protection, casing structure housing relatively fixed and movable electrical contact means, actuator means supported in said casing structure and operatively connected with said movable contact means for moving said contact means to open and closed positions, means in electrical connection with said contact means and responsive to the current conducted when said contact means are closed to cause said movable contact means to move automatically to open position upon the current reaching a predetermined overload value, latch means associated with said actuator means for releasably retaining the same in its closed position, said actuator means being movable in said casing relative to said latch means upon exertion of a predetermined manual effort thereto to open or close said contact means, means operating against said actuator means to urge the actuator means to open position, and means connecting said latch means with said movable contact means, said connecting means being operated to condition said latch means to permit said actuator means to be moved to open position by said urging means upon said current responsive means being actuated to move the movable contact means to open position.

2. An electric switch as claimed in claim 1, said latch means including movable means engageable with said actuator means to hold the latter in open or closed position, and said connecting means comprising a spring connected with said movable contact means, said spring being energized by movement of said movable contact means to closed position, said energized spring urging said movable latch means into tensioned holding relation with respect to said actuator means, said spring being automatically de-energized upon automatic release of the movable contact means to open position, whereby to free the said actuator means for actuation by said urging means.

3. An electric switch as claimed in claim 1, said connecting means comprising a spring and said latch means including a pivoted part, said spring being connected between said pivoted part and said movable contact means and being tensioned when said movable contact means is moved to closed position, said tensioned spring tensioning said pivoted part into holding relation with respect to said actuator, said spring being automatically de-energized upon automatic release of said movable contact means to open position, whereby the pivoted latch part is relieved of said tension and said actuator urging means is able to free the actuator from the holding restraint of said latch means.

4. In an electric manual off-on switch having automatic overload protection, casing structure housing relatively fixed and movable electrical contact means, actuator means supported in said casing structure and operatively connected with said movable contact means for moving said contact means to open and closed positions, means in electrical connection with said contact means and responsive to the current conducted when said contact means are closed to cause said movable contact means to move automatically to open position upon the current reaching a predetermined overload value, latch means supported in said casing and frictionally engaging said actuator means for retaining the same in its closed position, said actuator means being moveable in said casing relative to said latch means upon exertion of a predetermined manual effort thereto to open and close said contact means, means operating against said actuator means to urge the same to open position, and means connecting said latch means with said movable contact means so that when said movable contact means moves to open position due to actuation of said current responsive means said latch means will be actuated to release said actuator means for movement by said urging means.

5. In an electric manual off-on switch having automatic overload protection, casing structure housing relatively fixed and movable electrical contact means, actuator means including a plunger supported in said casing structure for lineal movement and operatively connected with said movable contact means for moving said contact means between open and closed positions, means in electrical connection with said contact means and responsive to the current conducted when said contact means is losed to cause said movable contact means to move automatically to open position upon the current reaching a predetermined overload value, said actuator means plunger including detent means, ball means supported in said casing for movement toward and away from said plunger and normally engaging said plunger detent means, means urging said ball means into engagement with said detent means for retaining said actuator means in its closed position, said actuator means being movable in said casing relative to said ball means upon exertion of a predetermined manual effort thereto to open and close said contact means, resilient means connected between said movable contact means and said ball urging means, said resilient means being under tension when said movable contact means is closed so as to resiliently urge said ball means into engagement with said detent means and being relieved from tension and releasing said ball means when said current responsive means moves said movable contact means to open position, and means acting against said actuator means for moving the latter to its open position when said ball means has been released.

6. In an electric manual off-on switch having automatic overload protection, a hollow casing in which relatively fixed and movable electrical contact means are disposed, actuator means movably supported in said casing for movement between contact open and closed positions, thermostatic means supported on said actuator means for movement therewith and mechanically and electrically connected with said contact means, said thermostatic means being responsive to current conducted when said contact means are closed to move relative to said actuator means and to move said contact means automatically to open position upon the current reaching a predetermined overload value, latch means engageable with said actuator means for releasably retaining the same in its closed position, said actuator means being movable in said casing relative to its latch means to open or close said contact means upon exertion of a predetermined manual effort thereto, means urging said actuator means to open position, and link means connecting said latch means with said movable contact means so that when said movable contact means moves to open position because of actuation of said

thermostatic means said link means will actuate said latch means to permit said urging means to move said actuator means to open position.

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