United States Patent [19]

Kraulits

[11] **3,845,433**

[45] **Oct. 29, 1974**

[54] **SWITCH OPERATOR WITH TRIPPING MEANS**

[75] Inventor: **John E. Kraulits,** Norfolk, Mass.

[73] Assignee: **Arrow-Hart, Inc.,** Hartford, Conn.

[22] Filed: **Sept. 28, 1973**

[21] Appl. No.: **401,939**

[52] **U.S. Cl.** ..... **335/254,** 200/153 SC, 335/25

[51] **Int. Cl.** **H01h 3/02**

[58] **Field of Search** ..... 200/153 SC, 153 G, 50 A; 335/25, 26, 254

[56] **References Cited**

UNITED STATES PATENTS

3,582,595 6/1971 Stene 335/25

3,689,721 9/1972 McGuffie ..... 200/153 SC

Primary Examiner—Harold Broome

Attorney, Agent, or Firm—Kenway & Jenney

[57] **ABSTRACT**

A switch operator has a trip spring charged and latched by a single closing motion, and a closing spring charged by release of the trip spring and released to close the switch by the closing motion. The switch is tripped open by either an electric solenoid or a trip button unlatching and releasing the trip spring.

19 Claims, 11 Drawing Figures

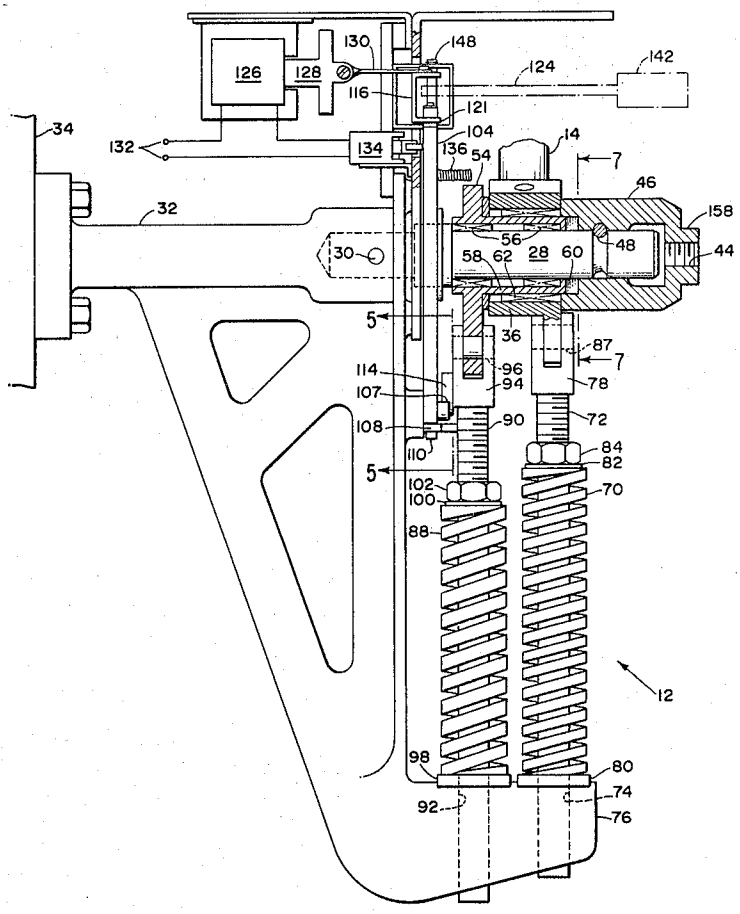


FIG. 1

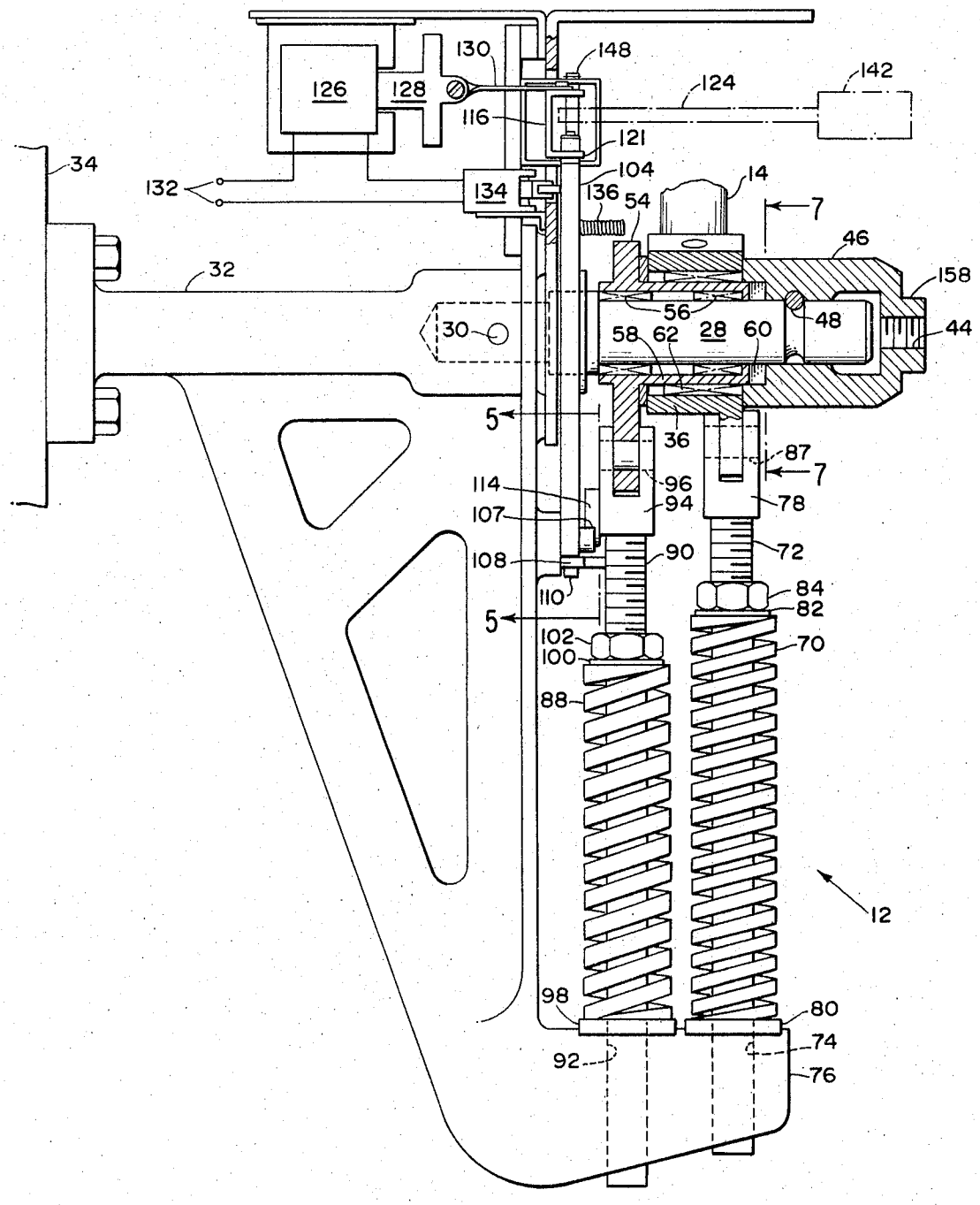

126
128
130
148
124
142
116
121
34
132
134
104
136
54
14
7
46
32
158
56
48
44
30
58
62
28
60
5
36
87
7
114
96
94
78
107
108
90
72
110
84
82
5
102
100
70
88
12
98
80
74
92
76

FIG. 2

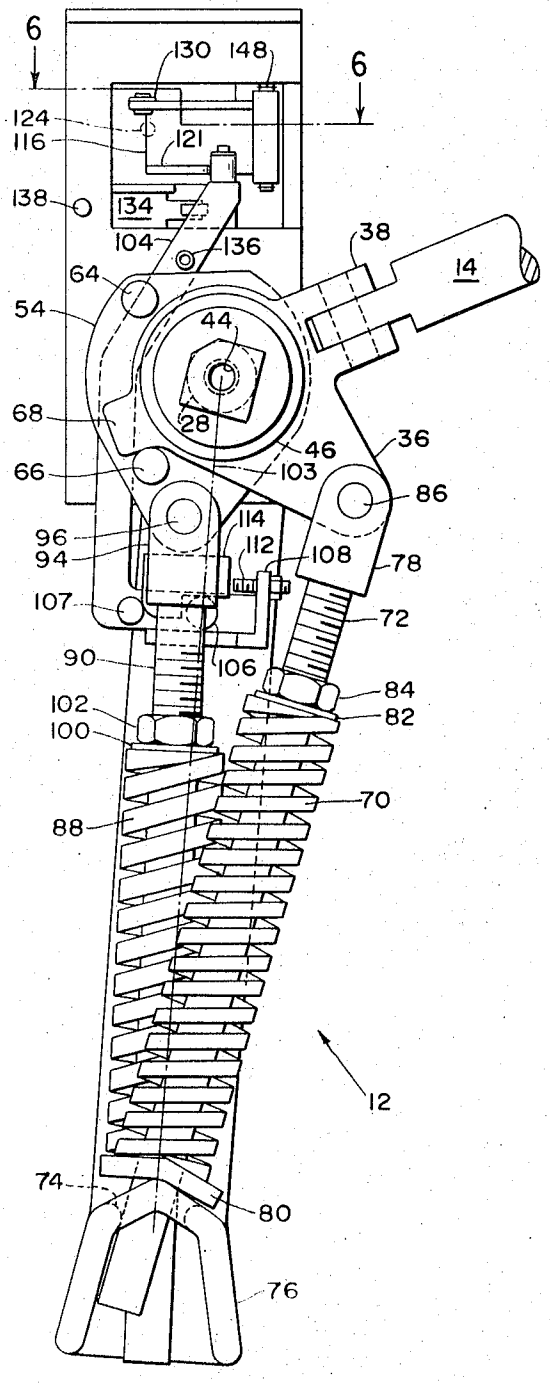

6
6
130
148
124
116
121
138
134
104
136
38
14
64
54
44
68
28
46
36
66
103
86
96
94
114
112
108
78
107
72
90
106
84
102
82
100
70
88
12
74
80
76

FIG. 3

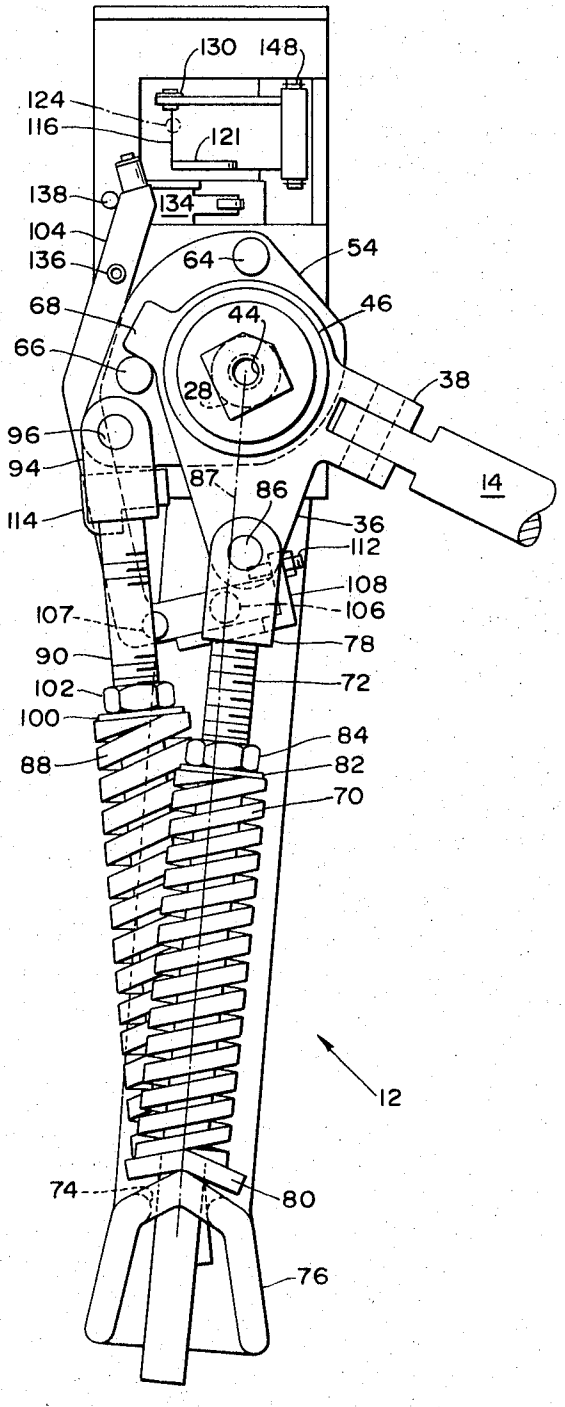

130
148
124
116
121
138
134
104
136
64
54
68
44
46
66
28
38
14
96
94
87
86
114
36
112
108
106
107
78
90
72
102
100
84
88
82
70
12
74
80
76

FIG. 4

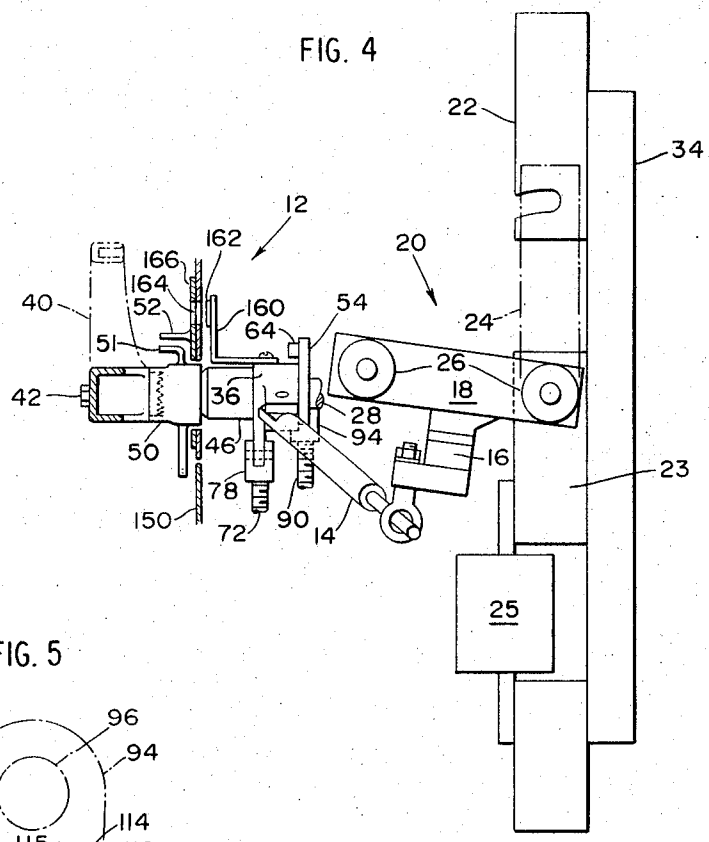
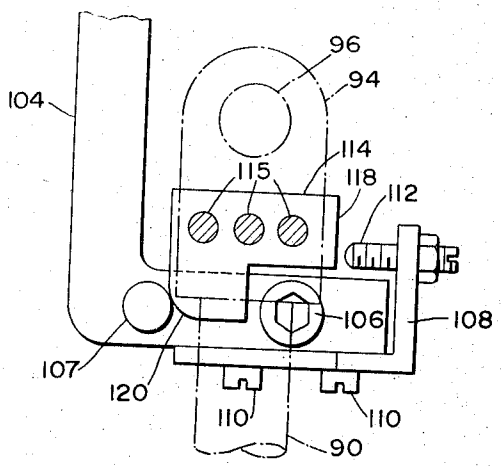


FIG. 5



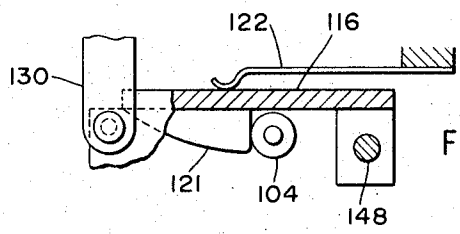


FIG. 6

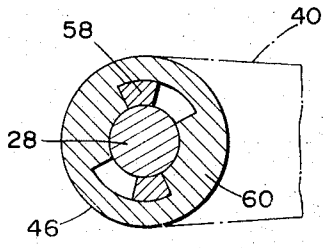


FIG. 7

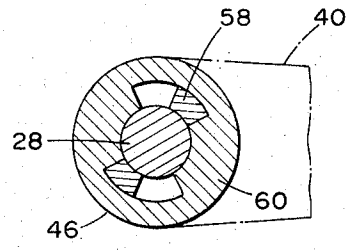


FIG. 8

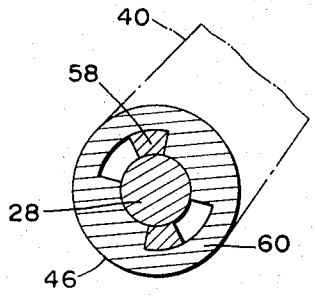


FIG. 9

FIG. 10

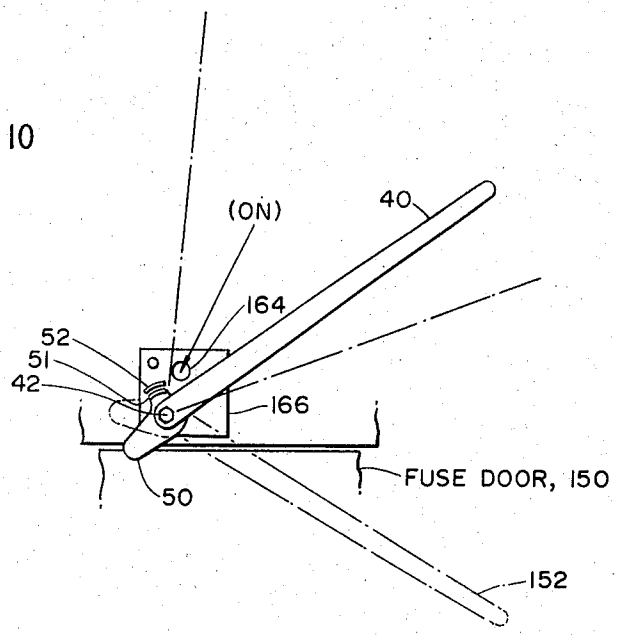
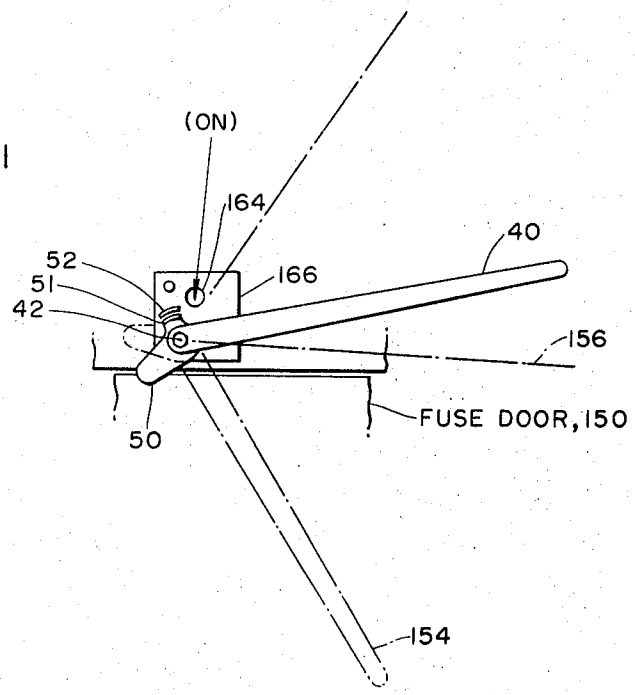

(ON)
40
164
52
51
42
166
FUSE DOOR, 150
50
152

FIG. 11


(ON)
164
40
52
51
42
166
156
FUSE DOOR, 150
50
154

SWITCH OPERATOR WITH TRIPPING MEANS

BRIEF SUMMARY OF THE INVENTION

This invention relates to operating mechanisms for electrical switches of the general type having a relatively large current carrying capacity, such as service entrance switches. Typical examples which should not be considered to restrict the scope of the invention are two- and three-pole single throw switches carrying 800 to 4,000 amperes at 480 volts alternating current.

This invention is more specifically directed to means for closing and tripping open a switch, wherein the switch mechanism is adapted for performance of each of these functions by a single motion. The switch may be a simple knife switch or it may be of more complex construction such as a bolted pressure contact switch. Examples of the latter are described in U.S. Pat. No. 2,845,512 dated July 29, 1958 to Burt et al., U.S. Pat. No. 2,960,590 dated Nov. 15, 1960 to Kussmaul et al., and U.S. Pat. No. 3,410,974 dated Nov. 12, 1968 to Kussmaul. These switches may be provided with operating arm mechanisms as described for example in U.S. Pat. No. 3,244,827 dated Apr. 5, 1966 to Kussmaul. The invention may also be applied to many other types of switches having or adaptable for single-motion opening and closing operations.

In certain applications it is desired to trip the switch open very rapidly in case of an emergency such as a ground fault in the load circuit. To facilitate such tripping it may be desired to initiate this function with the application of substantially less energy than that required either to open or to close the switch. Further, it may be desired to trip the switch manually as by a trip button, or electrically as by a solenoid connected with a remote circuit having a pushbutton, manual switch or ground fault relay. Thus a switch having relatively powerful closing and tripping functions might be tripped by the application of a relatively small amount of electrical power delivered from a remote source to the solenoid of the tripping mechanism.

With a view to providing a switch closing and tripping mechanism of the last-mentioned type, this invention comprises a drive arm actuator and a tripping plate each pivotal on a shaft fixedly mounted on an operator main frame which in turn is mounted on a switch frame in position for the drive arm actuator to be connected with the switch yoke by a drive arm of the type described in said U.S. Pat. No. 3,244,827, for example. Closing spring means are connected to the drive arm actuator and tend to rotate it in a first direction to close the switch. Trip spring means are connected to the tripping plate and tend to rotate it in the opposite direction. The drive arm actuator and tripping plate are mutually engageable by abutments permitting a predetermined lost motion between the arms. The trip spring is charged by rotating the handle to close the switch, and it is automatically latched when the switch reaches the closed position. The trip spring may be unlatched and released either by operation of an electrical solenoid or by pushing a trip button, whereupon the tripping plate rotates the drive arm in a direction to open the switch, thereby at the same time charging the closing spring. When it is desired to close the switch again, only a brief initial rotating movement of the operating handle is required to release the closing spring and permit the energy stored therein to complete the closing of the switch. Thus substantially all of the energy applied to the handle during the closing movement is stored in the trip spring, and comprises not only the energy required at a later time to trip the switch open but also the energy that will be transferred to the closing spring during the tripping movement for a still later reclosing of the switch.

Other features of the invention are related to the foregoing operations and provide important advantages for reliability of performance. One such feature resides in a lost motion connection between the operating handle and the tripping plate whereby the latter is disengaged from the handle during the tripping movement which is sudden and forceful. This provides safety to personnel and to the handle mechanism itself. Another feature resides in details of the latching mechanism associated with the tripping plate, such mechanism including electrical solenoid means for releasing a latching arm to trip the switch.

Still other features of the invention reside in certain combinations, structures and modes of operation that will be understood by reference to the following description of a preferred embodiment, having reference to the appended drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a side elevation partially in section, showing the preferred embodiment of the switch operating mechanism.

FIG. **2** is a front elevation of the mechanism, showing the elements in the closed switch position.

FIG. **3** is a front elevation similar to FIG. **2**, showing the elements in the tripped switch position.

FIG. **4** is a side elevation of the switch operating mechanism associated with a switch.

FIG. **5** is a fragmentary enlarged front elevation, taken on line **5—5** of FIG. **1**, showing details of the latching arm and related parts of the latching mechanism.

FIG. **6** is a plan view partially in section, taken on line **6—6** of FIG. **2**, showing the latch.

FIGS. **7, 8** and **9** are elevations in section showing the splined sleeve connection between the handle and the tripping plate.

FIGS. **10** and **11** illustrate alternate mounting positions of the handle.

DETAILED DESCRIPTION

Referring first to FIG. **4** and related parts of FIGS. **1** to **3**, the invention comprises a switch operator designated generally at **12**, connected by a drive arm **14** with a yoke **16**. The yoke **16** comprises a part of a blade operating mechanism connected to the movable blade or blades **18** of the poles of a switch **20**. The switch **20** has fixed top terminals with blades **22** and fixed bottom or load terminals with blades **23** and is closed by rotating the blades **18** to a position designated by phantom lines **24**. Commonly a fuse **25** is mounted in each pole of the switch. The switch may have pressure plates **26** for applying pressure between the fixed and movable blades in the closed position as described in the above-mentioned patents, particulary U.S. Pat. No. 3,410,974. The drive arm **14** connects the operating mechanism **12** with the switch **20**, and although a simplified form of drive arm has been shown for present purposes of illustration, the mechanism of said U.S.

Pat. No. 3,244,827 may be substituted, as may any other suitable mechanism or link to the switch.

The principal parts of the switch operator **12** are mounted upon a fixed shaft **28** pinned at **30** (FIG. **1**) to a main frame **32.** This frame is bolted to the frame **34** of the switch. The shaft **28** and the other principal parts of the switch operator **12** are located at one side of the switch blades **18,** so as to permit easy access to the faces **25** and the lower or load terminals. A drive arm actuator **36** is rotatable on the shaft, and has a clevis **38** pinned to the drive arm **14.**

The switch is closed by rotating the drive arm actuator **36** counterclockwise as viewed in FIGS. **2** and **3** to the closed switch position shown in FIG. **2.** The switch is opened when the drive arm actuator rotates clockwise to the open switch position shown in FIG. **3.** Energy for these operations is applied to the mechanism by manually rotating a handle **40** (FIG. **4**). The handle has a splined fit in an adaptor **50,** and a bolt **42** fastens the handle and adaptor by threads **44** (FIG. **1**) to a main drive hub **46.** The hub **46** is rotatably fastened to the shaft **28** by a split ring **48** in an annular groove on the shaft, or by other suitable means permitting rotation of the hub **46** about the shaft. The adaptor **50** is provided with a lug **51** (FIGS. **10** and **11**) aligned with a fixed lug **52** on the switch housing for applying a padlock.

The drive hub **46** is indirectly connected with the drive arm **14.** The hub is drivingly engageable through splines with a tripping plate **54** as shown particularly in FIGS. **1** and **7** to **9.** The tripping plate is mounted on the shaft **28** by needle bearings **56** and has internal, axially extending splines **58.** These splines engage splines **60** on the hub **46.** The drive arm actuator **36** is received over the splined portions of the trip arm and hub on needle bearings **62.** Pins **64** and **66** (FIGS. **2** and **3**) secured to the tripping plate **54** are equidistant from the axis of the shaft **28** and project in the direction of the drive arm actuator **36** so that in certain positions one or the other of the pins abuts an integral projection **68** on the drive arm actuator.

A closing spring **70** is received over a guide rod **72** which projects at one end freely through a round hole **74** in a projection **76** on the main frame **32.** The guide rod has a connector clevis **78** pivotally fastened to the drive arm actuator **36.** Washers **80** and **82** are provided at the ends of the spring **70,** and an adjusting nut **84** is threaded onto the guide rod for adjusting the compression of the spring.

In operation, the guide rod **72** moves between a closed switch position shown in FIG. **2,** and an open switch position as viewed in FIG. **3.** In the position of FIG. **3** the axis of a pin **86** in the clevis **78** is displaced a short distance to the right of a line **87** passing through the axis of the shaft **28** and the center of the hole **74.** Thus, in the open switch position, the closing spring linkage is near dead center and in that position it applies insufficient torque to rotate the drive arm actuator and the parts connected therewith into the closed switch position. Also, this torque is offset by the abutment of the pin **66** as hereinafter described. However, if the drive arm actuator **36** is rotated counterclockwise through a small angle as viewed in FIGS. **2** and **3,** the closing spring will then exert a substantially greater torque sufficient to close the switch, as also hereinafter more fully described.

A trip spring **88,** which has a higher spring constant than the closing spring **70,** is received over a guide rod **90** which passes freely through a round hole **92** in the projection **76** and has a connector clevis **94** connected to the tripping plate **54** by a pin **96.** A washer **100** is provided at the top of the spring **88,** and an adjusting nut **102** is threaded onto the guide rod for adjusting the compression of the spring.

In operation, the guide rod **90** moves between the open switch position shown in FIG. **3** and the closed switch position as viewed in FIG. **2.** In the closed switch position the axis of the clevis pin **96** is displaced a short distance to the left of a line **103** between the axis of the shaft **28** and the center of the hole **92.** As hereinafter described, means are provided to latch the tripping plate in the closed switch position of FIG. **2,** and therefore this position of the parts is also referred to as the latched position. In this position the trip spring linkage is near dead center but the spring **88** applies a small torque to the trip arm, this torque being sufficient when the trip arm is unlatched to rotate the tripping plate **54** clockwise as viewed in FIG. **2,** thereby to cause the pin **66** to abut and displace the projection **68** on the drive arm actuator **36,** and to rotate the drive arm with the tripping plate in a clockwise direction, and thus to open the switch. As this movement progresses the torque exerted by the trip spring **88** forcefully completes the opening movement of the switch while transferring energy to the closing spring **70** as the latter moves to the open switch position of FIG. **3.**

A latching arm **104** with a roller at its end is pivoted to the main frame **32** by a screw **106** (FIG. **2**). A pin **107** projects from the latch arm. An L-shaped actuator bracket **108** is screwed to the latching arm **104** by screws **110** (FIG. **5**). If desired, the bracket **108** may be welded to the latching arm **104.** An adjustable stop screw **112** is threaded into this bracket. A latch cam **114** is screwed to the connector clevis **94** by screws **115,** or integrally cast on the clevis, and has a flat surface **118** for engagement with the screw **112.** It also has a curved surface **120** for engagement with the pin **107.**

In the closing movement, as the tripping plate **54** rotates in a counterclockwise direction from the position shown in FIG. **3** toward the position shown in FIG. **2,** the surface **118** on the latch cam **114** reaches and abuts the screw **112** on the actuator bracket **108,** rotating the latching arm **104** clockwise as viewed in FIGS. **2, 3** and **5** and causing the pin **107** to move upwardly into engagement with the surface **120** on the latch cam, thereby restraining the connector clevis **94** and the parts connected therewith. The latching arm **104** is then held in this position at its upper end by a latch **116** which has a fixed pivot **148** and a cam projection **121** engaging a roller on the latching arm. A spring **122** (FIG. **6**) bears on the latch, tending to move it in the direction of the roller on the latching arm **104.**

Alternate manual and electrical means described below provide for rotating the latch **116** clockwise as viewed in FIG. **6** to release the roller on the latching arm **104.** This has the immediate effect of opening the switch because, in the latching position of FIG. **2** the trip spring **88** is off center as described above, causing the latch cam surface **120** to bear with a light pressure on the pin **107** on the latch arm. The removal of the restraint of the cam projection **121** on the latch arm permits the latching arm to rotate from the position shown

in FIG. 2 to the position shown in FIG. 3 against a fixed stop pin 138, by the force of the cam surface 120 on the pin 107. The trip spring 88 is then free to complete its movement as described above.

The manual means for initiating the tripping of the switch comprise a trip button 142 attached to a rod 124 (FIG. 1), the rod being located to abut the latch 116. The electrical means comprise an electrical solenoid 126 having a plunger 128 with a link 130 pivotally connecting the plunger to the latch 116. The solenoid 126 is energized to pull in the plunger 128, thereby to withdraw the latch 116 and to trip the switch open, by energization of terminals 132. These terminals are connected to the solenoid in series with a limit switch 134 having a lever actuated by the latching arm 104. The limit switch 134 is actuated to its closed position only when the latch arm is in the latched position illustrated in FIG. 2. Once the switch has been tripped the solenoid energizing circuit is disabled, thereby protecting the solenoid from prematurely burning out as a result of continuous energization following the tripping operation.

A small coil spring 136 is fastened to the latch arm 104 and projects in the direction of the tripping plate 54. These parts are out of engagement in the latched position of FIG. 2, but when the switch is tripped by movement of the latch arm to the position of FIG. 3, the tripping plate pivots to a position in which it would abut the spring 136 if the latch arm were to bounce back from the stop pin 138 (or other form of strip for the latching arm) toward the latching position. This prevents relatching with the switch open.

The full sequence of operation of the switch may be described by assuming first that the parts are in the open switch position of FIG. 3. In this position the handle 40 is down as shown in FIG. 8, and the splined sleeve 60 on the hub 46 is in or close to engagement with the splined portion 58 of the tripping plate 54. Force is then applied manually or in any other desired manner to rotate the handle 40 counterclockwise to the position shown in FIG. 9, thereby rotating the tripping plate and compressing the trip spring 88, and moving the clevis 94 to move the latching arm to the latching position of FIG. 2. Before this movement begins the pin 66 will have engaged and restrained the projection 68 on the drive arm, but this restraint is removed as the tripping plate rotates. However, as stated above the closing spring 70 develops insufficient torque in this position to close the switch. As the rotation of the tripping plate progresses, the pin 64 ultimately reaches the projection 68 and begins to rotate the drive arm actuator 36. This causes the closing spring 70 to begin to exert a greater torque on the drive arm, and after a short further movement the spring 70 develops sufficient torque to close the switch, the movement being completed with the projection 68 on the drive arm swinging from the pin 64 into engagement with the pin 66 in the latching position.

Thus it will be seen that the energy applied to the handle 40 during the closing operation is substantially entirely stored in the trip spring 88, with only a small amount being applied to the drive arm to initiate the release of the already stored energy in the spring 70 which actually closes the switch mechanism.

Upon completion of the closing movement as described above the handle 40 is in the position of FIG. 9, and upon release of the handle it falls by gravity from the position of FIG. 9 to the position of FIG. 7. The lost motion in the splined connection beteeen the sleeve 60 and the portion 48 of the tripping plate 54 thereby causes the handle 40 to be out of engagement with the trip arm when the tripping mechanism is later actuated, and the arm 40 is thereby protected from the application of substantial force applied by the trip spring 88 to open the switch.

The switch is tripped open either manually by the trip button 122 of electrically by the solenoid 126, thereby releasing the restraint of the latch 116 on the roller of the latching arm 104 as described above. The latching arm pivots from the position of FIG. 2 until it abuts the pin 138 (or other stop), thereby releasing the latch cam 114 and allowing the tripping plate 54 to rotate clockwise from the position shown in FIG. 2 to the position shown in FIG. 3. During this movement the pin 66 abuts the projection 68 on the drive arm and rotates the latter clockwise, opening the switch and compressing the spring 70. Upon completion of this movement the parts reach the position illustrated in FIG. 3.

It will be evident from the foregoing description that if the tripping spring 88 were incapable of opening the switch for any reason, the switch can be opened manually by means of the handle 40.

FIGS. 10 and 11 show other features of the switch operating mechanism that increase its safety and the convenience of manual operation. The adapter 50 has an integral fuse door interlocking projection that prevents opening of a fuse door 150 when the switch is closed and the handle has been allowed to return to rest in its "on" position shown in full lines in these figures. The figures show alternative handle mounting positions to be selected for the convenience of operating personnel on the basis of the best leverage for closing. FIG. 10 shows the normal mounting position with the "off" position of the handle 40 shown at 152. FIG. 11 shows an alternate position with the "off" position of the handle shown at 154. The position of FIG. 11 is such that the closing motion of the handle begins compression of the spring 88 when it reaches a position 156, the operating force being then applied vertically. This is preferred, for example, when the switch is mounted at a higher elevation.

The foregoing features result from the construction of the adaptor 50 and related parts. The adaptor 50 is preferably a casting which fits over a keyed projection 158 (FIG. 1) on the main drive hub 46. The casting has inwardly projecting splines that mate with splines on the hub of the handle 40. The single screw 42 fastens both the handle 40 and the adaptor 50 to the hub 46. This arrangement permits the adaptor 50 to be properly located to clear the fuse door 150 in the "off" position and to interlock with the door in the "on" position independently of the handle mounting position to be selected.

As shown in FIG. 4, the drive arm actuator 36 has a position indicator plate 146 fastened to it. This plate has a portion 162 visible through a window 164 in a plate 166 when the switch is in the closed or "on" position.

It will be understood that certain details of the illustrated preferred form of the switch operator including certain configurations and arrangements of the parts may be varied to adapt it to differing applications, while still retaining the improved features of the invention hereinabove described.

I claim:

1. An operator for a switch having, in combination,

a shaft,

a drive arm actuator pivotal on the shaft and having closing spring means tending to rotate the drive arm actuator in a first direction to a predetermined closed switch position,

a tripping plate pivotal on the shaft, having trip spring means tending to rotate the tripping plate in the opposite direction, and having means abutting the drive arm actuator to cause a transfer of energy from the trip spring means to the closing spring means during said opposite rotation,

means for applying energy to rotate the tripping plate in the first direction to a latching position, thereby storing energy in the trip spring means and causing the abutting means to disengage the drive arm actuator and allow its movement to the closed switch position,

a latch operable to latch the tripping plate in said latching position, and

means to release the latch to allow the tripping plate to rotate in said opposite direction.

2. An operator according to claim 1, in which the tripping plate rotates in said opposite direction to displace the closing spring means to a position in which it delivers a minimum torque to the drive arm actuator.

3. An operator according to claim 1, in which the trip spring means delivers a minimum torque to the tripping plate in said latching position.

4. An operator according to claim 2, with a frame member in fixed relation to the shaft, and in which the closing spring means comprise a guide rod having a pivotal connection to the drive arm actuator at one end and being slidable in the frame member, and a spring urging the guide rod from the frame member in the direction of said pivotal connection.

5. An operator according to claim 3, with a frame member in fixed relation to the shaft, and in which the trip spring means comprise a guide rod having a pivotal connection to the tripping plate at one end and being slidable in the frame member, and a spring urging the guide rod from the frame member in the direction of said pivotal connection.

6. An operator according to claim 1, with a frame member in fixed relation to the shaft, and in which each of the drive arm actuator and tripping plate has a guide rod with a pivotal connection thereto at one end and being slidable in the frame member, and a spring for each guide rod urging it from the frame member in the direction of said pivotal connection.

7. An operator according to claim 6, in which the frame member is located near the line defined by the shaft axis and the guide rod pivotal connection to the drive arm actuator when the tripping plate reaches its limit of motion during said opposite rotation.

8. An operator according to claim 6, in which the frame member is located near the line defined by the shaft axis and the guide rod pivotal connection to the tripping plate in the latching position.

9. An operator according to claim 6, in which the frame member is located near the line defined by the shaft axis and the pivotal connections to the drive arm actuator and tripping plate when the tripping plate is in the latching position and when the drive arm actuator is in its position corresponding to the limit of motion of the tripping plate during said opposite rotation.

10. An operator according to claim 7, in which the means abutting the drive arm actuator include an abutment on the tripping plate in position to engage the drive arm actuator after the tripping plate has rotated through a substantial portion of its motion in said first direction.

11. An operator according to claim 7, in which the means abutting the drive arm actuator include a pair of spaced abutments respectively located on the tripping plate to turn the drive arm actuator during substantially the entire tripping plate movement in said opposite direction, and to turn the drive arm actuator during only a final portion of the tripping plate movement in said first direction.

12. An operator according to claim 1, in which the latch comprises a latching arm pivotal to a position operative to restrain the tripping plate.

13. An operator according to claim 12, in which the latching arm is pivoted to said position restraining the tripping plate by movement of the tripping plate into the latching position.

14. An operator according to claim 1, in which the means to release the latch comprise an electrical solenoid.

15. An operator according to claim 1, in which the means for applying energy comprise a handle and a connection between the handle and the tripping plate adapted to engage the tripping plate during substantially the entire tripping plate movement in said first direction, to permit the handle to return after the tripping plate is latched, and to be disengaged from the tripping plate during substantially the entire tripping plate movement in said opposite rotation.

16. An operator according to claim 1, in which the trip spring means have a higher constant than the closing spring means.

17. An operator according to claim 1, including a drive arm attached to the drive arm actuator and adapted to extend a substantial distance laterally therefrom for attachment to a switch.

18. An operator according to claim 1, in which the means for applying energy comprise a drive hub rotatable on the shaft and engageable with the tripping plate, and a handle having means for connection to the drive hub permitting changing of the handle positions corresponding to the open and closed positions of the switch.

19. An operator according to claim 18, in combination with a cabinet therefor having a fuse door, in which the means for connection comprise an adaptor having a portion extending therefrom in position to interlock with the fuse door in the closed switch position.

* * * * *