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Dykes et al.

[11] **3,876,847**

[45] **Apr. 8, 1975**

[54] **OPERATING MECHANISM FOR OPENING AND CLOSING AN ELECTRICAL SWITCH**

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[73] Assignee: **Square D. Company**, Park Ridge, Ill.

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[21] Appl. No.: **446,861**

[52] **U.S. Cl.** .... **200/153 SC;** 200/50 A

[51] **Int. Cl.** **H01h 3/30;** H01h 9/22; H01h 31/06

[58] **Field of Search** .... 200/153 SC, 153 H, 70; 185/37

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Assistant Examiner—John W. Redman
Attorney, Agent, or Firm—Harold J. Rathbun; Ernest S. Kettelson

[57] **ABSTRACT**

An operating mechanism for opening and closing a heavy duty electrical switch is provided. The mechanism includes a switch-closing spring means, a switch-opening spring means, a manually actuated first means for charging both spring means when said switch is in an open condition, and a manually actuated second means operative, only when both of said spring means are charged, to effect discharge of the switch-closing spring means and closing of the switch. The switch-opening spring means can be either manually or automatically discharged so as to open the switch. Automatic discharge of the switch-opening spring means occurs only when a predetermined condition exists in the electrical system.

10 Claims, 19 Drawing Figures

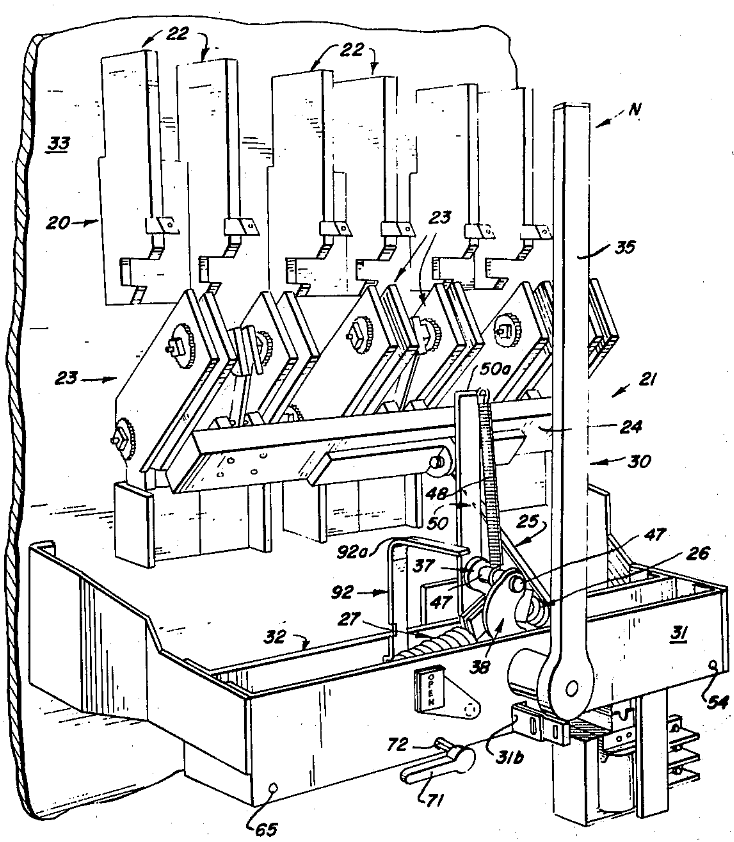
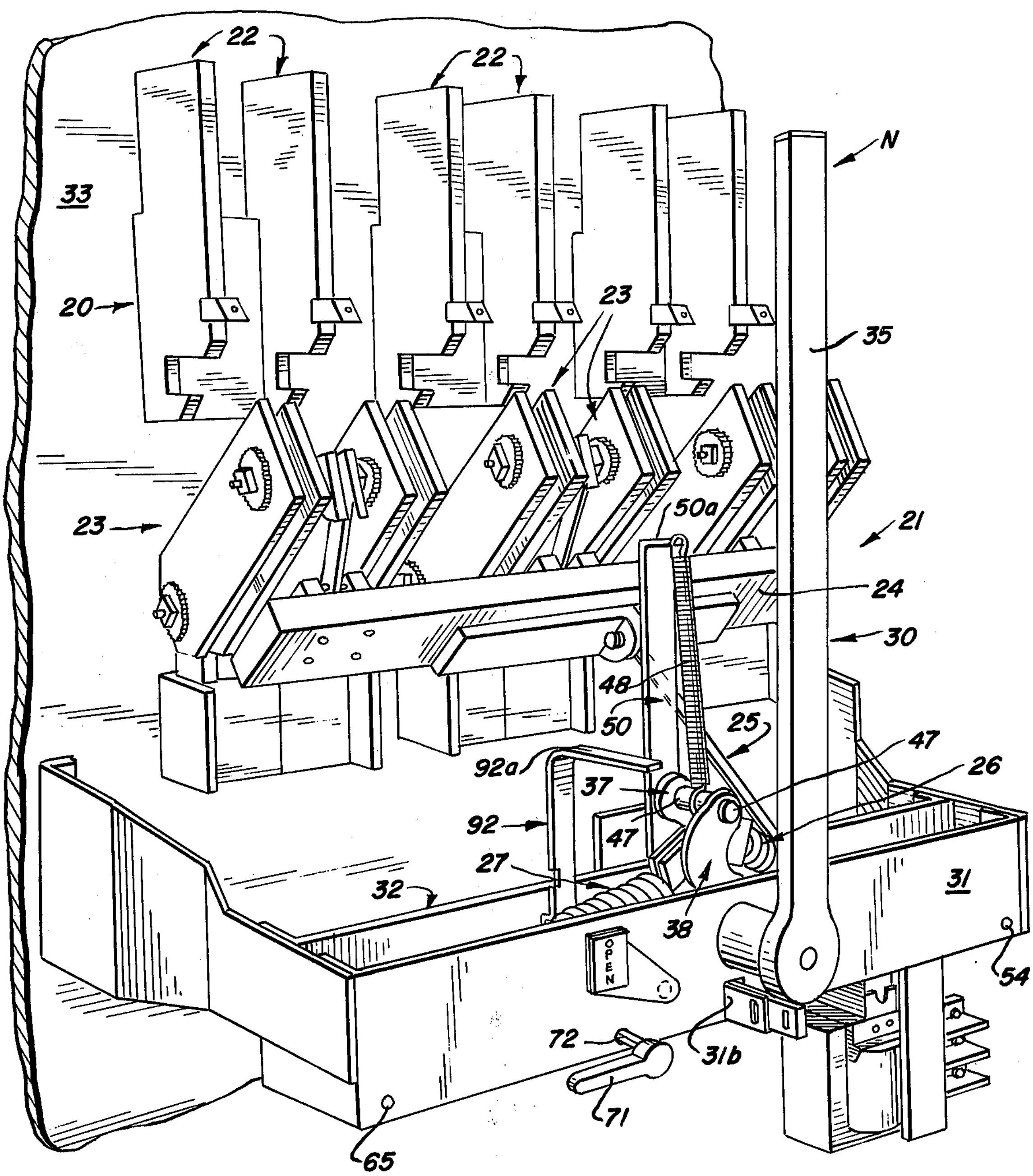


FIG. 1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N
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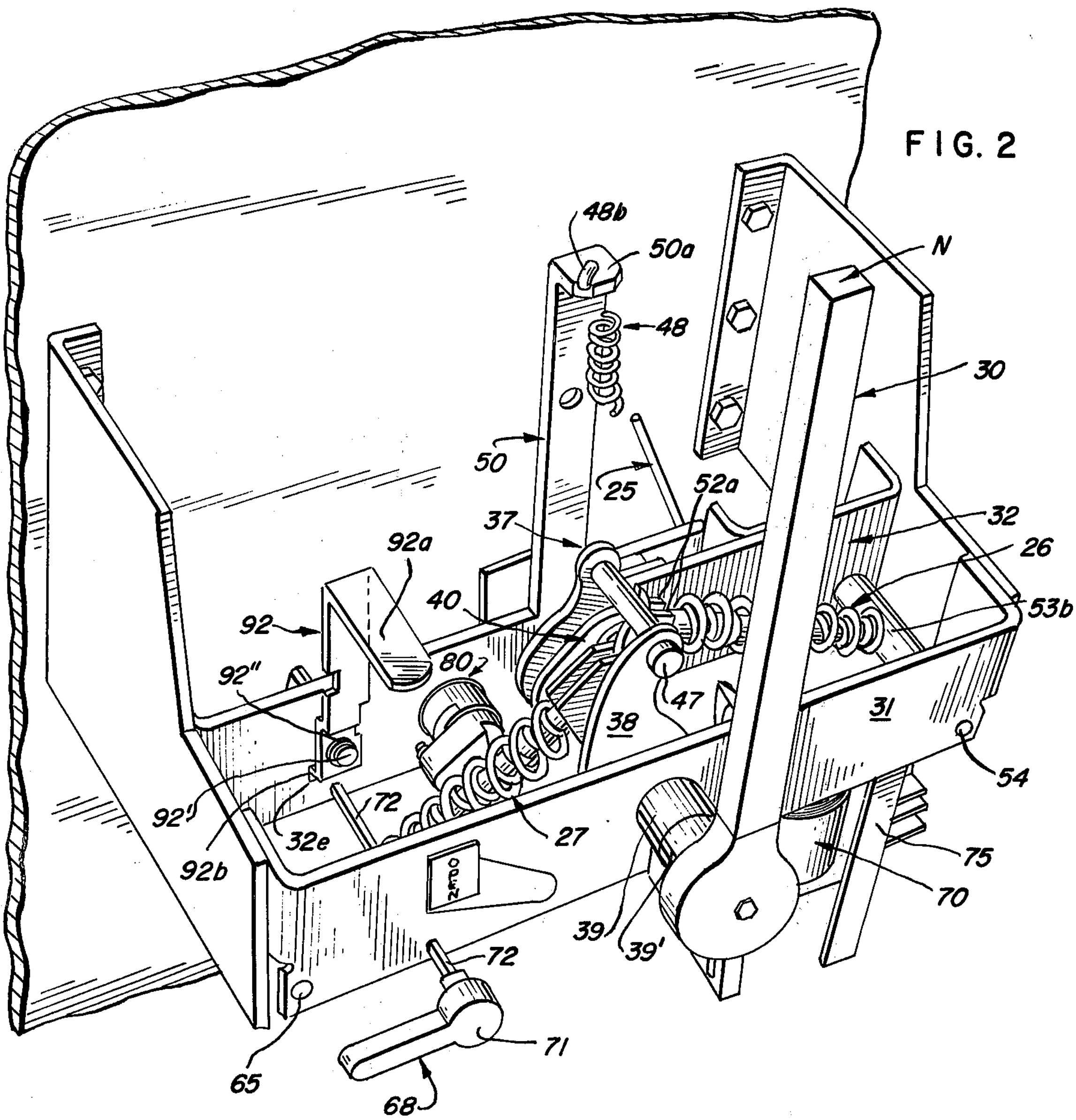
92
47
27
32
38
31
54
72
31b
71
65
OPEN

FIG. 2


48b
50a
N
48
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50
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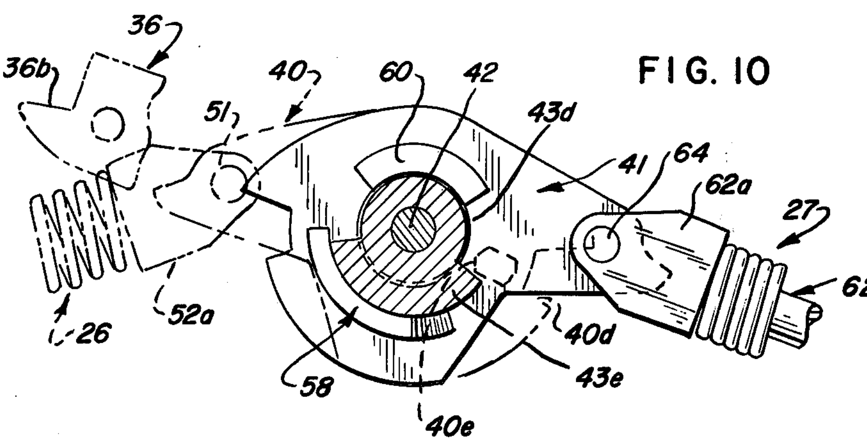
32
37
26
92a
40
53b
92
80
92"
47
38
31
54
92'
72
27
32e
92b
75
OPEN
70
39
39'
72
71
65
68

FIG. 10


36
36b
40
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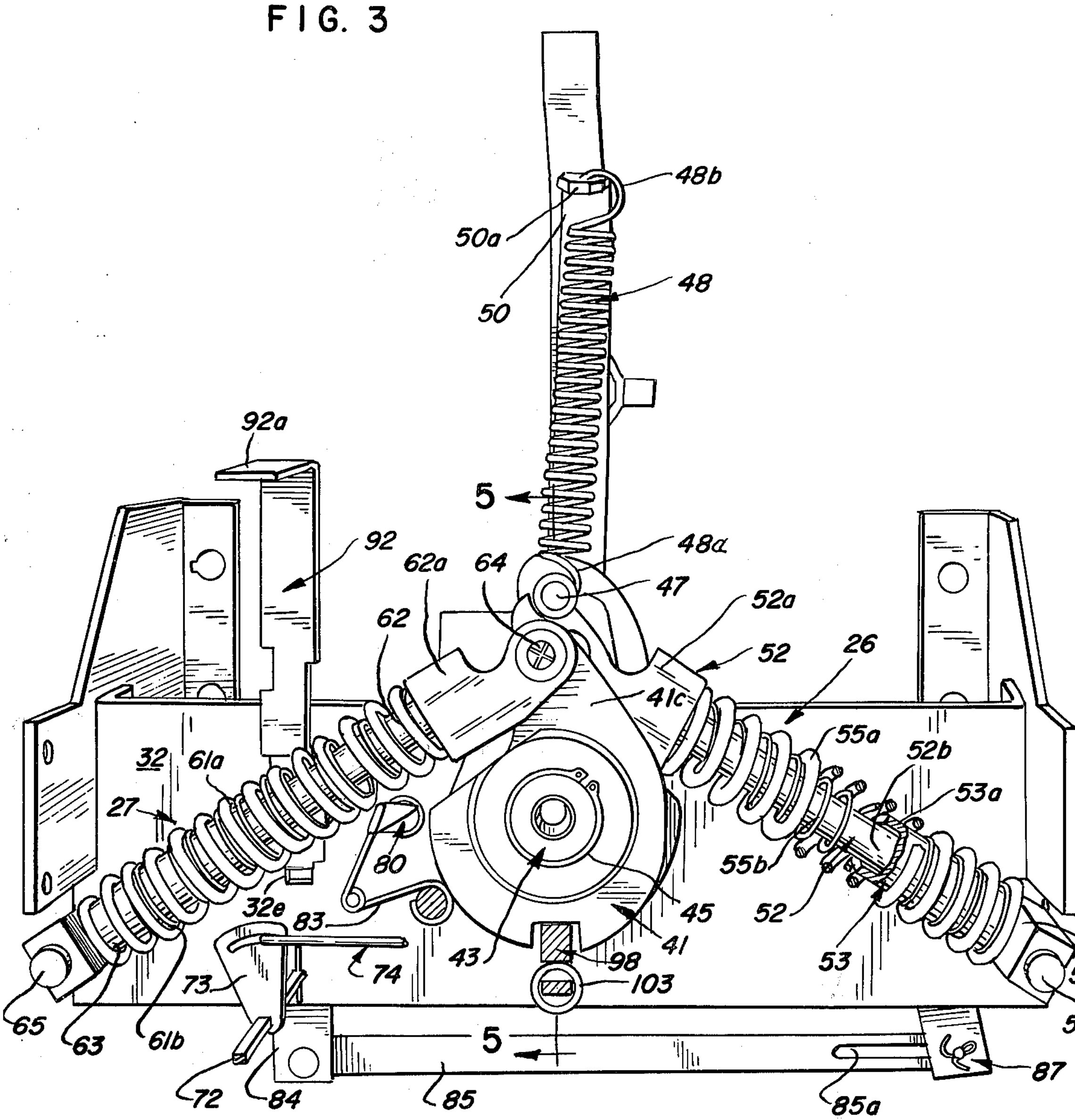
42
51
43d
41
64
62a
27
62
26
52a
40d
58
43e
40e

FIG. 3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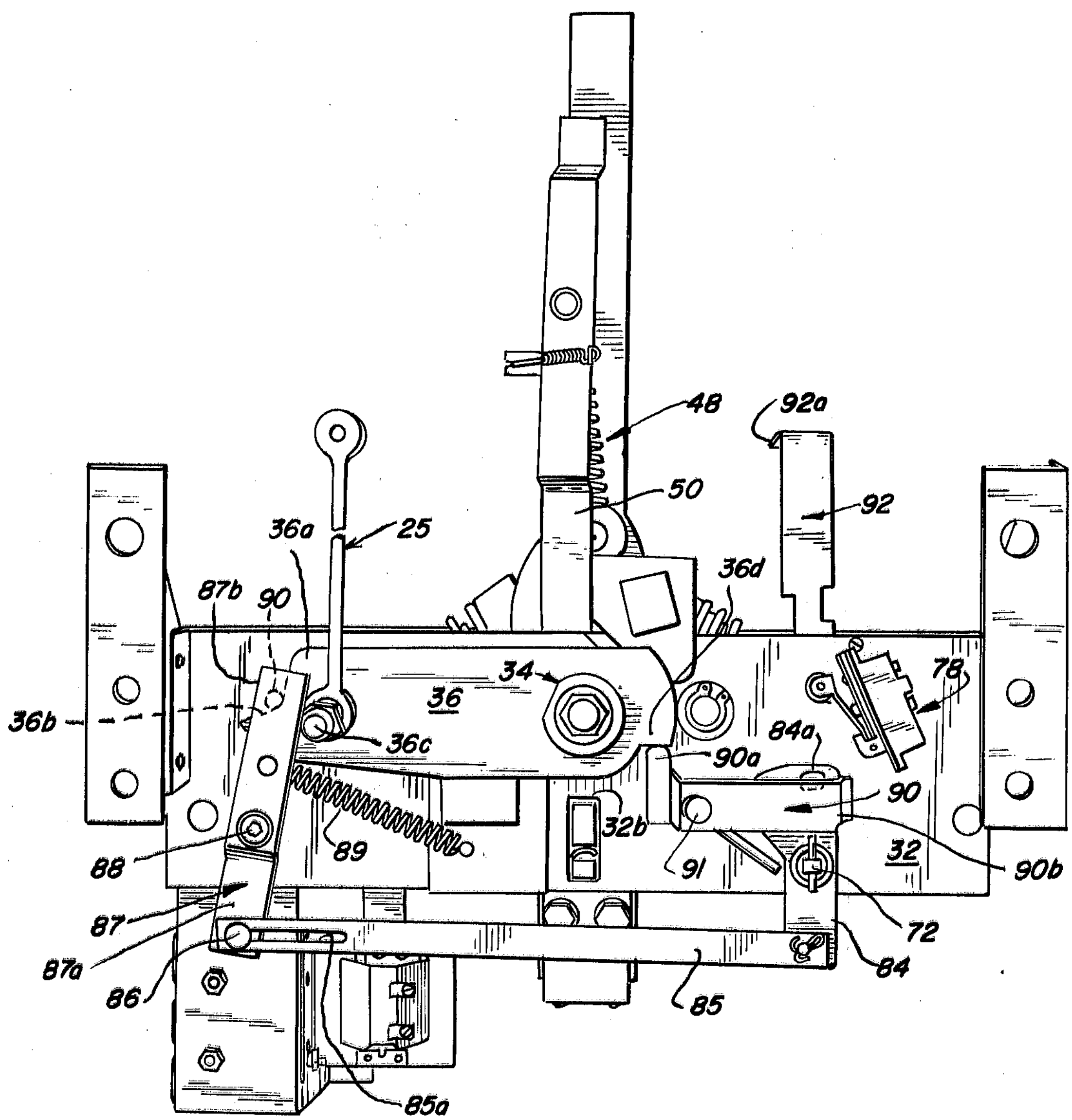
64
47
52a
62
52
26
41c
32
61a
55a
52b
53a
27
80
55b
32e
83
45
52
41
43
98
53
74
73
103
53b
65
63
61b
54
5
87
72
84
85
85a

FIG. 4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92a
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92
25
36a
36d
87b
90
34
36
78
36b
36c
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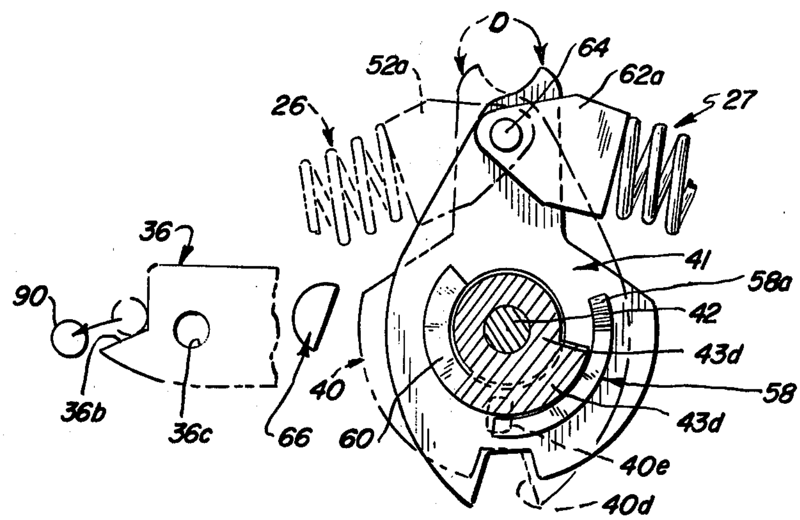
32b
88
89
91
32
90b
87
72
87a
84
86
85
85a

FIG. 7


D
52a
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43d
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43d
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36c
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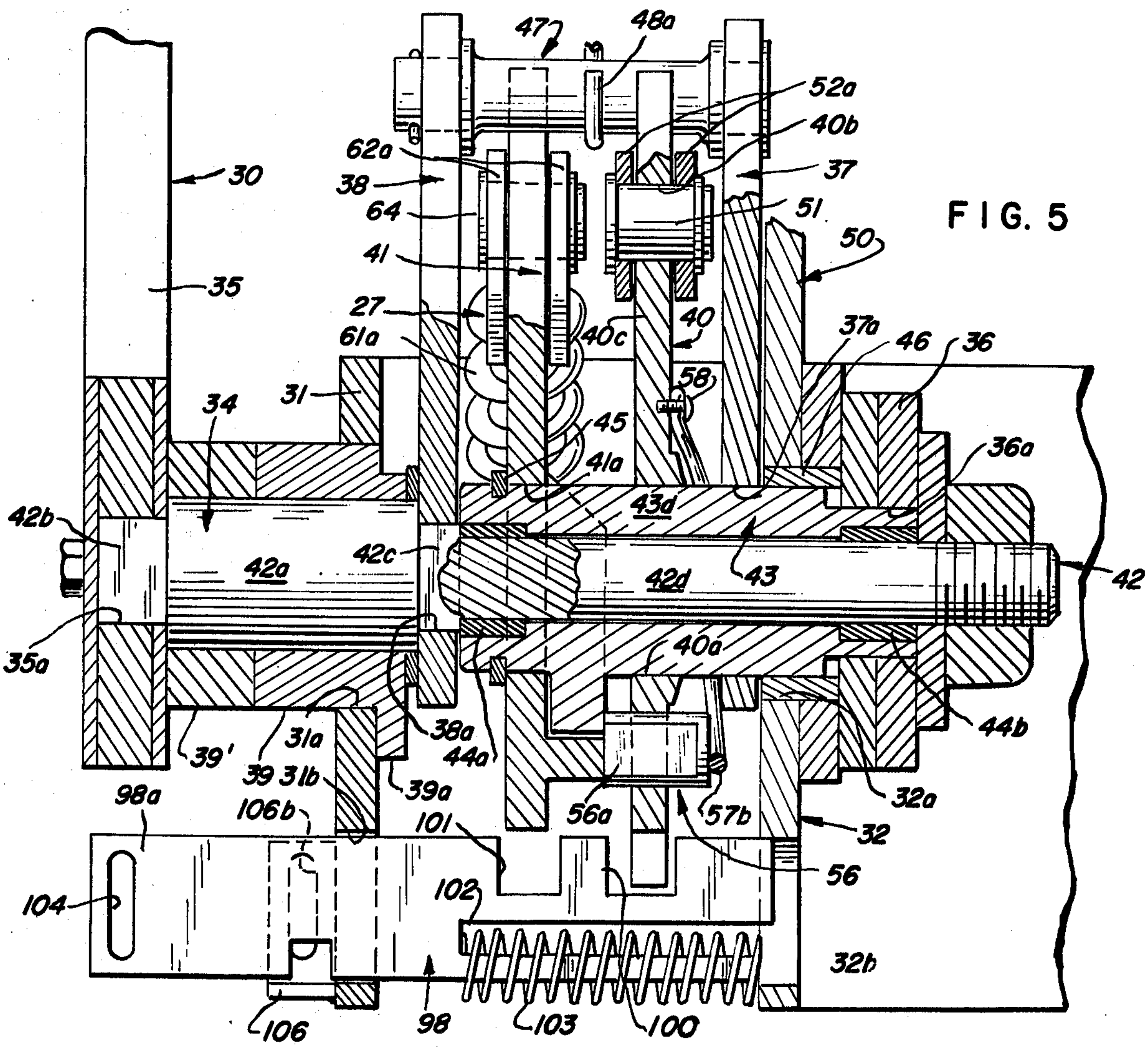
60
40e
40d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40b
62a
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64
51
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50
41
27
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35
61a
40c
37a
46
36
31
58
34
45
41a
36a
43d
42b
42c
42a
42d
43
42
35a
40a
38a
44b
39'
39
31a
44a
31b
39a
32a
98a
106b
101
56a
57b
32
104
102
56
32b
106
98
103
100

FIG. 5

FIG. 6

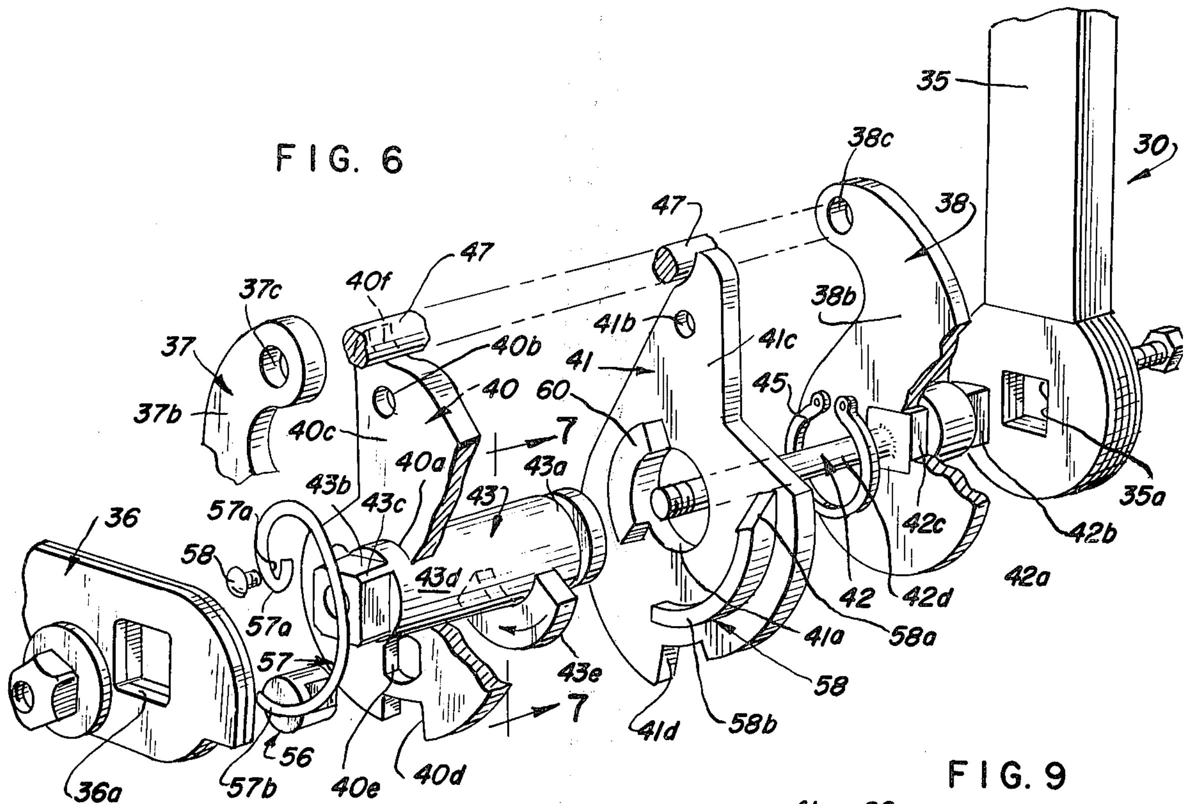


FIG. 9

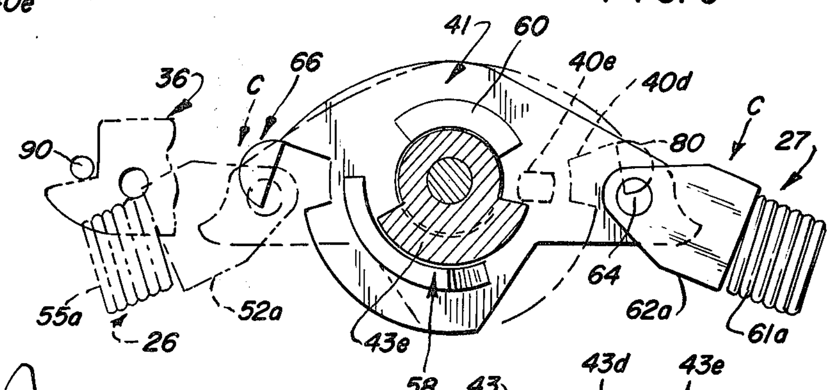


FIG. 8

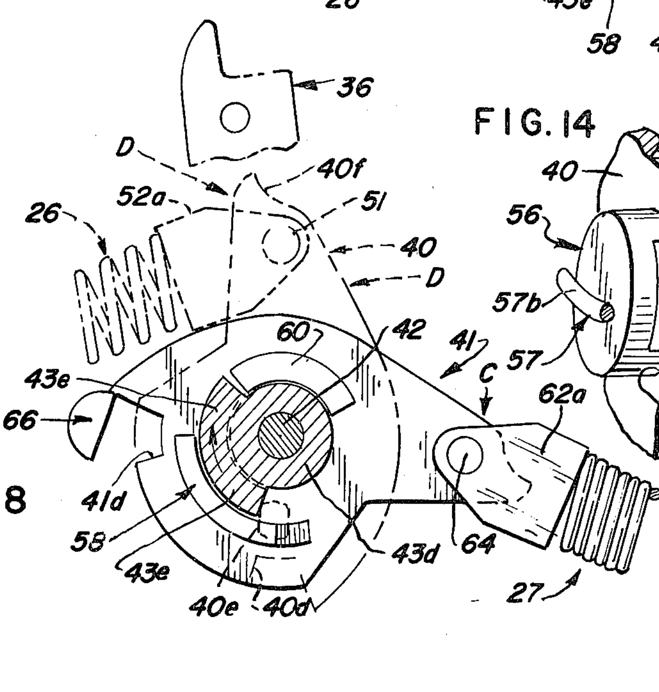


FIG. 14

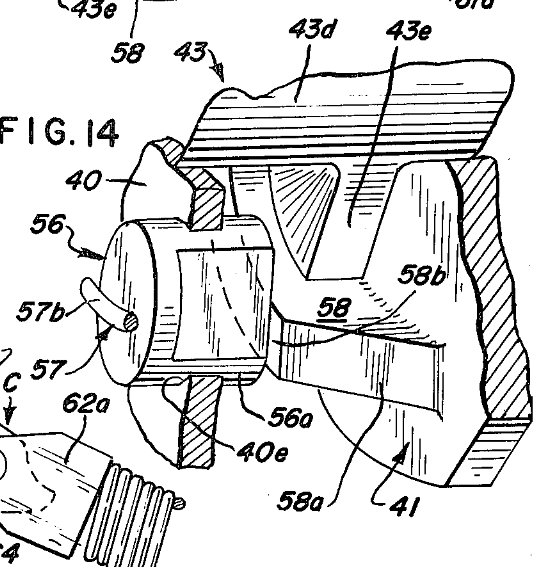


FIG. 11

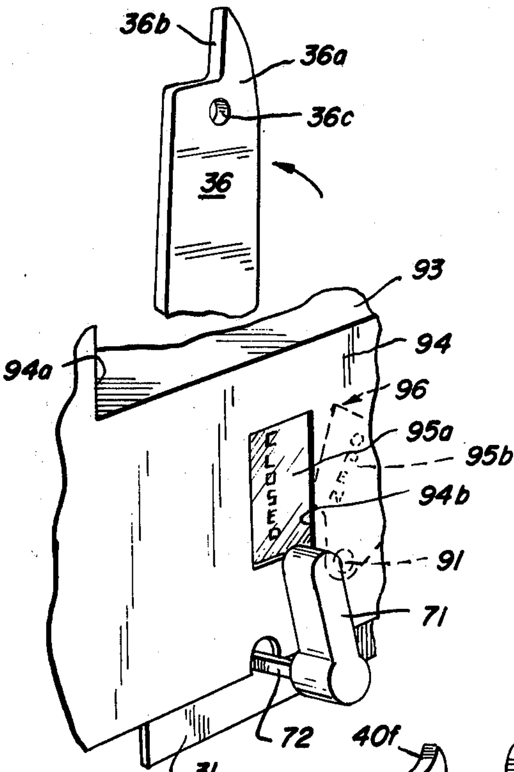
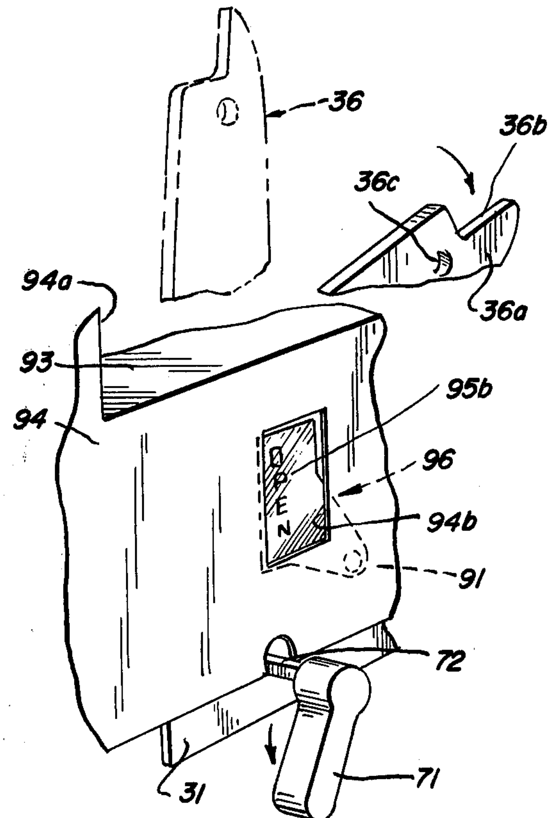


FIG. 12



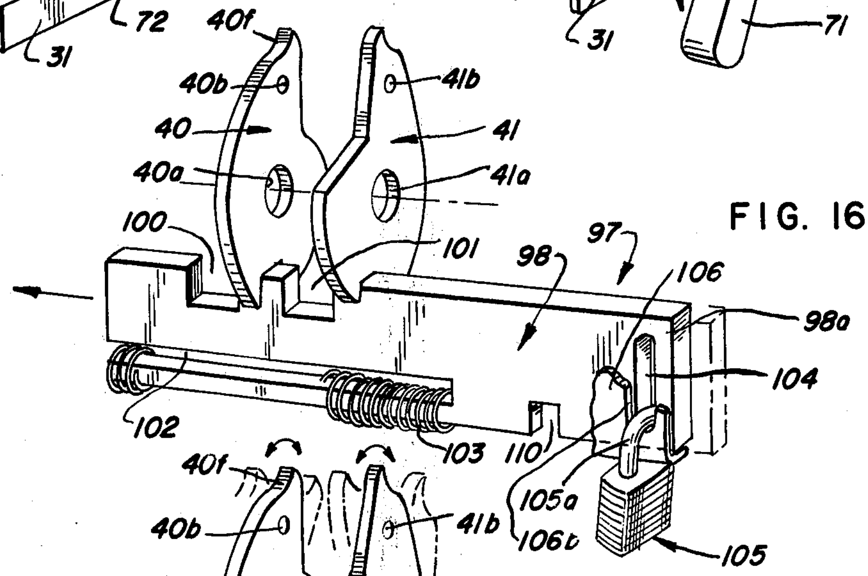


FIG. 16

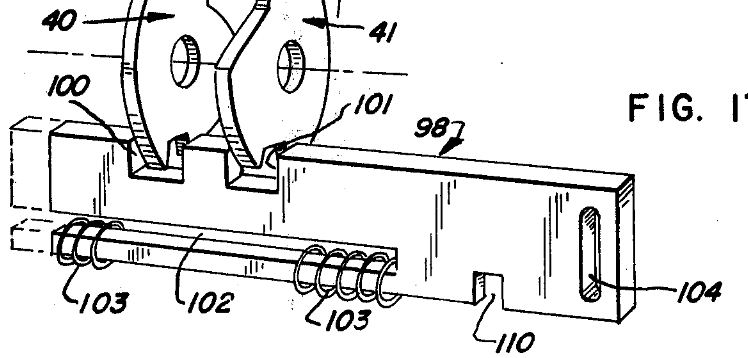


FIG. 17

FIG. 13

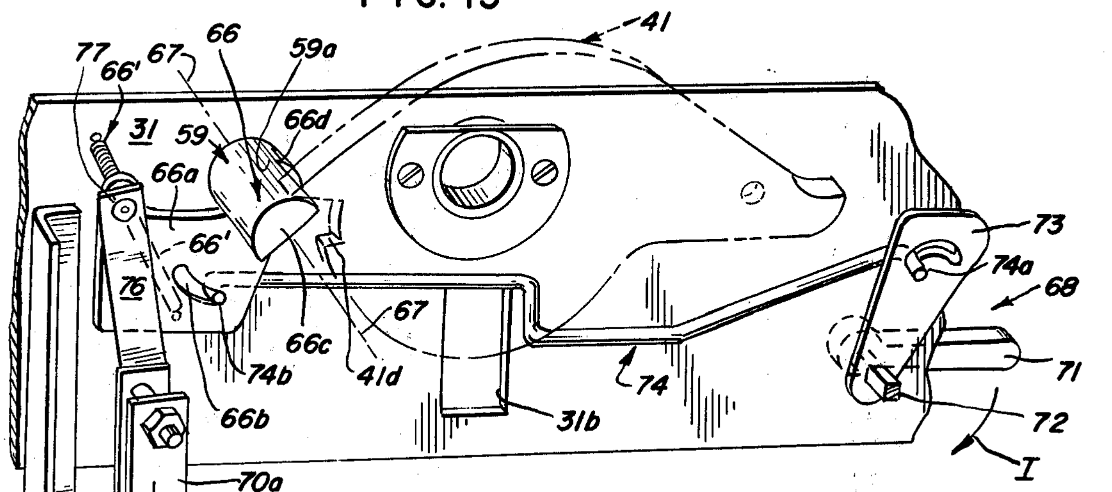
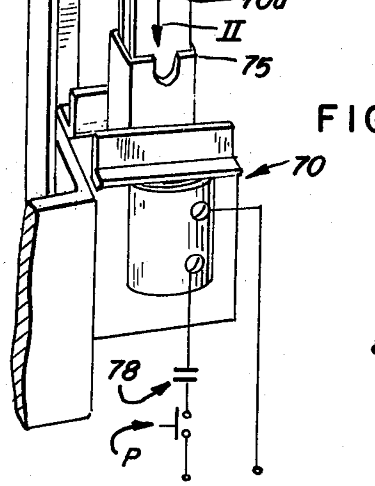
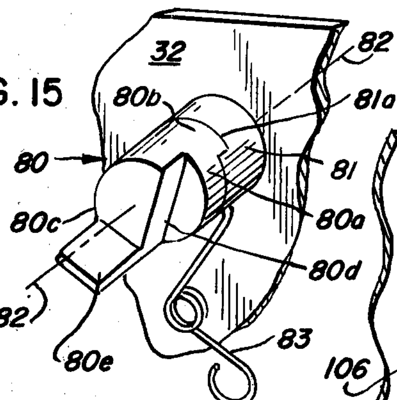



FIG. 15



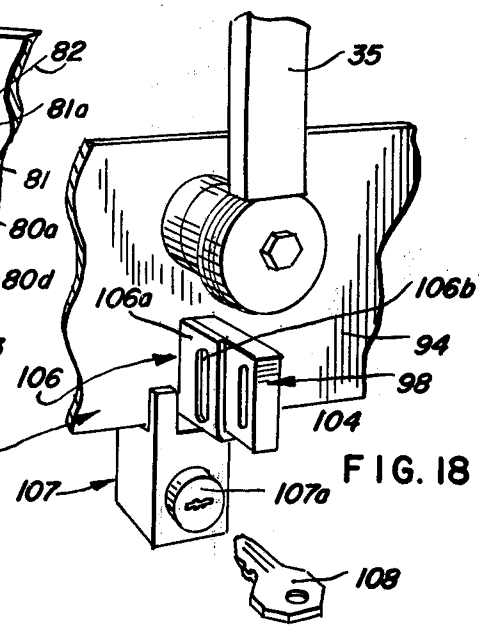


FIG. 18

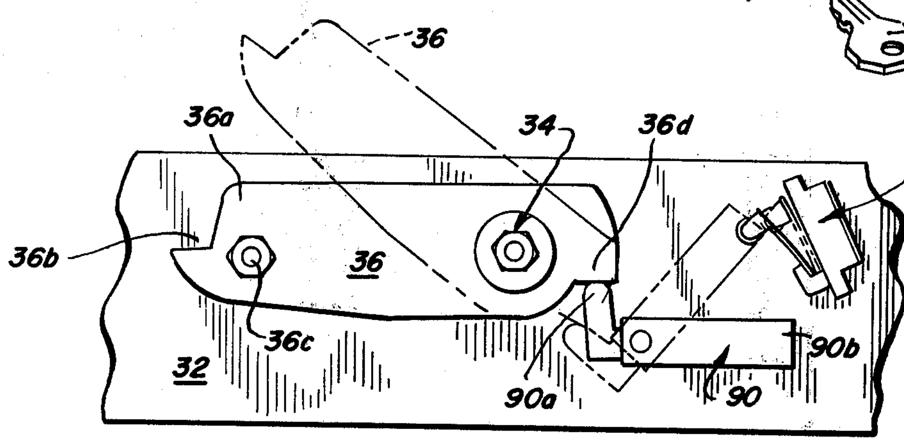


FIG. 19

OPERATING MECHANISM FOR OPENING AND CLOSING AN ELECTRICAL SWITCH

BACKGROUND OF THE INVENTION

It is important for reasons of safety that an electrical system having high current-carrying capabilities be provided with a heavy duty switch which operates on a close-open cycle only. Furthermore, in such a system the complemental current-carrying components of the switch must make full contact in such a way that various safety code requirements are fufilled.

To assure proper operation of switches of this general type, various operating mechanisms have heretofore been provided; however, because of certain design characteristics the prior mechanisms have been beset by one or more of the following shortcomings: (a) the mechanism was difficult and awkward to manually manipulate so as to charge the spring means embodied within the mechanism; (b) the mechanism was highly susceptible to malfunction; (c) the mechanism could be manipulated to effect closing of the switch without the switch-opening spring means being charged; (d) it could not readily be ascertained whether the switch was in either an open or closed condition by merely observing the exterior of the housing in which the switch and operating mechanism were accommodated; (e) the mechanism was not capable of manual and automatic operation to effect opening of the switch; (f) the mechanism was bulky and difficult to install and service; and (g) the mechanism could not be utilized with switches varying in size and shape over a wide range.

SUMMARY OF THE INVENTION

Thus, it is an object of this invention to provide an improved operating mechanism of the type described which is not beset with any of the aforenoted shortcomings.

It is a further object of the invention to provide an improved operating mechanism of the type described which embodies security features, thereby permitting manipulation of the mechanism only by authorized personnel.

It is a still further object of the invention to provide an improved operating mechanism of the type described incorporating numerous safety features which, if circumvented, will render the mechanism inoperative in closing the switch.

Further and additional objects will appear from the description, accompanying drawings, and appended claims.

In accordance with one embodiment of the invention, an operating mechanism is provided for use with a heavy duty electrical switch having a movable current-carrying component. The mechanism operates in a close-open cycle and includes a switch-closing spring means, a switch-opening spring means, and a manually actuated means for charging the spring means independently of one another. A control device is provided for discharging the switch-closing spring means and effecting movement of the switch current-carrying component to a closed position only if both spring means have been fully charged. The control device is also adapted to be either manually or electrically actuated to effect opening of the switch.

DESCRIPTION

For a more complete understanding of the invention reference should be made to the drawings wherein:

FIG. **1** is a fragmentary perspective front view showing one form of the operating mechanism in combination with a heavy duty switch disposed in an open position.

FIG. **2** is a fragmentary perspective view of the operating mechanism shown in FIG. **1.**

FIG. **3** is a fragmentary front elevational view partially in section of the mechanism of FIG. **2** showing both switch-closing and switch-opening spring means in discharged conditions.

FIG. **4** is a fragmentary rear elevational view of the mechanism of FIG. **3** and showing the control device in an inoperative position.

FIG. **5** is a fragmentary enlarged sectional view taken along line **5—5** of FIG. **3.**

FIG. **6** is an exploded perspective view of the manually actuated means for charging both spring means.

FIG. **7** is an enlarged fragmentary, sectional view taken along line **7—7** of FIG. **6** and showing both spring means in discharged conditions, the switch-closing spring means being shown in phantom lines.

FIG. **8** is like FIG. **7** but showing the switch-opening spring means in a charged condition and the switch-closing spring means in a discharged condition.

FIG. **9** is like FIG. **8** but showing both spring means in charged conditions.

FIG. **10** is like FIG. **9** but showing the switch-closing spring means in a state of becoming dicharged.

FIG. **11** is an enlarged fragmentary perspective view showing the control device disposed on the front face of the mechanism having been manually actuated to a first position wherein the switch-closing spring means moves from its charged position (FIG. **9**) to its discharged position (FIG. **8**).

FIG. **12** is similar to FIG. **11** but showing the control device having been manually actuated to a second position wherein the switch-opening spring means moves from its charged position (FIG. **8**) to its discharged position (FIG. **7**).

FIG. **13** is an enlarged fragmentary view of the various components comprising the control device for discharging the spring means, said components normally being concealed from view.

FIG. **14** is an enlarged fragmentary perspective view of the clutch pin and cam surface, shown in FIG. **6**; said pin and surface being disposed in engaged relation, thereby permitting the switch-closing spring means to remain in a charged condition while the crank handle, utilized to manually charge the spring means, returns to its upright neutral position, as seen in FIGS. **1** and **2.**

FIG. **15** is an enlarged perspective view of the latch pin utilized to retain the switch-closing spring means in a charged condition.

FIG. **16** is a fragmentary perspective view of one form of a lock assembly shown in position for securing the crank handle in an inoperative position.

FIG. **17** is similar to FIG. **16** but showing the lock assembly in a released or unlocked position whereby the crank handle can be manipulated so as to charge both spring means.

FIG. **18** is a fragmentary perspective view of a modified form of lock assembly.

FIG. 19 is a fragmentary rear view of the crank lever, seen in FIGS. 4 and 6, and showing in phantom lines the lever in a changed position which occurs when the switch-opening spring means moves from charged to discharged conditions.

Referring now to the drawings and more particularly to FIG. 1, a heavy duty switch 20 is shown in combination with a preferred embodiment of the improved operating mechanism 21. The switch 20 may be of a type rated 480 volt AC, 800 through 4000 amps and suitable for use with ground fault equipment. Basically, the switch 20, as illustrated in FIG. 1, includes a plurality of laterally spaced stationary blades 22, and pairs of contact blades 23 arranged in laterally spaced relation and movable as a unit into a closed or open position with respect to the stationary blades 22. The number of stationary blades and corresponding pairs of contact blades may vary from that shown and will depend upon the electrical system in which the switch is incorporated. When the pairs of blades 23 are moved into a closed position, each pair of blades 23 will clampingly engage the aligned stationary blade thereby making full contact between the complemental blades and closing the electrical circuit. The spacing between the blades 23 comprising a pair may be adjustable so as to assure proper contact between the engaging blade surfaces.

To effect unitary movement of the pairs of contact blades 23, the latter are carried on a crossbar 24 which is pivotally mounted so as to move through a predetermined sector between open and closed positions. A rod or link member 25 interconnects the crossbar 24 to the mechanism 21 whereby movement of certain components of the mechanism will be transmitted to the crossbar in a manner to be hereinafter described. The components of the switch 20 per se and their function are described in detail in the application of T. J. Rys, Ser. No. 329,804, filed Feb. 5, 1973, and thus further description thereof is not deemed warranted.

The operating mechanism 21, as illustrated, includes a switch-closing spring means 26 and a switch-opening spring means 27 both of which are adapted to be independently moved to a charged condition by a common, manually actuated assembly 30. The spring means 26 and 27 and the assembly 30 are supported by a pair of spaced parallel plate members 31 and 32 which, in turn, are suitably secured to the mounting panel 33 of the switch 20. The mounting panel 33 supports the stationary blades 22 in proper spaced relation.

Assembly 30, as seen more clearly in FIG. 5 comprises an elongated shaft 34 which is disposed transversely of plate members 31 and 32 and extends through suitable openings 31*a* and 32*a* formed therein. One end of the shaft projects forwardly from plate member 31 and has affixed thereto a suitable crank handle 35. The opposite end of shaft 34 projects rearwardly from plate member 32 and has affixed thereto an elongated operating lever 36. Mounted on shaft 34 and disposed intermediate plate members 31 and 32 are a pair of longitudinally spaced crank plates 37 and 38 and a pair of operator plates 40 and 41 arranged in side-by-side relation and disposed between the crank plates 37 and 38, see FIGS. 5 and 6.

Shaft 34 is of composite construction and includes an elongated rod 42 having an enlarged head formed at the forwardly projecting end thereof. The enlarged head includes a cylindrical section 42*a*, which is of greater diameter than the remainder of the rod; a square or facetted section 42*b* disposed to one side of section 42*a* and accommodated within a matching opening 35*a* formed formed in crank handle 35; and a second square or facetted section 42*c* disposed on the opposite side of section 42*a* and accommodated within a matching opening 38*a* formed in crank plate 38, thereby causing plate 38 and crank handle 35 to pivot as a unit about the axis of rod 42. Encompassing the cylindrical section 42*a* of the enlarged head of rod 42 are a flanged bushing 39 and a spacer 39'. The flanged bushing 39 is disposed within the opening 31*a* formed in plate member 31. The flange 39*a* formed on the bushing 39 engages the rear surface of the plate member 31, see FIG. 5.

Encompassing the portion 42*d* of the rod projecting rearwardly from head section 42*c* is a sleeve 43 supported at opposite ends by needle bearings 44*a* and 44*b* which also encompass the rod. The sleeve is retained in a fixed longitudinal position on rod position 42*d* by a lock ring 45 which is disposed within an external groove 43*a* formed adjacent one end of sleeve 43, see FIG. 5. The ring 45 when in place engages the front face of operator plate 41. The opposite or rear end 43*b* of sleeve 43 has a generally square configuration with rounded corners 43*c* which are extensions of the cylindrical periphery of the sleeve central portion 43*d*. Fixedly mounted on the sleeve central portion is an arcuate-shaped lug 43*e*, the function of which will be described more fully hereinafter. The generally square-shaped rear end 43*b* of sleeve 43 is accommodated within a matching opening 36*a* formed in operating lever 36. A bushing 46 engages the rear part of the central portion 43*d* of sleeve 43 and is disposed within the opening 32*a* formed in the rear supporting plate member 32.

Arranged between the lock ring 45 and the bushing 46 and encompassing the cylindrical central portion 43*d* of sleeve 43 are the operator plates 40 and 41 and the crank plate 37. Each of the plates is provided with a matching opening 40*a*, 41*a* or 37*a* which permits the sleeve to rotate independently of the plates or vice versa as will be discussed more fully hereinafter.

As seen in FIGS. 5 and 6, crank plates 37 and 38 are of similar construction except for the configuration of the openings 37*a* and 38*a* formed therein and through which the shaft 34 extends. Thus, because of the round configuration of opening 37*a*, rear plate 37 functions as an idler plate, whereas the front plate 38 with its square-shaped opening 38*a* functions as the drive plate when the spring means 26 and 27 are being manually charged in a manner to be more fully described hereinafter.

Each plate 37 or 38 has a curved, laterally extending portion 37*b* or 38*b*. An opening 37*c* or 38*c* is formed in the outer extremity of portion 37*b* or 38*b* and is adapted to receive an end of an elongated crank pin 47. The pin interconnects the outer extremities of the crank plates and has an axis which is substantially parallel to the axis of shaft 34.

At substantially its mid-point, crank pin 47 is engaged by one end 48*a* of a coil spring 48, see FIG. 3, which exerts a bias on the crank plates and the crank handle 35 causing same to assume a neutral or upright position N, see FIGS. 1–4, when the crank handle has been released. The upper end 48*b* of the biasing spring is connected to an offset end 50*a* of an upright fixed bracket 50 carried by plate member 32.

Operator plate **40** is pivotally connected to the switch-closing spring means **26** by a connecting pin **51** which is accomodated in an opening **40***b* formed in a laterally extending portion **40***c* of the plate **40.** The pin **51** is also disposed within suitable openings formed in the bifurcated end **52***a* of a telescoping rod section **52.** The lower end **52***b* of the rod is slidably disposed within the upper end **53***a* of a lower rod section **53,** see FIG. **3.** The lower end **53***b* of the rod section is pivotally connected at **54** to the plate members **31** and **32.** Encompassing the rod sections **52** and **53** is a pair of concentric coil springs **55***a* and **55***b* which are disposed between the upper end **52***a* of rod section **52** and the lower end **53***b* of rod section **53.** When the concentric springs are in a fully charged (compressed) condition and the rod sections are in a retracted relation, see FIG. **9,** there is sufficient stored energy to cause the crossbar **24,** carrying the blades **23,** to rapidly move into a closed relation with the stationary blades **22** when the springs **55***a* and *b* are released or discharged in a manner to be hereinafter described.

As seen in FIG. **6,** operator plate **40** is provided with a peripheral notch **40***d* which is disposed substantially diametrically opposite opening **40***b*. An additional opening **40***e* is disposed in substantial radial alignment with notch **40***d*. The distal end **40***f* of the laterally extending portion **40***c* of plate **40** defines a shoulder which is adapted to be engaged by the crank pin **47** when the crank handle **35** and crank plates **37** and **38** pivot as a unit in one direction about the shaft **34** as an axis.

Opening **40***e* of plate **40** is adapted to slidably receive an end **56***a* of a clutch pin **56** which is secured to the rear surface of plate **40** by a spring piece **57.** One end **57***a* of piece **57** is affixed by a fastener **58** or the like to the rear surface of the plate **40** and the opposite end **57***b* is affixed to the rear end of the clutch pin **56.** The spring piece **57** exerts a bias on the clutch pin **56** urging same to project through plate opening **40***e*. When the forward end **56***a* of the clutch pin projects through and forwardly from the plate opening **40***e*, the end **56***a* will be in position to be engaged by an end of the acrcuate lug **43***e* affixed to portion **43***d* of the sleeve **43.** Such a condition occurs when both the operator plates **40** and **41** assume a charged or cocked position C, see FIG. **9.** Upon the switch-closing spring means **26** being released from its charged position, the clutch pin **56** will drive the sleeve **43** through lug **43***e* in a clockwise direction through an arc of approximately 90°, see FIGS. **9** and **8,** and at the same time cause lever **36** to move through the same arc from a substantially horizontal position, FIGS. **4** and **9,** to an upright position, FIG. **8.** The effect of this movement by the lever **36** will be discussed more fully hereinafter.

Upon the plate **40** reaching its upright position while spring means **27** remains in a charged condition, see FIG. **8,** the protruding end **56***a* of the clutch pin **56** will engage and move up the bevelled end **58***a* of an arcuate cam **58** which is affixed to the rear surface of operator plate **41,** see FIGS. **6** and **14.** The center of curvature of the cam **58** is coincident to the axis of rod **42.** It should be noted, however, that the greatest radius defining the outer curved peripheral surface of lug **43***e* is less than the smallest radius defining the inner curved peripheral surface of cam **58.** Thus, lug **43***e* and cam **58** are adapted to move in substantially concentrically disposed paths as seen in FIGS. **7–10.** The height of cam **58** is such that when end **56***a* of pin **56** has moved up the bevelled end **58***a* and is engaging the flat surface **58***b* of the cam, the end **56***a* will be recessed from the rear surface of the operator plate **41** to such an extent that the clutch pin end **56***a* will no longer be disposed within the path of the sleeve lug **43***e* upon subsequent movement of the sleeve **43** in a counterclockwise direction upon switch-opening spring means **27** being released from its charged position C (FIG. **8**) to its discharged position D (FIG. **7**).

Counterclockwise movement of the sleeve **43** is effected through an arcuate lug **60** formed on the rear surface of operator plate **41,** see FIG. **6.** The radii forming lugs **43***e* and **60** are substantially the same; thus, when spring means **26** is in a discharged position D and spring means **27** is in a charged position C, see FIG. **8,** lugs **43***e* and **60** are disposed in abutting end-to-end relation. Counterclockwise movement of plate **41** is effected by releasing the stored energy of the compressed concentric springs **61***a* and **61***b* which encompass telescoping rod sections **62** and **63.** The springs **61***a* and *b* and the telescoping rod sections **62** and **63** are similar in construction and function to that of springs **55***a* and *b* and rod sections **52** and **53** heretofore described with regard to the switch-closing spring means **26.**

As in the case of rod section **52,** rod section **62** has a bifurcated upper end **62***a* which is adapted to accommodate a portion **41***c* of operator plate **41.** A connector pin **64** pivotally joins the bifurcated end **62***a* to the plate **41.** A suitable opening **41***b* is provided in the plate portion **41***c* to receive the pin **64.** The lower end of rod section **63** is pivotally connected at **65** to the supporting members **31** and **32.**

To retain the switch-opening spring means **27** in a charged position C, once it has been moved into such position by the manual manipulation of the crank handle **35** in a counterclockwise direction as viewed in FIGS. **1** and **2,** a latch pin **66** is provided which is adjustably mounted on the rear surface of the front-supporting plate member **31,** see FIG. **13.** The latch pin **66** is mounted on a stationary bearing **59** carried on and extending rearwardly from plate member **31.** The latch pin is rotatable about a transverse axis **67.** The pin **66** is integrally joined to a substantially flat member **66***a* in which is formed a curved slot **66***b*. The rearwardly extending distal end portion **66***c* of the pin **66** has a substantially crescent or semi-cylindrical cross-sectional configuration, see FIGS. **7–10** and **13.** When operator plate **41** is in its charged position C, see FIGS. **9** and **10,** the pin end portion **66***c* will engage and be disposed within a peripheral notch **41***d* formed in the plate **41.** The notch is disposed substantially diametrically opposite the opening **41***b*. Pin **66** is biased by a coil spring **66'** in a clockwise direction about axis **67,** as viewed in FIG. **13,** so that the end portion **66***c* will automatically assume an interlocking position within the notch **41***d* when the latter is aligned therewith. The adjacent surfaces of the bearing **59** and pin are provided with complemental stops **59***a* and **66***d* which limit the extent to which the pin can rotate in a counterclockwise direction, see FIG. **13.**

The end portion **66***c* may be released from its interlocking engagement with the plate notch **41***d* by either a manually actuated control lever unit **68** or by an electrically actuated solenoid assembly **70,** see FIG. **13.**

Unit **68** includes an exposed handle **71** which is connected to an elongated transversely extending rod **72.**

The axis of rod **72** is substantially parallel to the pin axis **67.** The rod is supported by members **31** and **32** for rotation about its longitudinal axis. Mounted on rod **72** and movable therewith as a unit about the rod is a lever **73** which is disposed adjacent the rear surface of member **31.** Pivotally connected to lever **73** at a point offset laterally from the rod axis is one end **74***a* of an elongated connecting arm **74.** The opposite end **74***b* of arm **74** is offset and slidably disposed within the curved slot **66***b* formed in the member **66***a* joined to latch pin **66.** Thus, if handle **71** is turned downwardly in the direction indicated by the arrow I in FIG. **13,** through an arc of approximately 90°, such motion will be transmitted to the latch pin **66** through rod **72,** lever **73,** and arm **74** causing the latch pin end **66***c* to move in a counterclockwise direction, as viewed in FIG. **13,** about axis **67** until the flat side **66***e* of the pin end **66***c* faces the open side of the notch whereby the plate periphery is clear of the latch pin. Once the latch pin end is clear of the periphery of the plate **41,** the stored energy of the compressed springs **61***a* and *b* can be subsequently released in a manner to be hereinafter described, thereby driving the plate **41** in a counterclockwise direction, as viewed in FIG. **13,** so as to open the switch.

The same releasing clockwise motion can be imparted to the latch pin **66** by the solenoid **70,** the latter being secured to member **31** by a suitable bracket **75.** The core of the solenoid **70** has an extension **70***a* which is pivotally connected to a link piece **76** which, in turn, is pivotally connected at **77** to member **66***a* of the latch pin **66.** The solenoid core is adapted to normally assume an up position by reason of the bias, previously mentioned, being exerted on the pin **66** by spring **66'.**

The actuating circuit for the solenoid **70** includes an interlock micro-switch **78,** see FIGS. **13** and **19,** which, in the illustrated embodiment, is mounted on the rear surface of supporting plate member **32.** The switch **78** normally assumes a closed condition whereupon, if a predetermined circuit condition occurs, the solenoid **70** will be automatically energized causing the core extension **70***a* and link piece **76** to instantly move downwardly, see arrow II, FIG. **13,** thereby rotating the latch pin end **66***c* to a release position. The core extension will remain in a down position until the interlock micro-switch **78** breaks the circuit and deactivates the solenoid permitting the core extension **70***a* to return to its normal up position as seen in FIG. **13.** The arcuate slot **66***b* in the latch pin member **66***a* permits the latch pin to be actuated by the solenoid **70** without affecting the control lever unit **68.** It will be understood that the predetermined circuit condition can be the closing of a control circuit to the solenoid **70** by means of a push button P, see FIG. **13,** or by means of an overload responsive device in a circuit in which the switch **78** is interposed.

The operator plate **40** is initially retained in its charged position C, see FIG. **9,** by a second latch pin unit **80,** see FIG. **15,** mounted on a stationary bearing **81** affixed to the rear support member **32** for rotation about an axis **82** which is disposed transversely of the member **32** and parallel to the axis of shaft **34.** Unit **80** includes an inner portion **80***a* having a stop **80***b* formed on the end face thereof which is adapted to engage a complemental stop **81***a* formed on the bearing end face, thereby limiting the extent to which the pin **80** can rotate in a clockwise direction about axis **82,** see FIG. **15.** The pin **80** is biased in the clockwise direction by a spring **83.** Next to the inner portion **80***a* of the pin **80** is a central portion **80***c* which has a crescent or semi-cylindrical configuration. The central portion **80***c* will normally be disposed within the peripheral notch **40***d* of the plate **40,** upon the plate being moved to its charged position, see FIG. **9,** and before plate **40** is so moved by manipulation of the crank handle **35** first in a clockwise direction from its neutral position N, as seen in FIGS. **1** and **2.** When the latch pin **80** is rotated in a counterclockwise direction so that the flat face **80***d* of the central portion **80***c* is aligned with the open side of the plate notch **40***d*, then the latch pin **80** is no longer capable of retaining the plate **40** in its charged state. Notwithstanding this deposition of the flat face **80***d*, the plate **40** will not move to its discharged position until certain other conditions occur in a manner to be hereinafter described.

As seen in FIG. **15,** latch pin **80** is provided with an outer tongue-like portion **80***e* which is adapted to be engaged by the bifurcated end **62***a* of the telescoping rod section **62** comprising a part of the spring means **27,** when the latter is charged by manipulation of the crank handle **35** in a counterclockwise direction. Upon the tongue-like portion **80***e* being engaged by the bifurcated end **52***a*, the latch pin **80** will be rotated in a counterclockwise direction about axis **82,** thereby causing the portion **80***c* to become disengaged from plate notch **40***d*. Once this occurs, however, the plate **40** which is in its charged position will not move to its discharged position until the control lever unit **68** is manually rotated upwardly, as seen in FIG. **11,** which, in turn, rotates lever **87** so as to disengage stop pin **90** from notch **36***b* of lever **36.**

As aforementioned, rod **72** which forms a component of unit **68** is supported by plate members **31** and **32.** The inner end of rod **72** protrudes beyond member **32** and is connected to a lever **84,** see FIG. **4.** To the lower end of lever **84** is pivotally connected one end of an elongated arm **85,** the latter having a longitudinally extending slot **85***a* formed adjacent the opposite end. Slidably disposed within slot **85***a* is a pin **86** carried on the lower end **87***a* of a second lever **87** which is adapted to pivot about a stationary stud **88** which is affixed to and projects rearwardly from plate member **32.** The upper end **87***b* of lever **87** is bifurcated and is provided with a transversely extending stop pin **90.** The lever **87** is connected to one end of a biasing spring **89** at a location intermediate stationary stud **88** and stop pin **90.** The opposite end of the spring is affixed to member **32.** The spring **89** urges lever **87** in clockwise direction as seen in FIG. **4.**

The bifurcated end **87***b* of lever **87** is adapted to accommodate a notched end **36***a* of the lever **36,** when the latter assumes a substantially horizontal position, as seen in FIG. **4.** When the lever end **36***a* is accommodated by the bifurcated end **87***b*, the stop pin **90** will be disposed within the notch **36***b* and prevent the lever **36** from pivoting in a clockwise direction about the shaft **34** as an axis, see FIG. **4.**

The length of the slot **85***a* formed in arm **85** is such that when the handle lever **71** is manually manipulated in a clockwise direction to an up position, see FIG. **11,** such pivotal movement will be transmitted to lever **87** causing same to pivot a like amount in a counterclockwise direction, see FIG. **4,** about stud **88** as an axis, thereby moving the stop pin **90** clear of the notched end **36***a* of lever **36.** The slot **85***a* permits the handle lever 71 to be manually manipulated from a neutral position, see FIGS. 1 and 2, to a down position, see FIG. 12, without causing the lever 87 being effected. When the handle lever 71 is in its down position, the switch-opening spring means 27 will be discharged.

As seen in FIG. 4, the pivotal motion of the lever 36 is transmitted to the switch cross bar 24 through rod 25 which is connected at 36*c* to lever 36 adjacent its notched end 36*a*.

The opposite end of lever 36 is fore-shortened and provided with a shoulder 36*d*. The shoulder engages a leg 90*a* forming a portion of a dog-leg type of trip lever 90 which is secured to the rear end of an elongated rod 91. The rod is disposed transversely of the plate members 31 and 32 and is supported thereby for rotation about its longitudinal axis. The opposite end 90*b* of trip lever 90 is adapted to engage and close switch 78, when the lever 36 moves in a clockwise direction as seen in phantom lines in FIG. 19.

As a safety feature, the handle lever 71 of the control unit 68 cannot be manually manipulated from its neutral (horizontal) position to either an up or down position unless the upper end 92*a* of a safety lever 92 is pushed inwardly, when an inspection door 93 hingedly connected to a housing 94 assumes a closed position with respect to an access opening 94*a*, see FIGS. 11 and 12. The housing 94 is of conventional design and is adapted to enclose various components of the operating mechanism 21 and the switch 20. The door 93 and opening 94*a* provide a ready means of access to the interior of the housing to facilitate adjustment of the switch and/or the operating mechanism.

Safety lever 92 is adjustably connected to the front face of plate member 32 by means of a transversely extending stationary pin 92′, see FIG. 2. The pin extends through an elongated slot, not shown, formed in lever 92. A coil spring 92″ encompasses the pin 92′ and is disposed between the lever 92 and the end of pin 92′ and exerts a bias on the lever whereby the upper end 92*a* thereof seeks to project outwardly through the access opening formed in the housing 94 and is prevented from doing so when the door 93 is closed. The lower end 92*b* of lever 92 is offset rearwardly and extends through an opening 32*c* formed in plate member 32. The length of the offset end 92*b* is such that it will extend through a suitable opening 84*a*, see FIG. 4, formed in lever 84, when the latter is disposed in its upright, neutral position. Thus, safety lever 92 prevents rotation of the control lever 71 when the offset end 92*b* is disposed with opening 84*a*.

A window 94*b* is formed in the front wall of the housing 94 through which can be observed indicia 95*a* and *b* indicating whether the switch 20 is in either a closed or open position. The "open" indicia 95*a* is disposed on a flag piece 96 which is secured to the front end of rod 91 and rotates therewith. Thus, flag piece 96, rod 91 and trip lever 90 will rotate as a unit about the longitudinal axis of rod 91. When trip lever 90 is in the positon shown in phantom lines in FIG. 19, the flag piece 96 is disposed in an offset position relative to the window 94*b*, as seen in FIG. 11. The "closed" indicia 95*a* is fixedly mounted on the front surface of plate member 31 and can be observed through the window only when the flag piece assumes the position shown in dotted lines in FIG. 11.

FIGS. 16 and 17 disclose one form of a device 97 which is adapted to secure the operator plates 40 and 41 in an inoperative condition, as seen in FIG. 16. Device 97 includes an elongated bar 98 which is mounted for endwise adjustment within suitable aligned openings 31*b* and 32*b* formed in plate members 31 and 32, respectively, see FIGS. 13 and 4. The configuration of bar 98 is such that segments of the upper portion thereof will fit within the peripheral notches 40*d* and 41*d* of the operator plates 40 and 41, see FIG. 16, and thus prevent either plate from rotating about the axis of shaft 34. The upper portion of bar 98 is provided with a pair of longitudinally spaced open end slots 100 and 101.

The spacing between the slots corresponds to the spacing between the plates 40 and 41. The depth of each slot is such that, when the slots are aligned with the plates, as seen in FIG. 17, the bar will not obstruct the movement of the plates either during charging or discharging thereof.

The underside of bar 98 is provided with an elongated longitudinally extending open end slot 102 which is disposed adjacent to and substantially parallel with the lower edge of the bar. Accommodated within slot 102 is a coil spring 103 which exerts a bias on the bar urging same to assume an extended position wherein the slots 100 and 101 are aligned with the operator plates 40 and 41, respectively. The exposed end 98*a* of the bar is provided with an opening 104 which is sized to accommodate the bail 105*a* of a padlock, or the like, 105, see FIG. 16.

Affixed to plate member 31 and protruding forwardly therefrom is a channel-shaped element 106 which is adapted to partially embrace the protruding end 98*a* of the bar 98. The upwardly protruding sides 106*a* of the element 106 are provided with aligned openings 106*b* which are similar in configuration to the opening 104 formed in the bar 98. When the bar 98 is in a retracted position, as shown in FIG. 16, the openings 104 and 106*b* will be in registration with one another so as to accommodate the bail of the padlock 105.

FIG. 18 illustrates a modified form of lock 107 used to retain bar 98 in a retracted position. Lock 107 is affixed to the lower edge portion of the plate member 31 and embodies a bolt, not shown, which is adapted to assume either an extended or retracted position. The position of the bolt is determined by a key 108 which is adapted to be inserted into a tumbler 107*a*. When the bolt is disposed in an extended position and bar 98 is in its retracted position, see FIG. 16, the bolt will fit within an open-ended slot 110 formed along the lower edge of the bar 98, see FIGS. 16 and 17. The bar can assume its retracted position only when the operator plates 40 and 41 are in their discharged positions. Various other types of devices from those herein described and illustrated may be utilized for locking the operator plates in discharged positions.

In order to operate mechanism 21 to effect closing of switch 20, it is necessary that the certain procedural steps be followed, namely: (a) the padlock 105 must be removed or the key 108 must be inserted into the tumbler 107*a* and the bolt retracted so as to free the bar 98 and allow the slots 100 and 101 to align themselves with the operator plates 40 and 41; (b) the access door 93 must be closed so as to disengage the safety lever 92 from the lever 84; (c) the crank handle 35 is manually rotated in either a clockwise direction, as viewed in FIG. 1, through an arc of approximately 90° until the peripheral notch 40*d* of plate 40 is engaged by the latch pin **80,** thereby charging spring means **26,** or in a counterclockwise direction, as viewed in FIG. **1,** through an arc of approximately 90° until the peripheral notch **41***d* is engaged by the latch pin **66,** thereby charging spring means **27,** see FIG. **8**; (d) depending upon which direction the crank handle **35** was rotated under (c) hereof to charge a spring means, the handle is then rotated in the opposite direction from the neutral upright position through an arc of approximately 90° so as to charge the other spring means, thereby resulting in both spring means being sequentially charged, see FIG. **9**; and (e) the control handle **71** is then manually rotated in a clockwise direction, see FIG. **13,** through an arc of approximately 90° whereupon the operator plate **40** is released from its charged position and instantly moves to its discharged position under the combined force of the springs **55***a* and *b* and this in turn moves the lever **36,** and the movement of the latter is transmitted to the switch crossbar **24** through connecting rod **25.**

While the switch has been closed by the mechanism in accordance with the procedural steps above-outlined, the switch-opening spring means **27** remains in a charged state. The discharge of the spring means **27** to effect opening of the switch is accomplished by either manual rotation of the control lever **71** in a counterclockwise direction from its neutral position through an arc of approximately 90°, or the solenoid **70** being energized so as to cause the core **70***a* thereof to move to a retracted position. Either of the foregoing manipulations will effect movement of the latch pin portion **66***c* out of interlocking engagement with the peripheral notch **41***d* of plate **41.**

Thus, it will be seen that an operating mechanism for a heavy duty switch has been provided which requires both the switch-opening and switch-closing spring means to be charged before the switch can be closed. The operating mechanism can be secured in a locked position whereby the operator plates can be rendered immovable and thus reduce the possibility of unauthorized manipulation of the mechanism. The mechanism is capable of being either manually or automatically actuated so as to cause the switch to assume an open position.

Various modifications may be made in the structure shown and described without departing from the scope of the invention.

I claim:

1. An operating mechanism for opening and closing an electrical switch comprising a frame, a spring-actuated switch-closing member; a spring-actuated switch-opening member, said members being disposed in spaced side-by-side relation and mounted for independent pivotal movement about a common axis; manually actuated means for independently pivoting said members in opposite directions into cocked positions wherein the springs therefor are in charged condition; adjustable control means mounted on said frame for successive releasing of the switch-closing member and the switch-opening member from said cocked positions, said switch-closing member being released from said cocked position only if said switch-opening member remains in said cocked position; and lock means mounted on said frame for manual adjustment between lock and unlock positions, said means when in said lock position retaining said members in an immovable state.

2. The operating mechanism of claim **1** wherein said manually actuated means includes an elongated shaft means having the longitudinal axis thereof coincident to said common axis, and at least one crank member mounted on said shaft means and movable therewith as a unit about said common axis, said crank member when manually moved in one direction through a predetermined mined sector engaging only one spring-actuated member and moving same to said cocked position and when manually moved in a second direction through a predetermined sector engaging the other spring-actuated member and moving same to said cocked position whereby both of said members are disposed in cocked positions.

3. The operating mechanism of claim **2** wherein said shaft means includes an elongated rod, a sleeve element rotatably mounted thereon, and a lug protruding from and affixed to the periphery of said sleeve element, said lug being disposed intermediate said spring-actuated members; said switch-closing member being provided with an adjustably mounted clutch element adapted to engage said lug when said switch-closing member is disposed in a cocked position, said sleeve and switch-closing member moving as a unit through a first predetermined sector in one direction independently of said elongated rod upon said switch-closing member being released from said cocked position; said switch-opening member being provided with a protruding cam affixed thereto and a protruding lug affixed thereto and annularly spaced and offset relative to said cam; said sleeve element lug and said member lug being disposed in abutting relation and the clutch element engaging said cam and being out of engagement with the sleeve element lug only upon the switch-closing member being in a discharged position and said switch-opening member being in a cocked position whereby upon subsequent release of said switch-opening member, said sleeve and said switch-opening member move as a unit through a second predetermined sector in a second direction; the movement of said sleeve element through said first predetermined sector being adapted to close the switch, and the movement of said sleeve element through said second predetermined sector being adapted to open the switch.

4. The operating mechanism of claim **1** wherein the periphery of each spring-actuated member is provided with a first locking component, and the periphery of said lock means is provided with a second locking component, said first and second components being in interlocking relation only when said lock means is disposed in said lock position and said spring-actuated members are disposed in discharged positions.

5. The operating mechanism of claim **4** wherein said first locking component comprises a peripheral notch, and said second locking component comprises an elongated rigid bar adjustably mounted on said frame for endwise movement relative to said spring-actuated members, the endwise movement of said bar being substantially parallel to said common axis; said bar, when in one position of adjustment, having longitudinally spaced portions thereof disposed within said aligned peripheral notches and locking said spring-actuated members against pivotal movement about said common axis.

6. An operating mechanism for opening and closing an electrical switch comprising a frame; a spring-actuated switch-closing member pivotally mounted on said frame for movement between cocked and uncocked positions, said member being engaged by a spring disposed in a charged condition when said member assumes a cocked position; a spring-actuated switch-opening member pivotally mounted on said frame for movement between cocked and uncocked positions, said switch-opening member being engaged by a second spring disposed in a charged condition when the latter member assumes a cocked position, said members being movable about a common axis; an elongated shaft means having an elongated rod coaxial with said common axis, and a sleeve element encompassing said rod and being rotatable independently of said rod, said sleeve element being provided with an outwardly projecting lug; a clutch element mounted on and carried by said switch-closing member, said clutch element being movable independently of said switch-closing member between extended and retracted positions, said clutch element, when both of said spring-actuated members are in cocked positions, projecting from said switch-closing member towards said switch-opening member and being disposed within the path of movement of the lug carried on said sleeve element; a cam mounted on said switch-opening member and extending towards said switch-closing member and engaging said clutch element and causing same to be moved out of the path of movement of said sleeve element lug, engagement between said clutch element and said cam occurring only when said switch-closing member has moved to an uncocked position and said switch-opening member has remained in a cocked position; a lug mounted on said switch-opening member and extending towards said switch-closing member, said lug being annularly spaced and offset from said cam, said sleeve element lug and said switch-opening member lug being disposed in abutting end-to-end relation when said switch-closing member is in an uncocked position and said switch-opening member is in a cocked position; and a control device adjustably mounted on said frame for successive releasing of said switch-closing member and said switch-opening member from said cocked positions, said switch-closing member being released from said cocked position only if said switch-opening member is disposed in said cocked position.

7. The operating mechanism of claim **6** wherein the control device includes an adjustable latch pin mounted on said frame and when in one position of adjustment engaging said switch-opening member and retaining same in a cocked position; said latch pin, when in a second position of adjustment, being disengaged from said switch-opening member whereby the latter automatically moves from said cocked position to an uncocked position.

8. The operating mechanism of claim **7** wherein adjustment of said latch pin is manually controlled.

9. The operating mechanism of claim **7** wherein adjustment of said latch pin is automatically effected by electrically energized means.

10. The operating mechanism of claim **6** wherein the clutch pin is biased so as to project from the switch-closing member towards the switch-opening member.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,876,847 Dated April 8, 1975

Inventor(s) Donald L. Dykes et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 19, "position" second occurrence, should read -- portion --; line 60, "point" should read -- length --. Column 5, line 42, "acrcuate" should read -- arcuate --. Column 7, line 4, after "rod" insert -- axis --. Column 8, line 14, "deposition" should read -- disposition --. Column 12, line 6, after "determined" delete "mined"

Signed and Sealed this

eleventh **Day of** *May 1976*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

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