July 27, 1965 A. R. NORDEN 3,197,582

ENCLOSED CIRCUIT INTERRUPTER

Filed July 30, 1962 3 Sheets-Sheet 1

FIG. 1

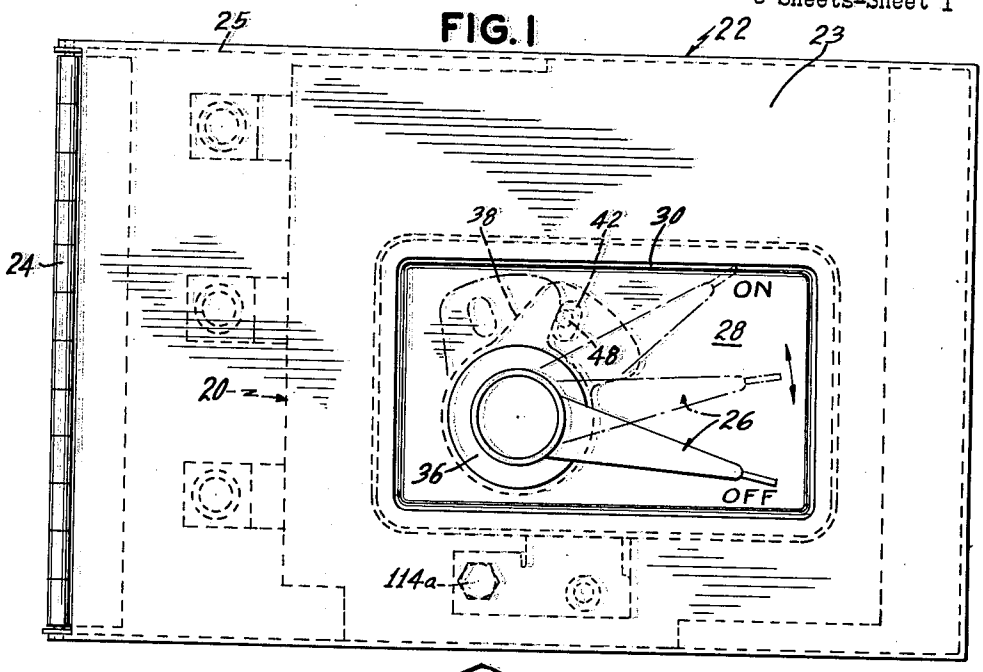
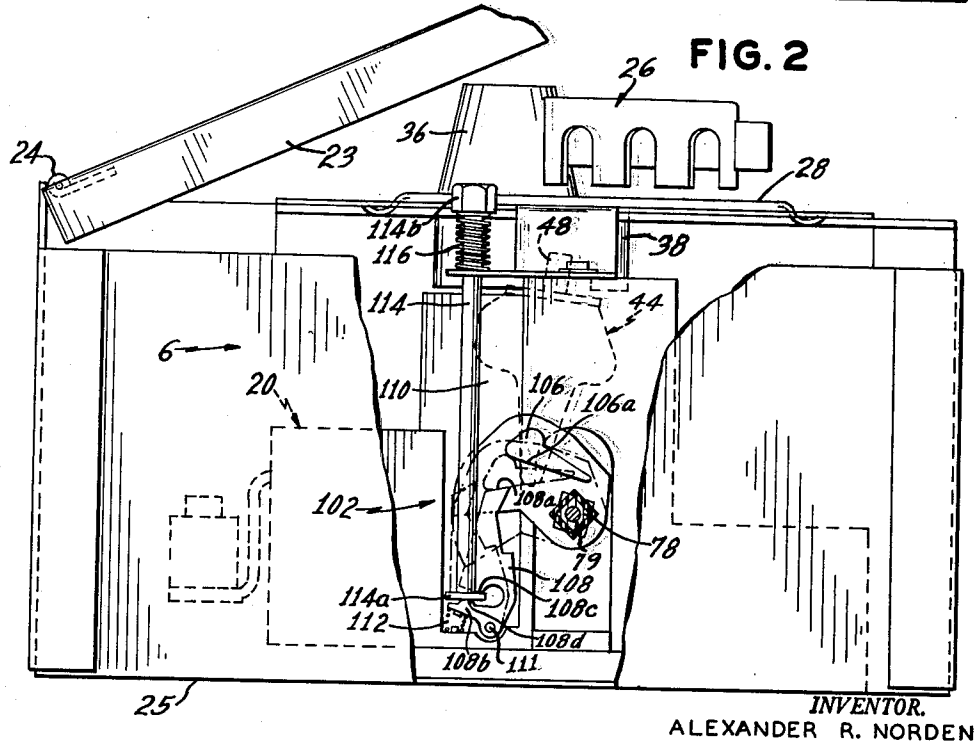


FIG. 2



INVENTOR.
ALEXANDER R. NORDEN

BY Richard M. Rothstein

ATTORNEY

July 27, 1965 A. R. NORDEN 3,197,582

ENCLOSED CIRCUIT INTERRUPTER

Filed July 30, 1962

3 Sheets-Sheet 2

FIG. 3

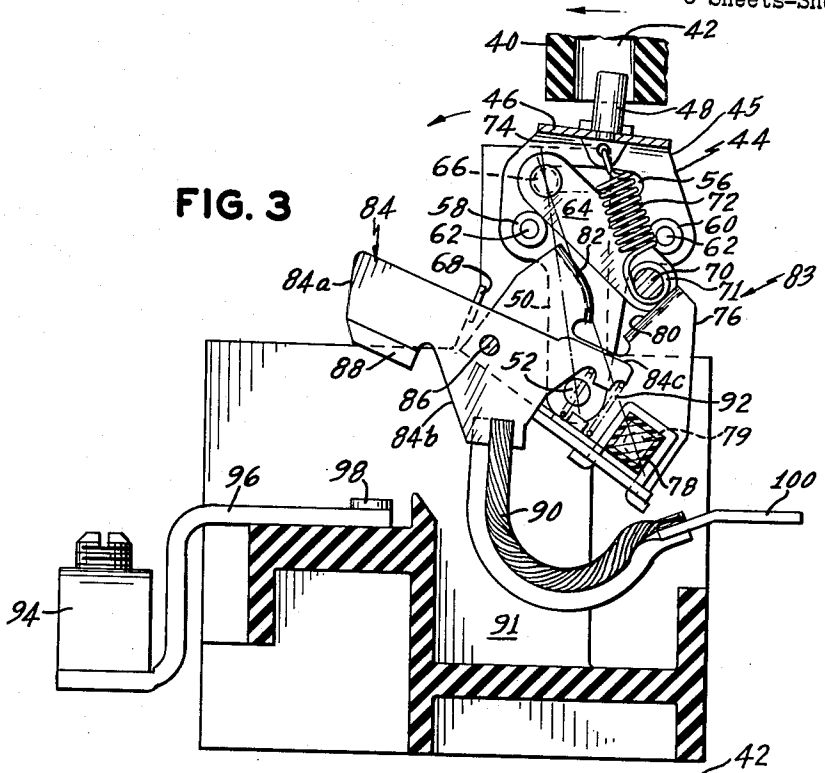


FIG. 5

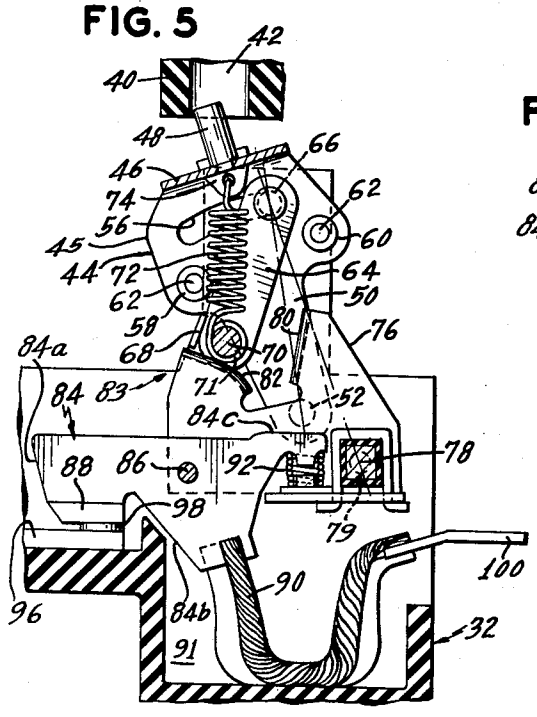
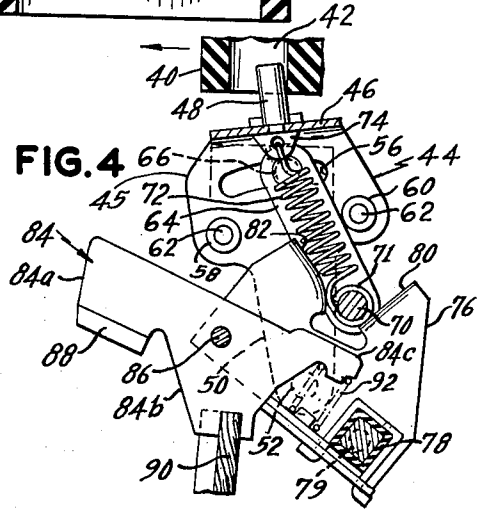


FIG. 4



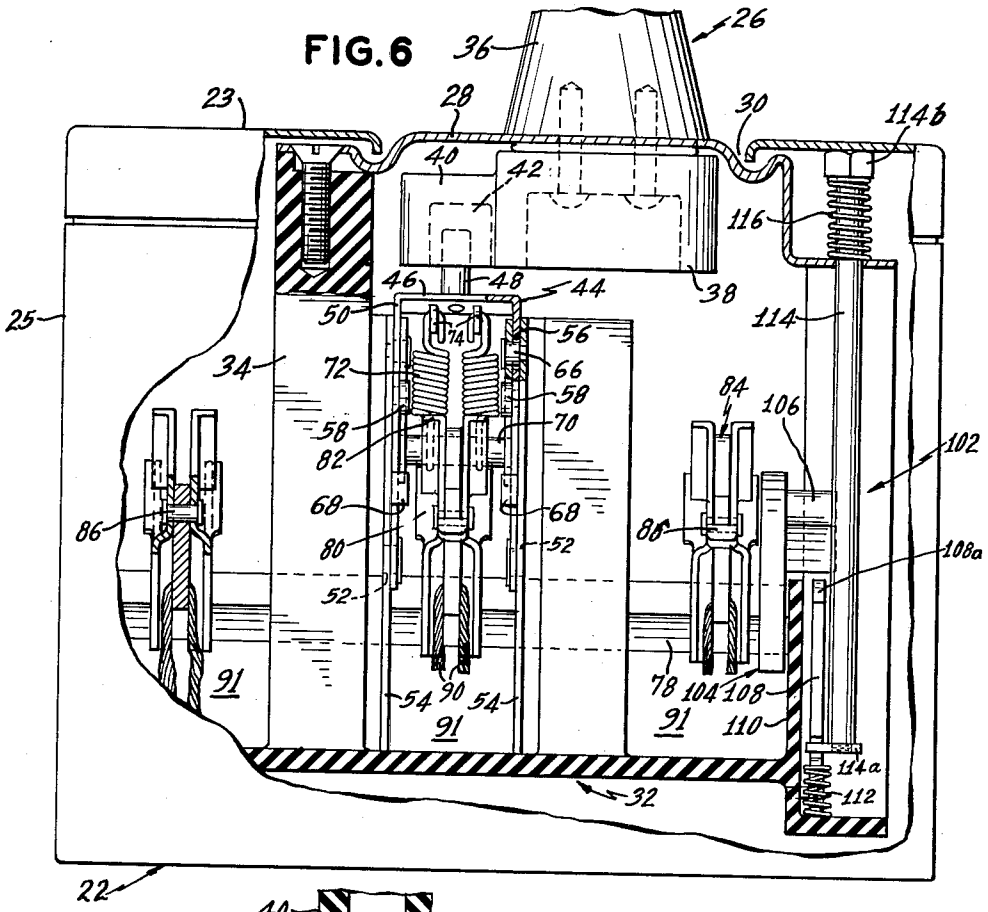
INVENTOR.
ALEXANDER R. NORDEN
BY Richard M. Rabkin
ATTORNEY

July 27, 1965 A. R. NORDEN 3,197,582

ENCLOSED CIRCUIT INTERRUPTER

Filed July 30, 1962 3 Sheets-Sheet 3

FIG. 6



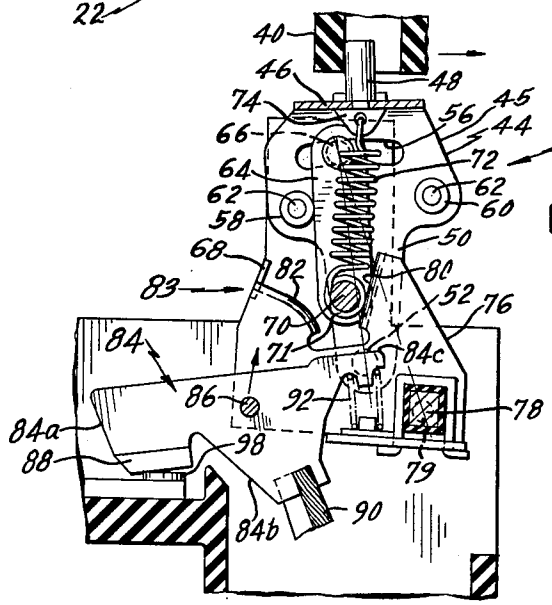


FIG. 7

INVENTOR.
ALEXANDER R. NORDEN
BY Richard M. Rakin
ATTORNEY

United States Patent Office

3,197,582
Patented July 27, 1965

1

3,197,582

ENCLOSED CIRCUIT INTERRUPTER

Alexander R. Norden, New York, N.Y., assignor to Federal Facific Electric Company, a corporation of Delaware

Filed July 30, 1962, Ser. No. 213,364
6 Claims. (Cl. 200—50)

The present invention relates generally to enclosed circuit interrupters having operating handles disposed externally of the enclosure and more particularly to the operating and interlocking mechanisms for such devices.

Overcentering mechanisms are used in circuit interrupters to give "snap" opening and closing of the contacts. In this type of mechanism a spring or set of springs connects the handle and an overcentering toggle linkage connected to the contact arms. The springs are used to operate the toggle linkage, in response to handle movements, to thereby control the movement of the switch contacts. On some occasions, the contacts of the switch may stick together forming what is known in the art as "stick welds." An object of this invention is to provide an interrupter having an improved handle operated overcentering mechanism for enabling the interrupter contacts to be opened in the event of contact-to-contact welds.

An additional problem encountered with the use of overcentering mechanism was the possibility of breakage of the overcentering springs or loss of spring tension for any reason. While such contingency is relatively remote, it is an important safety consideration that some positive means be provided for insuring opening of the contacts by operation of the handle without depending upon the springs. An object of this invention is to provide an interrupter having an improved overcentering mechanism which assures positive opening of the contacts.

Yet another object of the invention is the provision of an enclosed circuit interrupter having interlock means which is responsive to the position of the enclosure cover and which prevents closing of the contacts when the cover of the enclosure is open.

The above and other objects and advantages are achieved in an illustrative embodiment of the invention described in detail below with reference to the accompanying drawings. In those drawings:

FIG. 1 is a plan view of an enclosed circuit interrupter with the enclosure door in the closed position;

FIG. 2 is a side elevation of the apparatus of FIG. 1, with the enclosure door open, in partial section and with some parts broken away, showing the enclosure cover interlocking mechanism in its operative position;

FIG. 3 is a fragmentary side elevation of the contact operating mechanism of the circuit interrupter, on an enlarged scale, in the contact "open" position;

FIG. 4 is a view similar to FIG. 3 showing the mechanism partially operated in the "on" direction;

FIG. 5 is a view similar to FIG. 3 showing the mechanism in the full "on" or contact "closed" position;

FIG. 6 is an end view of the apparatus of FIG. 2, with the enclosure door closed, as viewed in the direction of the arrow 6 in FIG. 2, in partial section and with some parts broken away for simplicity and clarity; and,

FIG. 7 is a view similar to FIG. 3 showing the operation of the positive drive mechanism in assisting the separation of the contacts.

Referring now to the drawings, a switch 20, as one

2

form of circuit interrupter, is shown mounted in a metal enclosure 22 having a cover 23 connected by a hinge 24 to the enclosure body 25. Operating handle 26 and a portion of the upper cover plate 28 of the switch 20 are disposed within the access opening 30 provided in the cover.

Switch 20 is provided with a base of insulation 32 which has upstanding walls 34 (only one shown) to which the cover plate 28 is secured. A two-part operating handle 26 is pivotally mounted on plate 28 and has a main hub 36 above the plate 28 and a secondary hub 38 below the plate. Lower hub 38 is provided with an offset portion 40 containing a recess 42. Referring to FIG. 3 switch 20 has operating means 44 which includes an operator 45 that is generally U-shaped (FIG. 6). The bight portion 46 of operator 45 has a central pin 48 secured thereto. Pin 48 cooperates with recess 42 to pivot the operator 45 in response to movement of handle 26. The operator has a pair of spaced legs 50 that are pivoted on pins 52 secured to the main switch frame 54, this being two metal plates fixed to base 32 (FIG. 6). Arcuate clearance slots 56 are formed in each of the legs 50 adjacent the bight portion 46. Two pairs of spaced, opposed rollers 58, 60 are mounted on each of the operator legs 50, by pins 62, between the pivots 52 and slots 56. The function of these rollers will be more fully explained later.

A link 64 is pivoted, adjacent each leg 50, on a pin 66 which passes through the arcuate slot 56 in the operator 44. The pins 66 are attached to the frame 54. The other ends of the links 64 are joined together by a stepped-diameter pin 70 which ties the links together and which has a larger diameter portion 71 that functions as a cam follower or driver, as will be explained later. Stops 68, to limit travel of the links 64 in the closed contact position, are formed on the frame 54. A pair of overcentering springs 72 (see FIG. 6) are fixed at one end to the narrow diameter portions of pin 70 and, at their other end, to a bracket 74 secured to the underside of bight 46 of the operator 45. The bracket end of the springs 72 is above the pivots 66 of the links 64. The extremities of the springs 72 define the line of action of the springs.

Contact arm carriers 76, one for each pole of the switch, are secured to insulated switch shaft 78 which is common to all poles. The operating mechanism 44 is at the center pole of the illustrative embodiment and the operating forces are transmitted to the outboard poles by shaft 78 which passes through the frame 54 and is journaled at 79 at each end in the insulated body 32 of the switch 20. The center pole contact arm carrier 76 (FIG. 6) is positioned between the legs 50 of the operator 45 and has a planar cam surface 80 and a curvilinear cam surface 82 (FIG. 3) for cooperation with the cam surface 71 of pin 70. Link 64 and carrier 76, pivoted at 66 and 79 respectively, form a toggle linkage 83. The toggle 83 has a knee which is a lost motion coupling formed by pin 70 and the carrier cam surfaces 80 and 82.

Each pole of the switch has a tri-furcated contact arm 84 which is pivoted at 86 on its contact arm carrier 76. Contact arm 84 has the movable contact 88 affixed to one leg 84*a* of the arm and has a connecting braid 90 secured to another leg 84*b*. The braid 90 and contact arm portion 84*b* are receivable in a recess 91 in the base 32 of the switch. Contact pressure is provided by overtravel spring 92 which reacts between the contact arm car-

rier 76 and leg 84c of the contact arm. The travel of the contact arm 84 relative to the contact arm carrier 76 in the open position is limited by the engagement of the carrier and a leg 84b of the contact arm as best seen in FIG. 3. The circuit through each pole of the switch 20, when the contacts are closed, is as follows; through connector 94 to conductor 96, stationary contact 98, movable contact 88, contact arm 84, braid 90, and lug 100 to which the external connection may be made in conventional manner.

Contact position-responsive interlock means 102 are provided to prevent closing of the contacts when the enclosure cover 23 is open. The interlock 102 includes an arm 104 of insulation, secured to the switch shaft 78 to which the contact arm carrier 76 are attached. Referring to FIGS. 2 and 6, arm 104 has a projection 106 which extends laterally through an aperture in the interior wall 110 of the base 32. The projection 106 has a flat under surface 106a which cooperates with a stop or cam member 108 pivoted at 111 on an interior wall 110. Stop 108 has an end surface 108a which engages the arm surface 106a when the interlock is actuated. Stop 108 is resiliently urged in the arm 104 engaging direction by spring 112. Stop actuator 114 is mounted for reciprocating movement along wall 110 and is biased upwardly in FIG. 2, in the cover 23 engaging direction, by spring 116. The lower end of the actuator 114 carries a flat member 114a that is between opposed arms 108b and 108c of the stop. Arm 108b has a rounded projection 108d against which the actuator member 114a presses. The upper end 114b of the actuator is adapted to engage the cover 23 as in FIG. 6. When the cover is closed, actuator 114 is depressed causing stop 108 to be pivoted to a non-interfering position (shown in dotted lines in FIG. 2) from the arm engaging position (shown in solid lines in FIG. 2) wherein it interferes with rotation of the switch shaft 78 to the contact closed position. The positive drive feature of the overcentering mechanism, to be described below, acts only in the contact-opening direction and accordingly does not conflict with the operation of this interlock mechanism.

Having described the embodiment of the invention illustrated in the drawings, a description of the operation thereof follows. Before the circuit interrupter 20 may be shifted from a contact "open" to a contact "closed" position, it is necessary for the cover 23 to be closed to deactivate the interlock 102. When the cover is closed the actuator 114 pivots stop 108 to a non-obstructing position clear of the arm projection 106 as shown in dotted lines in FIG. 2.

Referring now to FIG. 3, the interrupter 20 is shown in the contact "open" position. When handle 26 is rotated the operating means 44 is actuated and operator 45 pivots to the left. Rollers 60 on the operator 45, which act against links 64 in the contact closing direction, may be called "contact-closing" rollers. These rollers are driven against the links 64 and assist the overcentering springs 72 in driving the knee pin 70 of the toggle 83 in the toggle erecting direction. In FIG. 4 the links 64 have been swung from their rest position (FIG. 3) and have been shifted nearly into line with the line of action of the springs 72. During this motion, springs 72 are stretched, and thus develop stored energy that is later released to close the contacts. Continued pivotal movement of the operator in the contact closing direction brings the upper end of the overcentering springs 72 across the line of centers 66, 70 of the toggle link 64. When the upper ends of the springs have passed overcenter sufficiently, the knee pin 70 leaves the planar surfaces 80 and crosses to the curvilinear surfaces 82. The links 64 continue moving along cam surfaces 82 with a snap action under the force of the springs 72. The force of the springs 72 drives the pin 70 along the cam surfaces 82 accelerating the contact carrier 76 and contact arms 84 in the contact closing direction. Springs 92 that provide contact pressure are compressed during the contact-closing motion of links 64 and contact carrier 76. The contour of cam surfaces 82 in relation to links 64 provides mechanical advantage after initial contact engagement, producing progressive compression of the contact pressure springs 92. In FIG. 5, which shows the fully "closed" position, the links 64 are substantially normal to the portion of cam surfaces 82 which they engage. Further travel of links 64 is prevented by interposed stops 68. The position of links 64 normal to the curvilinear surfaces 82 maintains the contact carriers 76 locked in the "on" position. Springs 72 provide clockwise bias holding links 64 against stops 68, thus holding the links 64 in their locking position.

To open the contacts the handle is driven from the "on" position toward the "off" position, in the direction of the arrow near part 40 in FIG. 5. Operator 45 is pivoted to the right from its position in FIG. 5. Rollers 58 bear against the links 64 to shift the links 64 toward alignment with springs 72. As this occurs, the upper ends of springs 72 are shifted toward pivots 66 of links 64 and, in this motion, the tension in springs 72 is increased Continued movement of the handle brings the upper ends of springs 72 overcenter. Links 64 are then carried overcenter of the centers 66, 70 and knee pin 70 is driven sharply against the planar surfaces 80 thus driving the contact carriers 76 to the open position with a snap-action. At the completion of this stroke, links 64 are biased against rollers 60 and in this position links 64 are normal to the cam surfaces 80 of the contact carrier 76. This locks the contact carriers in the open position. The limiting position of stop rollers 60 is reached when rollers 58 engage the opposite edges of links 64.

In the event that the overcentering springs 72 should be weakened, break or become disabled for some reason while the contacts are closed, or if a "stick weld" condition of the contacts should develop, it is still possible, in the illustrative embodiment, to open the contacts. Movement of the operator 45 in the opening direction drives the rollers 58 against the links 64 (FIG. 7) and moves the pin 70 clear of the cam surfaces 82. When the carriers are retained in the "on" position because of contact-to-contact welding, the pin 70 may be driven directly against the planar surface 80 of the contact arm carrier means 76. Because of the positive mechanical connection, sufficient force to break the weld and to return the contact arm to the open position is developed without dependence on the springs.

It was noted that roller 60 helps to bring the springs and links 64 into alignment in a contact-closing operation of the handle. It would not be necessary for roller 60 to be movably supported on operator 45 if its only function were to act as a stop. In that event it would be possible to rely solely on the operator 45 to shift the upper ends of springs 72 past the line of centers 66, 70 of link 64. However, such an arrangement would compel considerably greater elongation of the springs which might then be stressed excessively. The fact that roller 60 carries links 64 to the left (FIG. 3) as the springs are shifted toward their overcentering relationship to links 64 greatly simplifies the service requirement of the springs. The foregoing analysis is pertinent in connection with the action of roller 58 in shifting links 64 into line with the springs as the springs are being stressed by initial return movement of the operator 45 in the "off" direction.

When the cover is open (FIG. 2), the end 108a of stop 108 projects beneath the projection 106 and prevents movement of switch shaft 78 beyond the position shown in phantom in FIG. 2. When the shaft 78 is arrested the contacts are positively prevented from closing. However, the operator 45 is free to move to the "on" position by virtue of its spring coupling to the switch shaft 78. The spring connection between the handle 26 and the link 64 does not function as an over-centering

mechanism when the switch shaft is obstructed. Instead, springs 72 return the handle 26 to its "off" position, when released.

The above described embodiment of the invention fulfills the objects with the provision of a relatively simple structure capable of repeated operations with a high degree of reliability and safety for the operating personnel.

It will be apparent that the mechanism described above, while being the presently preferred embodiment of the invention, is subject to a wide latitude of modification and varied applications by those skilled in the art, so that this invention should be construed in accordance with its full spirit and scope.

What I claim is:

1. Enclosed switching apparatus having an enclosure, a door hingedly mounted on said enclosure, switching apparatus mounted in said enclosure, said apparatus being operable with said enclosure door closed, said apparatus including a movable contact and a stationary contact, a switch shaft pivoted in said apparatus, said movable contact being carried by said shaft, manual operating means forming part of said switching apparatus and being movable between "on" and "off" positions for moving said switch shaft between open and closed contact positions, said operating means including a manual operator fixed to said switching apparatus and overcentering spring means operatively connected to said shaft, and interlocking means engageable with said shaft, said interlocking means being responsive to the position of said enclosure door to obstruct movement of said shaft in the contact closing direction when said enclosure door is open, so that the operator may be manipulated to the "on" position against the bias of said spring means despite obstruction of the switch shaft.

2. Apparatus according to claim 1 wherein said interlocking means includes a cam member secured to said switch shaft, a pivoted stop member resiliently urged into engagement with said cam member to obstruct movement of said shaft in the circuit closing direction, door position sensing means including a rod mounted for movement between an extended position and a retracted position, said rod being adapted to engage said door at one end and to engage said pivoted stop member at the other, and means resiliently urging said rod to its extended position, said rod being driven into its retracted position by the door in its closed position and thereby pivoting said stop member clear of said cam member on said switch shaft to allow movement of said contacts in the circuit closed direction.

3. Enclosed switching apparatus having an enclosure, a door hingedly mounted on said enclosure, switching apparatus mounted in said enclosure, said apparatus being operable with said enclosure door closed, said apparatus including a movable contact and a stationary contact, a switch shaft pivoted in said apparatus, said movable contact being carried by said shaft, manual operating means forming part of said switching and being movable between "on" and "off" positions for moving said switch shaft between open and closed contact positions, said operating means including a manual operator fixed to said switching apparatus and overcentering spring means operatively connected to said shaft, and interlocking means engageable with said shaft, said interlocking means being responsive to the position of said enclosure door to obstruct movement of said shaft in the contact closing direction when said enclosure door is open, so that the operator may be manipulated to the "on" position despite obstruction of the switch shaft, said spring means being arranged to bias the manual operator away from the "on" position when the switch shaft is obstructed.

4. Switching apparatus including a movable contact arm, a companion contact engaged thereby in the closed condition of the switching apparatus, and mechanism for

operating said movable contact arm to effect quick closing and quick opening of the contacts, said mechanism including a two-part cam operably connected to said contact arm, a link having a fixed pivot at one end and having an active opposite end, an operator movable relative to said fixed pivot and reversely operable in contact-closing and contact-opening strokes, an overcentering spring connected at its extremities to said operator and to said active end of the link, respectively, said operator being arranged to shift the spring across said fixed pivot reciprocably for effecting quick overcentered strokes of the link in response to said strokes of the operator, and said link being arranged to cooperate successively with the two parts of said cam in each stroke of overcentered operation of the link and having a range of lost-motion between separation of the link from one part of the cam and engagement with the other during each stroke of overcentered operation of the link, stop means limiting the positions of said link at each end of the stroke thereof, said parts of said cam having surface portions engaged by said link, said cam surface portions diverging toward said fixed pivot of said link, said parts of said cam having portions engaged by said link in said end positions which cam portions are substantially transverse to a line between the pivot of the link and the engaged part of the link for locking the link against any operating effect by said cam and thereby locking the contact arm.

5. A circuit interrupter including a movable contact, a companion contact engaged thereby in the closed condition of the circuit interrupter, mechanism for operating said movable contact to effect quick closing and quick opening of the contacts, said mechanism including a link having a fixed pivot at one end and having an active opposite end, an operator movable relative to said fixed pivot and reversely operable in contact-closing and contact-opening strokes, an overcentering spring connected at its extremities to said operator and to said active end of the link, respectively, said extremities defining the line of action of said spring, said operator being arranged to shift its end of the spring across said fixed pivot reciprocably, a contact-carrier for said movable contact, a cam fixed to said contact carrier and engageable by said link upon overcentering of the spring relative thereto for driving the contacts open and closed, and stop means for limiting the travel of said link in the contact opening stroke, said cam having a contour that is transverse to said link when the link is arrested by said stop means so as to lock the contact carrier at the end of said contact opening stroke.

6. Switching apparatus including a movable contact arm, a companion contact engaged thereby in the closed condition of the switching apparatus, resilient means for providing contact pressure when said switching apparatus is in its closed circuit condition, and mechanism for operating said movable contact arm to effect quick closing and quick opening of the contacts, said mechanism including cam means operably connected to said contact arm, a first portion of said cam means being employed in closing said contacts and a second portion of said cam means being employed in opening said contacts, a link having a fixed pivot at one end and having an active end for engaging said portions of said cam means, said first portion of said cam means having a substantially curvilinear surface along which said active end of said link travels from a point of initial contact to an end point, said second portion of said cam means having a substantially planar surface along which said active end of said link travels from the point of initial contact to an end point, the tangent to said surface of said first portion at said end point forming an acute angle with the tangent to said cam surface of said second portion, said link being substantially perpendicular to the engaged cam surface at both said end points, an operator movable relative to said fixed pivot and reversely oper-

able in contact-closing and contact-opening strokes, an overcentering spring connected at its extremities to said operator and to said active end of the link, respectively, said operator being arranged to shift the spring across said fixed pivot reciprocably for effecting quick overcentered strokes of the link in response to said strokes of the operator, and said link being arranged to cooperate successively with said first portion and said second portion of said cam means in each stroke of overcenter operation of the link and having a range of lost-motion between separation of the link from one portion of the cam and engagement with the other during each stroke of overcentered operation, said link and said cam means

cooperating at both said end points to lock said contact arm against movement.

References Cited by the Examiner

UNITED STATES PATENTS

2,442,464	6/44	Link	200—116
2,468,645	4/49	Steinmayer	340—222
2,937,254	2/57	Ericson	200—114

FOREIGN PATENTS

192,280	2/23	Great Britain.
734,845	8/55	Great Britain.

BERNARD A. GILHEANY, *Primary Examiner.*