June 13, 1944. H. F. ALFERY 2,350,978

COMBINED SAFETY SWITCH AND LIMIT CONTROL

Filed June 19, 1941 2 Sheets-Sheet 1

Fig. 1.

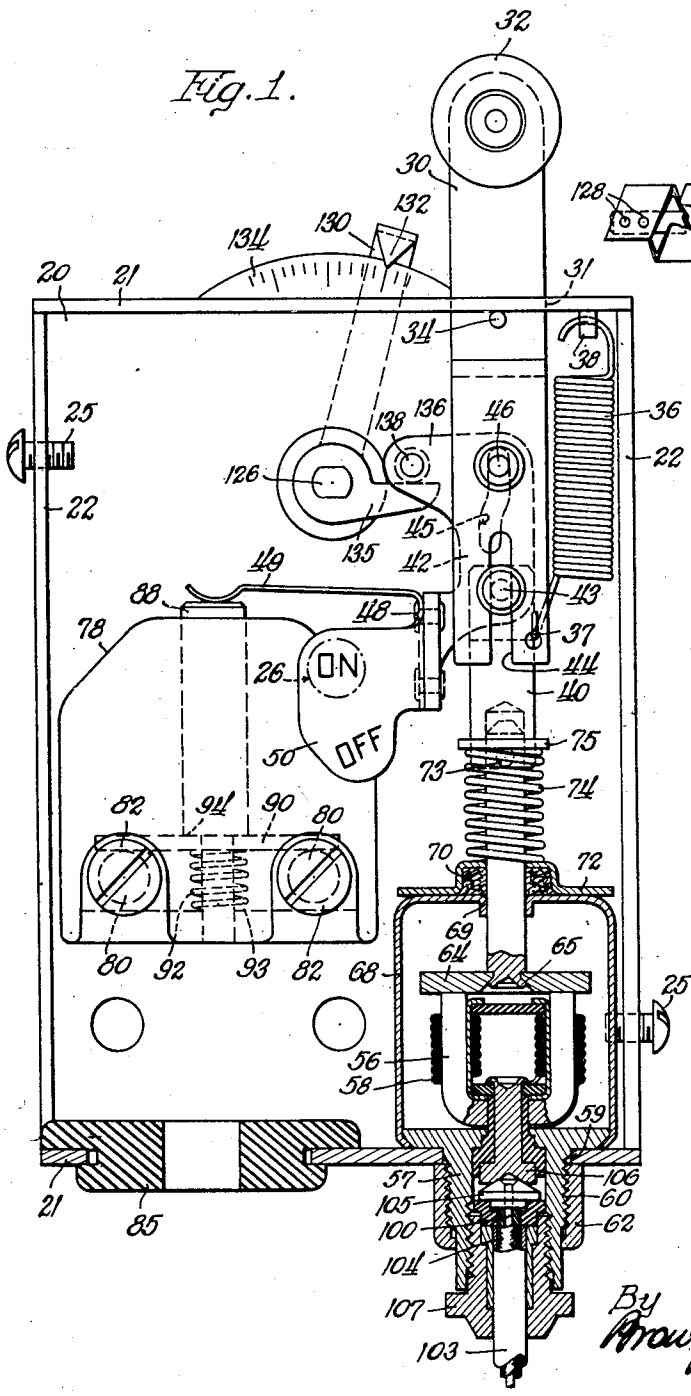
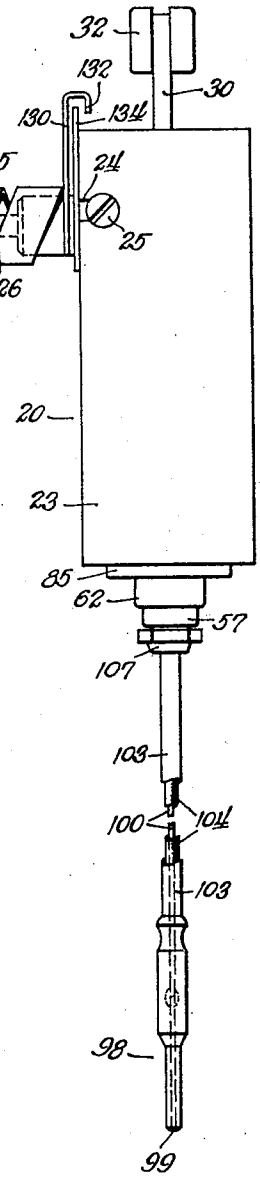


Fig. 2.



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Fig. 4.

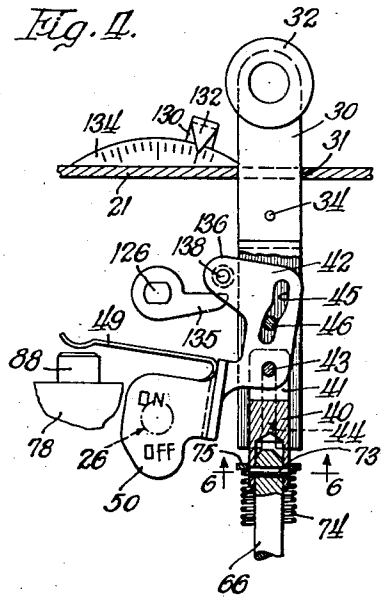


Fig. 3.

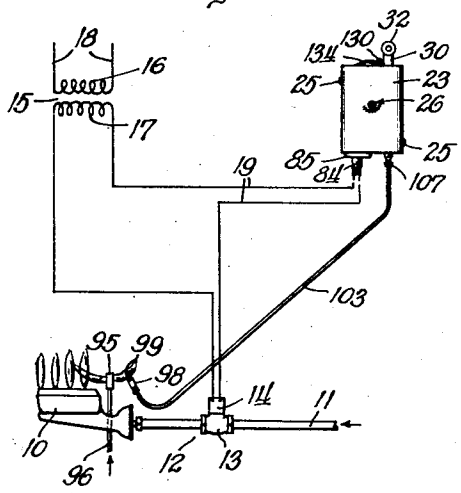


Fig. 5.

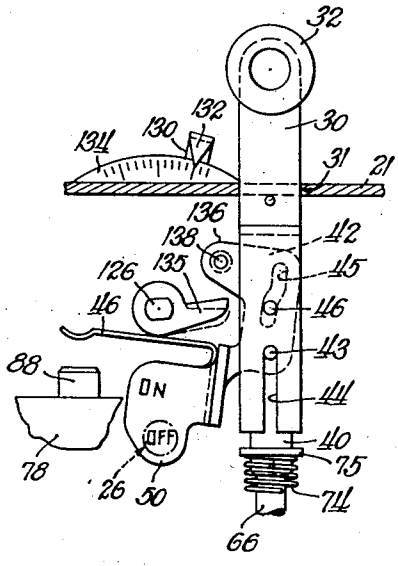
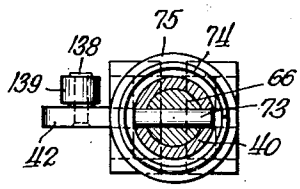


Fig. 6.



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UNITED STATES PATENT OFFICE

2,350,978

COMBINED SAFETY SWITCH AND LIMIT CONTROL

Henry F. Alfery, Milwaukee, Wis., assignor to Milwaukee Gas Specialty Company, Milwaukee, Wis., a corporation of Wisconsin

Application June 19, 1941, Serial No. 398,756

8 Claims. (Cl. 200—87)

This invention relates, generally, to protective devices for burner apparatus, and it has particular relation to a combined safety switch and limit control.

While the particular device which I shall describe in connection with the drawings is a combined safety switch and limit control operative to cause a valve in the fuel supply pipe leading to the burner to close not only whenever a flame to which the device is responsive—as a pilot flame—goes out, but also upon the occurrence of an abnormal temperature, it is to be understood that the invention, in its broader aspects, is not limited to this particular use but may be employed in all similar work as suitable or desired.

Moreover, while I have shown and shall describe the combined safety switch and limit control of the present invention in connection with a valve that requires current only for opening the same, the invention is not limited to use with valves of this particular type, but may be employed with valves that require current for both opening and closing the valve, and it is to be understood that the combined safety switch and limit control may be used for controlling other circuits and other devices than the particular circuit and particular device selected for illustration.

One of the main objects of the invention is to provide a combined safety switch and limit control for opening the circuit into which the device is connected, for example, not only upon extinguishment of the flame to which the device is responsive, or upon the occurrence of some other abnormal condition or malfunctioning of the apparatus, but also upon the occurrence of an excessive temperature or other additional abnormal condition or malfunctioning of the apparatus.

Another object of the present invention is to provide, in a device of the character set forth, a switch or other control device which is adapted to be reset to closed or operating position only when the flame to which the device is responsive is burning and when the temperature has dropped below the excessive temperature at which the limit control is operative, or when the other different abnormal conditions to which the device is responsive are cured.

Another object of the invention is to provide a combined safety switch and limit control which is of simple, inexpensive, and improved construction embodying few parts and operative effectively to accomplish the results set forth.

While the particular structural features and combinations by which I obtain a device of the character set forth are important features within the more specific aspects of the invention, it is to be understood that the precise features shown and described may be varied within the broader aspects of the invention.

In order to acquaint those skilled in the art with the construction and operation of a safety switch embodying the present invention, I will now describe, in connection with the accompanying drawings, one preferred embodiment of the invention.

In the drawings:

Figure 1 is a front view of a combined safety switch and limit control embodying the present invention, partially in section and with the cover removed, and showing the switch in closed position;

Figure 2 is a side elevational view of the combined safety switch and limit control;

Figure 3 is a more or less diagrammatic view showing the switch in front elevation and in connection with burner apparatus;

Figure 4 is a fragmentary detail view showing the position of the switch actuator and reset means, with the reset member pressed inwardly to cock or reset the device;

Figure 5 is a view similar to Figure 4 showing the position of the switch actuator and reset means with the switch in open position and the reset member and reset stem released; and

Figure 6 is a detail section taken on the line 6—6 of Figure 4.

In Figure 3 of the drawings, a gas or other fuel burner of any suitable or preferred type is conventionally illustrated at 10. The burner 10 may be the burner of a room or space heater, water heater, floor furnace, gas range, or any other burner. A gas or other fuel supply pipe 11 leads to the burner 10 for the delivery of gas or other fuel thereto—for example, through a mixing chamber (not shown) to which air is admitted in the usual way, as well understood in the art.

A power actuated or electroresponsive valve 12, such as a solenoid or motor valve, is interposed in the fuel supply pipe 11. The valve 12 is shown as comprising a valve body 13 and a hood 14 having suitable power operated valve actuating means therein. A step-down transformer 15 supplies power for the operation of the valve 12. This transformer comprises a line voltage primary 16 and a low voltage secondary 17. The primary 16 is connected to line wires

18 leading to any suitable source of current or power (not shown). The valve actuating means for the valve 12 is connected into the secondary circuit 19. The safety switch and limit control of the present invention is also connected into the secondary circuit 19, as will presently appear.

For purposes of illustration, it may be assumed that the valve 12 is of a character to be actuated to open position by closing of the circuit 19, and to be held in open position to supply fuel or operative energy to the burner 10 as long as the circuit 19 is closed. The valve 12 may have spring means, or other suitable means, for actuating the valve to closed position to shut off the supply of fuel to the burner 10 when the circuit 19 is opened or otherwise disabled.

The safety switch selected for illustration is similar to that more fully disclosed in the copending application of Harold A. Montz, Serial No. 394,601, filed May 22, 1941, which became Patent No. 2,340,197 on January 25, 1944, but it is to be understood that the construction and operation of the safety switch part of the combined safety switch and limit control of the present invention may, within the broader aspects of the invention, be of any other suitable or preferred form.

The safety switch and limit control is shown as located within a housing 20. The opposite ends of the back wall of the housing are turned in to form end walls 21, and, at the opposite sides of the back wall, are inturned flanges 22. The cover 23, which may be of generally U-shaped cross section, fits over the inturned end walls 21, with the inner marginal edges of the sides of the cover fitting over the flanges 22. Slots 24 opening inwardly from the inner marginal edges of the side walls of the cover fit over the shanks of screws 25 having threaded engagement in the side flanges 22. These screws 25 are adapted to be tightened to secure the cover in place on the base of the housing, and to be loosened to permit removal of the cover. The screws 25 and slots 24 may be positioned at different distances from the opposite ends of the device to assure proper mounting of the cover 23.

The front wall of the cover 23 has an opening 26, shown in Figure 3 and in dotted lines in Figures 1, 4, and 5, through which opening an indicator is adapted to be viewed to indicate the position of the switch, as will hereinafter appear.

An actuator or reset member 30 operates between open and closed positions by rectilinear movement through an opening 31 in the adjacent end wall 21 of the housing. The outer end of the actuator member 30 is provided with an operating button 32. The actuator member 30 is shown as comprising a pair of actuator member parts forming a fork at the inner end of the actuator member and secured together outwardly of the forked inner end. A pin 34, secured in the actuator member 30 outwardly of its forked inner end, cooperates with the adjacent end wall 21 to limit outward movement of the actuator member.

The actuator member 30 is yieldingly retained in its outwardly projected position as shown in Figures 1 and 5, and upon release of the button 32, as will presently appear, is returned to this outwardly projected position by a coiled return spring 36. This spring 36 is shown as connected between the inner end of the actuator member 30 at 37 and a spring anchoring lug 38 pressed inwardly from the adjacent end wall 21 of the housing.

A reset member 40 extends between the sides of the forked inner end of the actuator member 30. The inner end of the member 40 has a bifurcation or slot at 41 within which a cam lever 42 is pivoted on a pin 43, the opposite ends of which pin extend into longitudinal slots 44 in the opposite sides of the forked inner end of the actuator member 30. The cam lever 42 has a cam slot 45 through which extends a pin 46, the opposite ends of which are secured in the opposite sides of the forked inner end of the actuator member 30.

The cam lever 42 has secured thereto, for example, at 48, an overtravel spring arm 49 for actuating the switch to closed position. The lever 42 carries a flag or indicator member 50. This indicator member 50 has "on" and "off" markings thereon as shown, or is provided with colored or other appropriately marked portions for indicating through the opening 26 in the switch cover 23 the position of the switch, as will presently appear.

The means for holding the reset member 40 in the position shown in Figure 1 so that the switch will close when the actuator member is released following its inward resetting movement and will remain closed as long as the member 40 is held in the position shown in Figure 1 and the actuator member 30 is in its outwardly projected position is shown in the form of an electromagnet located within the housing 20. The electromagnet selected for illustration comprises a magnet frame 56 secured, for example, to a terminal bushing 57 in the manner more fully disclosed in the copending application of Clarence Wantz, Serial No. 328,923, filed April 10, 1940. The coil 58 of the electromagnet is wound around the legs of the magnet frame 56. The bushing 57 is shown as extending through an opening 59 in the adjacent end wall 21, and as externally threaded for threaded engagement at 60 with a nut 62 by means of which the bushing is clamped in place in the end wall 21 of the switch housing.

The electromagnet has an armature 64 attached at 65 to the adjacent end of a stem 66, if desired, in a manner to permit self-accommodation of the armature when in attracted position to the pole ends of the magnet frame 56. The electromagnet and armature are enclosed within a cup 68. The stem 66 extends for reciprocatory movement through an opening 69 in the inner end of the cup 68. The opening 69 is sealed by suitable sealing material, such as a leather washer, felt packing or the like, as indicated at 70, interposed between the inner end of the cup 68 and a spring seating disc 72. The end of the stem 66 opposite the end on which the armature 64 is mounted is secured, for example, by a pin 73 to the adjacent end of the reset member 40. A coiled spring 74 interposed between the spring seating disc 72 and a spring seat member 75 actuates the armature 64 to retracted position and the reset stem and reset member 40 to the position shown in Figure 5 when the electromagnet is deenergized, for example, upon extinguishment of the flame to which the device is responsive.

The particular switch selected for illustration is indicated in its entirety at 78, and is shown as comprising a pair of contacts or contact pins 80 positioned in spaced relation and suitably insulated from each other and the other parts of

the device. The contact pins 80 are connected to terminals 82. The conductors 19 of the circuit for the valve 12, which conductors are insulated at 84, enter the housing 20 through an insulating grommet 85. One of the conductors 19 is connected to the terminal 82 for one switch pin 80, and the other conductor 19 is connected to the other terminal 82 for the other switch pin 80.

The switch stem 88 has rectilinear sliding movement in the insulating base or block of the switch 78 with the outer end of the stem in position for cooperation with the free end of the switch operating spring arm 49 on the cam lever 42. Within the switch block, the reduced inner end of the stem 88 passes through a bridging contact plate 90. A coiled spring 92, surrounding the reduced inner end of the stem 88 and interposed between the contact plate 90 and an abutment 93 on, or forming a part of, the switch base, yieldingly urges the plate 90 out of bridging contact with the contacts 80 to open the circuit 19. By engagement of the contact plate 90 with the shoulder 94 on the stem 88, the spring 92 also yieldingly urges the stem 88 to its outwardly projected position as shown in Figure 5. Stop means (not shown) may be provided for limiting the outward movement of the switch pin 88 under the action of the spring 92.

The pilot burner 95, which is located in juxtaposition to the main burner 10 to maintain a pilot light for lighting the main burner, is supplied with gaseous fuel by a pilot supply pipe 96. The pilot supply pipe 96 may be connected with the main fuel supply pipe 11 anterior of the valve 12, or it may be supplied with fuel for delivery to the pilot burner in any other desired manner.

A thermocouple, indicated at 98, is placed in position so that the hot junction 99 thereof will be heated by the pilot flame as long as the pilot flame is burning. The construction of the thermocouple may be similar to that more fully disclosed in Oscar J. Leins Patent No. 2,126,564, granted August 9, 1938, or a thermopile, or any other form of thermoelectric generator may be employed.

For the purposes of the present description, suffice it to state that the particular thermocouple 98 shown in the drawings comprises an outer tubular thermocouple member and an inner metallic thermocouple member of different thermoelectric characteristics. The inner thermocouple member is joined at one end to the outer end of the outer thermocouple member to form the thermojunction 99 which is placed in position to be heated by the pilot flame. An inner lead conductor 100 is joined to the inner thermocouple element to form an internal thermojunction, and an outer tubular lead conductor 103 is connected to the outer thermocouple member—for instance, through a sleeve—to form a third thermojunction. The lead conductors are of flexible character so as to be readily bent to insure neat installations. The inner lead conductor 100 is insulated from the outer lead conductor 103, for instance, by a wrapping of insulation 104 on the inner lead conductor.

A quick detachable or removable connection is preferably provided between the coil 58 of the electromagnet and the ends of the leads 100 and 103 opposite the ends which are connected to the thermocouple. This removable lead connection may be of the form disclosed in the copending application of Clarence Wantz hereinbefore identified, and is illustrated in that form, although it may be of any other suitable or preferred form. Suffice it to state that the inner lead 100 has a connector cone 105 which seats in the correspondingly recessed outer end of the terminal tip 106 and is clamped in contact therewith by a connector sleeve 107. The adjacent end of the outer tubular lead conductor 103 is connected in circuit with one side of the coil 58 through the bushing 57, and the other side of the coil is connected to the terminal tip 106, the parts being suitably insulated as shown.

To start the operation of the system shown in the drawings, as thus far described, the following sequence is followed:

The actuator or reset member 30 is pressed inwardly from the position shown in Figure 5 by engaging the button 32 with the hand or fingers and imparting pressure thereto. The armature 64 is in released or retracted position at the beginning of the inward movement of the actuator member 30, and the spring 74 holds the pin 43 in engagement with the inner ends of the slots 44. As a result, the inward movement of the actuator member 30 moves the reset stem 66 with it in the same direction until the armature 64 is cocked or set into attracted position against the pole ends of the magnet frame 56.

The pilot burner 95 is lighted, or, having been lighted, heats the thermoelectric generator, and the actuator member 30 is held pressed inwardly until the heat of the pilot flame on the thermoelectric generator has energized the electromagnet sufficently so that it will hold the armature 64 attracted thereto.

When the electromagnet is energized sufficiently to hold the armature 64 in attracted position, the actuator member 30 is released and the reset stem 66 and reset member 40 remain in cocked position holding the pivot 43 for the cam lever 42 in the position shown in Figure 4. The switch operating spring arm 49 assumes the position shown in Figure 4 when the actuator member 30 is pressed inwardly. Then with the armature 65 held attracted to the magnet frame 56, thereby holding the pivot 43 for the cam lever 42 in the position shown in Figure 4, when the actuator member 30 is released the outward movement of the actuator member 30, under the action of the spring 36, causes the pin 46, by its outward movement in the cam slot 45, to swing the arm 49 in a counterclockwise direction (Figures 1 and 4) about the pivot 43 from the position shown in Figure 4 to the position shown in Figure 1. The arm 49, by cooperation with the outer end of the switch pin 88 in this movement, moves the contact plate 90 inwardly against the action of the spring 92 and into bridging contact with the contacts 80 to close the circuit 19. The circuit is thus closed not by the inward movement of the actuator member 30, but by the movement of this member 30 to its outwardly projected position following the resetting operation and only when the electromagnet is effective to hold the armature 64 in attracted position. The overtravel character of the spring arm 49 assures good firm contact of the contact plate 90 with the contacts 80, there being preferably some overtravel of the cam lever 42 after engagement of the contact plate 90 with the contacts 80 which tensions the spring arm 49 to assume firm and tensioned contact.

If the pilot burner is not lighted to produce the thermoelectric current for holding the armature 64 in attracted position upon setting the same to that position by the actuator member

30, the armature 64 and reset stem 66 will move to retracted position upon release of the actuator member 30, the spring 92 at this time maintaining the switch plate 90 in open position.

If, after the parts are set as shown in Figure 1 and the pilot burner is lighted to hold the parts in the position shown in this figure, the pilot burner is extinguished, the armature 64 is released and the spring 74 then operates to move the armature 64 to retracted position. The cam lever 42 moves outwardly with the movement of the reset stem 66 to released position through the pin connected at 43, and the cam slot 45, cooperating with the pin 46 by this movement of the cam lever 42 relative to the actuator member 30, swings the arm 49 in a clockwise direction about the pivot 43 to the position shown in Figure 5. This releases the switch pin 88, and the spring 92 separates the contact plate 90 from the contacts 80. This opens or interrupts the circuit 19, and the valve 12 operates to closed position to shut off the supply of fuel to the main burner.

When the armature is in retracted position with the actuator member 30 in released position as shown in Figure 5, the "off" marking on the indicator arm 50 is positioned to be viewed through the opening 26 in the cover of the housing to indicate that the switch is "off." When the armature is in attracted position and the actuator member 30 is in its outwardly projected position as shown in Figure 1, the "on" marking on the indicator arm 50 is positioned to be viewed through the opening 26 to indicate that the switch is "on."

The limit control is shown for purposes of illustration as comprising a bimetallic element 125 of helical form. The bimetallic element 125 surrounds a shaft 126 journaled for turning movement, for example, in the back wall of the housing 20. One end of the bimetallic element 125 is secured at 128 to the outer end of the shaft 126. The other end of the bimetallic element is secured to an adjusting lever 130 which is mounted to be turned about the axis of the shaft 126 and relative to the shaft. The adjusting lever 130 has a pointer 132 which cooperates with the temperature markings on the dial 134.

The end of the shaft 126 opposite the end which is secured to the bimetallic element 125 extends into the housing 20 and carries, for turning movement therewith, a tripping lever 135. The cam lever 42 has a laterally extending lug 136 which carries a tripping pin 138 having a roller 139 for cooperation with the tripping lever 135.

When the selected temperature is reached as determined by the setting of the pointer 132 along the temperature markings on the dial 134, the bimetallic element 125 turns the shaft 126 and thereby the arm 135 in a counterclockwise direction from the position shown, for example, in Figure 1. Assuming that the armature 64 is in attracted position, with the actuator member 30 in released position and the switch closed as shown in Figure 1, this counterclockwise movement of the tripping lever 135 causes this lever to engage the roller on the tripping pin 138 and to lift the cam lever 42 upwardly as the device is viewed in Figure 1. This separates the armature 64 from the magnet frame 56. As a result, the reset stem moves to retracted position and the arm 49 moves to released position releasing the switch pin 88 so that the switch opens under the action of the spring 92.

When the temperature to which the limit control is responsive drops below the temperature for which the limit control is set, the tripping lever 135 is turned in a clockwise direction (Figure 1) to position to permit resetting the device in the manner already described. As long as the limiting temperature or other limiting condition to which the limit control is responsive continues, however, the tripping lever 135 is positioned to prevent resetting the device.

The embodiment of the invention shown in the drawings is for illustrative purposes only, and it is to be expressly understood that said drawings and the accompanying specification are not to be construed as a definition of the limits or scope of the invention, reference being had to the appended claims for that purpose.

I claim:

1. In a device of the class described, in combination, a reset stem, an actuator member, a cam lever pivoted to said reset stem, cam means on said actuator member for cooperation with said lever, said actuator member cooperating with said reset stem independently of said cam lever for resetting said stem to reset position, means for holding said reset stem in reset position, a controlling member actuated to operating position by swinging movement imparted to said cam lever by cooperation of the cam means on the actuator member therewith upon movement of said actuator member to released position with said reset stem held in reset position, movement of said reset stem to retracted position upon release of said holding means swinging said cam lever in a counterdirection by cooperation between said cam lever and the cam means on said actuator member for movement of said controlling member to safety position, and limit control means cooperable with said cam lever and operable to separate said reset stem from said holding means for movement of said controlling member to safety position.

2. In a switch of the class described, in combination, a reset stem, an actuator member, a cam lever pivoted to said reset stem, cam means on said actuator member for cooperation with said lever, said actuator member cooperating with said reset stem independently of said cam lever for resetting said stem to reset position, means for holding said reset stem in reset position, a switch pin having "on" and "off" positions and spring-pressed to one of said positions, a spring arm carried by said cam lever and cooperating with said switch pin to actuate said pin to its other position by cooperation of the cam means on the actuator member with said cam lever upon movement of the actuator member to released position with said reset stem held in reset position, and limit control means cooperable with one of the parts comprising said reset stem, said actuator member, and said cam lever, and operative to separate said reset stem from said holding means for movement of the switch pin to the position opposite the position to which said pin is spring-pressed.

3. In a switch of the class described, in combination, a reset member movable between reseet and released positions by rectilinear movement, an actuator member movable between resetting and released positions by rectilinear movement and adapted for resetting said reset member to reset position, means for holding said reset member in reset position, a cam lever pivoted to said

reset member and having a cam slot therein, a cam pin carried by said actuator member and engageable in said cam slot for swinging said cam lever in one direction about its pivotal connection with said reset member upon movement of the actuator member to released position with said reset member held in reset position and swinging said cam lever in a counter direction upon movement of said reset member to released position, a switch operating member movable between "on" and "off" positions, a spring arm carried by said cam lever and cooperating with said switch operating member to actuate said member to one of its positions by swinging movement imparted to said cam lever by movement of said actuator member to released position with said reset member held in reset position and actuated to its other position by movement of said reset member to released position, and limit control means cooperable with said cam lever and operative to separate said reset member from said holding means for movement of said switch member to the position to which it is actuated upon movement of the reset member to released position.

4. In a switch of the class described, in combination, a reset member movable between reset and released positions by rectilinear movement, an actuator member movable between resetting and released positions by rectilinear movement and adapted for resetting said reset member to reset position, means for holding said reset member in reset position, a cam lever pivoted to said reset member and having a cam slot therein, a cam pin carried by said actuator member and engageable in said cam slot for swinging said cam lever in one direction about its pivotal connection with said reset member upon movement of the actuator member to released position with said reset member held in reset position and swinging said cam lever in a counterdirection upon movement of said reset member to released position, a switch operating member movable between "on" and "off" positions, a spring arm carried by said cam lever and cooperating with said switch operating member to actuate said member to one of its positions by swinging movement imparted to said cam lever by movement of said actuator member to released position with said reset member held in reset position and actuated to its other position by movement of said reset member to released position, and limit control means cooperable with said cam lever and operative to separate said reset member from said holding means for movement of said switch member to the position to which it is actuated upon movement of the reset member to released position.

5. In a combined safety switch and limit control, a switch control member having a first position and a second position, an operating lever for said member, resetting means cooperating with said lever comprising an actuator member yieldingly held in a first position and movable therefrom to a second position and a reset member movable from a first position to a second position and vice versa and yieldingly urged toward its said first position, means whereby movement of said actuator member from its first position to its second position moves said reset member from its first position to its second position and movement of said actuator member from its second position to its first position moves said control member from its first position to its second position when said reset member is held in its second position, movement of said reset member to its first position when said actuator member is in its first position causing movement of said control member to its said first position, an electromagnet for releasably holding said reset member in its said second position, and limit control means cooperating with said lever for urging said reset member away from said electromagnet with a force effective for releasing said reset member from said electromagnet.

6. In a combined safety switch and limit control, a switch control member having a first position and a second position, resetting means cooperating with said control member comprising an actuator member having a first position and a second position and a reset member movable from a first position to a second position and vice versa means whereby movement of said actuator member from its first position to its second position moves said reset member from its first position to its second position and movement of said actuator member from its second position to its first position moves said control member from its first position to its second position when said reset member is held in its second position, movement of said reset member from its said second position to its said first position causing movement of said control member to its first position, said reset member being yieldingly urged toward its said first position, an electromagnet which when energized holds said reset member in its said second position, and limit control means cooperating with said resetting means for mechanically urging said reset member away from said electromagnet with a force effective for releasing said reset member from said electromagnet.

7. In a combined safety switch and limit control, a switch control member having a first position and a second position, resetting means comprising a reset member having a reset position and a released position and an actuator member movable from a first position to a second position for resetting said reset member, means whereby said control member is moved into its first position in the movement of said actuator member to its second position and in the movement of said reset member to its released position when said actuator member is in its first position and is also moved to its second position in the movement of said actuator member to its first position when said reset member is in its reset position, an electromagnet which when energized holds said reset member in its reset position, and limit control means for mechanically urging said reset member away from said electromagnet with a force effective for releasing said reset member therefrom.

8. In a combined safety switch and safety control, a switch control member having a first position and a second position, actuating means for moving said control member from its said first position to its said second position, an electromagnet which when energized holds at least a portion of said actuating means in position for securing and maintaining said switch control member in its said second position, and limit control means operative to impart a force to the held portion of said actuating means in a direction away from said electromagnet effective to release from the latter said held portion of said actuating means.

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