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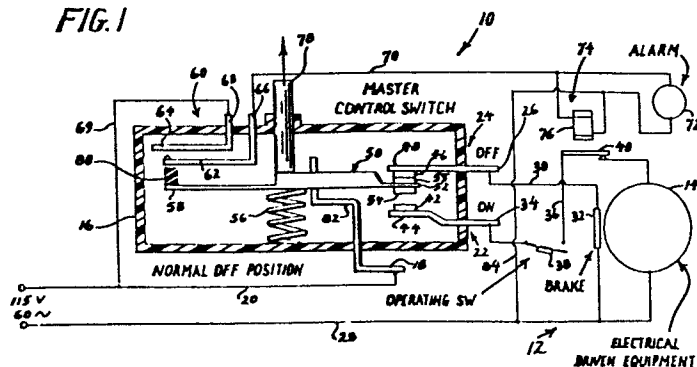
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54 Safety switch.

57 A switch (10) for providing a safety function when its main contacts are fused or stuck together in the "ON" position, comprising a housing (16) containing a pair of main contacts (42, 54), one being designated an ON contact, and the other main contact being carried by a movable switch arm (50) in the housing (16). This switch arm (50) has a first end which carries the movable main contact (54) and a second end, and spring means (56) mechanically coupled to the movable switch arm (50) normally bias the movable main contact (54) toward open position away from engagement with the ON contact. Switch operating means including

movable actuator means (78) overcome the biasing force of the spring means (56) for moving the movable main contact (54) to closed position into engagement with the ON main contact. There are auxiliary safety contact means (60) within the switch housing for completing a safety circuit and/or for deenergizing the main circuit in response to abnormal movement of the movable switch arm (50) when the actuator means (78) is moved to OFF position, but the movable main contact (54) remains fused or stuck to the ON main contact. Fig. 1.

FIG. 1



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SAFETY SWITCH
BACKGROUND OF THE INVENTION

The present invention relates to control switches, and more particularly to a control switch for automatically providing a safety function when the main contacts remain fused or stuck together in the "ON" position after the switch actuator has been moved to the "OFF" position.

During the operation of electrical equipment, occasions can arise in which the contacts of a control switch, e.g., a microswitch, become fused, welded or stuck together in their ON position. This fused condition can occur under heavy load when increased current is being drawn at the instant when the switch is turned OFF, with the result that there is arcing across the ON contacts and therefore fusing or welding of the contacts occurs, causing them to remain in their closed position, even though the switch operating means has been moved to OFF position.

For example, a control switch may be used to operate alternating current electrical equipment including a motor. If the switch actuator happens to be moved to the OFF position at an instant during a cycle of the alternating current when peak current is flowing in a heavily loaded motor, severe arcing with consequent welding can occur as the contacts start to part, due to the energy stored in the magnetic field of the motor which momentarily tends to maintain a large current flow through the contacts as they start to separate. Therefore, the contacts remain fused together in their ON condition, after the switch operating means has been turned OFF.

With a switch in this fused or "welded" condition, the circuit to the electrical equipment is still capable of energizing the equipment. Further, a switch in this welded con-

dition is quite dangerous to the operator of the equipment, since the operator knows that steps have previously been taken to turn OFF the control switch, which normally opens (de-activates) the electrical circuit. Moreover, if the operator visually checks the switch actuating the mechanism, it is seen to be in its open circuit position. If the switch housing is visible and the operator visually checks, viewed from the exterior of the switch housing, the switch appears to be deactivated or turned OFF, because the visible switch actuating mechanism, e.g., an actuator or manually movable handle, is in its OFF position. However, the internal contacts, which are welded or stuck together, remain in their ON position.

The operator of the electrical equipment is lulled into a false sense of security when he/she looks at an operating control or at the switch and sees that the switch actuating mechanism is in its OFF position. Consequently, the operator incorrectly concludes that the circuit to the electrical equipment has been safely de-energized. The operator may then proceed to perform maintenance or cleaning of the equipment, assuming that the equipment cannot be activated. In the course of such service, the operator may accidentally engage a nearby operating switch. The circuit to the equipment is then completed and the equipment then proceeds to operate, with possible consequential damage to the equipment or injury to the operator. Moreover, if the equipment has been partially disassembled for maintenance, and then is activated, considerable damage may occur.

The terms "fused", "welded" or "stuck" are used herein interchangeably in a generic sense to mean that the main contacts of a switch are remaining together touching or joining each other in a current-conducting relationship, when these main

contacts are intended to be separated from each other in a non-conducting relationship by moving the switch operating means to the OFF position.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a switch which automatically provides a safety function if its main contacts remain fused, welded or stuck together in their ON position, when the switch actuator is moved to the OFF position, for example the safety function may be to give an alarm signal or to interrupt the circuit which is controlled by the switch.

It is an object of the present invention to provide auxiliary contact means within the housing of a switch which become moved if the switch actuator is turned or moved to OFF position but its main contacts remain in their ON position.

An object of this invention is to provide a safety switch having spring-biased auxiliary safety contact means within the switch housing which become triggered and released from a first position to a second position for producing a safety function, when the switch operating means are moved to OFF position but the main contacts of the switch remain together in their ON position. In an embodiment of this invention the auxiliary contacts are triggered into a closed position for producing a safety function, for example for giving an alarm signal or for operating a relay, and in another embodiment the auxiliary contacts are triggered into an open position for producing a safety function, for example for interrupting a circuit, for example for interrupting the main circuit.

Among the advantages of the present invention are those resulting from safety apparatus to be incorporated in a

switch. This safety apparatus includes auxiliary contacts which are moved from a first relationship to a second relationship for producing a safety function in the event the main switch contacts remain together in their closed or ON position after the switch operating means have been moved to the OFF position.

It is a further object of the present invention to provide a switch having auxiliary safety contacts for automatically deactivating a circuit controlled by the switch to prevent energization of equipment in the circuit when the main switch contacts remain together in their ON condition, after the switch has been turned OFF, for example the main circuit may be deactivated.

It is a further object of the present invention to provide a switch having auxiliary safety contacts for producing an audible and/or visible alarm signal when its main contacts remain together, after the switch operating means are turned OFF.

It is a still further object of the present invention to provide a switch having auxiliary safety contacts for automatically energizing a circuit to transmit a signal to a remote location for alerting personnel that the control switch has malfunctioned by its main contacts remaining in their ON position, after the switch actuator has been moved to OFF position.

The present invention provides a switch which advantageously protects the operator of driven electrical equipment from accidental injury when the contacts of the switch remain together in their ON position, after the switch actuator has been moved to its OFF position.

Briefly, in one illustrative embodiment of the present invention, a switch is provided including a housing having a common terminal and an ON terminal each extending to the exterior of the housing, the ON terminal having an ON contact thereon located within the housing, a movable switch arm in the housing having first and second ends with movable contact means carried by the first end of the movable switch arm, the movable switch arm being movable between open and closed positions, spring means in the housing for urging the movable switch arm to its open position, a movable actuator accessible from the exterior of the housing and operatively associated with the movable switch arm for moving the movable switch arm from its open to its closed position for causing the movable contact carried by the first end of the movable switch arm to touch the ON contact when the movable switch arm is in its closed position for completing an electrically conductive path between the common terminal and the ON terminal, the actuator when released allowing the spring means to return the movable switch arm from its closed to its open position, with apparatus within the switch housing capable of automatically producing a safety function in the event the movable contact becomes welded to the ON contact, comprising safety switch means located within the housing automatically becoming activated when the movable actuator has been released, but the movable contact remains stuck to the ON contact.

In accordance with the present invention in certain of its aspects safety apparatus is provided within a switch having first and second main contacts, switch operating means movable in a first direction for causing said main contacts to touch each

other for turning the switch ON, said switch operating means being movable in a second direction for causing said main contacts to separate for turning the switch OFF, such safety apparatus in the switch housing comprises: first and second auxiliary contact means, a movable member operatively associated with said first and second auxiliary contact means and with said switch operating means, said first auxiliary contact means normally being in a first relationship with respect to said second auxiliary contact means, spring bias for urging said movable member to move said first auxiliary contact means into a second relationship with respect to said second auxiliary contact means for producing a safety function, said movable member normally being restrained against said spring bias by said switch operating means, and said movable member being released to respond to said spring bias in the event that said switch operating means is moved in said second direction but said main contacts do not become separated and thus the switch is actually not OFF for releasing said movable member to be moved by said spring bias for moving said first auxiliary contact means into said second relationship with respect to said second auxiliary contact means for producing said safety function.

In accordance with the present invention in certain aspects, the safety apparatus provided in such a switch comprises: first and second auxiliary contact means, the first auxiliary contact means normally being in a first relationship with respect to the second auxiliary contact means, the first auxiliary contact means being movable into a second relationship with respect to the second auxiliary contact means for producing a safety function, and a movable member operatively associated with said switch operating means for moving said first auxiliary

contact means into said second relationship with respect to said second auxiliary contact means for producing said safety function in the event that the switch operating means is moved into position for separating the main contacts of the switch, i.e., for turning the switch OFF, but the main contacts do not become separated and thus the main contacts of the switch are actually not in OFF condition.

In accordance with the present invention in certain aspects there is provided a safety switch having a housing wherein main contacts are closed for completing a circuit and are opened for interrupting the circuit, said safety switch being characterized by normally closed auxiliary contacts located within the switch housing, and means within the switch housing for causing said auxiliary contacts to open if the main contacts remain closed when the switch is actuated for opening the main contacts.

Other objects, aspects and advantages of the present invention will be understood from the detailed description considered in conjunction with the drawings, which are presented herein and should be construed in an illustrative but not in a limiting sense, as follows:

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is an enlarged side elevation view of the components of a switch embodying the present invention showing the switch electrically coupled to driven electrical equipment and a deactivating/warning safety circuit, with the housing of the switch being cut away in section, and the switch/^{is} shown in its normal OFF position;

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FIG. 2 is an enlarged side elevation view of the switch of FIG. 1, with the switch in its normal ON position;

FIG. 3 is an enlarged side elevational view of the switch of FIG. 1, with the main switch contacts "welded" together in their ON position, when externally the switch operating means give the appearance that the switch is in its OFF position. Consequently, auxiliary safety contact means in the switch have functioned to give a warning and to deenergize the electrical driven equipment which is normally controlled by the main contacts of the switch;

FIG. 4 is an enlarged side elevational view of a second embodiment of the present invention in which there is only one auxiliary safety contact with one external terminal.

FIG. 5 is an enlarged side elevational view of another switch embodying the present invention in another modification. Three different conditions of this switch are illustrated, including the normal ON position, the normal OFF position, and the abnormal "welded" ON position when the switch is intended to be turned OFF. Consequently, the auxiliary safety contact means have produced a safety function;

FIG. 6 is an enlarged side elevational view of a switch comprising another embodiment of the invention, with the housing of the switch being shown cut away in section and the switch shown in its OFF position;

FIG. 7 is an enlarged side elevation view of the switch of FIG. 6, showing its ON position;

FIG. 8 is an enlarged side elevational view of the switch of FIG. 6, with the main contacts of the switch "welded" together in their ON position, after the switch operating means

has been moved to OFF position. Consequently, auxiliary safety contact means within the switch have been released to move into a second relationship for producing a safety function;

FIG. 9 is a further enlargement of a portion of FIG. 7 showing in greater detail how the auxiliary safety contact means are being held in their first relationship against the force of a cocked spring while the switch continues to operate in normal manner;

FIG. 10 is a further enlargement of a portion of FIG. 8 showing in greater detail how the auxiliary safety contact means are released so that the cocked spring can immediately move them into a second relationship for producing a safety function, when the switch operating means are moved to OFF position but the main switch contacts remain "welded" together in their ON position;

FIG. 11 shows the switch of FIGS. 6 through 10 connected in a circuit including electrical equipment which is controlled by this switch.

FIG. 12 is an enlarged side elevational view of a switch comprising another embodiment of the invention, with the housing of the switch being shown cut away in section and the switch shown in its OFF position. Auxiliary safety contact means within the switch housing are normally held closed for completing a circuit, for example, such as shown in FIG. 18;

FIG. 13 is an enlarged side elevational view of the switch of FIG. 12, showing its ON position;

FIG. 14 is an enlarged side elevational view of the switch of FIG. 12, with the main contacts of the switch "welded" together in their ON position, after the switch operating means has been moved to OFF position. Consequently, the auxiliary

safety contact means within the switch have automatically been released immediately to open for interrupting the circuit;

FIG. 15 is a further enlargement of a portion of FIG. 12 showing in greater detail how the auxiliary safety contact means are being held closed against the force of a cocked spring while the switch continues to operate in normal manner;

FIG. 16 is a further enlargement of a portion of FIG. 14 showing in greater detail how the auxiliary safety contact means are released so that the cocked spring can immediately move them into open relationship for interrupting a current flow path, when the switch operating means are moved to OFF position but the main switch contacts remain "welded" together in their ON position;

FIG. 17 is a partial sectional view taken along the line 17-17 in FIG. 15 showing further details of the auxiliary safety contacts and the member which normally holds them closed against the force of a stressed cocked spring;

FIG. 18 shows the switch of FIG. 12 through 16 connected in a circuit including electrical equipment which is controlled by this switch.

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DETAILED DESCRIPTION

It has been a long standing problem that switch contacts can occasionally unexpectedly become welded or fused or stuck together in their ON or closed circuit condition, when appropriate steps have been taken by an operator or by control mechanism which are intended to turn OFF, i.e., to open a circuit, with consequent possible damage to electrical equipment controlled by the switch or possible injury to the operator or both. The present invention has solved this problem in a practical, compact and feasible manner, and this invention readily lends itself to be incorporated in various advantageous embodiments in various switches.

Referring to FIG. 1, a switch embodying the present invention is illustrated generally at 10. The switch 10 is shown as a master control switch for opening and closing a control circuit 12 which energizes driven electrical equipment 14, for example, such as an electric motor drive. The switch 10 includes an insulating housing 16 having a common terminal 18 affixed to the housing 16 and extending externally therefrom. One line 20 from a power source (not shown), e.g., a 115V, 60 Hz A.C. voltage source, is electrically coupled to the common terminal 18.

A pair of spaced ON and OFF terminals 22 and 24 are also affixed to the housing 16 and extend externally therefrom. The external end 26 of the OFF terminal 24 is electrically connected to the other line 28 from the power source, e.g. through a lead 30 and brake 32. The external end 34 of the ON terminal 22 is electrically connected to the driven electrical equipment 14 and the line 28, e.g. through a lead 36, an operating switch 38 and relay contacts 40.

The ON terminal 22 has an ON contact 42 affixed to its internal end 44 located within the housing 16. Similarly, the OFF terminal 24 has an OFF contact 46 affixed to its internal end 48 located within the housing 16. The ON contact 42 and OFF contact 46 are positioned relative to one another to receive a movable switch arm 50 therebetween. Specifically, the first end 52 of the movable switch arm 50 is interposed between the ON contact 42 and the OFF contact 46.

Affixed to the first end 52 of the movable switch arm 50 is contact 54 which moves with the movable switch arm 50 from a first ("ON") position of engagement with, i.e., touching, the ON contact 42 (FIG. 2) to a second ("OFF") position of separation from this ON contact 42 (FIG. 1). Also shown affixed to this first end 52 of the movable switch arm 50 is another contact 55 which moves with the switch arm. When the switch arm is in its second (OFF) position as shown in FIG. 1, the movable contact 55 is in engagement with (touches) the OFF contact 46. The movable switch arm 50 is normally biased upwardly by a spring 56, so that the movable contact 55 engages the OFF contact 46. Advantageously, the spring 56 is mechanically coupled to the movable switch arm 50 and, e.g., affixed to the housing 16, or other stationary component of the switch 10, to provide a bias force for urging the switch arm 50 toward the OFF position.

The ON contact 42 and the movable contact 54 are the "main" contacts of the switch 10. When these main contacts 42 and 54 touch each other, they enable the electrical circuit 12 which is controlled by the switch 10 and which contains the equipment 14 to be energized.

There is a member 58 forming an extension at the second end of the movable switch arm, and this member 58 is positioned proximate to but normally spaced from auxiliary safety contact means generally indicated at 60. As shown in FIG. 1, the auxiliary safety contact means 60 include a pair of spaced safety contacts 62 and 64. Contact 62 has a terminal portion 66 extending externally of the housing 16 and contact 64 also has a terminal portion 68 extending externally of the housing 16. The terminal portions 66 and 68 of these auxiliary contacts 62 and 64 are advantageously affixed to the housing 16, and these auxiliary contacts are normally separated from each other, as seen in FIGS. 1 and 2.

A lead 69 electrically connects the line 20 to the terminal portion 68. Lead 70 connects the terminal portion 66 to the line 28 through an audio or visual alarm 72 and/or electrical equipment deactivating means 74, illustrated as a relay 76, which opens relay contacts 40 for deactivating the electrical equipment 14, and through lead 84. Advantageously, the electrical equipment deactivating means 74 may also provide for permanent deactivation by using a quick-acting heating element at the location of the relay winding 76 for heating a nearby fuse incorporated in the control circuit 12 in place of the relay contact 40. This burnt fuse is replaced when the malfunctioned switch 10 is replaced.

This switch 10 includes operating means for moving its main contacts 42 and 54 into closed ("ON") position and into open ("OFF") position. These switch operating means include a movable actuator shown in the form of a manually or mechanically actuatable plunger 78 which is accessible from the exterior of the housing 16, and is mechanically coupled to the movable switch arm 50. However, it is to be understood that the

actuator may also be automatically actuated. The movable switch arm 50 is included in the switch operating means, and the actuator 78 is capable of moving this switch arm 50 from its open to its closed position, when the actuator 78 is moved by external means to cause the main contact 54 affixed to the first end 52 of the movable switch arm 50 to engage the ON main contact 42. Upon release of the actuator 78, the spring force of the spring 56 returns the movable switch arm 50 to its open position, as shown in FIG. 1, with contact 55 engaging contact 46.

It is to be understood that conductive means are included in the switch housing 16 for providing an electrically conductive path continuously existing between the common terminal 18 and the movable switch arm 50, for example, this terminal 18 is mechanically and electrically connected to a conductive element 82 which, in turn, is mechanically and electrically coupled as desired to the switch arm 50, for example, by abutting against the arm for maintaining sliding contact therewith or through a hinged linkage (for example, such as shown at 104 in FIG. 5) or through the spring 56. Thus, the common terminal 18 is continuously electrically connected to the movable arm 50 during its movement and when the contact 54 or 55 carried by this arm is respectively engaging the ON contact 42 or the OFF contact 46.

Referring to FIG. 2, when the actuator 78 is depressed, the main contact 54 is moved into engagement with the ON main contact 42, with movable switch arm 50 now moved to its closed position. Thus, the normal sequence of operation for a correctly functioning switch 16 is illustrated in FIGS. 1 and 2 with the movable switch arm 50, spring 56 and actuator 78 moving the main contact 54 into engagement with the ON main contact 42 to place the switch 10 in the ON position as shown in

FIG. 2, when the actuator 78 is depressed; and moving the contact 55 into engagement with the OFF contact 46, as shown in FIG. 1, when the actuator 78 is released. The member 58 of the movable switch arm 50 advantageously includes an insulating element 80 which moves with the movable switch arm 50, but is dimensioned so that it does not normally affect the auxiliary safety contact means 60, the latter remaining open so that the circuit to the alarm 72 and deactivating means 74 remain inoperative.

However, should sufficient current be flowing through the lines 20 and 28, so that arcing occurs between the main contact 54 and ON main contact 42, as they are being separated, the contacts 54 and 42 may become fused or welded together. If fusing occurs, the contact 54 will remain electrically connected to the ON contact 42, when the actuator 78 is in its released or open position as shown in FIG. 3. That is, with the main contact 54 and ON main contact 42 fused together as shown in FIG. 3, upon release of the actuator 78, it will move upward under the force of the spring 56 to the same position as shown in FIG. 1. Thus, viewed from the exterior of the housing 16, it appears that the movable switch arm 50 and contact 54 are in the OFF position as shown in FIG. 1 with the master control switch 10 open, so that the electrical equipment 14 cannot be energized even upon intentional or accidental closure of the operating switch 38. However, in actuality, as seen from the interior of the housing in FIG. 3, the contact 54 remains fused to the ON contact 42, and the master control switch 10 remains ON in its closed condition.

Advantageously, if the contact 54 remains fused to the ON contact 42 when the actuator 78 is released, the movable switch arm 50 is dimensioned so that the spring 56 will force the movable switch arm 50 upward causing it to effectively pivot about the weld or fusion between the contact 54 and the ON contact 42, with the result that the insulating element 80 on the member 58 forming an extension at the second end of the movable switch arm 50 pushes safety contact 62 deflecting its terminal portion 66 and thus forcing it into engagement with safety contact 64.

In summary, the member 58 is operatively associated with the switch operating means 78, 50 and 56. When these switch operating means are moved to OFF position, but the main contacts 54, 42 remain together in their ON position, then the auxiliary safety contact means 60 are moved by the member 58 into a second relationship, as shown in FIG. 3 for producing a safety function. Thus, a circuit is completed through the safety contacts 62 and 64 to the alarm 72 and relay 76 to provide a visual or audible warning of this switch malfunction and/or to deactivate the electrical equipment control circuit 12 by opening the relay contacts 40, see FIG. 3. Further, it is to be understood that closure of safety contacts 62 and 64 may also be utilized to provide a signal to a remote location for indicating this switch malfunction.

Referring to FIG. 4, an alternative embodiment of the present invention is illustrated as switch 10A, with components of this switch 10A which are similar to corresponding components of the switch 10 being given similar reference numerals. However, with this embodiment of the present invention, the auxiliary safety contact means 60A include only a single external terminal 66A with a contact 90 which is closed by engagement with a conductive contact portion 92 affixed to

the member 58A forming an extension at the second end of the movable switch arm 50A and thus being operatively associated with the switch operating means 78A, 50A and 56A. When the switch operating means 78A, 50A and 56A are moved to their OFF position, but the main contacts 54A and 52A remain together in their ON position, then the member 58A causes the auxiliary safety contact means 60A to move into a second relationship as shown in FIG. 4 for producing a safety function. The auxiliary contacts 92 and 90 are moved together for completion of the circuit including the lead 70A to the alarm 72A and deactivating relay 76A to provide an audible or visual alarm of the welded condition of the contacts 54A and 42A and/or for deactivation of the electrical circuit 12A including equipment 14A.

The circuit including the lead 70A is completed from the supply line 20A through the common terminal 18A, through the conductive element 82A, through the switch arm 50A and member 58A, through closed contacts 92, 90 and terminal 66A to the lead 70A to the alarm 72A and the deactivating means 74A, 76A for the circuit 12A and through the lead 84A to the other electrical supply line 28A. By virtue of the fact that the circuit 12A has been deactivated by the opening of the relay contacts 40A, the equipment 14A cannot become energized by accidental or intentional closure of the operating switch 38A. It is to be understood that the deactivating means 74A for the circuit 12A may comprise a fuse (not shown) at the location of the relay contacts 40A. Such a fuse is associated with a quick-acting heater (not shown) at the location of the relay winding 76A, with this heater being near the fuse for immediately burning out this fuse when the auxiliary safety contacts 92 and 90 touch each other.

Referring to FIG. 5, another embodiment of the present invention is illustrated as switch 10B, with components of this switch 10B which are similar to corresponding components of the switches 10 and 10A being given similar reference numerals. Common terminal 18B includes an electrically conductive element portion 82B mounted internally of the housing 16B, and its end 100 is secured within the housing by being received within housing slot 102. A second electrically conductive element 104 in the form of a movable hinged linkage is mechanically coupled and hinged at one end to the electrically conductive portion 82B at a slot or socket 106 and at the other end to the movable switch arm 50B at a second slot or socket 108.

A spring means in the form of a bow spring 56B is mechanically coupled at one end to the movable switch arm 50B at a slot or socket 110 and is mechanically coupled at its other end to the electrically conductive portion 82B at a slot or socket 112. The bow spring 56B is under compression, and thus it normally applies an upward component of force to the movable switch arm 50B to bias its contact 55B into engagement with the OFF contact 46B. The OFF or open position of the movable switch arm 50B is shown in dashed outline at 50B" in FIG. 5.

Depression of the movable actuator 78B, which may advantageously be accomplished through means of manually or automatically depressing a generally L-shaped lever 111 which overlies the movable actuator 78B, causes the electrically conductive linkage 104 and movable switch arm 50B to move downwardly, overcoming the upward bias force of the bow spring 56B to move the movable main contact 54B into engagement with the ON main contact 42B. The normal ON or closed position of the switch arm 50 is shown at dashed outline 50'B.

Upon release of the actuator 78B the movable switch arm 50B normally assumes the open position 50B" with the movable contact 54B engaging the OFF contact 46B as shown in dashed outline in FIG. 5. However, should fusing or welding of the main contacts 54B and 42B occur, then the movable switch arm 50B will assume the abnormal tilted or canted position shown in solid outline in FIG. 5.

Auxiliary safety contact means 60B are illustrated in FIG. 5 to include two spaced contact elements 62B and 64B and their respective external terminals 66B and 68B. However, it is to be understood that the auxiliary safety contact means 60B may optionally include only one contact element 62B and its external terminal 66B, similar to FIG. 4. In the event there is only the one auxiliary safety contact element 62B with its external terminal 66B, then the associated alarm and/or de-activation circuit is closed by a conductive leaf spring member 116 (FIG. 5) to be described touching a contact 113 of the contact element 62B. The two spaced contact elements 62B and 64B are positioned proximately to leaf spring member 116 associated with the second end 58B of the movable switch arm 50B. Contact elements 62B and 64B include contact portions 113 and 114, respectively. The leaf spring member 116 has a generally U-shaped configuration with a short arm portion 118 and a long arm portion 120, and is positioned with its bight extending around a mounting pin 122 affixed to the housing 16B. The end 124 of the short arm portion 118 is positioned in pressure contact with the contact portion 114 of the contact 64B. The end 126 of the long arm portion 120 is positioned in pressure contact with a notched portion 128 formed near the end 58B of the movable switch arm 50B.

The spring 116 is configured so that upon depression of the actuator 78B by the lever 111 to place the switch 10B in the ON position, the long arm portion 120 of the spring 116 will be deflected downwardly as shown in dashed outline at 120' as the movable switch arm 50B is moved downwardly to the generally horizontal ON position shown in dashed outline 50B' in FIG. 5. The end 124 of the spring 116 will remain in engagement with the contact portion 114 of contact 64B; however, there is no engagement between the deflected spring 120' and the contact portion 113. Thus, the circuit between contacts 62B and 64B and thus between terminals 66B and 68B remains open when the switch 10B is in the ON position.

Upon release of the actuator 78B by the release of the lever 111, the movable switch arm 50B will move upwardly under the biasing force of the bow spring 56B. Normally, when the contacts 54B and 42B are not welded or fused together, upon release of the actuator 78B, the bow spring 56B will move the movable switch arm 50B to the generally horizontal OFF (open) position, as shown in dashed outline at 50B". The movable contact 54B is now in engagement with the OFF contact 46B, and the spring 116, specifically its long arm portion 120 is positioned slightly below the contact portion 113 in spaced non-contacting relationship. Thus, auxiliary safety contact means 60B remains electrically open, when the switch arm is in its normal OFF (open) position 50B".

In the event that the contacts 54B and 42B become fused or welded together, when the actuator 78B is released, the bow spring 56B will move the movable switch arm 50B upwardly causing the movable switch arm 50B to effectively pivot about the welded region to assume an abnormal canted or tilted position, as shown in solid outline in FIG. 5. In this canted

arm position, the long arm portion 120 of the spring 116 effectively moves upwardly higher than normal, thereby touching the contact portion 113 for completing a circuit between the terminals 66B and 68B.

The long arm spring portion 120 is allowed by canted switch arm 50B to move higher than normal, because the second (left) end 58B of the canted arm 50B is above its normal OFF (open) position 50B". Also, the long arm spring portion 120 is now allowed to move slightly forward (leftward) in the notched portion 128, since the end 58B of canted switch arm 50B has tilted up slightly above its normal horizontal OFF position, with the result that the point of application of the downward force on the long arm portion 120 is further rearward (rightward) toward the end 126 of the long arm portion 120, thereby allowing the long arm portion 120 to bow upward into engagement with the contact portion 113 to complete a circuit through the auxiliary safety contacts 62B and 64B, and thus through the terminals 66B and 68B. The circuit between the contacts 62B and 64B is now completed through the conductive leaf spring member 116 touching contact portion 113 and 114.

It is to be understood that the switch 10B of FIG. 5 can be connected into any desired electrical control circuit, for example, such as the circuit 12 shown in FIGS. 1 and 3 or, for example, such as the circuit 12A shown in FIG. 4. In other words, the switch 10B can be substituted for the switch 10 in FIGS. 1, 2 and 3, and this switch 10B can be substituted for the switch 10A in FIG. 4.

In operation, referring first to FIGS. 1 through 3, when the actuator 78 is in its released position, as shown

in FIG. 1, the spring force from spring 56 biases the movable switch arm 50 upwardly so that the contact 55 normally engages the OFF contact 46. Thus, a circuit is completed from the power source (not shown) through the line 20, the common terminal 18, electrically conductive element 82, movable switch arm 50 and its contact 55, OFF contact 46, OFF terminal 26, lead 30, brake 32, and line 28 to activate the brake 32 and stop the driven electrical equipment 14. Moreover, with the master control switch 10 in the position illustrated in FIG. 1, the electrical equipment 14 cannot be energized even when the operating switch 38 is closed.

However, upon depression of the actuator 78, the upward biasing force of the spring 56 is overcome, and the movable switch arm 50 is moved downwardly under the influence of the force of the actuator 78, so that the contact 54 engages the ON contact 42, as seen in FIG. 2. The circuit to the brake 32 is now open, and the circuit to the electrical equipment 14 is placed in a ready state by completion of a circuit to one side of the operating switch 38 through line 20, common terminal 18, electrically conductive element 82, movable switch arm 60, ON contact 42, and ON terminal 34. The other side of the operating switch 38 is electrically coupled to the power source through the line 28, the electrical equipment 14, and the relay contacts 40. Thus, upon closure of the operating switch 38 by the operator the electrical equipment 14 is energized to run.

In the event that the main contact 54 and the ON main contact 42 remain fused or welded together, when the actuator 78 is released, the brake 32 is not energized and the electrical equipment 14 remains in the dangerous condition of being capable of being energized upon intentional or accidental closure of the operating switch 38. Further, the brake 32 is

not being energized to stop any coasting of the electrical equipment 14. However, advantageously, the auxiliary safety contact means 60 are closed by the movable member 58 on the movable switch arm 50 in its abnormal position for causing the circuit to the alarm 72 and relay 76 to be completed from the power source through line 20, lead 68, safety contacts 65 and 62, and lead 70 through alarm 72 and relay 76 and lead 84 to line 28. Thus, an audible or visual alarm is provided, and the electrical equipment 14 is deactivated by opening relay contacts 40, or a fuse as described earlier. Therefore, even in the presence of intentional or accidental closure of the operating switch 38, the electrical equipment 14 remains deactivated. Further, a safety indication 72 is provided to the operator that the brake 32 has not been energized to stop the electrical equipment 14 if it is coasting after the switch operating means has been moved to OFF position.

The operation of the auxiliary safety contact means 60A in FIG. 4 is similar to that shown in FIGS. 1-3, with the exception that the contact 90 is closed through engagement with an electrically conductive contact 92 by the movable member 58A on the movable switch arm 50A. A circuit is completed from the power source through line 20A, common terminal 18A, electrically conductive element 82A, movable switch arm 50A, safety contact 92, safety contact 90, lead 70A, through alarm 72A, relay 74 and lead 84A to line 28A back to the power source.

The operation of the auxiliary safety contact means 60B in FIG. 5 to close a circuit to the power source is similar to that shown in FIG. 1 to 3. However, in the embodiment of FIG. 5, the abnormal upward canting movement of the movable switch arm 50B allows the long arm portion 120 of the spring member 116 to come into engagement with the contact portion 113 of the contact terminal 62B for completing a circuit between

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the contact portions 114 and 113 and thus completing a circuit between the terminals 66B and 68B, when the contacts 54B and 42B are fused or welded together and the actuator 78B is released.

A modified embodiment similar to FIG. 5 may be employed which includes only a single contact member 62B, and external terminal 66B, and the second contact 64B and terminal 68B as shown in FIG. 5 would be eliminated. With such a modified embodiment, the external electrical connections would be similar to those in FIG. 4. The end 124 of the short arm portion 118 of the spring 116 would rest against an insulating portion of the housing 16B. Completion of the electrical circuit to the various safety devices would occur when the long arm portion 120 engages the contact portion 113 of the contact 62B, with the circuit through the master control switch 10B being completed through the terminal 66B, contact portion 113, spring member 116, movable switch arm 58B, electrically conductive elements 104 and 82B, and terminal 18B.

The various switch embodiments of the present invention are described as including an OFF contact 46, 46A or 46B and an OFF external terminal 26, 26A or 26B. It is to be understood that the intended meaning of "OFF contact" is to be broadly construed to include either a conductive or a non-conductive element against which a portion of the first end 52, 52A or 52B of the switch arm 50, 50A or 50B comes to rest when the switch arm is in its normal OFF (open) position. For example, the OFF contact 46, 46A or 46B can be omitted entirely to be replaced by a non-conductive abutment or fixed post serving merely as a mechanical stop in the housing 16, 16A or 16B, and then the external OFF terminal 26, 48 or 26A, 48A or 26B, 48B is also omitted. In other words, the described embodiments of

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the present invention solve the problem of main switch contacts 42, 54 or 42A, 54A or 42B, 54B becoming fused, welded or struck together in their ON position, regardless of whether the OFF contact is conductive or non-conductive or omitted or non-existent or is present but not utilized in any external circuit. It is to be understood that the OFF contact (or button element) 55 or 55A or 55B carried by the first end 52, 52A or 52B of the switch arm 50 or 50A or 50B serves as a mechanical stop which abuts against an opposed element, such as a contact or stop 46, 46A or 46B, when the switch arm is moved to its normal OFF position, for limiting and defining the amount of upward travel of this first end of the switch arm when it is moved to its open (OFF) position as pushed upwardly by the spring means 56, 56A or 56B. The shoulders 79B on the actuator 78B normally serve as stop means for limiting the upward travel of the second end of the switch arm. In the switches 10 and 10A, the upward travel of the second end of the switch arm 50 or 50A is limited by the length of the spring 56 or 56A. If desired, shoulders similar to those at 79B in FIG. 5 can be provided on the actuator 78 or 78A.

Referring to FIGS. 6 through 10, a further embodiment of the present invention is illustrated as switch 10C, with components of this switch 10C which are similar to corresponding components of the switch 10 or 10A or 10B being given similar reference numerals. The right half of this switch 10C is very similar to the right half of the switch 10B, except that the contact element 46C merely serves as a mechanical stop and does not perform any electrical function. This stop contact 46C is mounted upon a support 48C which is anchored in the wall of the housing 16C. The housing 16C is molded of durable rigid

insulating plastic material in two mating parts. After the switch components have been assembled in the interior of the housing, its two mating parts are secured together by fastening means, for example, rivets or screws or bolts and nuts, which are inserted through appropriate mounting holes, for example, at 94 and 96. It is to be understood that the other switch housings 16, 16A and 16B can similarly be assembled from two mating parts.

The left half of this switch 10C is different from the left half of the switch 10B, as will now be explained. There is a control leg 130 extending diagonally from the left (second) end of the movable switch arm 50C. The foot end 129 of this diagonal control leg 130 is received loosely in a recess 132 at the lower left corner of the housing 16C. The purpose of this diagonal control leg 130 is to stabilize, define and mechanically control the desired movement of the switch arm 50C for making its motion behave in a predetermined manner as will now be explained.

In FIG. 6, the switch arm 50C is shown in its normal open (OFF) position with its main contact 54C separated from the ON main contact 42C. The foot end 129 of the control leg is abutting at 134 against the top of the recess 130, while the button element 55C abuts against the stop 46C. In other words, the bow spring 56C is exerting an upward component of force, and the upward travel of the switch arm 50C is stopped at 134 and at 46C. Also, the shoulders 79C serve as stops for limiting upward travel of the actuator 78C and of the switch arm.

In FIG. 7, the switch arm 50C is shown in its normal closed (ON) position with the main contacts 54C and 42C firmly touching each other. As the actuator 78C is moved

downwardly (arrow 135) in going from its initial outer position shown in FIG. 6 to its fully depressed position shown in FIG. 7, the foot end 129 initially moves down in its recess 132 until it touches the lower side of this recess at 136 as shown in FIG. 7. This mechanical abutting at 136 arrests the downward movement of the control leg 130 and thereby positively causes the right (first) end 52C of the switch arm 50C to swing down firmly for bringing the main contacts 54C and 42C together in firm contact as shown in FIG. 7.

Summarizing, during the downward motion 135 of the actuator 78C, the foot end 129 moves down until it abuts against the housing wall at 136. Thereafter, this foot end 129 acts like a fulcrum pivot, forming a pivot point at 136 for positively causing the first end 52C of the switch arm 50C to swing down firmly into the closed position, as shown in FIG. 7. The bow spring 56C plus the hinged link 104 produce a quick-acting toggle-like action. Consequently, after the fulcrum pivot has been established at 136 and after the first end 52C of the switch arm has begun to swing down and while the hinged link 104 is swinging down about its fixed pivot point at 106, the bow spring moves past its toggle position, and then the first end 52C of the switch arm swings down quickly with a snap-like action into its fully closed position, as shown in FIG. 7. The spring 56C continues to exert an upward component of force, but the main contacts are held firmly closed by the depressed 135 actuator 78C.

Conversely, as the actuator 78C is allowed to move upwardly for turning the switch 10C OFF, the foot end 129 initially rises being pushed upwardly by the upward component of

bow spring force, until this foot end 129 forms an abutting fulcrum at 134 (FIG. 6). While the pivotable link 104 is swinging upwardly about its fixed pivot point 106 and when the first end 52C of the switch arm begins to move upwardly, the bow spring 56C passes its toggle point, and the first end of the switch arm then quickly snaps up to its fully open position as shown in FIG. 6.

At the left (second) end of the housing 16C are auxiliary safety contact means generally indicated at 60C. These auxiliary safety contact means 60C include the pair of spaced auxiliary safety contacts 62C and 64C which slope inwardly toward each other and have external terminal portions 66C and 68C respectively. Positioned between the two contacts 62C and 64C is a movable conductive safety switch element 140 having a truncated conical cup-shape for conforming with these contacts, as seen most clearly in FIGS. 9 and 10. This safety switch element 140 is normally in open position; that is, spaced from its contacts 62C and 64C, as shown in FIGS. 6, 7 and 9, so long as the main contacts 54C, 42C do not become fused together as they are shown in FIG. 8.

A coil spring 142 seating in a recess 144 presses against the switch element 140 for urging it toward closed position wherein it bridges across between its contacts 62C, 64C, as shown in FIGS. 8 and 10. In order to control the auxiliary safety switch means 60C by normally restraining the switch element 140 against the switch-closing bias force of the spring 142, there is a rod-like control member 150, as illustrated most clearly in FIGS. 9 and 10. As will be explained later, this control member 150 is operatively associated with the switch operating mechanism, which includes the actuator 78C, the switch

arm 50C and its leg 130 and the hinged link 104 plus bow spring 56C. This control member 150 has one of its ends 152 (FIGS. 9 and 10) inserted in loose-fitting relationship through a hole in the center of the switch element 140, and it has a pair of shoulders 154 (only one is seen) against which the switch element 140 is pushed by the spring 142.

The second end 156 of the control member 150 is normally being pushed toward the right by the bias spring 142, so that this end 156 thrusts against the upper end 159 of the hinged link 104. This end 159 of the link 104 extends up through an opening or slot 108 in the switch arm 50C. Thus, the control member 150 is normally prevented from moving toward the right under the bias force of the spring 142, because its second end 156 is abutting against the upper end 159 of the link 104 which acts as a mechanical stop. Preferably, to electrically isolate the auxiliary safety contact means 60C from the remainder of the switch components, then the control member 150 is formed from rigid insulating material.

In addition to the switch-closing compression spring 142, there is a leaf spring 160 which serves as a trigger spring. This trigger spring 160 has its second end 158 anchored in a socket 162, while its first end 164 continually exerts an upward force on the control member 150, i.e. exerts a force in a direction generally transverse with respect to the length of said control member.

When the actuator 78C is depressed as shown by arrow 135 (FIGS. 7 and 9) turning the switch ON, the control member 150 swings (tilts) downwardly as its second end 156 (FIG. 9) is pushed down by the actuator. Its first end 152 is sufficiently

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loosely received in the hole in the switch element 140 for allowing this slight tilting movement of the control member 150 without also tilting the switch element. Conversely, when the actuator is moved to OFF position, the control member 150 swings back up to a more nearly horizontal position as shown in FIG. 6. Thus, in this normal ON and OFF operation, the second end 156 of the control member always remains abutting against the upper end 159 of the hinged link 104. The rightward thrust of the safety switch-closing spring 142, which causes a rightward thrust of the control member 150 against the end 159 of the hinged link 104 which, in turn, causes a rightward thrust of the hinged link 104, is ultimately resisted by the fixed pivot at 106 where the end of link 104 is hingedly received in a socket slot in the portion 82C of the fixed common terminal 82C.

In the event that the main contacts 54C, 42C remain welded, fused, or stuck together as shown in FIG. 8 when the actuator 78C is allowed to move upwardly as indicated by arrow 137 for turning the switch OFF, then these joined-together contacts 54C-42C act as a hinge or pivot point to prevent the first end 52C of the switch arm 50C from rising. The upward component of force exerted by bow spring 56C causes the second end of the switch arm to swing up until the foot end 129 of leg 130 abuts against the recess wall at 136 preventing further upward movement of the switch arm. That is, the upward motion of the switch arm 50C is now totally arrested at both of its ends, but the first end 164 of the trigger spring 160 continues to lift upwardly on the control member 150 as indicated by the curved arrow 166 (FIGS. 8 and 10).

Thus, the switch operating means has assumed an abnormal position when the upward motion of the switch arm 50C is arrested at both ends while the actuator 58C is being moved toward OFF position.

As seen most clearly in FIG. 10, this trigger spring now causes the second end 156 of the control member 150 to be lifted as shown by arrow 167 above the end 159 of the link 104, thus immediately releasing the control member 150 to move to the right as indicated by arrow 168, thus allowing the compressed or cocked spring 142 to quickly move the switch element 140 into its closed position bridging across between safety contacts 62C and 64C for automatically effecting a desired safety function. The desired safety function(s) which is (are) effected by closure of the auxiliary safety contact means 60C is (are) determined by the particular arrangement of the associated control circuit, for example, such as the circuit 12C shown in FIG. 11, for deactivating the electrical equipment 14 and for giving an alarm signal.

The control circuit 12C shown in FIG. 11 is similar to the control circuit 12 shown in FIGS. 1 and 2, except that the OFF terminal 24 and the brake 32 are omitted. Also, the deactivating means 74 is shown as including a fast-acting heater 76C near a fuse 40C.

It is to be understood that the switch 10C is adapted to include an L-shaped actuator lever for depressing the actuator 78C, similar to the lever 111 in FIG. 5. The fixed end of this actuator lever is mounted in an external socket 170 in the housing 16C.

Referring to FIG. 12, a safety switch embodying the present invention is illustrated generally at 10D. This switch 10D is shown by way of example as a control switch used with an interlock mechanism 211 (FIG. 18) for opening and closing a circuit 212, for example as shown in FIG. 18, which energizes electrical equipment 214, for example such as an electric motor drive for driving a tool or other machinery 215.

This interlock mechanism 211 is illustratively shown associated as indicated by the dashed line 217 with a cover or door 219 which blocks access to the tool or machinery 215, until this access barrier 219 is opened. The interlock mechanism includes a plunger 221 which depresses a switch operating level 223 and an actuator 225 for keeping the switch 10D in its ON condition, so long as the access barrier 219 is closed. When the operator opens the barrier 219 to obtain access to the tool or machinery 215, the interlock mechanism 211 causes the plunger 221 to be raised, thus allowing the actuator 225 to move upwardly as explained later for turning OFF the switch 10D for preventing the motor drive 214 from becoming energized.

The switch 10D includes an insulating housing 216 having a fixed common terminal 218 extending externally from the housing. A pair of fixed spaced ON and OFF terminals 222 and 224 also extend externally from the housing.

The ON terminal 222 has an ON contact 232 fastened to its internal end 236 located within the housing 216. Similarly, the OFF terminal 224 has an OFF contact 234 fastened to its internal end 218 located within the housing 216. The ON contact

232 and OFF contact 234 are spaced relative to one another to receive the end of a movable switch arm 240 between them.

Specifically, the first end 242 of the movable switch arm 240 is interposed between the ON contact 232 and the OFF contact 234.

Affixed to this first end 242 of the movable switch arm 240 is a contact 244 which moves with the arm between an ON position of engagement with, i.e., touching the ON contact 232 (FIG. 13) to an OFF position of separation from this ON contact (FIG. 12). Also shown affixed to this first end 242 of the switch arm is a movable contact 245 which moves with the arm. When the switch arm is in its OFF position, as shown in FIG. 12, the movable contact 245 is in engagement with (touches) the OFF contact 234. The movable switch arm 240 is biased upwardly by a bow spring 246, so that the movable contact 245 normally engages the OFF contact 234. This spring 246 is mechanically coupled to the movable switch arm 240 and thrusts at a location 227 against the stationary internal end 228 of the common terminal 218 for providing a bias force urging the switch arm 240 toward the OFF position. This inner end portion 228 of the common terminal is anchored in a recess 229 in the wall of the switch housing, and there is a notch or concave bend at the location 227 for receiving the end of the bow spring 246. The other end of the bow spring hooks at 231 into a slot in the switch arm 240. If desired, the switch operating level 223 may be omitted from the switch 100 as is shown in FIGS. 12-14, in which case the plunger 221 is directly aligned over the actuator 225 for depressing it. Although this switch actuator 225 is illustratively shown to be moved by an interlock mechanism, it is to be understood that this actuator may be moved down or depressed by external operation of the switch in a variety of ways, such as manually or mechanically, depending upon the particular installation in which the switch is used.

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When the actuator 225 is pushed down as shown by the arrow 247 in FIG. 13, the switch arm 240 is caused to move down into its closed (ON) position against the force of the bow spring 246 for bringing the main contacts 244 and 232 together for completing a conductive path between the common terminal 218 and the ON terminal 222.

The ON contact 232 and the movable contact 244 are considered the "main" contacts of the switch 10D, because the closure of these main contacts enables the electrical circuit 212, which is controlled by the switch 10D and which contains the equipment 214, to be energized by closure of an operating switch 230 (FIG. 18) which is included in the circuit 212.

The switch 10D includes operating means for moving its main contacts 244, 232 into the closed (ON) position and into the open (OFF) position. These switch operating means include the actuator 225 already described (plus the level 223 if it is present) and the bowed spring 246 and also a movable link 248 to be described. This movable link 248 is formed of electrically conductive material having the lower of its ends hingedly sealed at 249 to the inner portion 228 of the common terminal 218. For example, this hinged relationship at 249 is provided by receiving the end of the link 248 into a recess or slot in the fixed terminal portion 228. The upper end 250 of this movable link 248 is hingedly sealed at 251 on the switch arm. For example, this hinged relationship at 251 is provided, as seen most clearly in FIGS. 15 and 16, by extending the link end 250 up through an opening 252 in the switch arm 240 for the edge of this opening to rest in a notch in the side of the link end 250. Thus, this hinged link 248 serves as a component of the switch operating means for it swings down with the switch arm about its fixed hinge location at 249, as seen in FIG. 13, when the switch arm

240 is moved down to the closed (ON) position by depressing the actuator 225 as shown by the arrow 247. The bow spring 246 continues to exert an upward component of force on the switch arm 240, regardless of whether the switch arm is in its open (FIG. 12) or closed (FIG. 13) position.

Forming part of the operating means for the switch arm 240, there is a control leg 260 extending diagonally from the left (second) end of the movable switch arm 240. The foot end 258 of this diagonal control leg 260 is received loosely in a recess 262 at the lower left corner of the housing 216. The purpose of this diagonal control leg 260 is to define and mechanically control the desired movement of the switch arm 240.

In FIG. 13, the switch arm 240 is shown in its normal closed (ON) position with the main contacts 244 and 232 firmly touching each other. As the actuator 225 is moved downwardly (arrow 247) in going from its initial outer position shown in FIG. 12 to its fully depressed position shown in FIG. 13, the foot end 258 initially moves down in its recess 262 until it touches the lower side of this recess at 264 as shown in FIG. 13. This abutting at 264 arrests the downward movement of the control leg 260 and thereby positively causes the right (first) end 242 of the switch arm to swing down for bringing the main contacts 244 and 232 together in firm contact as shown in FIG. 13.

In operation, during the downward motion 247 of the actuator 225, the foot end 258 moves down until it abuts against the housing wall at 264. Thereafter, this foot end acts like a fulcrum pivot at 264 for positively causing the first end 242 of the switch arm 240 to swing down firmly into the closed position, as shown in FIG. 13. The bow spring 246 plus the hinged link 248

produce a quick, toggle-like action. Consequently, after the fulcrum pivot has been established at 264 and after the first end 242 of the switch arm has begun to swing down and while the hinged link 248 is swinging down about its fixed pivot point at 249, the bow spring moves past its toggle position, and then the first end 242 of the switch arm swings down quickly with a snap-like action into its fully closed position, as shown in FIG. 13. The spring 246 continues to exert an upward component of force, but the main contacts are held firmly closed by the depressed (arrow 247) actuator 225.

Conversely, as the actuator 225 is allowed to move upwardly for turning OFF the switch 10D, the foot end 258 initially rises being pushed upwardly by the upward component of bow spring force, until this foot end forms an abutting fulcrum at 266 (FIG. 14). While the link 248 is swinging upwardly about its fixed pivot point 249 and when the first end 242 of the switch arm begins to move upwardly, the bow spring 246 passes its toggle point, and the first end of the switch arm then quickly snaps up to its fully open position as shown in FIG. 12.

If sufficient current happens to be flowing through the electrical equipment 214 (FIG. 18), so that arcing occurs between the main contacts 232 and 244 as they are being separated when the switch is being turned OFF, then these main contacts may become fused or welded together. If fusing occurs, the contact 244 will remain electrically connected to the ON contact 232 when the actuator 225 is in its released or open position as shown in FIG. 14.

In order advantageously to disable or interrupt the electrical circuit 212, which is under control of the switch 10D, in the event that its main contacts 244 and 232 remain together when the actuator 225 is released as shown by the arrow 256,

auxiliary safety contact means, generally indicated at 70, are provided in the housing 16. The auxiliary safety contact means 70 include a pair of spaced auxiliary safety contacts 272 and 274 which extend toward each other and have respective external terminal portions 276 and 278. Positioned near these two contacts 272 and 274 is a movable conductive safety switch element 280 having a cup-shape with a flat circular flange 282 (FIGS. 15 and 16) for pressing flat against these contacts in good conductive relationship as seen in FIG. 15 for providing a highly conductive path through the switch element 280 bridging across these contacts. This safety switch element 280 is normally in closed position; that is, engaging both contacts 272 and 274 so long as the main contacts 244, 232 do not become fused together as they are shown in FIG. 14.

A larger diameter coil spring 284 has one end pressing against the flange 282 for urging the switch element 280 toward closed position wherein it bridges across between contacts 272, 274, as shown in FIGS. 12, 13, and 14. The other end of this coil spring 284 (FIG. 17) presses against a pair of shoulders 286 on a movable rigid insulating member 288 which serves to control the position of the switch element 280 by being operatively associated with the switch operating means, as will be explained later. This control member 288 has one of its ends 290 (FIG. 15, 16 and 17) inserted in loose-fitting relationship through an aperture 292 in the center of the switch element 280.

A smaller diameter coil spring 294 seating in a recess 296 in the switch housing presses against a pair of shoulders 298 on the control member 288 for continuously urging or biasing the control member toward the right, namely toward opening the auxiliary safety contact means 270. Thus, the second end 300 of this control member is normally being pushed toward the right by the bias spring 294, so that this end 300 thrusts against the upper end 250 of the hinged link 248. The control member 288 is normally prevented from moving toward the right under the bias

force of the switch-opening spring 294, because its second end 300 is abutting against the upper end of the link 248 which is acting as a mechanical stop having a fixed hinge point 249.

In addition to this switch-opening compression spring 294, there is a leaf spring 310 which serves as a trigger spring. This trigger spring has its second end 308 anchored in a socket 312, while its first end 314 continually exerts an upward force on the control member 288, i.e., exerts a force in a direction generally transverse with respect to the length of said control member.

When the actuator 225 is depressed as shown by arrow 247 (FIG. 13) turning the switch ON, the control member 288 swings (tilts) downwardly as its second end 300 is pushed down by the actuator. Its first end 290 is sufficiently loosely received in the aperture in the switch element 280 for allowing this slight tilting movement of the control member without also tilting the switch element. Conversely, when the actuator is moved to OFF position, the control member 288 swings back up to a more nearly horizontal position as shown in FIGS. 12 and 15.

Thus, in this normal ON and OFF operation, the second end 300 of the control member 288 always remains abutting against the upper end 250 of the hinged link 248. The rightward thrust of the switch-opening spring 294, which causes a rightward thrust of the control member 288 against the end 250 of the hinged link 248 which, in turn, causes a rightward thrust of the hinged link 248, is ultimately resisted by the fixed pivot at 249.

In order to assure that the control member end 300 will remain normally abutting against the side surface of the hinged link end serving as stop 250, the switch actuator 225 has a special configuration on its lower portion. There is an elevated central clearance recess 316 (FIG. 15) defining a downwardly protruding leg 318 which normally holds the control member end 300

down below the upper extremity of the stop 250, where the control member end cannot normally slip past this stop.

In the event that the main contacts 244,232 remain welded, fused, or stuck together as shown in FIG. 14 when the actuator 225 is allowed to move upwardly as indicated by arrow 256 for turning the switch OFF, then these joined-together contacts 244-232 prevent the first end 242 of the switch arm 240 from rising. The upward component of force exerted by bow spring 246 causes the second end 254 of the switch arm to swing up until the foot end 258 of the leg 260 abuts against the recess wall at 266 preventing further upward movement of the switch arm. That is, the upward motion of the switch arm 240 is now totally arrested at both of its ends, but the first end 314 of the trigger spring 310 continues to lift upwardly on the control member 288 as indicated by the curved arrow 320 (FIG. 16).

The switch operating means has assumed an abnormal position when the upward motion of the switch arm 240 is arrested at both ends while the actuator 225 is being moved 256 toward OFF position.

As seen most clearly in FIG. 16, this trigger spring 310 now causes the second end 300 of the control member 285 to be lifted as shown by arrow 322 above the stop end 250 of the link 248, thus immediately releasing the control member to move to the right as indicated by arrow 324, thus allowing the compressed spring 294 suddenly to lengthen to quickly move the switch element 280 into its open position. The circular shaped of the end of the coil spring 294 does not fit through the slotted aperture 292, even though the strip-shaped control member 288 can slide freely through the aperture as seen in FIG. 16. Consequently, the spring 294 moves the switch element 280 to the right as

seen in FIG. 16, and the conductive path between the auxiliary safety terminals 276 and 278 is interrupted.

In order to arrest the rightward movement 324 of the member 288, the lower portion of the actuator 225 has a second downwardly protruding leg 328 which is long enough to extend down into the opening 252 in the switch arm 240. The end 300 of the control member 288 is stopped by this leg 328.

The actuator 225 is made of rigid insulating material. The housing 216 is molded of durable rigid insulating plastic material in two mating parts. After the switch components have been assembled in the interior of the housing, its two mating parts are secured together by fastening means, for example, rivets or screws or bolts and nuts, which are inserted through appropriate mounting holes, for example, at 329 and 330.

As shown in FIG. 18, an advantageous way to connect the switch 10D into a circuit 212 is to include the auxiliary safety contact means 270 in series with the electrical equipment 214. One electrical supply line 332 (FIG. 18) from a power source (not shown), e.g., a 115V, 60 Hz A.C. voltage source, is shown electrically connected to the common terminal 218. The operating switch 230 may be included in this supply line, if desired. The OFF terminal 224 is shown electrically connected to the other supply line 334 from the power source, e.g., through a lead 336 to a brake 338 and through a lead 340 to the supply line 334. Thus, the brake 338 is applied whenever the switch 10D is OFF. The ON terminal 222 is connected through a lead 342 to one of the safety terminals 276 or 278, and another lead 334 is connected from the other safety terminal to the equipment 214 being controlled, with a lead 346 from the equipment to the other supply line 334. Therefore, the auxiliary safety contact means are

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connected directly in series with the electrical load 214. Interrupting the conductive path between the terminals 276, 278 will immediately disable the circuit 212 so that the equipment will not become energized by closure of the operating switch 230. This operating switch may be included at any desired location in circuit in series with the electrical load 214. For example, this operating switch may be located at 230' in the lead 344 instead of being at 230 in the supply line 332.

The switch embodiment 10D of the present invention has been described as including an OFF contact 234 and an OFF external terminal 224.

It is to be understood that the intended meaning of "OFF contact" is to be broadly construed to include either a conductive or a non-conductive element 234 against which a portion 245 of the first end 242 of the switch arm 240 comes to rest when the switch arm is in its normal OFF (open) position. For example, the OFF contact can be omitted entirely to be replaced by a non-conductive abutment or fixed post serving merely as a mechanical stop in the housing 216, and then the external OFF terminal 224 and the brake circuit 336, 338 and 340 are omitted. In other words, the described embodiment of the present invention solves the problem of main switch contacts 244, 232 becoming fused, welded or stuck together in their ON position, regardless of whether the OFF contact is conductive or non-conductive or omitted or non-existent or is present but not utilized in any external circuit. It is to be understood that the contact (or button element) 245 carried by the first end 242 of the switch arm 240 serves as a mechanical stop which abuts against an opposed element, such as a contact or stop 234 when the switch arm is moved to its normal OFF position, for limiting and defining

the amount of upward travel of this first end of the switch arm when it is moved to its open (OFF) position as pushed upwardly by the spring means 246. The shoulders 348 on the actuator 225 serve as stop means for limiting the upward travel of the second end 254 of the switch arm.

An example of an application wherein the present invention may be used to advantage is a food processor. In such an example, the food processing tool 215 is driven by a motor drive 214. A removable cover 219 is located on a working bowl (not shown) in which the rotatable tool 215 processes various food items. The interlock mechanism 211 includes a vertical plunger 221 mounted in the working bowl with a spring urging this plunger upwardly away from the switch actuator 225 and includes an element on the cover 219 which depresses the plunger 221 for turning ON switch 10D only when the cover has been properly placed by the operator on the rim of the bowl in readiness for food processing operation. In a food processor, the plunger 221 is directly aligned with the actuator 225, and the lever 223 is omitted. The operator uses an operating switch 230 or 230' for running the motor drive 214 after the cover 219 has been appropriately placed on the bowl. When the cover 219 is removed by the operator from the bowl, the plunger 221 moves upwardly for turning OFF the switch 10D, and thus closure of the operating switch 230 or 230' can not energize the motor drive 214 until the cover 219 is again placed on the bowl in readiness for further food processing operation.

In the event that the main contacts 244, 232, in the switch 10D happen to become welded, fused or stuck together, then the auxiliary safety contact means 270, which are connected in the main circuit 324, 344, 346 in series with the motor drive 214, are automatically triggered and moved into open position

for interrupting this main circuit. This opening of the auxiliary safety contact means 70 prevents further operation of the motor drive until the food processor appliance has been serviced by replacing the malfunctional interlock switch 10D with a new switch.

It is to be understood that physical orientation terms, such as "horizontal", "up", "upper", "upward", "upwardly", "rises", "higher", "above", "down", "downward", "downwardly", "lower", "below", "right", "rightward", "left", "leftward", "leftwardly", and similar terms, are set forth for convenience of the reader in readily understanding the description with reference to the drawings as shown and these terms are not intended to be limiting. The switches 10, 10A, 10B, 10C can be installed and mounted and will operate properly in any desired orientation, because their various components are operated by mechanical motions and by spring forces without any significant effect by the earth's gravity.

It is to be understood by those skilled in the art that various modifications may be made in the described embodiments of the present invention, without departing from the spirit and scope of the present invention, as described in the specification and defined in the appended claims, which provides a switch with auxiliary safety contact means which are changed in position when the switch actuator means is turned (moved) OFF, if the ON contacts remain fused, welded or stuck together, for automatically effecting a safety function, for example to prevent operation of the electrical equipment, to protect the operator or maintenance personnel from injury from unexpected actuation of the electrical equipment in question, and/or informing them that the switch has malfunctioned.

CLAIMS:

1. A safety switch (10, 10A, 10B, 10C, 10D) having a housing (16, 16A, 16B, 16C, 216) in which main contacts (54, 42; 54A, 42A; 54B, 42B; 54C, 42C; 244, 232) are closed by moving a movable actuator (78, 78A, 78B, 78C, 225) in one direction for completing an electrical circuit, and said main contacts are opened by moving said actuator in another direction for interrupting said circuit, said safety switch being characterized by: auxiliary safety contact means (60, 60A, 60B, 60C, 270) located within said switch housing and normally having a first relationship, and control means (58, 80; 58A, 128; 150; 288) within said switch housing causing said auxiliary contact means to move into a second relationship

if the main contacts remain closed when the actuator is moved in said other direction but the main contacts remain closed stuck together.

2. A safety switch as claimed in Claim 1, wherein there is a movable switch arm (50, 50A, 50B, 50C, 240) in the housing (16, 16A, 16B, 16C, 216) with one of said main contacts (54, 54A, 54B, 54C, 244) being on said movable arm, and wherein the movable switch arm assumes (moves into) an abnormal position (FIG. 3, FIG. 4, FIG. 5, FIG. 8, FIG. 14) occurring when said actuator (78, 78A, 78B, 78C, 225) is moved in said other direction but the main contacts remain closed stuck together, characterized in that: said control means (58, 80; 58A, 128; 150; 288) is responsive to the abnormal position of said switch arm for causing said auxiliary safety contact means to move into said second relationship.

3. A safety switch as claimed in Claim 2, further characterized in that: a stressed spring (116, 142, 294) is positioned within said housing for moving said auxiliary safety contact means (60B, 60C, 270) from said first relationship (FIG. 5, FIG. 6, FIG. 7, FIG. 12, FIG. 13) to said second relationship (FIG. 5, FIG. 8, FIG. 14), said control means (128, 150, 288) normally restrains said stressed spring to keep said auxiliary safety contact means (60C, 270) in said first relationship, said control means being released when the actuator (78B, 78C, 225) is moved in said other direction (FIG. 5, 137, 256) but the main contacts (54B, 42B; 54C, 42C; 244, 232) remain closed together, for allowing the stressed spring to move said auxiliary safety contact means to said second relationship.

4. A safety switch as claimed in Claim 2 or 3, wherein there is a movable link (104, 248) in the housing (16C, 216, having an end (159, 250) which moves with the movable switch arm (50C, 240), characterized in that: said control means (150, 288) normally rests against a surface of said end of the movable link, and said control means being released to move beyond said end of the movable link when the actuator (78C, 225) is moved in said other direction (137, 256) but the main contacts (54C, 42C; 244, 232) remain closed together.

5. A safety switch as claimed in Claim 3, wherein there is a movable link (104, 248) in the housing (16C, 216) having an end (159, 250) which moves with the movable switch arm (50C, 240), characterized in that: said control means (150, 288) normally rests against a surface of said end (159, 250) of the movable link, said stressed spring (12, 294) urges said control means against said end of the movable link, and said control means being released to move beyond said end of the movable link when the actuator (78C, 225) is moved in said other direction (137, 256) but the main contacts (54C, 42C; 244, 232) remain closed together.

6. A safety switch as claimed in Claim 3 or 5, further characterized in that: said auxiliary safety contact means (270) include spring means (284) urging said auxiliary safety contact means to said first relationship, and release of said control means allows said stressed spring (294) to deflect the action of said spring means (284) and to move said auxiliary safety contact means to said second relationship.

7. A safety switch as claimed in Claim 3 or 5, further characterized in that: said auxiliary safety contact means (60C) are normally open (FIGS. 6, 7, 9) in said first relationship, and said stressed spring (142) moves said auxiliary safety contact means to said second relationship wherein said auxiliary safety contact means are closed (FIGS. 8,10).

8. A safety switch as claimed in Claim 3, 5 or 6, further characterized in that: said auxiliary safety contact means (270) are normally closed (FIGS. 12,13,15) in said first relationship, and said stressed spring (294) moves said auxiliary safety contact means to said second relationship wherein said auxiliary safety contact means are open (FIGS. 14 and 16).

9. A safety switch as claimed in Claim 3, 4, 5, 6, 7 or 8, characterized further in that: said control means (150,288) has trigger spring means (160,310) operatively associated therewith urging said control means in a direction parallel with said surface of said end (159,250) of the movable link for releasing said control means from said surface to move beyond said end of the movable link when the actuator (78C,225) is moved in said other direction (137, 256) but the main contacts (54C,42C; 244,232) remain closed together.

10. A safety switch as claimed in Claim 9, characterized by: said trigger spring means (160,310) being a leaf spring.

11. A safety switch as claimed in Claim 9 or 10, characterized in that: said trigger spring means (160,310) urges said control means in a direction toward the extreme end of said end (159,250) of the movable link, said trigger spring means also urges said movable actuator (78C,225) in a direction away from the extreme end of said end of the movable link for creating a separation therebetween, and said control means (150,288) when released from said side surface moves into the resulting separation between said extreme end and said actuator.

12. A safety switch as claimed in any of Claims 1 to 11 characterized by: at least one auxiliary terminal (66,68; 66A; 66B,68B; 66C,68C; 276,278) extending to the exterior of the housing (16, 16A, 16B, 16C, 216) available for connection to an external circuit, said auxiliary terminal being electrically connected to said auxiliary safety contact means (60, 60A, 60B, 60C, 270).

13. A safety switch as claimed in any of Claims 1 to 11, characterized in that: a pair of auxiliary terminals (66,68; 66B,68B; 66C, 68C; 276,278) extend to the exterior of the housing (16,16B,16C, 216) available for connection to an external circuit, said pairs of auxiliary terminals being electrically connected to said auxiliary safety contact means (60,60B,60C,270).

14. A safety switch as claimed in any of Claims 1 to 13 characterized in that: said auxiliary contact means produce a safety function when they move into said second relationship, and said safety function includes one or more of the following: transmitting an audible alarm signal, transmitting a visible alarm signal, interrupting the circuit controlled by said main contacts.

FIG. 1

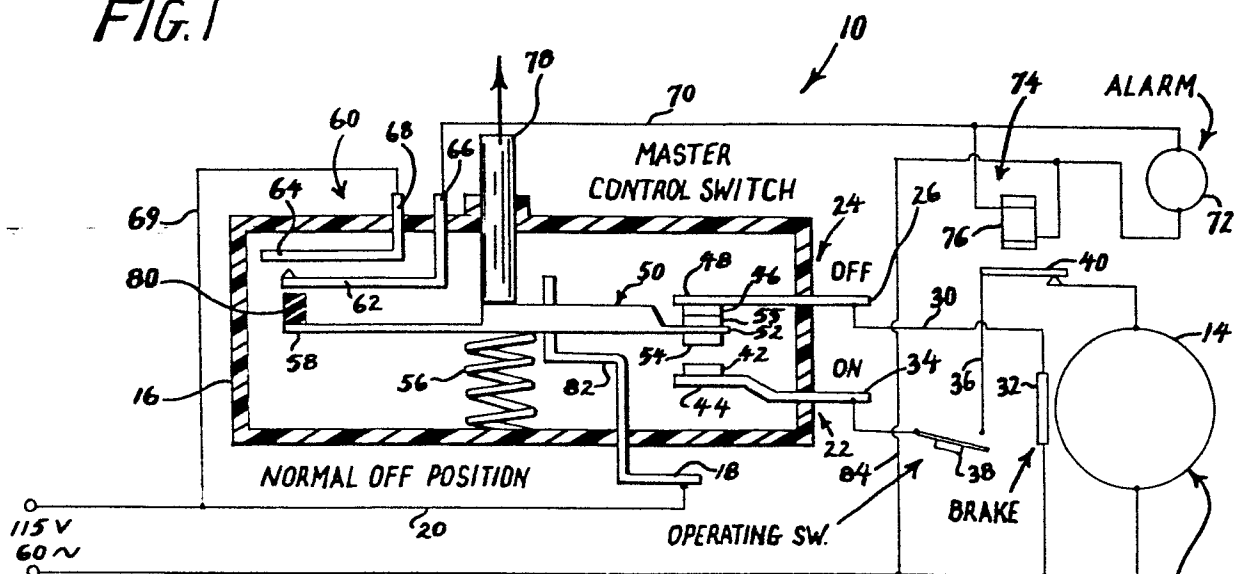


FIG. 2

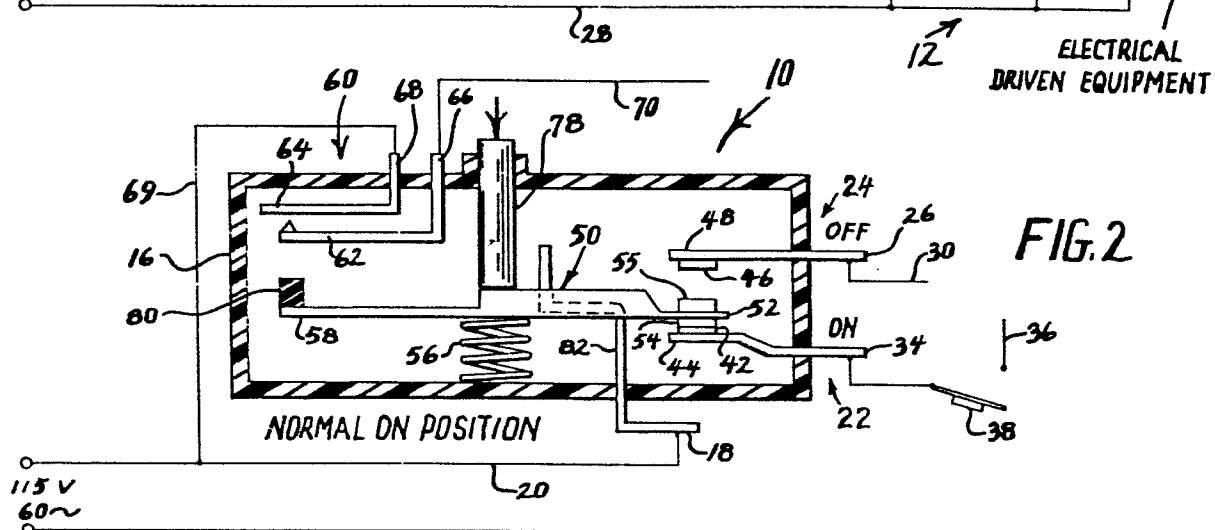
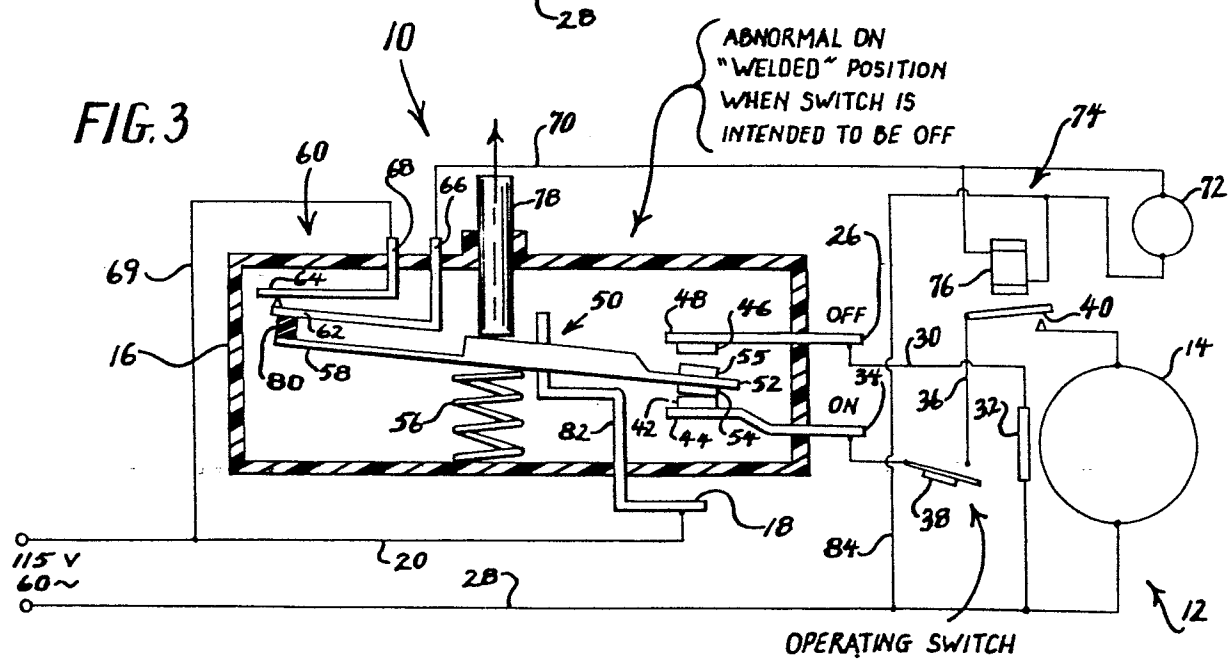


FIG. 3



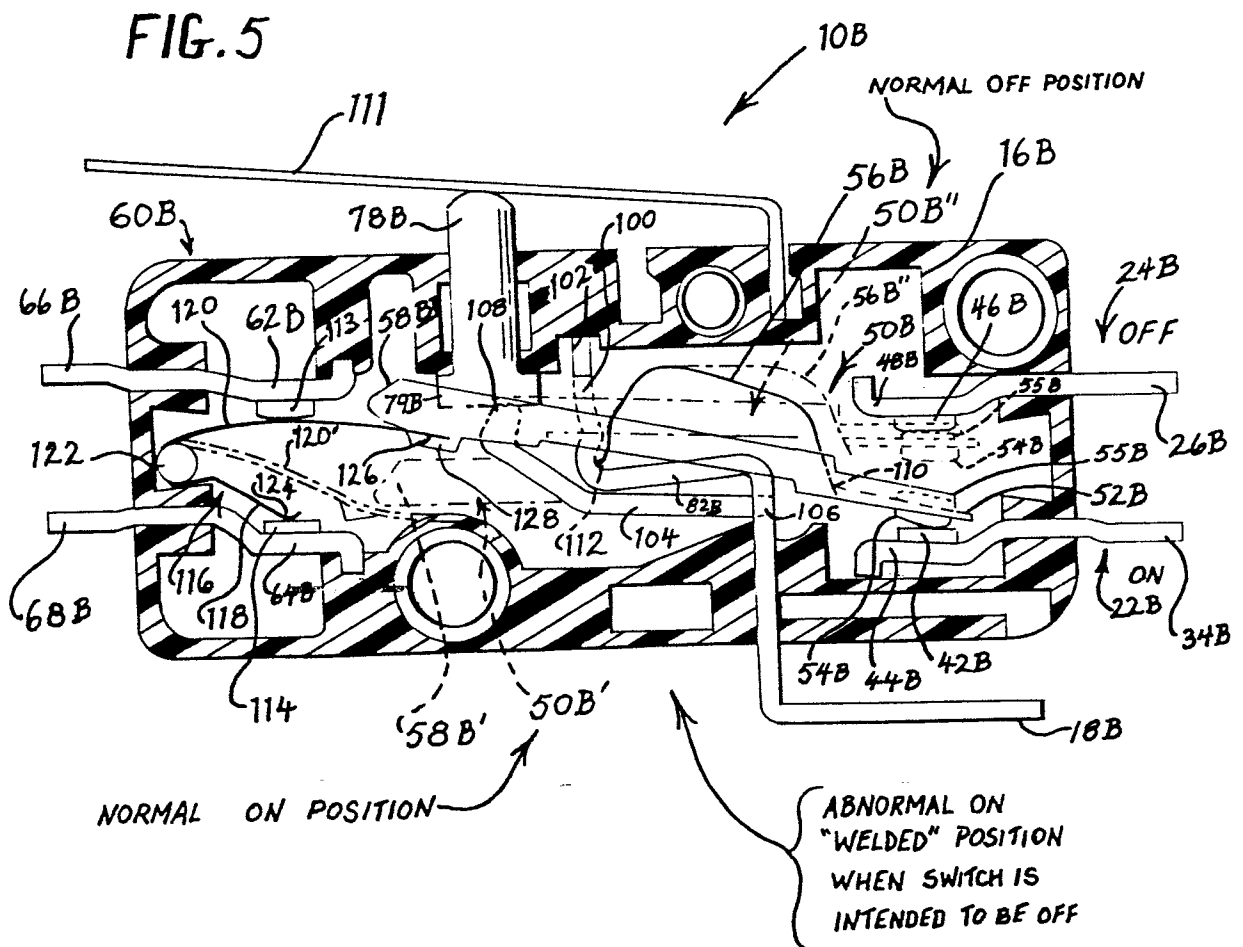
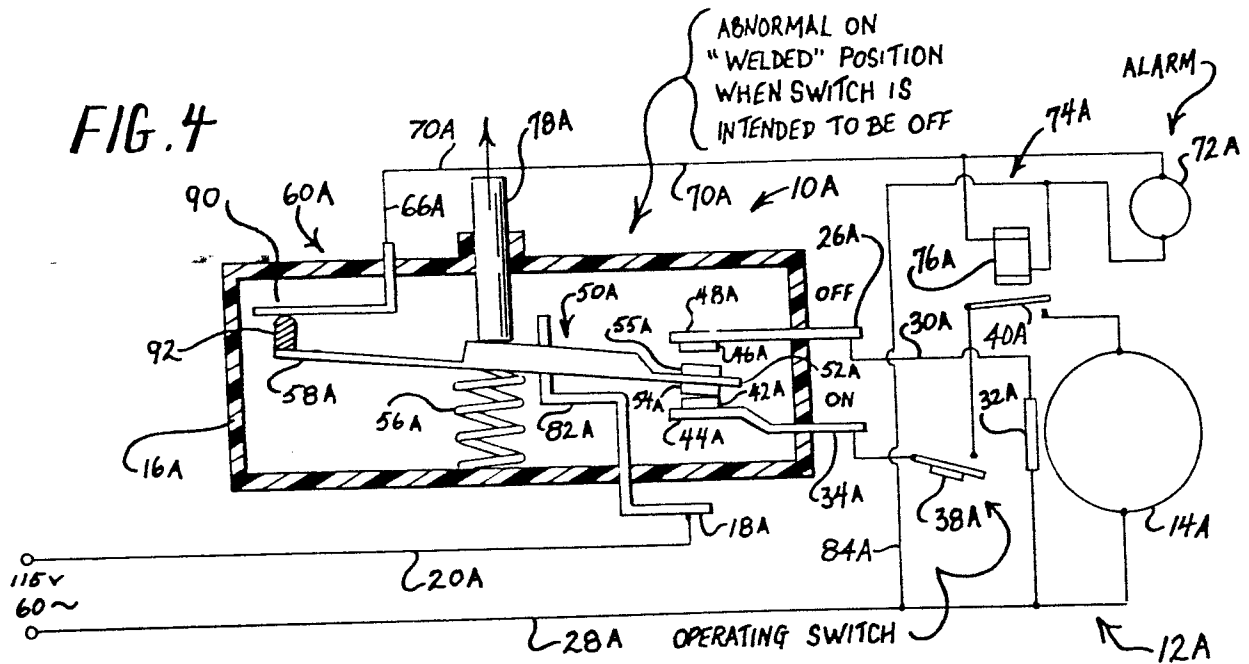


FIG. 9

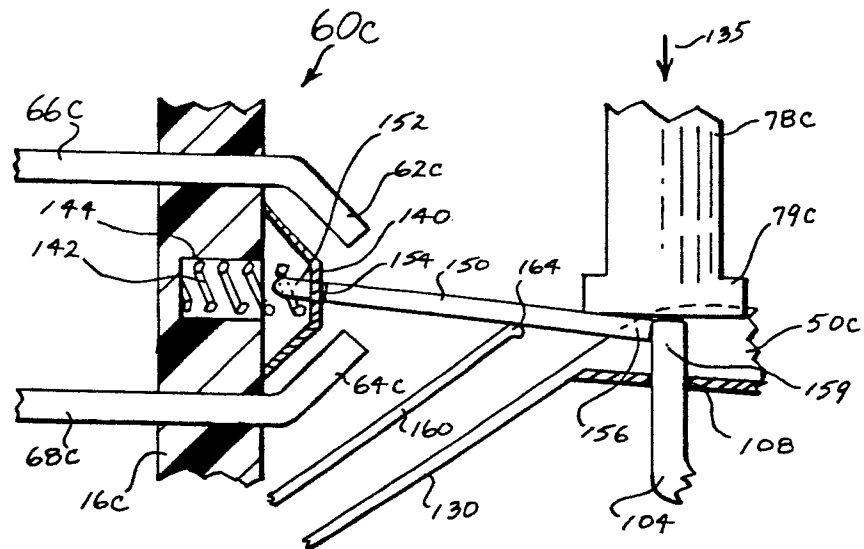
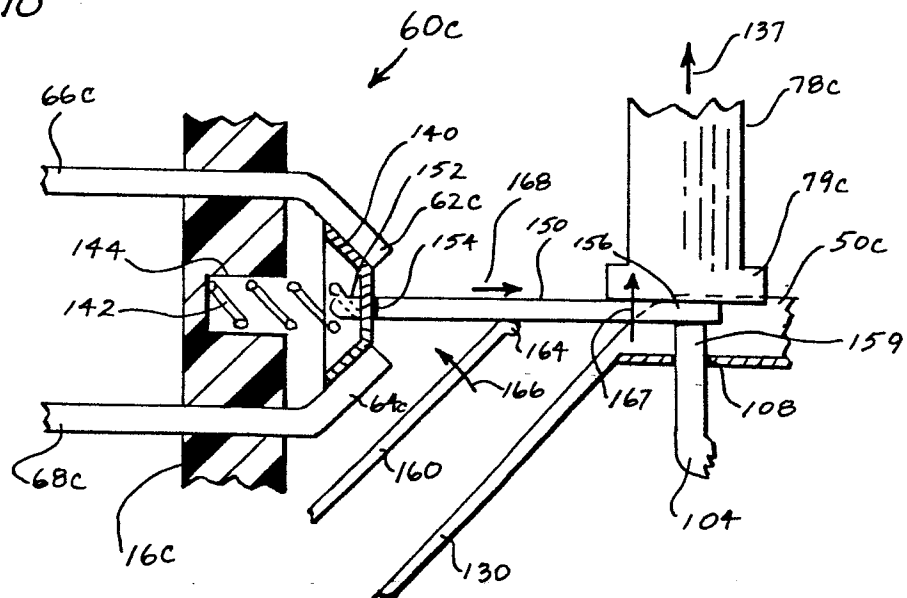


FIG. 10



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FIG. 12

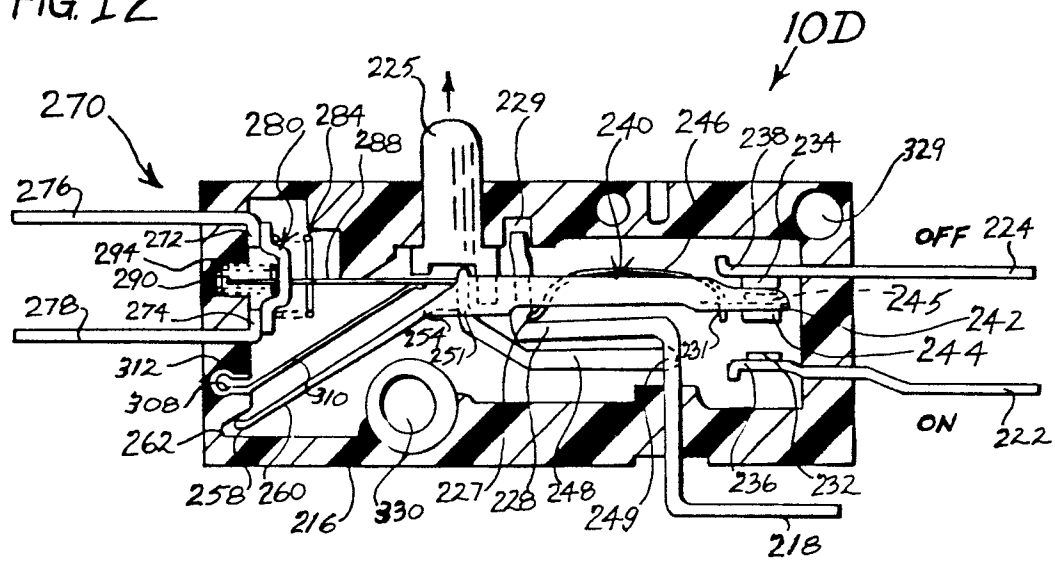


FIG.13

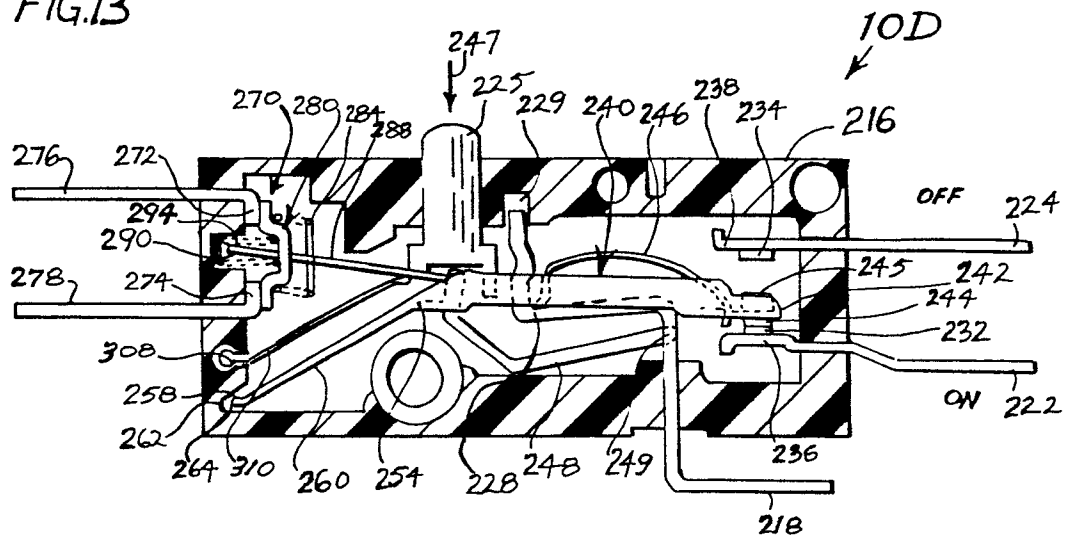


FIG. 14

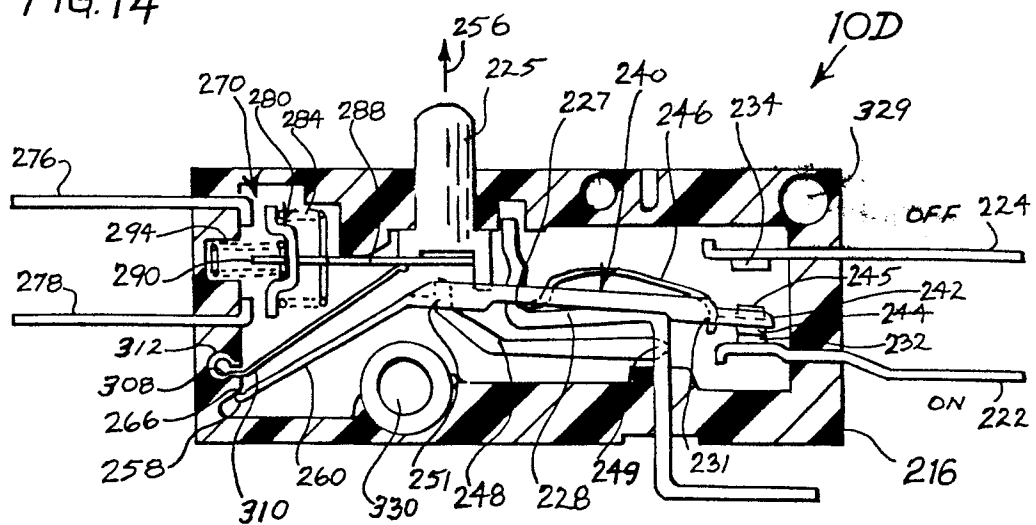


FIG. 15

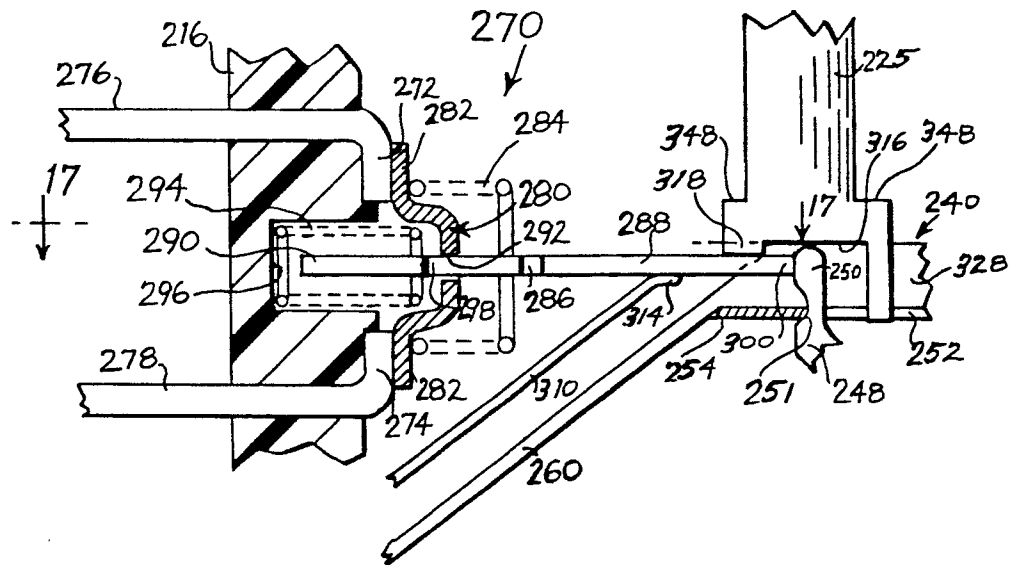


FIG. 16

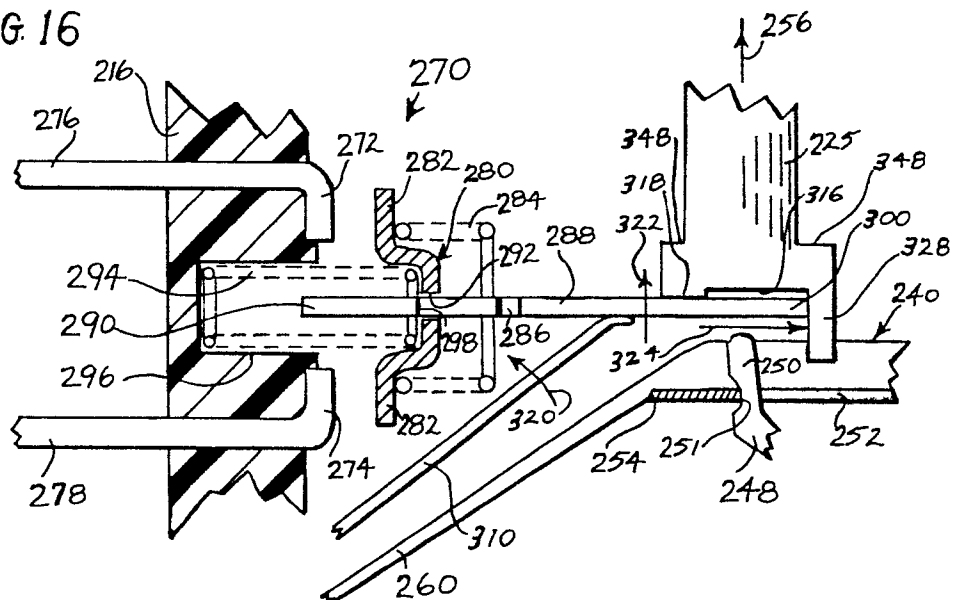


FIG. 17

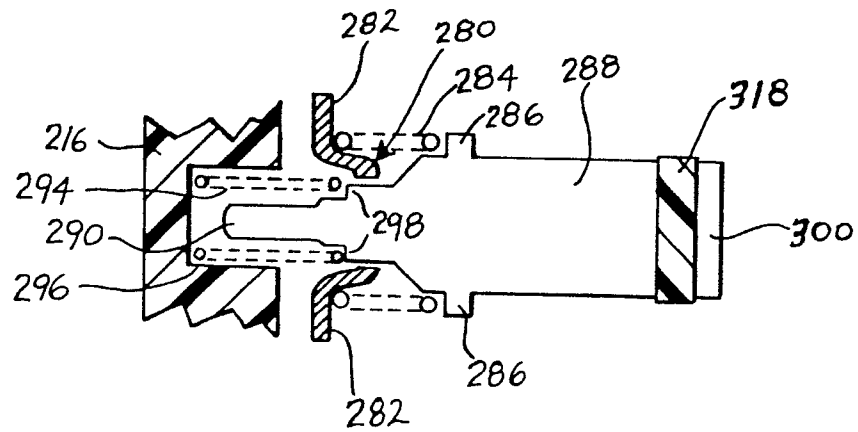


FIG. 18

