Dec. 31, 1963 S. I. LINDELL ETAL 3,116,391

HIGH VOLTAGE SWITCH HAVING LATCH OPERATED CURRENT INTERRUPTING MEANS

Filed Feb. 8, 1962 8 Sheets-Sheet 1

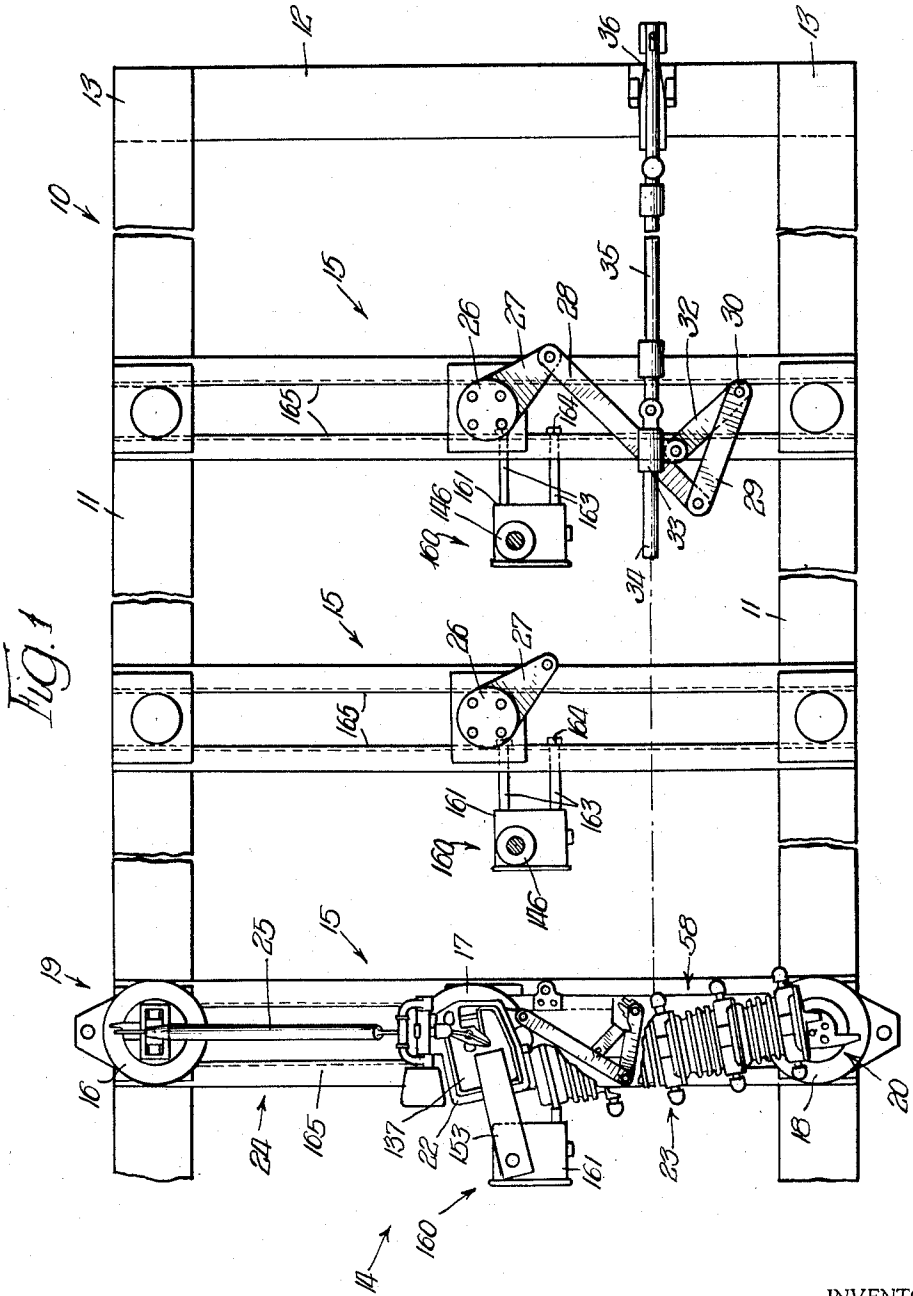


Fig. 1

INVENTORS.
Sigurd I. Lindell,
Leonard V. Chabala,
BY Robert R. Lockwood
Atty.

Dec. 31, 1963 S. I. LINDELL ETAL 3,116,391

HIGH VOLTAGE SWITCH HAVING LATCH OPERATED CURRENT INTERRUPTING MEANS

Filed Feb. 8, 1962 8 Sheets-Sheet 2

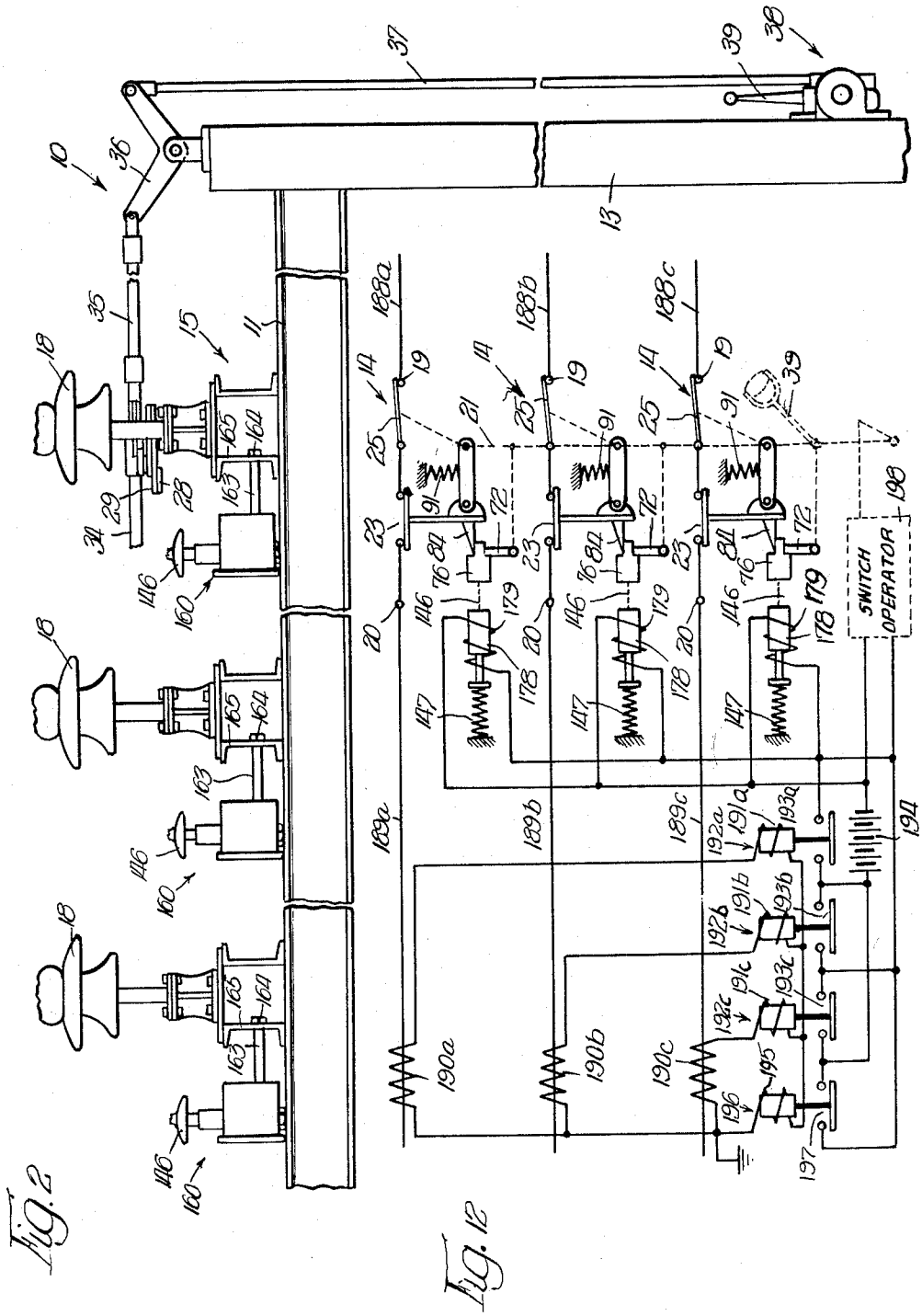
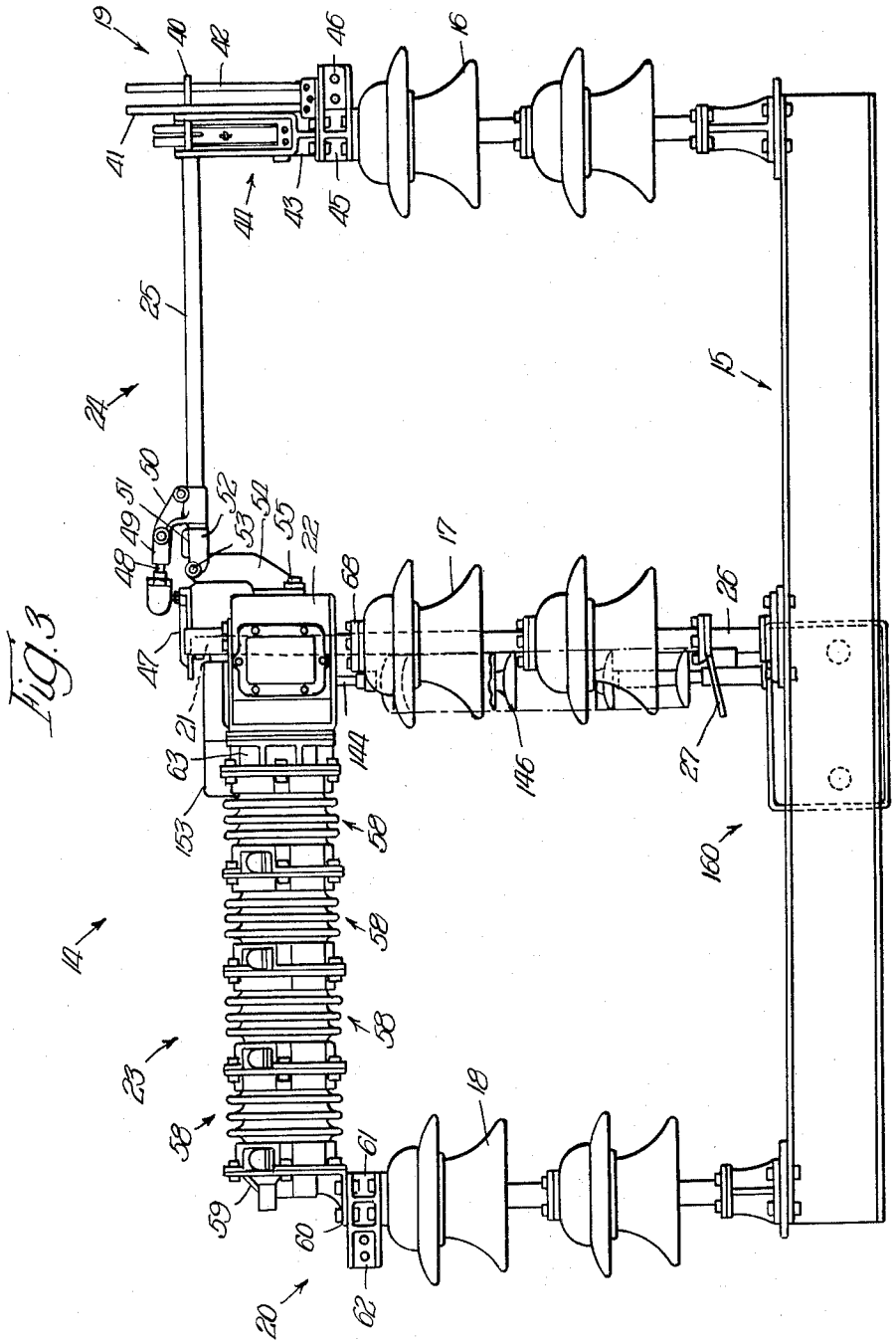


Fig. 2

Fig. 12

Fig. 3


19
40
42
46
16
41
44
43
45
25
24
15
50
51
52
49
48
53
54
55
22
17
68
26
47
21
63
144
146
27
153
58
160
14
58
58
23
18
58
61
59
60
62
20

Dec. 31, 1963 S. I. LINDELL ETAL 3,116,391
HIGH VOLTAGE SWITCH HAVING LATCH OPERATED CURRENT INTERRUPTING MEANS
Filed Feb. 8, 1962 8 Sheets-Sheet 4

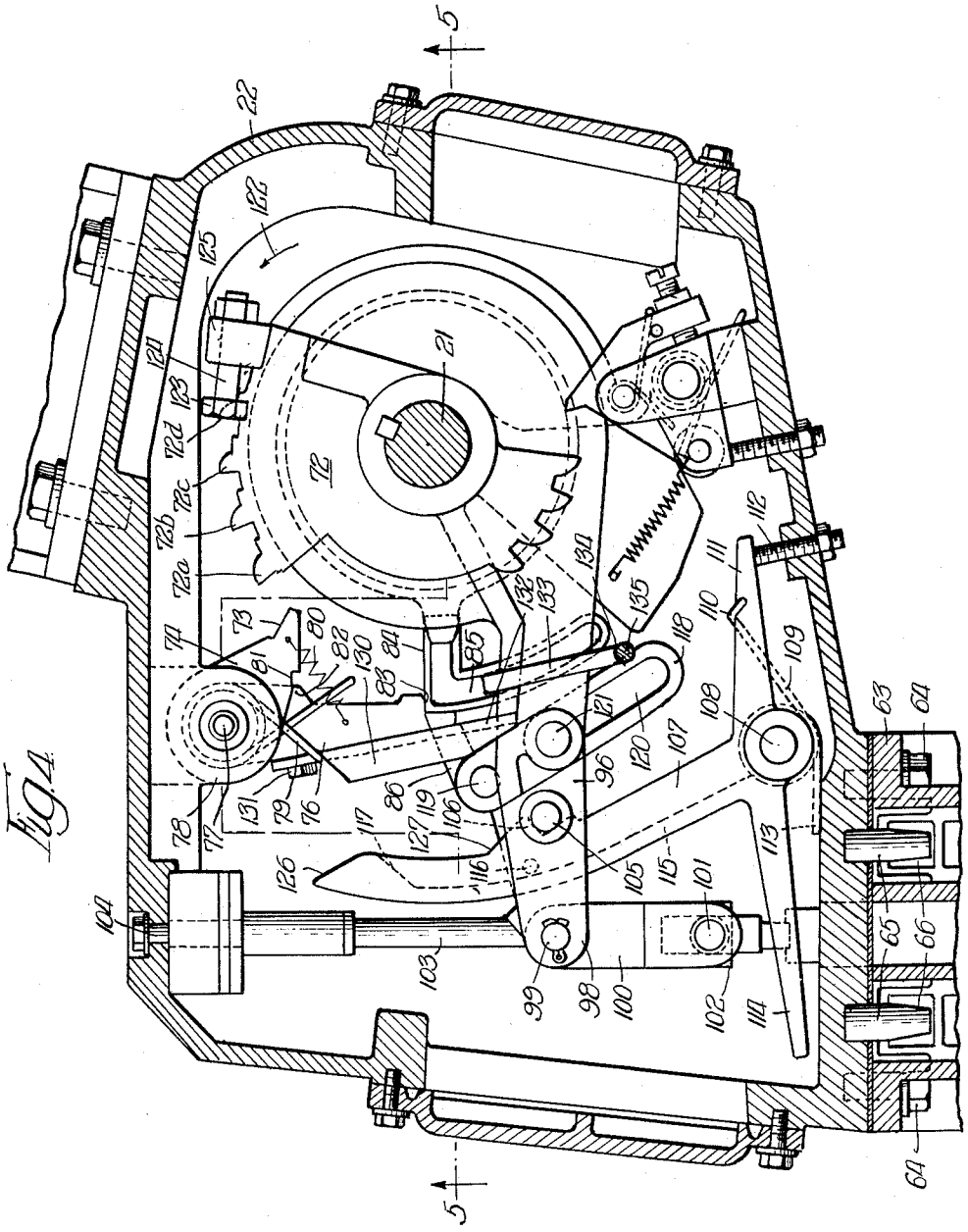


Fig 4

Dec. 31, 1963 S. I. LINDELL ETAL 3,116,391

HIGH VOLTAGE SWITCH HAVING LATCH OPERATED CURRENT INTERRUPTING MEANS

Filed Feb. 8, 1962 8 Sheets-Sheet 5

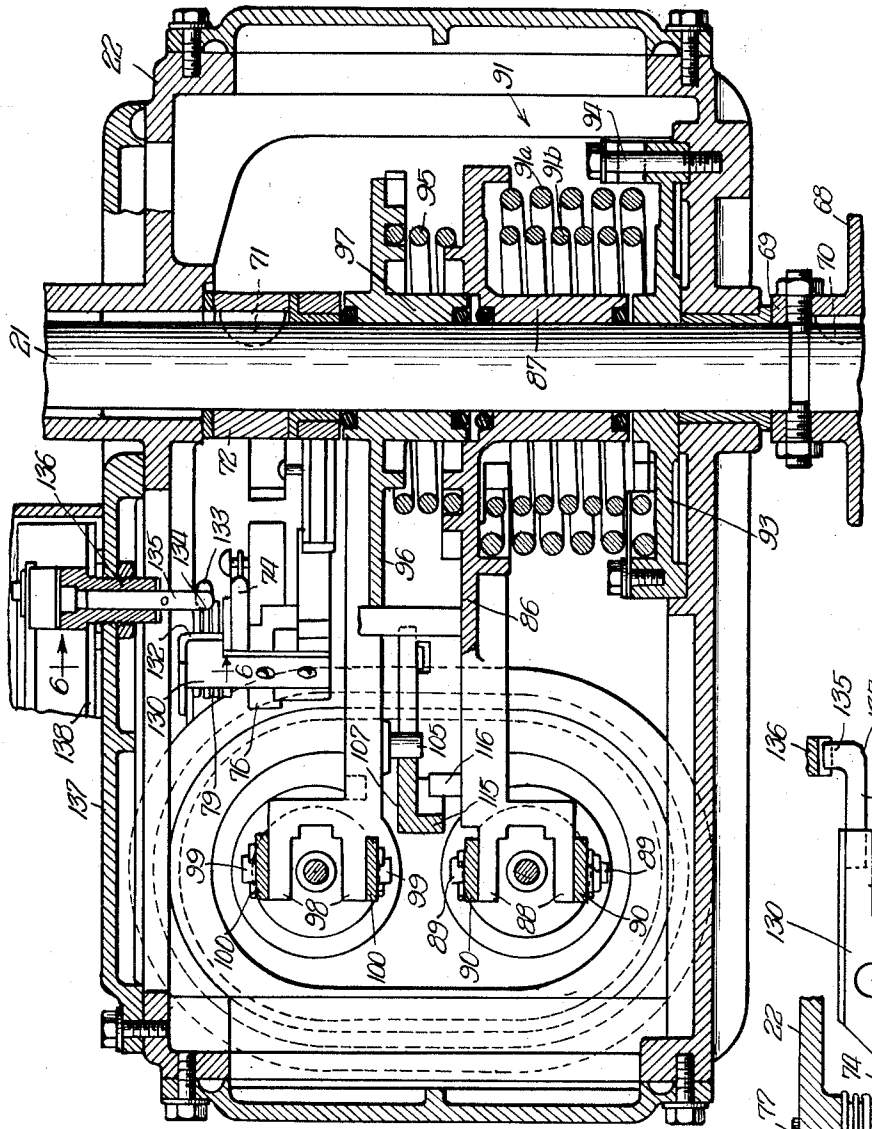


Fig. 5

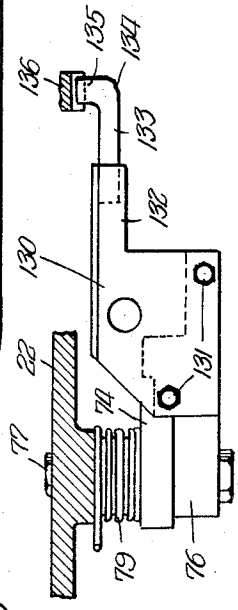


Fig. 6

Dec. 31, 1963 S. I. LINDELL ETAL 3,116,391

HIGH VOLTAGE SWITCH HAVING LATCH OPERATED CURRENT INTERRUPTING MEANS

Filed Feb. 8, 1962 8 Sheets-Sheet 6

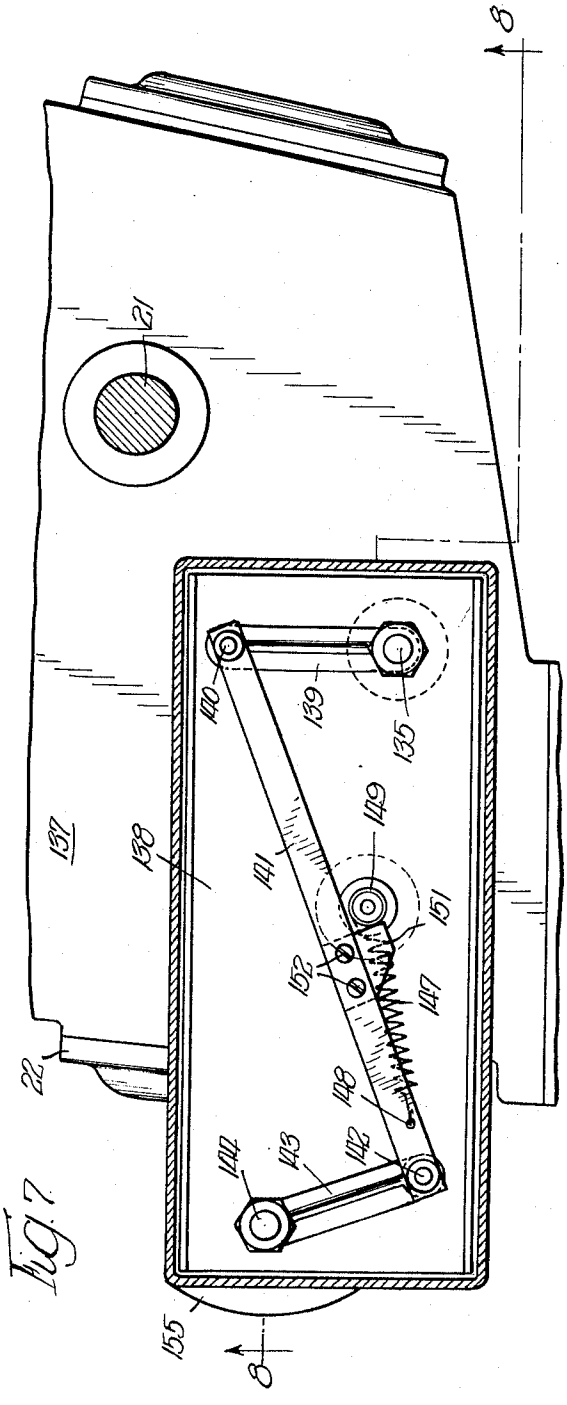


Fig. 7

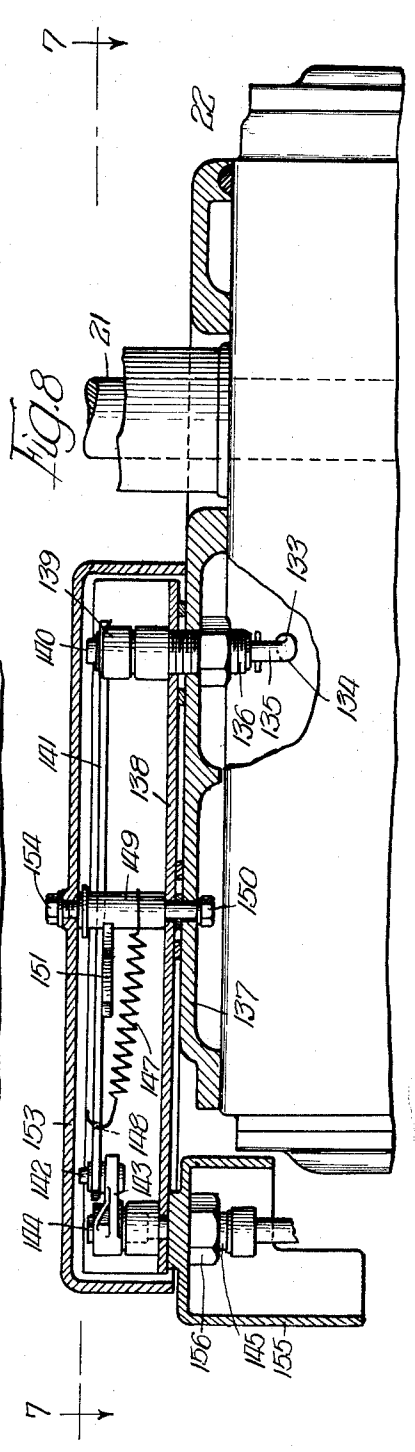


Fig. 8

Dec. 31, 1963 S. I. LINDELL ETAL 3,116,391

HIGH VOLTAGE SWITCH HAVING LATCH OPERATED CURRENT INTERRUPTING MEANS

Filed Feb. 8, 1962 8 Sheets-Sheet 7

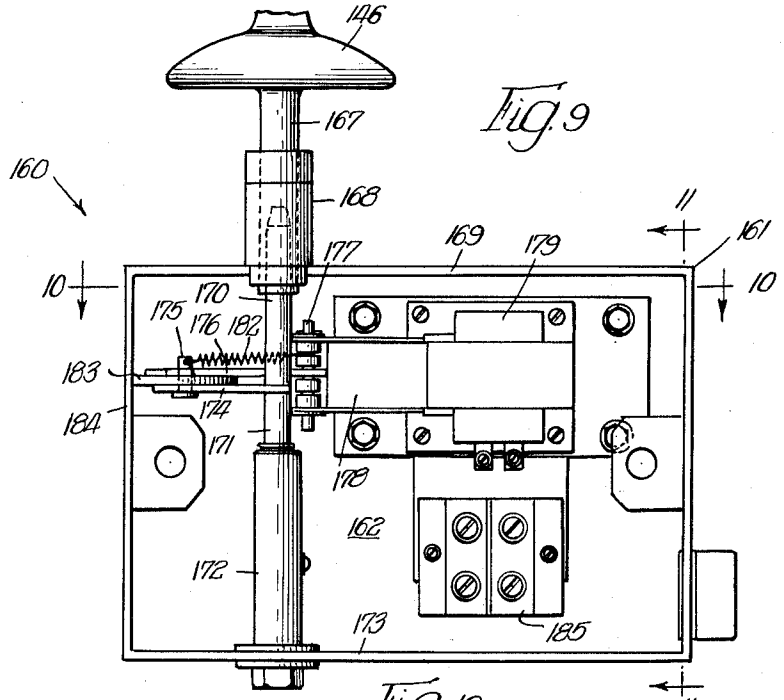


Fig. 9

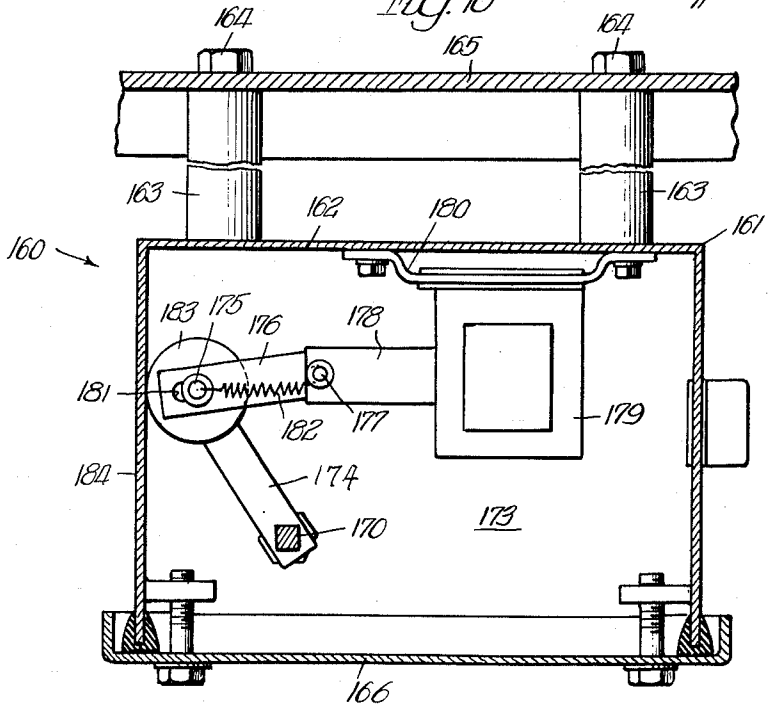
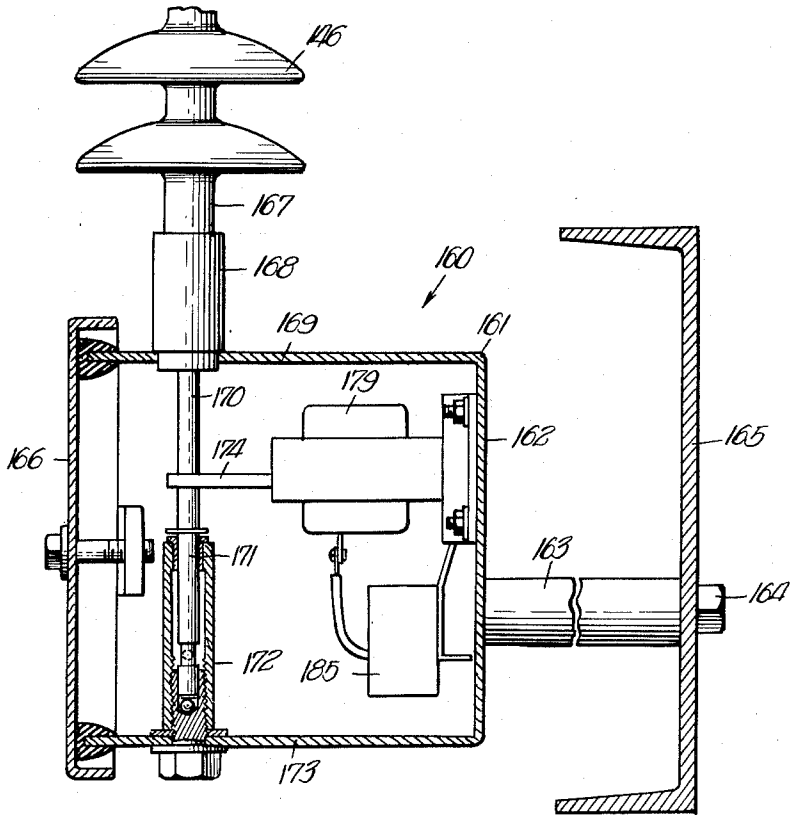


Fig. 10

Dec. 31, 1963 S. I. LINDELL ETAL 3,116,391
HIGH VOLTAGE SWITCH HAVING LATCH OPERATED CURRENT INTERRUPTING MEANS
Filed Feb. 8, 1962 8 Sheets-Sheet 8

Fig. 11



United States Patent Office 3,116,391 Patented Dec. 31, 1963

3,116,391

HIGH VOLTAGE SWITCH HAVING LATCH OPERATED CURRENT INTERRUPTING MEANS

Sigurd I. Lindell, Chicago, and Leonard V. Chabala, Maywood, Ill., assignors to S & C Electric Company, Chicago, Ill., a corporation of Delaware

Filed Feb. 8, 1962, Ser. No. 172,017
13 Claims. (Cl. 200—146)

This invention relates, generally, to the construction of high voltage circuit interrupters and it has particular relation to load break disconnecting switches. It constitutes an improvement over the invention disclosed in Gussow et al., U.S. Patent No. 3,030,481, issued April 17, 1962.

The load break disconnecting switch disclosed in the above identified application employs load interrupter contacts in series wtih a disconnecting switch blade of the beaver tail type. In the circuit closed position the interrupter contacts are held by a latch against opening movement under the influence of a spring which is fully stressed. The circuit is opened by rotating the beaver tail switch blade out of high pressure contact engagement with a line contact member and, while the circuit is still completed through the switch blade, tripping the latch to release the spring and open the interrupter contacts to effect interruption of the circuit. Subsequently the switch blade is swung to the open position while the contacts of the load interrupter are reclosed and their operating spring is recocked and latched. The foregoing operations are effected by rotating an insulator which forms a part of the insulating support structure for the switch. Such a rotating insulator necessarily is relatively large in order to be capable of transmitting the required operating torque and, because of its mass, has a relatively high inertia and a correspondingly slow speed of rotation with limited available driving torque.

Under certain operating conditions it is desirable to open the contacts of the load interrupter promptly and without requiring that the normal sequence of operations, above outlined, which requires an appreciable time, be followed. In accordance with this invention provision is made for over-reaching the normal operating mechanism and particularly the relavitely slowly rotatable insulator by employing a relatively low inertia and correspondingly high speed operating means for tripping the latch to open the contacts of the load interrupted. Thereafter, the switch blade is opened, the interrupter contacts are reclosed and the spring is recocked.

Such prompt action in the opening of the contacts of the load interrupter is employed for purposes of coordination with other interrupting devices when the circuit is subjected to the flow of fault current within the interrupting capabilities of the load interruper and the interrupter contacts are opened to clear the fault without waiting for the normal operating sequence to be accomplished including opening of the switch blade by rotating the insulator of relatively large mass in the usual manner. Another illustration of prompt action is involved when the operation of the load break disconnecting switch is coordinated with the operation of a high speed reclosing circuit breaker at fault current levels above the interrupting capability of the load interrupter and the interrupter contacts are promptly opened after the circuit breaker has interrupted the circuit and before it has reclosed, this being followed by opening of the switch blade in the usual manner. The switch blade, in open position, inserts in the circuit a fixed gap and permits reclosure of the interrupter contacts and subsequent completion of the circuit by reclosure of the switch blade.

Accordingly, among the objects of this invention are: To provide for unlatching the interrupter contacts of a

load break disconnecting switch for movement to open position under the influence of a previously cocked spring without requiring that the normal operating sequence for opening the switch be followed; to employ separate trip means for this purpose; to move the latch normally holding the interrupter contacts closed to the unlatched position by means operating independently of the switch operating means without interfering with the normal swich operation and permitting the remainder of the switch opening sequence to be accomplished followed by normal reclosure of the switch; to unlatch the contacts through a sequence of operations initiated at ground potential in response to the occurrence of certain operating conditions at high potential; to unlatch the contacts through the operation of an auxiliary rotatable insulator paralleling the rotatable insulator normally used for operating the switch; to rotate the auxiliary insulator by means located at ground potential in response to the occurrence of certain operating conditions, such as a predetermined overload on the circuit in which the switch is connected; to employ electromagnetic means for rotating the auxiliary insulator; to effect the energization of the electromagnetic means as a result of predetermined current flow in the circuit in which the switch is connected; to restore automatically the auxiliary tripping mechanism on deenergization of the electromagnetic means; and to initiate simultaneously the operation of the normal switch operating mechanism and the auxiliary trip mechanism in response to predetermined overcurrent conditions in the circuit in which the switch is connected to the end that the interrupter contacts are opened after a minimum time followed by the usual opening sequence of operations including opening of the switch blade.

In the drawings:

FIG. 1 is a top plan view showing how the switch means disclosed in the application above referred to can have embodied therewith the auxiliary or shunt trip mechanism of the present invention.

FIG. 2 is a view, in side elevation, of the structure shown in FIG. 1, only portions of the nearest insulators being shown.

FIG. 3 is a view, in side elevation, of one pole of the polyphase switch construction illustrated in FIGS. 1 and 2 and showing how the auxiliary or shunt trip mechanism of the present invention is applied thereto through the cover of the mechanism housing.

FIG. 4 is a top plan view of the operating mechanism for one pole of the three phase installation, the cover for the housing having been removed, the parts being shown in the positions corresponding to the closed position of the switch blade with the contacts of the load interrupter in closed position, the operating spring mechanism cocked, and the latch mechanism modified for auxiliary or shunt trip operation.

FIG. 5 is a vertical sectional view taken generally along the line 5—5 of FIG. 4.

FIG. 6 is a vertical sectional view taken generally along the line 6—6 of FIG. 5 and showing certain details of construction of the main latch and the manner in which it is modified for auxiliary or shunt trip operation in accordance with this invention.

FIG. 7 is a horizontal sectional view taken generally along the line 7—7 of FIG. 8 and showing the linkage which forms a part of the auxiliary or shunt trip mechanism that is mounted on the cover of the mechanism housing.

FIG. 8 is a vertical sectional view taken generally along the line 8—8 of FIG. 7.

FIG. 9 is a front elevational view of the auxiliary or shunt trip operating mechanism, the cover having been removed.

FIG. 10 is a horizontal sectional view taken generally along the line 10—10 of FIG. 9.

FIG. 11 is a vertical sectional view taken generally along the line 11—11 of FIG. 9.

FIG. 12 illustrates, diagrammatically, the application of the present invention to a conventional polyphase high voltage transmission system having a grounded neutral.

Reference will be had first to FIGS. 1, 2 and 3 of the drawings. The reference character 10 designates, generally, a switch support structure which may include longitudinal members 11, cross members 12 (only one being shown) and vertical members 13 all of which constitute a suitable support for gang operated switch means such as the switch means, shown generally at 14, described in detail in the application above referred to and modified in accordance with the present invention.

It will be understood that the invention is employed in conjunction with a high voltage three phase alternating current power distribtuion system. For illustrative purposes it is pointed out that the system may be operated at a voltage of 69 kv. However, other voltages can be used with appropriate changes in design as will be understood readily.

Each switch means 14 for each phase includes a base, shown generally at 15, which may comprise a pair of spaced rolled steel channels in back to back relation. They are supported at their ends on the longitudinal members 11. It will be understood that the spacing between the bases 15 depends upon the voltage of the system. First, second and third insulators 16, 17 and 18 are mounted on the base for each switch means 14. The first and third insulators 16 and 18 are stationary while the intermediate second insulator 17 is rotatably mounted. A line contact member, shown generally at 19, is stationarily mounted on the first insulator 16 of each switch means 14. A line terminal, shown generally at 20, is stationarily mounted on the third insulator 18 of each switch means 14. As pointed out hereinafter line conductors are connected to the line contact members 19 and to the line terminals 20 of the several switch means 14.

Rotatable with the second insulator 17 is an upstanding shaft 21 which projects upwardly through a metallic mechanism housing 22 that is held stationary with respect to the second insulator 17 and constitutes a terminal intermediate the line contact 19 and the line terminal 20. One end of a load current interrupter, shown generally at 23, is secured to one side of the housing 22 while its other end is secured to the line terminal 20. In series with the load current interrupter 23 is a disconnecting switch that is shown generally at 24. It includes a switch blade 25 which is rotatably mounted on the housing 22 and also is mounted to rotate about its longitudinal axis for high pressure contact engagement with the line contact member 19 which forms the stationary part of the disconnecting switch 24.

The switch means 14 is shown in the closed position in FIGS. 1 and 3 of the drawings. In this position the load current interrupter 23 is closed and the disconnecting switch 24 is closed. As disclosed in the application above referred to, provision is made for opening the circuit first by means of the load current interrupter 23. This is effected during the initial portion of the rotation of the second insulator 17 from a position corresponding to the switch closed position to its position which corresponds to the switch open position. When starting to open the switch means 14, rotation of the second insulator 17 through a small arc effects rotation of the switch blade 25 about its longitudinal axis but, before it separates from the line contact member 19, the circuit has been interrupted and current ceases to flow as a result of operation of the load current interrupter 23. On continued rotation of the second insulator 17, the switch blade 25 is swung to the open position which is slightly more than 90° away from the horizontal position shown in FIG. 3 of the drawings. During the movement of the switch blade 25 to the open position the spring, which is released

on initial movement of the second insulator 17 for operating the load current interrupter 23, is recocked and the contacts of the load current interrupter 23 are reclosed When the second insulator 17 is rotated in the opposite direction, the only function performed thereby is the swinging of the switch blade 25 from the vertical position to the horizontal switch closed position terminating in a rotation of the switch blade 25 about its longitudinal axis to move it into high pressure contact engagement with the line contact member 19. The circuit is completed between the switch blade 25 and the line contact member 19 since the load current interrupter 23 is closed previously as above noted.

In FIG. 1 it will be noted that a rotatable fitting 26 is provided on which each insulator 17 is carried and by means of which it is rotated to effect the sequence of operations involved in opening and closing the switch means 14. Extending from each rotatable fitting 26 is an arm 27 to the outer end of which one end of a link 28 is pivotally connected. The other end of the link 28 is pivotally connected to a link 29 which is secured to a shaft 30 that is journaled in a suitable bearing that is carried by the respective base 15, as described in the application above referred to. Also fastened to and rotatable with the shaft 30 is an arm 32 which is pivoted to a fitting 33 fast on an interphase rod 34 common to the three switch means 14. If desired, a separate operator can be provided for each switch means 14 and provision made for simultaneously energizing energizing them instead of employing the interphase rod 34 and a common operator, either manual or power driven.

Any suitable means can be employed for moving the interphase rod 34 from one position to the other in order to rotate the second insulator 17 between the closed and open positions. As shown, the interphase rod 34 is operated through the agency of a rod 35 which is pivotally connected to one arm of a bell crank 36 while the other end, as shown in FIG. 2, is connected by a vertical rod 37 to an operator, shown generally at 38, a description of which is set forth in the application above referred to. The operator 38 includes an operating handle 39 for manual operation by a lineman. Preferably, a power driven operator is employed for moving the vertical rod 37. For example, the motor mechanism shown in U.S. Patent No. 2,795,932, issued June 18, 1957, in the name of Carl T. McLuen, can be used.

As shown in FIG. 3 the line contact member 19 is arranged to cooperate with an arcing tip 40 at the distal end of the switch blade 25. The arcing tip 40 is arranged to make contact with staggered arcing horns 41 and 42 which extend upwardly from a base portion 43 that carries a contact housing member 44 which forms a part of the line contact member 19. The base portion 43 is mounted on an adapter 45 which, in turn, is mounted on the upper end of the first insulator 16. A terminal lug 46 extends from the adapter 45 to permit connection of a line conductor thereto.

Secured to and rotatable with the upper end of the shaft 21 which rotates with the second insulator 17, is a switch crank 47 that is connected to a link 48 terminating in a clevis 49 that is pivoted to an arm 50 which extends from and is clamped to the switch blade 25. The hinge end of the switch blade 25 is journaled in a bearing 51 that is carried by a blade carrier 52 which is pivoted at 53 to the upper end of a bracket 54 which is secured to the juxtaposed sides of the metallic mechanism housing 22 by bolts 55.

The load current interrupter 23 may comprise a plurality of interrupter units that are shown, generally at 58, and constructed as described in the application above referred to. The number of interrupter units 58 employed depends upon the voltage of the circuit in which the switch means 14 is connected. At one end the load current interrupter 23 is mounted on a terminal plate 59 which has a horizontal flange 60 at its lower side to facilitate mounting on an adapter 61 which is carried by the

upper end of the third insulator 18. A terminal lug 62 extends from the adapter 61 to permit connection of a line conductor thereto. At its other end the load current interrupter 23 is provided with a suitable adapter 63 to permit mounting on the juxtaposed end of the metallic mechanism housing 22.

The load current interrupter 23, as described in the application above referred to, is of the type which draws and extinguishes one or more arcs in air. For this purpose each of the interrupter units 58 is provided with a set of main separable contacts and a set of parallel auxiliary contacts with the respective main and auxiliary contacts of the interrupter units 58 being connected in series circuit relation and arranged for conjoint operation. The arrangement is such that the main contacts are opened first and the entire current flow is transferred to the auxiliary arcing contacts which, when they separate, draw and extinguish arcs to interrupt the flow of current. Any other suitable type of current interrupter can be employed. For example, the gas type circuit interrupter, shown in copending application Serial No. 111,998, filed May 23, 1961, in the names of John J. Mikos and Leonard V. Chabala and assigned to the assignee of this application, can be employed..

As shown in FIG. 4 the adapter 63 is secured to the mechanism housing 22 by suitable bolts 64. Electrical connection to the mechanism housing 22 is provided, in part, by outstanding contact plugs 65 which engage contact fingers 66.

Referring now particularly to FIG. 5 of the drawings, it will be noted that an insulator flange 68 is provided which, as shown in FIG. 3, is mounted on the upper end of the rotatable insulator 17. The insulator flange 68 has an upstanding sleeve 69 which is telescoped with the lower end of the shaft 21 and is non-rotatably secured thereto by a key 70. Near its upper end and within the mechanism housing 22 the shaft 21 is non-rotatably secured by a key 71 to a mechanism cam 72 that is shown in more detail in FIG. 4. As described in the application first above referred to the mechanism cam 72 is provided with trip detents 72*a*, 72*b*, 72*c* and 72*d*. One of these trip detents is arranged to engage a shoulder 73 on a latch arm 74 which is rotatably mounted together with a main latch 76 on a stud 77 which is carried by a boss 78 that is formed integrally with the mechanism housing 22. A spring 79 cooperates with the main latch 76 to bias it in a counterclockwise direction while a tension spring 80 reacts between the latch arm 74 and the main latch 76 to bias the former toward the latter. This arrangement provides a ratcheting effect to permit movement of the trip detents 72*a–d* past the shoulder 73 when the mechanism cam 73 is rotated in a clockwise or switch closing direction. The latch arm 74 has a shoulder 81 which engages a detent 82 on the main latch 76 to effect conjoint movement therewith in a clockwise direction on engagement of the shoulder 73 by any one of the trip detents 72*a–d*.

Near its outer end the main latch 76 has a shoulder 83 which engages a shoulder 84 on a detent 85 that extends upwardly from a main operating arm 86. As shown in FIG. 5 the main operating arm 86 has a hub portion 87 which is journaled on the shaft 21. At its outer end the main operating arm 86 has a bifurcated end portion 88 that is arranged to receive pins 89 for connection to links 90 which, as described in the application first above referred to, are connected to operate the main contacts of the load current interrupter 23 as an initial part of the opening of the circuit and transferring the current flow to the auxiliary arcing contacts.

The movement of the main operating arm 86 is effected by a main spring, shown generally at 91, which comprises an outer spring 91*a* and an inner spring 91*b*. At their upper ends the springs 91*a* and 91*b* are anchored to the under side of the main operating arm 86 while at their lower ends they are anchored to an adjustable operating spring base 93 that is held in the desired position by a bolt 94 to apply the desired pretensioning to the springs. Above the main operating arm 86 there is located a prestressed auxiliary spring 95. Its lower end is anchored to the upper side of the main operating arm 86 while its upper end is secured to the under side of an auxiliary operating arm 96 which has a hub portion 97 that is journaled on the shaft 21. The auxiliary operating arm 96 has an outer bifurcated end 98 through which pins 99 extend for connection to links 100 that are pivotally connected to trunnions 101 on a cross head 102 which is connected to operate the auxiliary arcing contacts of the load current interrupter 23 as described in the application first above referred to. The cross head 102 is guided for translatory movement within the mechanism housing 22 by a guide rod 103 that is secured at 104 to a side wall of the housing 22.

In order to hold the auxiliary operating arm 96 in the position shown in FIG. 4 of the drawings, corresponding to the closed positions of the main and auxiliary contacts in the load current interrupter 23, a pin 105 depends from the auxiliary operating arm 96 for engagement with a detent 106 of an auxiliary latch 107 which is rotatably mounted on a shaft 108 that is suitably journaled in the mechanism housing 22. A spring 109 acts to bias the auxiliary latch 107 to the position shown in FIG. 4 and to rock it in a clockwise direction to hold the detent 106 in the path of the depending pin 105 on the auxiliary operating arm 96. One end 110 of the spring 109 bears against a tail piece 111 that forms a part of the auxiliary latch 107 and serves to bias it against an adjusting screw 112 threaded in the adjacent side of the mechanism housing 22 and is employed for changing the position of the auxiliary latch 107 as may be required. The other end 113 of the spring 109 bears against the inner surface of the adjacent wall of the mechanism housing 22. A stop arm 114 is formed integrally with the auxiliary latch 107 to limit its movement in a counterclockwise direction when it is operated to the unlatched position.

Provision is made for swinging the auxiliary latch 107 to remove the detent 106 from the path of the pin 105. For this purpose a flange 115 depends from the auxiliary latch 107 to provide a track along which a pin 116 rides. The pin 116 is carried by the main operating arm 86, as shown in FIG. 5, and is arranged to ride over a cam portion 117 when the main operating arm 86 has been swung through a substantial portion of its opening movement to cause the auxiliary latch 107 to rock in a counterclockwise direction, FIG. 4, and moves the detent 106 out of the path of the pin 105. The prestressed auxiliary spring 95, which is further stressed by the movement of the main operating arm 86 to the position where the auxiliary latch 107 is operated, then is free to urge the auxiliary operating arm 96 in a clockwise direction, FIG. 4, to move the cross head 102 and therewith the movable auxiliary arcing contacts to the open position to effect interruption of the current flow.

In order to impart some of the kinetic energy of the main operating arm 86 and parts moving therewith to the auxiliary operating arm 96 a link 118 is pivoted at 119 to the main operating arm 86. The link 118 has a slot 120 through which a pin 121 carried by the auxiliary operating arm 96 projects. With this arrangement the auxiliary operating arm 96 and parts associated therewith are further accelerated when the outer end of the slot 120 picks up the pin 121 and effects conjoint movement of the auxiliary operating arm 96 with the main operating arm 86.

Provision is made, as described in the application first above referred to, for prying the main operating arm 86 and parts associated therewith from the fully closed position should they become frozen in this position. Since these pry out features per se form no part of the present

invention, reference can be had to the application first above referred to for a description thereof.

It will be recalled that the continued rotation of the shaft 21, after interruption of the flow of current by the current interrupter 23, effects the movement of the switch blade 25 to the open position. During the continued rotation of the shaft 21 in the direction indicated by the arrow 122, FIG. 4, for opening the switch blade 25, the main and auxiliary contacts of the current interrupter 23 are moved back to their closed positions and the springs 91*a* and 91*b* are recocked. This is accomplished through the agency of a detent 123 which forms the head of a bolt 124 that is carried by an extension or reclosing arm 125 which is formed integrally with the mechanism cam 72. During the continued rotation of the mechanism cam 72 in the direction indicated by the arrow 122, the detent 123 engages the shoulder 84 on the detent 85 which is carried by the main operating arm 86. Accordingly, the continued movement of the mechanism cam 72 and reclosing arm 125 in the closing direction effects rotation of the main operating arm 86 in a counterclockwise direction and therewith the auxiliary operating arm 96 since the pin 121 on the latter now engages the inner end of the slot 120 in the same relation as shown in FIG. 4. The movement continues until the main contacts and the auxiliary contacts in the current interrupter 23 are reclosed. Then the shoulder 83 on the main latch 76 is moved by the spring 79 into latching engagement with the shoulder 84. Since the springs 91*a* and 91*b* were recocked by the reverse rotation of the main operating arm 86, the main latch 76 then holds them in this condition and holds the main contacts of the current interrupter 23 in the closed positions. As the pin 116, carried by the main operating arm 86, rides over the beveled end surface 126 of the auxiliary latch 107, the latter is raised to permit the pin 116 to engage the under side of the flange 115. The continued movement of the auxiliary operating arm 96 brings the pin 105 carried thereby into engagement with the beveled approach surface 127 on the back side of the detent 106 and rotates it to permit engagement thereby with the pin 105 under the influence of the spring 109.

The switch blade 25 now is in the full open position while the main and auxiliary contacts of the current interrupter 23 are in the closed positions. When the switch blade 25 is to be reclosed, the shaft 21 is rotated in a clockwise direction as viewed in FIG. 4. During this reverse rotation of the shaft 21 only the switch blade 25 is moved to the switch closed position and the circuit is completed when its distal end makes contact with the line contact member 19 or more particularly when the arcing tip 40 engages the arcing horn 41.

It remains to describe how the main latch 76 is modified and provision made for operating it by an auxiliary or shunt trip mechanism for releasing the main operating arm 86 and auxiliary operating arm 96 for movement under the influence of the springs 91*a*, 91*b* and 95 without requiring rotation of the shaft 21 and of the mechanism cam 72.

Referring to FIGS. 4, 5 and 6 it will be observed that the main latch 76 has a latch extension 130 secured thereto by bolts 131. The latch extension 130 is in the form of a metal plate and it includes a lateral arm 132 that is arranged to be engaged by the distal end of a horizontal arm 133 that forms a part of a lever 134 which has a vertical arm 135 that is journaled in a bearing 136 which extends through a cover 137 that is removably mounted on the mechanism housing 22. Provision is made, as described hereinafter, for rotating the lever 134 and particularly the arm 133 in a counterclockwise direction, as viewed in FIG. 4, to engage the arm 132 on the latch extension 130 for the purpose of moving the shoulder 83 on the main latch 76 out of engagement with the shoulder 84 located on the detent 85 which is carried by the main operating arm 86. As soon as the main operating arm 86 is released, the springs 91*a* and 91*b* function in the manner described to rotate the main operating arm 86 and the auxiliary operating arm 96 for opening first and main contacts and next the auxiliary contacts of the current interrupter 23. This action takes place well in advance of the normal tripping action that is effected as a result of operating the interphase rod 34 to rotate the shaft 21 of each of the switch means 14 to cause the trip detent 72*a* on the mechanism cam 72 of the respective switch means to engage the shoulder 73 on the latch arm 74 and thereby effect operation of the current interrupter 23 in the manner described.

As illustrated in FIGS. 7 and 8 the bearing 136 extends through the cover 137 and through a base plate 138 mounted thereon and the vertical arm 135 has a radially extending arm 139 secured thereto for rotation therewith. The distal end of the arm 139 is pivoted at 140 to a link 141 which is pivoted at its other end at 142 to the distal end of an arm 143 which is secured to a shaft 144 that is journaled in a bearing 145 which extends downwardly through an overhanging end portion of the base plate 138. The shaft 144, as shown in FIG. 3, extends upwardly from a rotatable auxiliary elongated insulator 146 which extends parallel to the second rotatable insulator 17 for each of the switch means 14. Each of three mechanism housings 22 is modified in the manner described to provide the operating linkage on the cover 137 for connection to the rotatable auxiliary elongated insulator 146 associated therewith.

It will be noted that the rotatable auxiliary elongated insulator 146 is substantially smaller in diameter than the adjacent rotatable second insulator 17 although both are of the same length to provide the necessary insulation. For a 69 kv. installation the moment of inertia of the auxiliary insulator 146 was 0.037 inch pound second^2 while the moment of inertia of the adjacent rotatable insulator 17 was 6.67 inch pound second^2. The ratio of these moments of inertia is of the order of 1 to 180 and permits high speed tripping of the respective main latch 76 since the torque necessary to effect this operation is relatively small as compared to that required to be transmitted through the rotatable insulator 17 to perform the other functions incident to the opening and closing of the respective switch means 14.

In order to bias the lever 134 to the retracted position shown in FIGS. 4 and 5 of the drawings a coil tension spring 147 is employed. One end is connected at 148 to the link 141 adjacent the pivot 142. The other end of the spring 147 is anchored to a support post 149 that is secured by a bolt 150 in position on the base plate 138. It will be observed that the bolt 150 extends upwardly through the cover 137 and base plate 138 into the support post 149. Movement of the link 141 and thereby of the lever 134 to the retracted position is limited by a stop detent 151 that is secured by screws 152 to the underside of the link 141. The stop detent 151 is arranged to engage the support post 149 and to be held in this position by the spring 147. Overlying the linkage mounted on the base plate 138 is a linkage cover 153. It is secured in position by a bolt 154 that is threaded into the upper end of the support post 149. A weather shield 155 is supported on the bearing 145, as shown, and is held in place by a nut 156. The weather shield 155 overlies the upper end of the shaft 144 as shown in FIG. 8.

FIGS. 9, 10 and 11 illustrate, generally, at 160 an auxiliary or shunt trip operating mechanism which is employed for rotating the auxiliary elongated insulator 146. It includes a housing 161 having a rear wall 162 from which support posts 163 project. They are secured by bolts 164 to a base channel 165 which forms a part of the base 15. FIGS. 1 and 2 show how the auxiliary or shunt trip operating mechanisms 160 are mounted on the base channels 165 of the several bases 15. The open front of the housing 161 is closed by a removable cover 166.

The lowermost part of the auxiliary elongated insulator 146 is provided with a sleeve 167 which has an opening in its lower end of square cross section. The sleeve 167 extends downwardly through an upstanding sleeve 168 that is secured by suitable means to the top wall 169 of the housing 161. The lower end of the sleeve 167 non-rotatably telescopes with a square upper end 170 of a shaft 171 that is journaled, as shown more clearly in FIG. 11, in a bearing assembly 172 that is carried by the lower wall 173 of the housing 161. An arm 174 extends radially from the square upper end 170 of the shaft 171 and is pivotally connected at 175 to one end of a link 176 the other end of which is pivotally connected at 177 to an armature 178 that is arranged to be attracted by an energizing winding 179. The energizing winding 179 is mounted on a bracket 180 which is carried by the rear wall 162 of the housing 161. The link 176 has an elongated slot 181 to provide some lost motion between it and the arm 174 by permitting limited movement of the link 176 on energization of the winding 179 relative to the pivot 175. This arrangement facilitates breaking loose the auxiliary elongated insulator 146 and parts associated for movement therewith from restraint due to icing or corrosion products. A coil tension spring 182 extends between the pivotal connections 175 and 177 to hold the pivot 175 against one end of the slot 181. A washer 183 is carried by the pivot 175 to form a stop for limiting the reverse movement of the arm 174 by engagement with the side wall 184 of the housing 161. A terminal block 185, mounted on the rear wall 162, readily permits external connection to the energizing winding 179.

It will be understood that, on suitable energization of the winding 179, the armature 178 is attracted and through the link 176 and arm 174, the auxiliary elongated insulator 146 is rotated. At the upper end of the insulator 146 a corresponding rotation of the shaft 144 takes place. This is in a clockwise direction as viewed in FIG. 7 to move the link 141 in a corresponding direction for rotating the arm 135 of the lever 134 to cause the distal end of the horizontal arm 133 to engage the arm 132 on the latch extension 130 and move the main latch 76 to the unlatched position.

FIG. 12 illustrates diagrammatically how the several switch means 14 can be connected to a polyphase alternating current circuit having a grounded neutral. Other system connections can be employed and it will be understood that the showing here is merely illustrative. Line conductors 188*a*, 188*b* and 188*c* represent a polyphase system that is interconnected with polyphase load conductors 189*a*, 189*b* and 189*c* respectively by switch means 14 individual thereto. It will be observed that the polyphase line conductors 188*a*, 188*b* and 188*c* are connected to the line contact members 19 of the respective switch means 14 and that the polyphase load conductors 189*a*, 189*b* and 189*c* are connected to the corresponding line terminals 20.

The separable contacts of the current interrupter 23 of each of the switch means 14 are represented diagrammatically by the contacts shown as normally closed and indicated by the reference character 23. In series with each set of contacts 23 is the respective disconnecting switch blade 25. The diagram shows the polyphase line conductors 188*a–b–c* interconnected with the polyphase load conductors 189*a–b–c*. The respective contacts 23 are held in the closed position by the main latch which is shown diagrammatically at 76 as engaging the shoulder 84. For normal operation the mechanism cam 72 is arranged to move the main latch 76 out of engagement with the shoulder 84 and permit the spring 91 to open the respective contacts 23. For accomplishing this purpose the shaft 21, shown by a broken line, can be rotated by the operating handle 39 or other operating mechanism first to release the main latch 76 by operation of the mechanism cam 72 and next to rotate the disconnecting

switch blade 25 of each switch means 14 to the open position all as previously described. Insofar as possible the same reference characters have been applied to the diagrammatic showing in FIG. 12 in order to relate them to the corresponding parts shown in certain of the other figures of the drawings and described hereinbefore.

The auxiliary or shunt trip mechanism for independently operating the main latch 76 of each switch means 14 is shown by the broken line 146 which represents the respective auxiliary elongated insulator connected for operation to the respective armature 178 that is attracted by its energizing winding 179. The spring 147 indicates the retrieving spring shown in FIGS. 7 and 8 for returning the shunt trip mechanism to the unoperated position.

As illustrative of the manner in which the windings 179 can be energized, secondary windings 190*a*, 190*b* and 190*c* are shown in conjunction with the polyphase load conductors 189*a*, 189*b* and 189*c*. It will be understood that the secondary windings 190*a–b–c* are the secondary windings of current transformers having single turn primary windings represented by the load conductors 189*a–b–c* and that the currents flowing in the secondary windings 190*a–b–c* correspond to the currents flowing in the respective load conductors 189*a–b–c*.

The secondary windings 190*a–b–c* are connected to a conventional relay system arranged to protect against phase overcurrent and ground overcurrent. It will be observed that they are connected respectively to operating windings 191*a*, 191*b* and 191*c* of phase overcurrent relays 192*a*, 192*b* and 192*c*. These relays have normally open contacts 193*a*, 193*b* and 193*c* which are connected in parallel for applying energy from a suitable source, such as a battery 194, to commonly energize the windings 179 which are connected in parallel. Thus on closure of any set of contacts 193*a–b–c*, the windings 179 are commonly energized from the battery 194 to operate the auxiliary or shunt trip mechanism in the manner described.

It will be observed that the operating windings 191*a–b–c* are commonly connected through an operating winding 195 of a ground overcurrent relay 196 which has normally open contacts 197 that are connected in parallel with the contacts 193*a–b–c* and thus the auxiliary or shunt trip mechanism can be operated in the event of a ground fault in the same manner that it is operated in response to the occurrence of a phase fault or overcurrent in any of the load conductors 189*a–b–c*.

As pointed out a mechanical switch operator can be connected to the shaft 21 to effect opening and closing of the switch means 14. Such a device is illustrated diagrammatically at 198 in FIG. 12 of the drawings. Provision is made for energizing the switch operator 198 on closure of any of the contacts 193*a–b–c* and 197. On closure of any of these contacts the windings 179 are energized and the auxiliary latch mechanisms are operated to unlatch the main latches 76 to permit quick opening of the contacts of the load interrupter 23. A further result of the closure of any of these contacts is to initiate the operation of the switch operator 198 to effect the normal sequence of functions for opening the switch means 14. Since the main latches 76 are already tripped, the mechanism cam 72 is ineffective but the other functions are performed, as described, to open the switch blades, recock spring 91 and reclose the load interrupters 23.

It will be understood that the switch means 14 can be operated as described in the application first above referred to by operating either the handle 39 or the switch operator 198 for opening the circuit under normal operating conditions. In such case none of the windings 179 is energized and none of the auxiliary latch mechanisms is operated to unlatch the respective main latch 76. They are tripped by the respective mechanism cam 72 as a result of the rotation of its insulator 17.

What is claimed as new is:

1. Switch means comprising, in combination,
(a) a line contact member and a line terminal member in insulated spaced relation,
(b) a switch blade movable into and out of engagement with said line contact member,
(c) current interrupting means including separable contacts interconnecting said line terminal member and said switch blade,
(d) spring means biasing said contacts to open position,
(e) latch means holding said contacts closed,
(f) operating means connected to said switch blade and to said latch means to trip said latch means and release said spring means to separate said contacts and to open said switch blade,
(g) auxiliary trip means operatively related to said latch means and operable independently of said operating means to trip said latch means and release said spring means to separate said contacts.

2. Switch means comprising, in combination,
(a) a line contact member and a line terminal member in insulated spaced relation,
(b) a switch blade movable into and out of engagement with said line contact member,
(c) current interrupting means including separable contacts interconnecting said line terminal member and said switch blade,
(d) spring means biasing said contacts to open position,
(e) latch means holding said contacts closed,
(f) operating means connected to said switch blade and to said latch means to trip said latch means and release said spring means to separate said contacts and to open said switch blade,
(g) auxiliary trip means operatively related to said latch means,
(h) auxiliary insulator means connected at one end to said auxiliary trip means,
(i) and means operatively connected to the other end of said auxiliary insulator means and operable independently of said operating means to trip said latch means and release said spring means to separate said contacts.

3. The invention, as set forth in claim 2, wherein the operating means includes
(a) main insulator means,
(b) the main and auxiliary insulator means are independently rotatable to effect their respective functions,
(c) and the moment of inertia of said main insulator means is substantially greater than the moment of inertia of said auxiliary insulator means.

4. Switch means comprising, in combination,
(a) a line contact member and a line terminal member in insulated spaced relation,
(b) a switch blade movable into and out of engagement with said line contact member,
(c) current interrupting means including separable contacts interconnecting said line terminal member and said switch blade,
(d) spring means biasing said contacts to open position,
(e) latch means holding said contacts closed,
(f) operating means connected to said switch blade and to said latch means to trip said latch means and release said spring means to separate said contacts and to open said switch blade,
(g) auxiliary trip means connected to said latch means and operable independently of said operating means to trip said latch means and release said spring means to separate said contacts,
(h) and means responsive to predetermined current flow through said switch blade and said current interrupting means for operating said auxiliary trip means.

5. Switch means comprising, in combination,
(a) a line contact member and a line terminal member in insulated spaced relation,
(b) a switch blade movable into and out of engagement with said line contact member,
(c) current interrupting means including separable contacts interconnecting said line terminal member and said switch blade,
(d) spring means biasing said contacts to open position,
(e) latch means holding said contacts closed,
(f) and a plurality of independently operable means cooperating with said latch means for selectively releasing the same to release said spring means to separate said contacts.

6. Switch means comprising, in combination,
(a) a line contact member and a line terminal member in insulated spaced relation,
(b) a switch blade movable into and out of engagement with said line contact member,
(c) current interrupting means including separable contacts interconnecting said line terminal member and said switch blade,
(d) spring means biasing said contacts to open position,
(e) latch means holding said contacts closed,
(f) operating means connected to said switch blade and to said latch means to trip said latch means and release said spring means to separate said contacts and to open said switch blade,
(g) auxiliary trip means connected to said latch means and operable independently of said operating means to trip said latch means and release said spring means to separate said contacts,
(h) elongated insulator means mechanically connected at one end to said auxiliary trip means,
(i) and means connected to the other end of said insulator means for moving the same to operate said auxiliary trip means.

7. A polyphase switching system comprising, in combination,
(a) two sets of current carrying high voltage polyphase conductors individually interconnected by switch means;
(b) each switch means including:
(c) a line contact member connected to a conductor of one set of said polyphase conductors and a line terminal member connected to a corresponding conductor of the other set of said polyphase conductors,
(d) means supporting said members in insulated spaced relation,
(e) a switch blade movable into and out of engagement with said line contact member,
(f) current interrupting means including separable contacts interconnecting said line terminal member and said switch blade,
(g) spring means biasing said contacts to open position,
(h) latch means holding said contacts closed,
(i) operating means connected to said switch blade and to said latch means to trip said latch means and release said spring means to separate said contacts and to open said switch blade,
(j) and auxiliary trip means connected to said latch means and operable independently of said operating means to trip said latch means and release said spring means to separate said contacts.

8. A polyphase switching system comprising, in combination,
(a) two sets of current carrying high voltage polyphase conductors individually interconnected by switch means;
(b) each switch means including:
(c) a line contact member connected to a conductor of one set of said polyphase conductors and a line terminal member connected to a corresponding conductor of the other set of said polyphase conductors,

(*d*) means supporting said members in insulated spaced relation,
(*e*) a switch blade movable into and out of engagement with said line contact member,
(*f*) current interrupting means including separable contacts interconnecting said line terminal member and said switch blade,
(*g*) spring means biasing said contacts to open position,
(*h*) latch means holding said contacts closed,
(*i*) operating means connected to said switch blade and to said latch means to trip said latch means and release said spring means to separate said contacts and to open said switch blade,
(*j*) and axuiliary trip means connected to said latch means and operable independently of said operating means to trip said latch means and release said spring means to separate said contacts;
(*k*) and means responsive to predetermined current flow through any one of said conductors for operating said auxiliary trip means to open the respective separable contacts of the current interrupting means individual thereto.

9. Switch means comprising, in combination,
(*a*) support means;
(*b*) first, second and third insulators mounted on said support means in parallel spaced relation;
(*c*) a line contact member mounted on said first insulator,
(*d*) a line terminal mounted on said third insulator,
(*e*) a mechanism housing mounted on said second insulator,
(*f*) a shaft rotatably mounted on and extending within said mechanism housing,
(*g*) a switch blade for engaging said line contact member,
(*h*) means mounting said switch blade on said second insulator to move into and out of engagement with said line contact member,
(*i*) connecting means between said shaft and said switch blade whereby rotation of the former effects the aforesaid movement of the latter,
(*j*) separable contact means interconnecting said line terminal and said switch blade,
(*k*) an operating arm within said mechanism housing rotatably mounted on said shaft and connected to said separable contact means,
(*l*) spring means within said mechanism housing interposed between it and said operating arm and biasing said contact means to open position,
(*m*) latch means within said mechanism housing cooperating with said separable contact means to hold the same closed against the biasing action of said spring means,
(*n*) an operating member within said mechanism housing fast on said shaft having a trip detent to release said latch means on predetermined movement of said shaft in the switch opening direction,
(*o*) means for rotating said shaft to trip said latch means and release said spring means to separate said contact means and to open said switch blade,
(*p*) and auxiliary trip means connected to said latch means and operable independently of said operating member to trip said latch means and release said spring means to separate said contact means.

10. The invention, as set forth in claim 9, wherein the auxiliary trip means includes
(*a*) a lever rotatably mounted on the mechanism

housing and having an arm engageable with the latch means,
(*b*) a fourth insulator rotatably mounted at one end on the support means adjacent and parallel to the second insulator and mechanically connected at the other end to said lever,
(*c*) and operating means mounted on the support and connected to said one end of said fourth insulator and capable of rotating the same to rotate said lever to trip the latch means.

11. The invention, as set forth in claim 10, wherein the mechanical connection between the lever and the other end of the fourth insulator includes
(*a*) arms extending radially from said lever and said other end of the fourth insulator and a link interconnecting these arms,
(*b*) spring means biasing the mechanical connection to hold the arm on said lever engageable with the latch means out of engagement therewith,
(*c*) and stop means limiting the movement of the mechanical connection under the action of said spring means.

12. The invention, as set forth in Claim 10, wherein the operating means includes an armature mechanically connected to the one end of the fourth insulator and an energizing winding for moving said armature to rotate said fourth insulator.

13. Switch means comprising, in combination,
(*a*) a line contact member and a line terminal member in insulated spaced relation,
(*b*) a metallic mechanism housing between said members having a removable cover and an operating shaft extending therethrough,
(*c*) a switch blade pivotally mounted on said mechanism housing for movement into and out of engagement with said line contact member,
(*d*) operating means between said shaft and said switch blade for moving the latter on rotation of the former,
(*e*) current interrupting means including separable contact means interconnecting said line terminal member and said mechanism housing,
(*f*) spring means within said mechanism housing biasing said contact means to open position,
(*g*) latch means within said mechanism housing cooperating with said separable contact means to hold the same closed against the biasing action of said spring means,
(*h*) an operating member within said mechanism housing fast on said shaft having a trip detent to release said latch means on predetermined movement of said shaft in the switch opening direction,
(*i*) a rotatable insulator connected to said shaft for rotating it to trip said latch means and release said spring means to separate said contact means and to open said switch blade,
(*j*) auxiliary trip means on said cover adapted to engage said latch means and movable to trip the same,
(*k*) an auxiliary rotatable insulator paralleling said rotatable insulator and connected to said auxiliary trip means,
(*l*) and means for rotating said auxiliary rotatable insulator to operate said auxiliary trip means to trip said latch means.

References Cited in the file of this patent

UNITED STATES PATENTS

2,769,063 Lingal ---------- Oct. 30, 1956