

Dec. 31, 1957

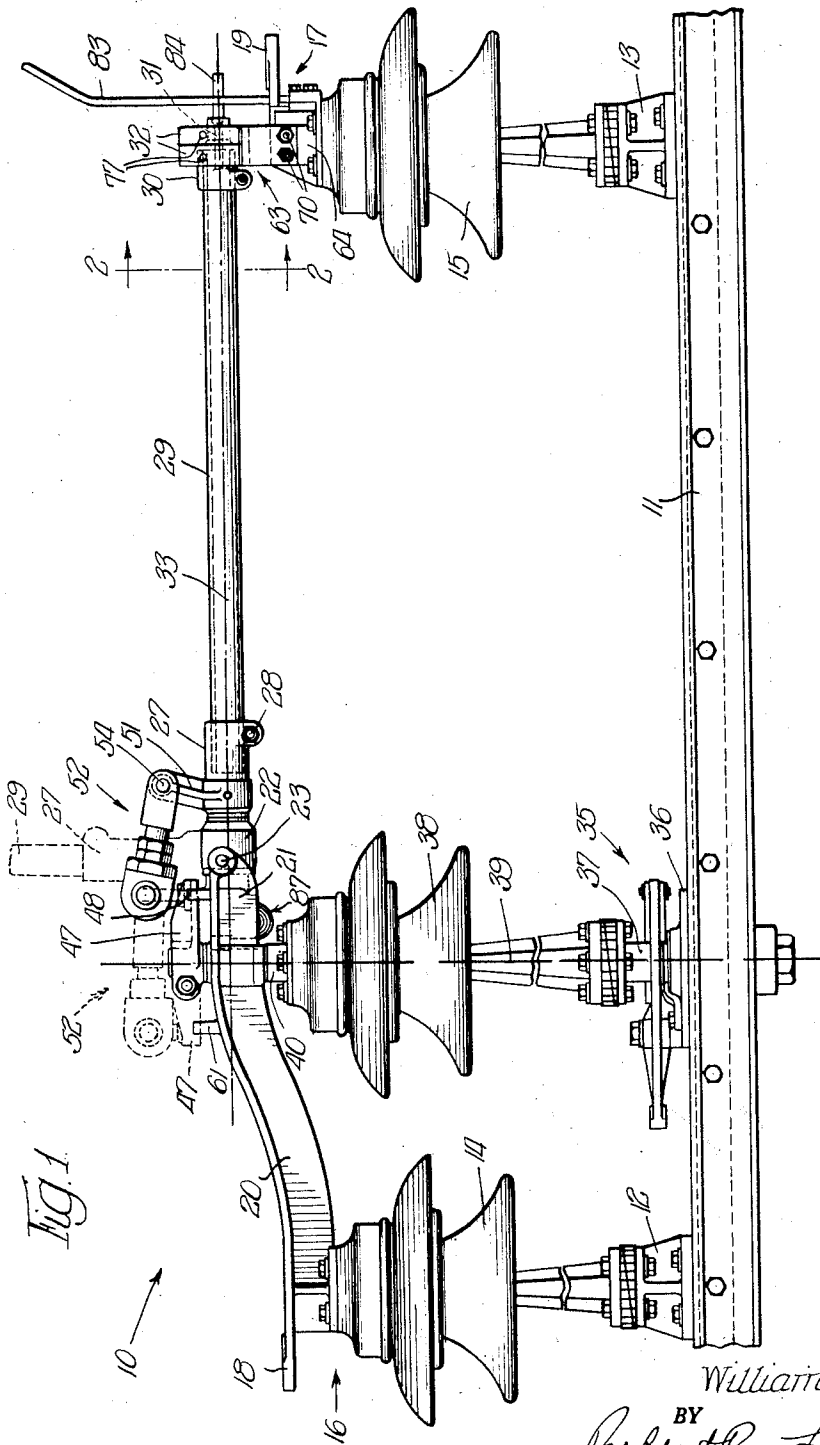
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2,818,474

SWITCH CONSTRUCTION

Filed March 22, 1954

8 Sheets-Sheet 1



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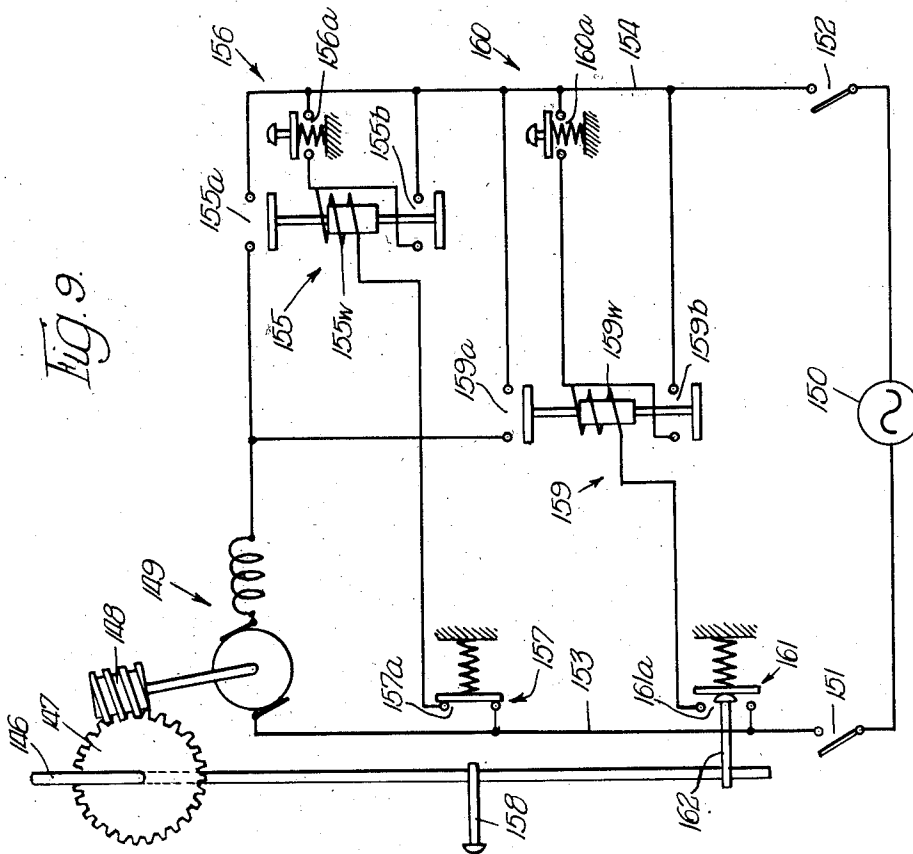
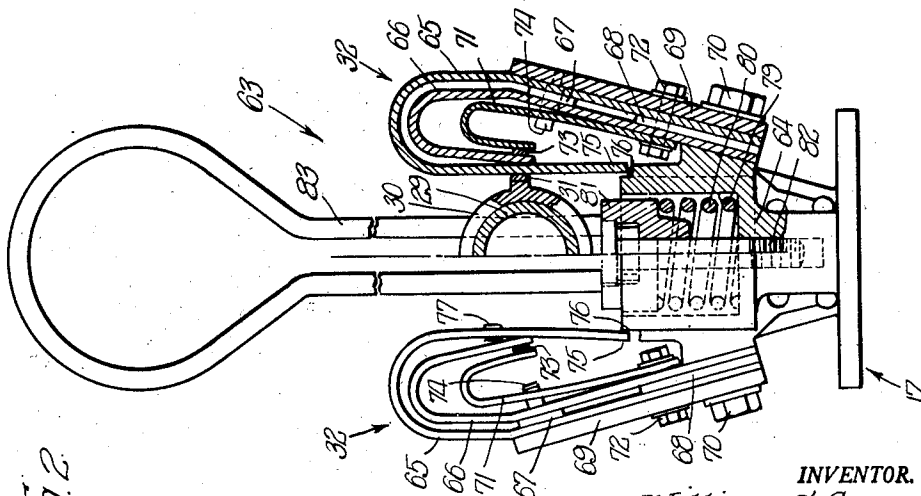
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Filed March 22, 1954

8 Sheets-Sheet 2



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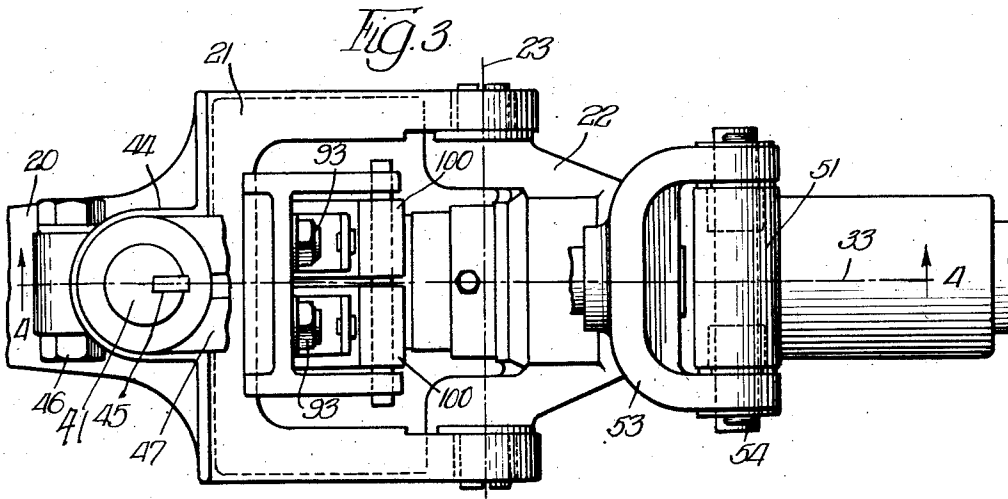
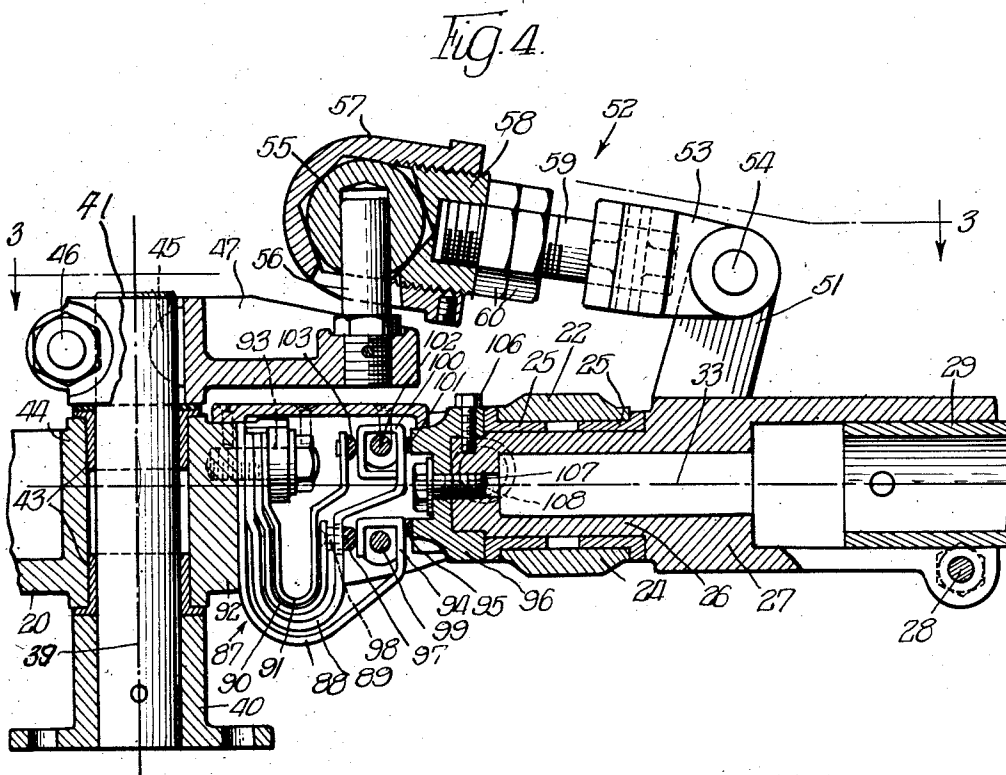
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Filed March 22, 1954

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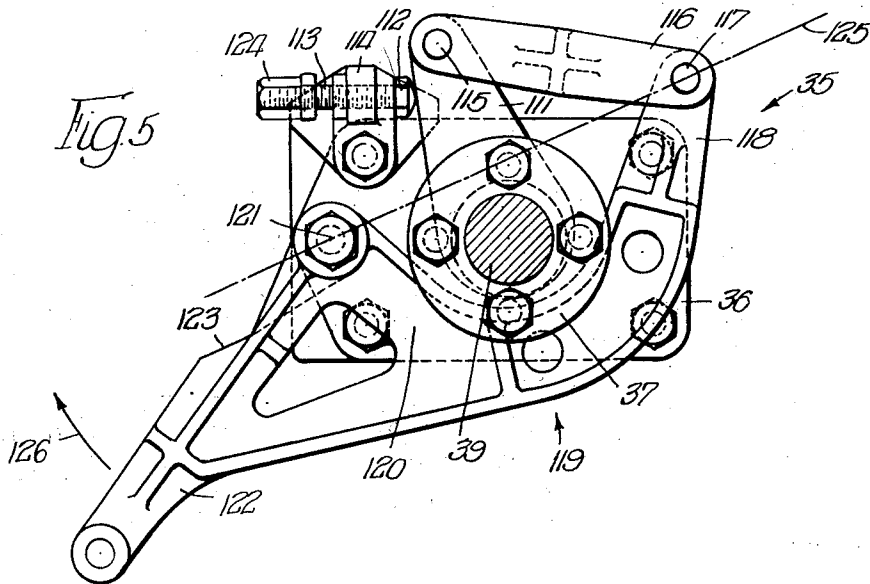
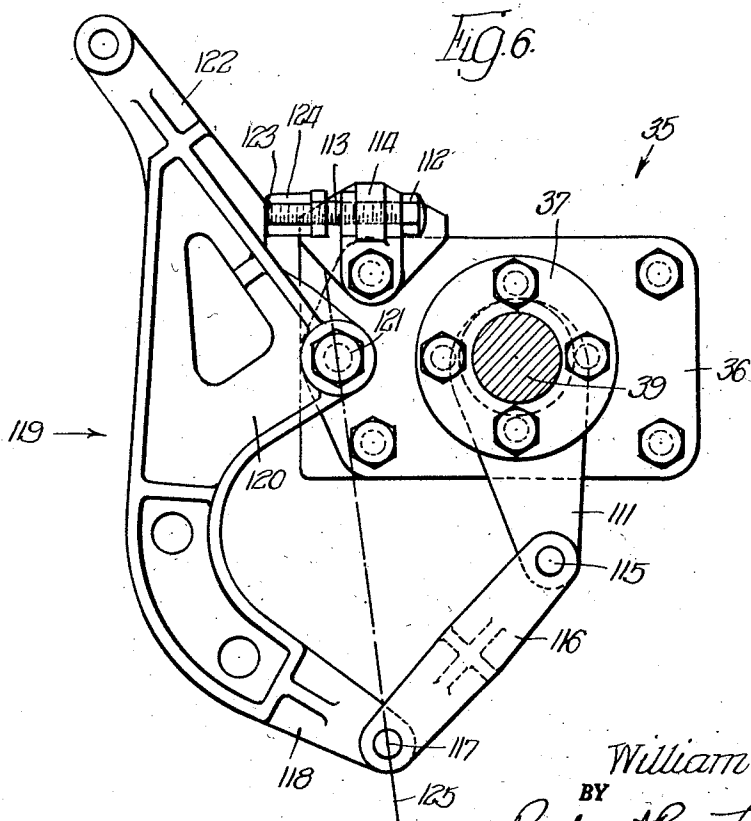
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Filed March 22, 1954

8 Sheets-Sheet 4



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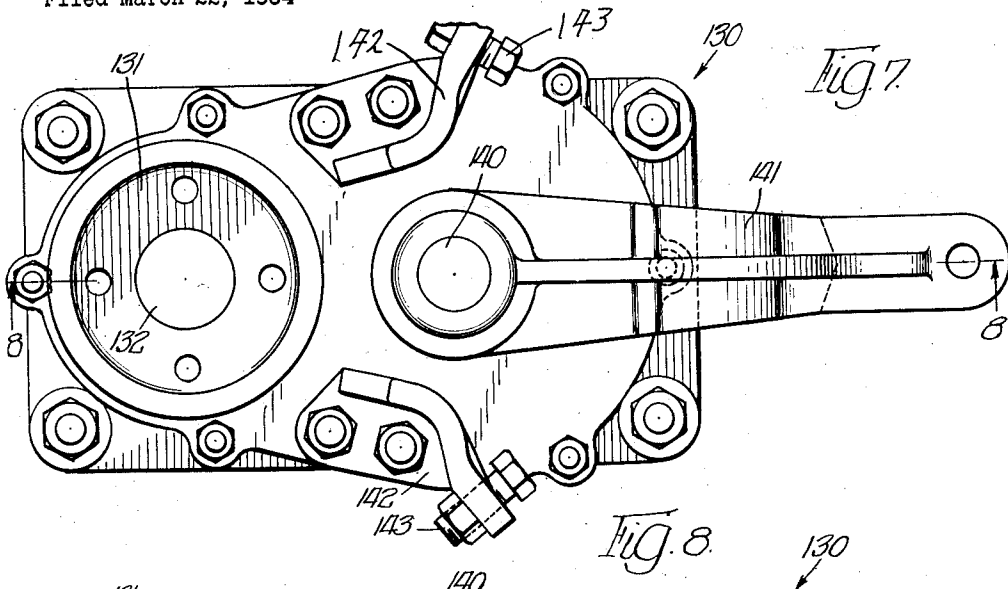
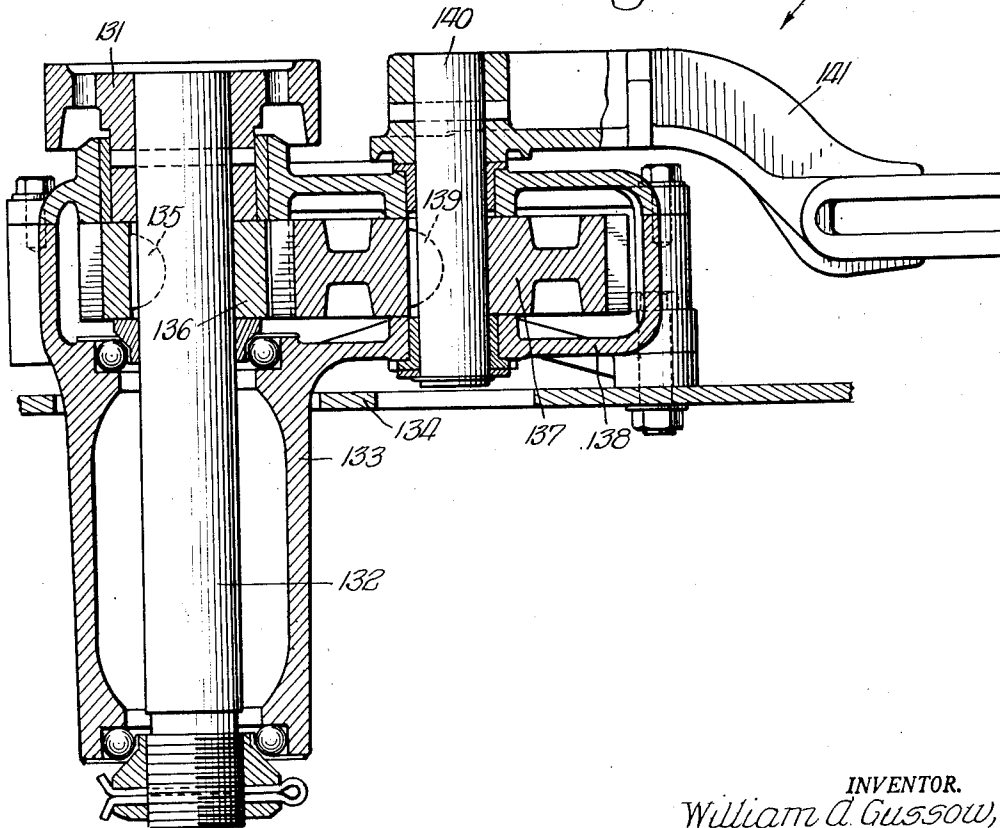
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Filed March 22, 1954

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SWITCH CONSTRUCTION

Filed March 22, 1954

8 Sheets-Sheet 6

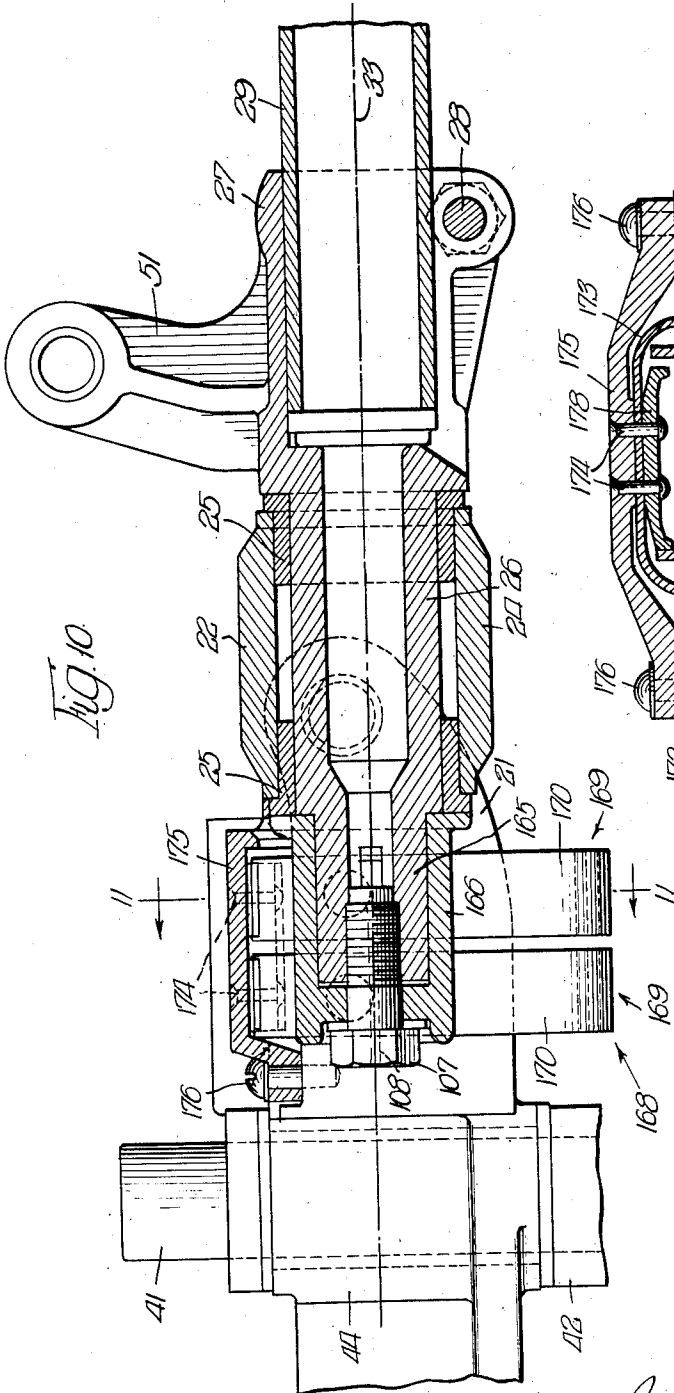


Fig. 10.

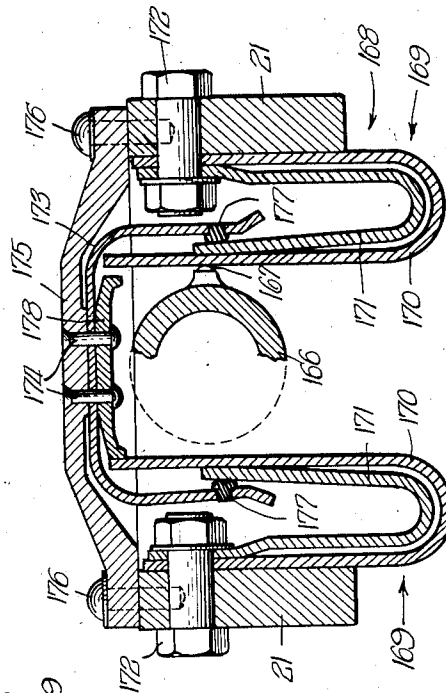


Fig. 11.

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Filed March 22, 1954

8 Sheets-Sheet 8

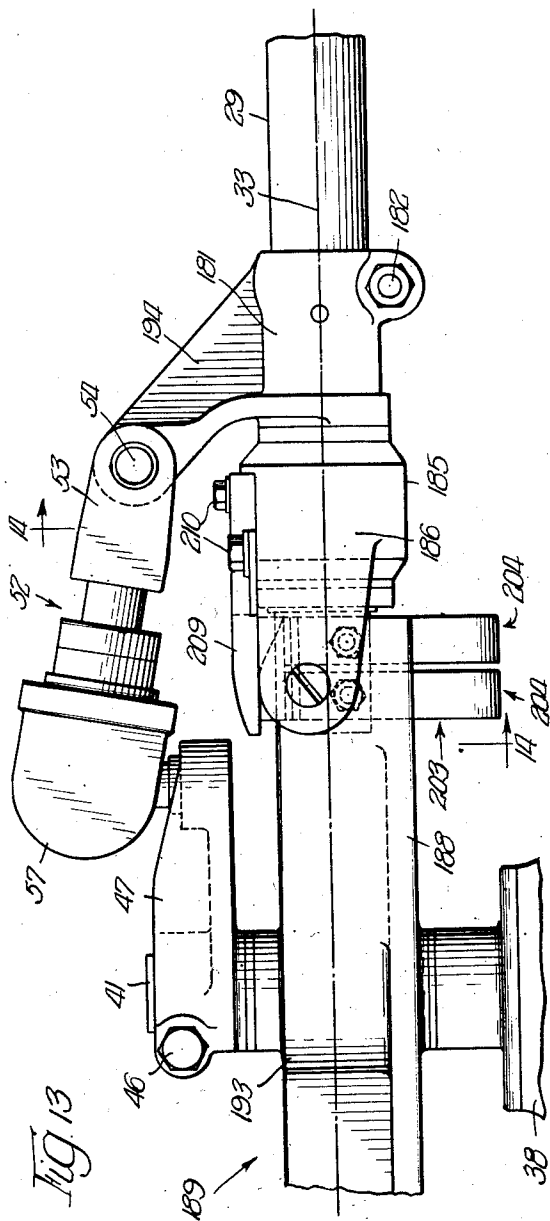


Fig. 13

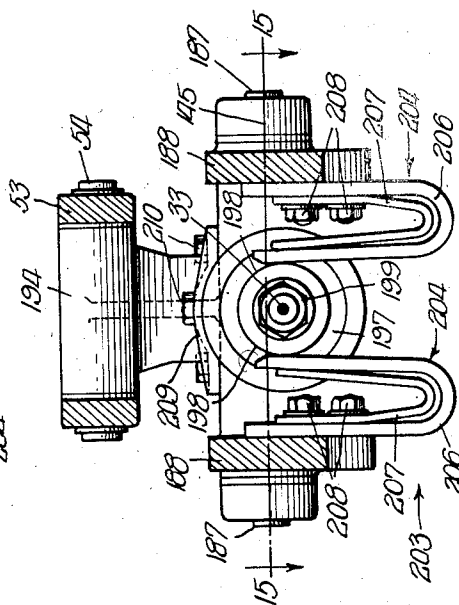


Fig. 14

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2,818,474

SWITCH CONSTRUCTION

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Application March 22, 1954, Serial No. 417,655

20 Claims. (Cl. 200—48)

This invention relates, generally, to the construction of electric power switches and it has particular relation to high voltage disconnecting switches.

Among the objects of this invention are: To interconnect a rotatable insulator and a disconnecting switch blade in such manner that the switch blade can be locked in the open or closed position as a result of rotation of the insulator through 180°; to obtain a mechanical advantage in starting to move the switch blade from the open position and from the closed position particularly under adverse conditions such as when the moving parts are encased in ice; to decrease the shock incident to stopping the switch blade near the limit of its opening movement after it has completed its vertical travel by sinusoidally slowing down the switch blade at the same time that the operating crank arm connected thereto proceeds towards its 180° toggle locked position; to rotate the insulator in the same direction for closing the switch that it is rotated to open it; to absorb the shock that may be incident to the engagement of the switch blade with the contact from which the switch blade separates to open the circuit; to engage sequentially a contact at the hinged end of the switch blade by swinging movement thereof into the switch closed position and then a contact at the remote end by rotation of the switch blade about its longitudinal axis; to engage contacts at both ends of the switch blade by rotating the same about its longitudinal axis; to employ a contact construction which increases the contact pressure applied thereby to the switch blade on flow of heavy current or short circuit current; to rotate the rotatable insulator through substantially 180° by moving an operating arm through substantially 90°; to rotate the insulator through less than 180° and by means of reduction gear means rotate the switch blade operator through 180°; to incorporate a prestressed construction in the contacts engaged by the switch blade at its ends; and to maintain uniform contact engagement with the contacts at the hinged end of the switch blade in any position thereof from open to closed position.

Other objects of this invention will, in part, be obvious and in part appear hereinafter.

This invention is disclosed in the embodiments thereof shown in the accompanying drawings, and it comprises the features of construction, combination of elements and arrangement of parts which will be exemplified in the constructions hereinafter set forth and the scope of the application of which will be indicated in the appended claims.

For a more complete understanding of the nature and scope of this invention, reference can be had to the following detailed description, taken together with the accompanying drawings, in which:

Figure 1 is a view, in side elevation, of a high voltage disconnecting switch in which certain features of the present invention are embodied;

Figure 2 is a view taken generally along the line 2—2 of Figure 1, certain parts being shown in section and

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other parts in elevation in order to illustrate the details of construction of the contact with which the switch blade engages at the end remote from the hinge end;

Figure 3 is a top plan view, taken generally along the line 3—3 of Figure 4 and showing at an enlarged scale the construction of the switch at the hinge end;

Figure 4 is a sectional view taken generally along the line 4—4 of Figure 3;

Figure 5 is a top plan view of one form of operating mechanism that can be employed for rotating the insulator which operates the switch blade through 180° on rotation of an operating arm through 90°;

Figure 6 is a view, similar to Figure 5, but showing the operating mechanism in the alternate position;

Figure 7 is a top plan view of a gear type of operating mechanism that can be employed for rotating the insulator through 180°;

Figure 8 is a vertical sectional view taken generally along the line 8—8 of Figure 7;

Figure 9 is a diagram which shows the circuit connections that can be employed for controlling the operation of a motor that is used for rotating the rotatable insulator in one direction to effect both closing and opening of the switch blade;

Figure 10 is a longitudinal sectional view of a modified form of contact construction at the hinge end of the switch blade;

Figure 11 is a vertical sectional view taken generally along the line 11—11 of Figure 10;

Figure 12 is a view, partly in top plan and partly in section, showing an alternate contact construction for the hinge end of the switch blade;

Figure 13 is a view, in side elevation, of the construction shown in Figure 12;

Figure 14 is a sectional view, taken generally along the line 14—14 of Figure 13;

Figure 15 is a horizontal sectional view taken generally along the line 15—15 of Figure 14; and

Figure 16 is a view, partly in side elevation and partly in section showing a planetary gear drive which can be mounted on the rotatable insulator shown in Figure 1 to provide 180° rotation of the operating arm on rotation of the insulator through 90°.

Referring now particularly to Figure 1 of the drawings, it will be observed that the reference character 10 designates a high voltage disconnecting switch in which are embodied certain features of the present invention. The switch 10 includes a base 11 having insulator support brackets 12 and 13 near its ends on which stationary insulators 14 and 15 are mounted. The number of insulators 14 and 15 employed on each bracket 12 and 13 is governed by the voltage of the circuit in which the switch 10 is connected. At the tops of the stationary insulators 14 and 15, line terminals 16 and 17 are mounted having terminal pads 18 and 19 to which the line conductors can be connected.

The line terminal 16 includes a terminal bracket 20 of good conducting material, such as cast brass. One end is secured to the insulator 14 as shown and the other end has a bifurcated end portion 21 as shown more clearly in Figure 3. Between the arms of the end portion 21 a bifurcated blade carrier 22 is positioned and it is mounted to rotate about a horizontal hinge axis 23 in a manner to be described presently. The blade carrier 22 has a centrally located bearing 24 for receiving bearing bushings 25 to rotatably mount a journal 26 which forms a part of a blade shaft and socket 27. The blade shaft and socket 27 is of split construction and is arranged to be clamped by a bolt 28 to one end of a tubular switch blade 29. At its other end the switch blade 29 has a contact fitting 30 that is provided with radially projecting contact ribs 31. Figure 2, for high pressure contact engagement with pre-

stressed contact fingers 32, the details of construction of which will be set forth presently. The switch blade 29 is rotatably mounted about its longitudinal axis 33 in the bearing 24 of the blade carrier 22. In the switch closed position, it will be observed that the longitudinal axis 33 is horizontal when the switch 10 is mounted as shown in Figure 1. The hinge axis 23 extends transversely of the axis 33 and is spaced slightly above the same when the switch blade 29 is in the switch closed position.

With a view to rotating the switch blade 29 about its longitudinal axis 33 and swinging it about the hinge axis 23, an operating mechanism, indicated generally at 35, can be employed. The details of construction of this operating mechanism will be set forth presently. It is here pointed out that the operating mechanism 35 is mounted on a base 36 which is carried by the base 11 and that it is arranged to rotate a bracket 37 through 180°. Mounted on the bracket 37 is a rotatable insulator 38 which constitutes a switch blade operator and is so referred to in the claims. When the switch 10 is positioned as in Figure 1 of the drawings, the insulator 38 is arranged to rotate about a vertical axis 39 which is spaced from the hinge axis 23 on the side away from the line terminal 17.

As shown more clearly in Figure 4 of the drawings, a bracket 40 is provided which, as shown in Figure 1, is fast on the top of the rotatable insulator 38. Secured to and rotatable with the bracket 40 is a short shaft 41 that is journaled in bushings 43 located in a bearing 44 which forms a part of the terminal bracket 20. Secured to the upper projecting end of the short shaft 41 by a semi-circular key 45 and a clamp bolt 46 is a first arm 47 the movement of which in the switch closing direction is limited by a stop 48, Figure 1, which is formed integrally with and extends upwardly from the terminal bracket 20. In the switch closed position with the switch blade 29, as shown in Figure 1, the first arm 47 extends from the vertical axis 39 above the switch blade 29 and toward the line terminal 17. In the switch closed position the arm 47 swings past a position parallel to the switch blade 29 a limited extent, for example 9° to 10°.

Provision is made for operatively interconnecting the first arm 47 with the switch blade 29 to rotate the same about its longitudinal axis 33 and then to swing about the hinge axis 23. For this purpose a second arm 51 extends transversely from the blade shaft and socket 27 or from the switch blade 29. When the switch blade 29 is in the switch closed position, the second arm 51 is located in a plane containing the vertical axis 39 of the rotatable insulator 38. The outer end of the second arm 51 is connected to the outer end of the first arm 47 by a link which is shown, generally, at 52. The link 52, as shown more clearly in Figure 3 of the drawings, has a bifurcated end 53 which is pivoted on a pin 54 that extends through the outer end of the second arm 51. The other end of the link 52 is universally connected to the outer end of the first arm 47 by means of a ball 55 which is carried by a pin 56 that extends vertically upwardly from the first arm 47 as shown in Figure 4. The ball 55 is enclosed in a socket 57 which is threaded onto a fitting 58 that, in turn, is threaded onto one end of a stud 59 which extends from the bifurcated end 53 of the link 52. Lock nuts 60 serve to hold the stud 59 in the adjusted position with respect to the fitting 58.

As shown in Figure 1, a stop 61 is formed integrally with and extends upwardly from the terminal bracket 20 and into the path of the first arm 47 for limiting its movement to a position diametrically opposite that shown by full lines or limiting its rotation substantially to 180° or stopping it at a position slightly past the 180° position. One reason for swinging the first arm 47 to the alternate position shown by the broken lines in Figure 1 is to lock the switch blade 29 in the switch open position also shown by broken lines in this figure, without requiring any additional locking elements.

As a result of using a relatively short arm 47 and swinging it through substantially 180° a mechanical advantage is obtained that is useful in breaking the switch blade 29 loose from either the closed or open position. Further, the switch blade is decelerated sinusoidally at the ends of its closing and opening movements with a corresponding reduction in shock incident to bringing it to a full stop.

When the insulator 38 is initially rotated about the vertical axis 39 from the position shown in Figure 1, the switch blade 29 is first rotated about its longitudinal axis 33 to move the contact ribs 31 out of high pressure contact engagement with the contact fingers 32. Continued rotation of the insulator 38 or switch blade operator then causes the switch blade 29 to be swung about the hinge axis 23 and away from the line terminal 17 to open the circuit. The rotation of the insulator 38 is accompanied by a pivoting of the link 52 on the second arm 51 and a universal movement with respect to the first arm 47 because of the universal joint connection therewith to the ball 55 and socket 57. Rotation of the insulator 38 continues until the first arm 47 is stopped by the engagement of the stop 61 the position of which depends upon the direction in which the first arm 47 is to be swung to operate the switch blade 29. During the last portion of the movement of the first arm 47 into engagement with the stop 61, the switch blade 29 is rotated in a reverse direction about its longitudinal axis 33 and is sinusoidally decelerated until it occupies a position in all respects at right angles to its switch closed position. Here the link 52 has passed the center position and overlies the first arm 47 and extends from the axis 39 away from the line terminal 17. Because of this relationship of the link 52 to the first arm 47, the switch blade 29 is locked in the open position. Any force tending to swing it about the hinge axis 23 is resisted by the first arm 47 which is now located in a position generally at right angles to the hinge axis 23. On rotation of the insulator 38 about the vertical axis 39 in the opposite direction, the switch blade 29 first is rotated about its longitudinal axis 33. However, in the switch open position the contact fitting 30 is out of engagement with a cooperating switch contact and thus this movement is without effect. Continued rotation of the insulator 38 through approximately 180° swings the switch blade 29 about the hinge axis 23 to the switch closed position shown in Figure 1, the final movement of the insulator 38 effecting rotation of the switch blade 29 about its longitudinal axis 33 to move the contact ribs 31 into high pressure contact engagement with the prestressed contact fingers 32.

In Figure 2 of the drawings, the details of construction of the prestressed contact fingers 32 are illustrated more clearly. It will be noted that they are arranged so as to provide a generally U-shaped contact construction 63 which includes a jaw base 64 in the form of a casting of good conducting material, such as brass. Each of the contact fingers 32 of the U-shaped contact construction 63 comprises a pair of inverted U-shaped outer blade leaves 65 and a pair of inverted U-shaped inner blade leaves 66 which are formed of good conducting material, such as copper. Spacers 67 and 68 serve to keep one arm of each of the leaves 65 and 66 apart. A clamp plate 69 overlies the outer blade leaf 65 and serves to resist outward movement of the leaves 65 and 66 under short circuit conditions. The assembly is secured to the jaw base 64 by bolts 70. The other arms of the blade leaves 65 and 66 are urged into high pressure contact engagement with the contact ribs 31 by inverted U-shaped contact springs 71. One arm of each contact spring 71 is secured by bolts 72 to the leaves 65 and 66 and to the clamp plate 69. The other ends of the contact springs 71 carry insulating knobs 73 which bear against the downturned ends of the inner blade leaves 66 which, in turn, bear against the downturned ends of the outer blade leaves 65 which are in contact engagement with the contact ribs 31. The knobs 73 are formed of insulation in order

to prevent the contact spring 71 from carrying current and thus being overheated. Studs 74 secured to the clamp plate 69 and extending through the blade leaves 65 and 66, the spacer 67 and the contact springs 71 serve to maintain the parts in predetermined aligned relationship.

As pointed out the contact fingers 32 are prestressed. This is accomplished by having the lower ends 75 of the arms of the outer blade leaves 65 engage shoulders 76 on opposite sides of the jaw base 64. As shown at the left-hand side of Figure 2, when the switch blade 29 is out of engagement therewith or the contact ribs 31 are out of engagement with the respective arms of the outer blade leaves 65, the outer blade leaves 65 and 66 are prestressed by the contact springs 71 against the shoulders 76. When the switch blade 29 is rotated about its longitudinal axis 33 in the switch closed position, it is only necessary to move the lower ends 75 of the outer blade leaves 65 out of engagement with the shoulders 76 whereupon the full force of the contact springs 71 is applicable to maintain high pressure engagement.

With a view to insuring that the switch blade 29 stops in a position where the contact ribs 31 are in proper contact engagement with the outer blade leaves 65, a rivet 77 is provided on one of the left-hand outer blade leaves 65, as shown in Figure 2, for engagement with the contact rib 31, individual thereto, so that further rotation of the switch blade 29 about the longitudinal axis 33 in a clockwise direction, as viewed in Figure 2, is prevented. When provision is made for operating the switch blade 29 by rotation of the insulator 38 through 360°, the rivet 77 is omitted as will be described hereinafter.

When the switch blade 29 is swung to the switch closed position, the contact fitting 30 may be stopped relatively quickly even though it has been sinusoidally decelerated from its maximum speed as a result of the use of the particular operating mechanism disclosed herein. Also, because of looseness in the joints and wear after the switch has been in operation for some time, there may be some movement of the switch blade 29 at the position where its speed otherwise would be reduced to zero. In order to take care of any shock incident to the closing of the switch blade 29, a shock absorbing mechanism is employed. For this purpose, the jaw base 64 has a socket 79 in which is positioned a coil compression spring 80. The lower end of the spring 80 bears against the bottom of the socket 79 while the upper end has a jaw blade stop 81 in engagement therewith. The jaw blade stop 81 is slidable in the upper end of the socket 79 and it is held in position therein by a bolt 82 which is tightened sufficiently so as to place the spring 80 under tension. When the contact fitting 30 engages the upper side of the jaw blade stop 81 during the switch closing operation, the spring 80 is compressed further and thus provides a shock absorbing action which causes the switch blade 29 to be decelerated gradually rather than rapidly as otherwise would be the case in the event that it engaged a stationary part.

With a view to preventing arcing between the contact ribs 31 and the respective outer blade leaves 65 when the switch blade 29 is swung to the open position and current is flowing therethrough, an arcing horn 83 is mounted on the line terminal 17. The contact fitting 30 at the outer end of the switch blade 29 has an axially extending tip 84 which maintains contact with the arcing horn 83 after the contact ribs 31 have moved out of engagement with the outer blade leaves 65. Any arc that results is drawn between the arcing tip 84 and the arcing horn 83 which are relatively inexpensive and can be replaced. When extremely heavy current or short circuit current flows through the switch 10, relatively high magnetic forces are generated. Advantage is taken of the magnetic forces thus generated in the employment of the inverted U-shape for the outer and inner blade leaves 65 and 66. When current of this magnitude flows through

the leaves 65 and 66, the magnetic forces generated thereby react to spread the arms of these leaves apart. Since they are amply braced, the net result is that they bear against the contact ribs 31 with increasing force under these conditions.

In Figures 3 and 4 of the drawings, there are shown the details of construction of a generally U-shaped butt contact which is indicated, generally, by the reference character 87. As will appear hereinafter, other types of contact construction can be employed at the hinge end of the switch blade 29. The butt type of contact construction here shown and described is satisfactory for this purpose.

It will be observed that the butt contact 87 includes outer and inner contact leaves 88 and 89 of generally U-shape and formed of good conducting material, such as copper. Nested within the contact leaves 88 and 89 are outer and inner generally U-shaped contact springs 90 and 91. One arm of each of the contact leaves 88 and 89 and one arm of each of the contact springs 90 and 91 are positioned on top of each other and are secured to a central portion 92 of the bifurcated end portion 21 by bolts 93. The outer end 94 of the other arm of the outer contact leaf 88 is generally hook-shaped and a portion thereof is arranged to bear against a transversely extending contact rib 95 which is carried by a blade rear contact 96 which is located at the rear end of the journal 26 which is a part of the blade shaft and socket 27 and is solidly connected to the switch blade 29. In order to urge the outer end 94 into high pressure contact engagement with the contact rib 95, the other arm of the outer contact spring 90 is provided with an insulating knob 97 which is secured in position thereon by a pin 98 and which extends through a suitable clearance opening in the other arm of the inner contact leaf 89 so as to bear against the downturned portion of the outer end 94 for urging it into high pressure contact engagement with the contact rib 95. The movement of the other end 94 is limited by a transverse pin 99 so that a prestressed contact construction is provided as described hereinbefore. The outer end 100 of the other arm of the inner contact leaf 89 is arranged to bear against a transversely extending contact rib 101 also carried by the blade rear contact 96. The movement of the outer end 100 is limited by a transverse pin 102 so as to provide the prestressed construction when it is urged into high pressure contact engagement with the contact rib 101 by the other arm of the inner contact spring 91. As shown this other arm carries an insulating knob 103 which bears against a downturned portion of the outer end 100. The reason for employing insulation for the knobs 97 and 103 is to prevent the contact springs 90 and 91 from carrying current which would result in their being heated and destroying their resilient characteristics.

Because of the U-shaped configuration of the contact leaves 88 and 89, the magnetic forces which are generated on flow of heavy current or short circuit current therethrough are such as to cause the outer ends 94 and 100 to exert greater contact pressure against the respective contact ribs 95 and 101 under these conditions. Since the switch blade 90, in the switch closed position, is anchored against endwise movement, the result of such heavy current flow is merely to increase the pressure with which the contact ribs 95 and 101 are engaged by the respective outer ends 94 and 100.

It will be observed that the blade rear contact 96 is secured in position against rotation on the rear end of the journal 26 by a bolt 106. A bolt 107 extends centrally of the blade rear contact 96, is threaded into the rear end of the journal 26 and acts to hold the former securely to the latter. The bolt 107 has a central aperture 108 extending therethrough which provides a drain to permit water to escape should any collect in the tubular switch blade 29 when it is in the open circuit position where it is located in an upright position.

The details of construction of the operating mechanism

35 are shown more clearly in Figures 5 and 6 of the drawings. As there shown a crank arm 111 extends radially from the bracket 37 so that it rotates with the rotatable insulator 38, Figure 1, about the vertical axis 39. The position of the crank arm 111 shown in Figure 5 corresponds to the switch blade 29 in the switch closed position. Here the crank arm 111 engages the head 112 of a stop bolt 113 which is threaded in a bracket 114 carried by the base 36. This limits the starting position of the crank arm 111 which corresponds, as indicated, to the switch closed position of the switch blade 29. The outer end of the crank arm 111 is connected by a pivot pin 115 to one end of a link 116, the other end of which is connected by a pivot pin 117 to one branch 118 of a generally C-shaped operating arm shown generally at 119. The other branch 120 of the C-shaped operating arm 119 is pivoted at 121 on the base 36. An arm 122 formed integrally with the C-shaped operating arm 119 extends therefrom and is adapted to have an operating lever or other suitable operating means connected thereto which is capable of swinging the C-shaped operating arm 119 through substantially 90°. The arm 122 is provided with a shoulder 123 that is arranged to engage a nut 124, as shown in Figure 6, for limiting the movement of the C-shaped operating arm 119 to a position which corresponds to the position of the switch blade 29 when it is in the switch open position as shown by the broken lines in Figure 1 of the drawings. It will be understood that the position of the crank arm 111 in Figure 5 can correspond to the switch open position and its position as shown in Figure 6, can correspond to the switch closed position, if desired.

In Figure 5 of the drawings, it will be observed that a line 125 drawn between the center of the pivot pin 117 and the pivot 121 is spaced from the axis 39 of rotation of the rotatable insulator 38 and that this line is shifted past the axis 39 as the C-shaped operating arm 119 is rotated in a clockwise direction indicated by the arrow 126 to the alternate position. By employing this configuration for the operating arm 119, it is possible to provide a compact operating mechanism and also one that need be operated only through 90° in order to effect a 180° rotation of the rotatable insulator 38.

In Figures 7 and 8 of the drawings, a gear type of operating mechanism is shown, generally, at 130 which can be employed in lieu of the lever and link operating mechanism 35 previously described. For this purpose a bracket 131 can be employed in lieu of the bracket 37 and the insulator 38 can be mounted thereon as will be understood readily. The bracket 131 is secured to the upper end of a shaft 132 which is journaled in a suitable bearing structure 133 that is carried by a base 134 which may be a part of the base 11. Secured by a semi-circular key 135 to the shaft 132 is a pinion 136 which meshes with a gear 137 that is located in a gear box 138 and is secured by a semi-circular key 139 to a short shaft 140 which projects above the gear box 138 and is journaled thereon. Secured to the projecting end of the shaft 140 is a crank arm 141 to which any suitable driving mechanism can be connected that is capable of swinging it through 90°. Stop brackets 142, carried by the gear case 138, are provided with adjusting bolts 143 for limiting the movement of the crank arm 141 in either direction.

In order that the shaft 132 will be turned through 180°, while the crank arm 141 is swung only through 90°, the gear ratio between the pinion 136 and the gear 137 is of the order of 2:1.

For operating the disconnecting switch 10 as shown in Figure 1 of the drawings, the first arm 47 is swung through 180° from the position shown by full lines to the position shown by the broken lines in order to swing the switch blade 29 from the switch closed position through 90° to the switch open position. For the construction thus far described the switch blade 29 is closed by reversing the rotation of the first arm 47 through 180° to swing

the switch blade 29 from the vertical upright open position to the horizontal closed position. In some instances it is desirable to effect the closing movement of the switch blade 29 by continuing the rotation of the first arm 47 in the same direction that it is moved for opening the switch blade 29. In such a construction provision is made for rotating the insulator 38 or the switch blade operator through 360°. Then it is unnecessary to provide a drive mechanism which is capable of being reversed as is required for the operating mechanisms 35 and 130. Provision can be made for rotating the rotatable insulator 38 or the switch blade operator in one direction with suitable control means being provided for stopping the rotation at 180° intervals corresponding to the positions of the switch blade 29 in either the closed or the open position.

In Figure 9 of the drawings, there is illustrated, diagrammatically, a drive system which can be employed for rotating the insulator 38 or the switch blade operator through 360° to effect the control of the movement of the switch blade. As there shown a shaft 146 is employed which may correspond to the shaft 132 for the gear type of operating mechanism 130 previously described. It will be understood that the shaft 146 is directly connected to the rotatable insulator 38. Fast on the shaft 146 is a gear 147 which may correspond to the pinion 136 on the shaft 132. Meshing with the gear 147 is a worm 148 that is arranged to be driven by a motor shown generally at 149. A worm 148 is shown for illustrative purposes, it being understood that a gear may be substituted therefor. Also it will be understood that any desired ratio of gear reduction can be employed as may be required.

The motor 149 is shown as being a conventional universal series type, but other motors can be employed as will be understood readily. The motor 149 can be energized from a source 150 of alternating current, such as 115-volt 60-cycle source. The source 150 is connected by switches 151 and 152 to energize conductors 153 and 154. The control of the motor 149 is effected, in part, by an opening relay shown generally at 155. The opening relay 155 is provided with an operating winding 155w and normally open contacts 155a and 155b. The energization of the operating winding 155w is controlled by a push button shown generally at 156 having normally open contacts 156a. The deenergization of the operating winding 155w is controlled by a limit switch that is shown, generally, at 157 and has normally closed contacts 157a which are opened by a cam 158 that is driven by the shaft 146.

The control of the motor 149 also is effected by a closing relay that is shown, generally, at 159 and has an operating winding 159w and normally open contacts 159a and 159b. The energization of the operating winding 159w is controlled by a push button that is shown, generally, at 160 and has normally open contacts 160a. The deenergization of the operating winding 159w is controlled by a limit switch shown, generally at 161 which has normally closed contacts 161a that are arranged to be opened by a cam 162 which is driven by the shaft 146.

The system shown in Figure 9 can be employed for operating the disconnecting switch 10 and in describing the functioning thereof, it will be assumed that the switch blade 29 is in the closed position, as shown by the full lines in Figure 1. Also it will be assumed that the switches 151 and 152 are closed and that the conductors 153 and 154 are suitably energized. In order to open the switch 10, the push button 156 is depressed to complete a circuit for energizing the operating winding 155w of the opening relay 155 which can be traced from the energized conductor 154 through contacts 156a, operating winding 155w, normally closed contacts 157a to energized conductor 153. On energization of the operating winding 155w, contacts 155b are closed to provide a shunt circuit around the contacts 156a of the push button 156. It then can be released and the energizing circuit for the operating winding 155w is maintained through

the contacts 155b. At contacts 155a, an obvious energizing circuit for the motor 149 is completed. It rotates the shaft 146 and the insulator 38 from the position shown in Figure 1 to a position where the first arm 47 is as shown by the broken lines. This, as previously described, is accompanied by a movement of the switch blade 29 to the open position through 90° where it is shown by broken lines. When the switch blade 29 reaches the full open position, the cam 158 has been rotated through 180° and it opens the contacts 157a of the limit switch 157. As a result the operating winding 155w is deenergized, contacts 155a are opened and the motor 149 is deenergized.

Now, when it is desired to close the switch 10, the push button 160 is depressed. Since the shaft 146 has been rotated through 180° as a result of the previous operation, the cam 162 will have swung through 180° and will have permitted the contacts 161a of the limit switch 161 to close. An energizing circuit for the operating winding 159w is completed from the energized conductor 154 through the contacts 160a, operating winding 159w, and contacts 161a to the energized conductor 153. At contacts 159b a shunt circuit for the contacts 160a is completed and the push button 160 can be released. At contacts 159a, an obvious energizing circuit for the motor 149 is completed. It rotates the shaft 146 in the same direction that it was previously rotated to rotate the first arm 47 in the same direction that it was previously rotated to operate the switch blade 29 from the vertical open position to the horizontal closed position.

When a system is employed which rotates the insulator 38 through 360°, the stops 48 and 61 on the terminal bracket 20 are omitted. Also, as previously pointed out, the rivet 77 on the left-hand outer blade leaf 65, Figure 2, is omitted. While a single source 150 of energization has been shown, it will be understood that separate sources can be used for energizing the motor 149 and the relays 155 and 159 and that either or both such sources can be direct or alternating current.

In Figures 10 and 11 of the drawings, another form of contact construction is illustrated which can be employed at the hinge end of the switch blade 29 in lieu of the butt contact construction 87 previously described. It will be observed that the journal 26 here is provided with a cylindrical extension 165 having a hinge contact socket 166 telescoped thereof and secured thereto by the bolt 107. Contact ribs 167 extend radially from diametrically opposite sides of the hinge contact socket 166, one being shown in Figure 11, for engagement with a prestressed generally U-shaped contact construction that is indicated, generally, at 168.

The U-shaped contact construction 168 includes two pairs of contact fingers 169, one pair being positioned on each side of the hinge contact socket 166.

Each contact finger 169 is made up of a U-shaped outer blade leaf 170 and a U-shaped inner blade leaf 171, both of good conducting material, such as copper. One arm of each of the U-shaped blade leaves 170 and 171 is secured by bolts 172 to the inner walls of the bifurcated end portion 21 of the terminal bracket 20. The other arms of the blade leaves 170 have contact engagement with the respective contact ribs 167.

With a view to urging the other arms of the blade leaves 170 and 171 into high contact pressure engagement with the contact ribs 167, an inverted U-shaped back-up spring 173 is employed. It will be observed that the spring 173 overlies the inner arms of the blade leaves 170 and 171 and that it is secured by rivets 174 to the underside of a sleet hood 175 which extends over the U-shaped contact construction 168 and is secured to the arms of the bifurcated end portion 21 by screws 176. Insulating knobs 177 at the lower ends of the arms of the back-up spring 173 contact the adjacent upwardly extending inner arms of the blade leaves 171 to transmit pressure thereto. The insulating knobs 177 pre-

vent the back-up spring 173 from carrying current and thus avoid overheating.

The prestressed construction is provided by a stop member 178 cooperating with the upper ends of the inner arms of the outer blade leaves. At the left-hand end of the inner arm of the outer blade leaf 170 is in side of Figure 11, it will be observed that the upper engagement with one end of the stop member 178. If the stop member 178 were not employed, this end of the blade leaf 170 would be biased further to the right and thus, when it is engaged by the corresponding contact rib 167 would necessarily have to be moved a much greater distance than is required when the stop member 178 is employed. All that is required when the stop member 178 is used is to lift the upper ends of the inner arms of the blade leaves 170 off of the ends of the stop member 178 and at once the full contact pressure is developed. In this manner a relatively high contact pressure is provided against the contact ribs 167 requiring a minimum of movement of the blade leaves 170.

In Figures 12, 13, 14 and 15 of the drawings, there is illustrated a contact construction for the hinge end of the switch blade 29 which remains in contact engagement therewith in all positions of the switch blade. As there shown, the switch blade 29 is carried by a blade shaft and socket 181 and is clamped thereto by a bolt 182. The socket 181 has a journal 183 formed integrally therewith and it is rotatably mounted in bushings 184 that are mounted on a bearing 185 which forms a part of blade carrier 186. The blade carrier 186 is swingably mounted on pivots 187 which extend outwardly from the arms of a bifurcated end portion 188 of a terminal bracket 189. The terminal bracket 189 corresponds generally to the terminal bracket 20 described hereinbefore and includes a bearing 193 in which the shaft 41, which extends upwardly from the rotatable insulator 38 is journaled.

The operating mechanism between the shaft 41 and the blade shaft and socket 181 is generally the same as described hereinbefore and is arranged on rotation of the shaft 41 through substantially 180° to swing the switch blade 29 through substantially 90° and vice-versa. If desired, the system shown in Figure 9 can be employed for rotation through 360°.

The connecting linkage includes the first arm 47 secured by the bolt 46 to the upper end of the shaft 41. The link 52 has a universal connection to one end of the first arm 47 and is connected by the pivot pin 54 to a second arm 194 that is formed integrally with the blade shaft and socket 181 and it corresponds to the second arm 51 previously described. On rotation of the first arm 47, the switch blade 29 first is rotated about its longitudinal axis 33 to disengage the contact at the far end and then it is swung about the pivots 187 and about a horizontal transverse axis 195 to the switch open position.

Formed integrally with the journal 183 is a cylindrical extension 196 over which a hinge contact socket 197 telescopes. The hinge contact socket 197 has arcuate contact surfaces 198 on its opposite side and they preferably form arcuate sections of a cylindrical contact surface. The hinge contact socket 197 is secured to the cylindrical extension 196 by a bolt 199 which has a central aperture 200 therethrough. As before, the aperture 200 is provided to prevent the accumulation of water at the base of the switch blade 29 when it is in the open upright position.

The arcuate contact surfaces 198 on the hinge contact socket 197 are arranged to have contact engagement with a generally U-shaped contact construction that is shown, generally, at 203. This contact construction comprises a pair of contact leaves slotted longitudinally to provide contact fingers 204 symmetrically positioned on opposite sides of a line 205, Figure 15, about which the switch blade 29 swings. In Figure 15, the switch blade

29 is shown in the vertical upright position where the longitudinal axis 33 intersects the line 205 which, as shown, extends between the pairs of contact fingers 204. One reason for employing this arrangement of the contact fingers 204 with respect to the contact surfaces 198 is to insure that they have uniform engagement with the contact fingers 204 not only in the horizontal position but also in the vertical switch open position.

Each contact finger 204 comprises a U-shaped outer blade leaf 206 and a U-shaped inner contact spring 207. One arm of each leaf 206 and each contact spring 207 is secured by bolts 208 to the respective arm of the bifurcated end portion 188 of the terminal bracket 189. As shown in Figure 14, the other arms of the leaves 206 of the contact fingers 204 have contact engagement with the arcuate contact surfaces 198 and they are resiliently urged into high pressure contact engagement therewith by the other arms of the contact springs 207. It will be understood that the contact fingers 204 maintain contact engagement with the arcuate contact surfaces 198 regardless of the position of the switch blade 29.

In order to protect the contact construction 203, a sleet hood 209 is secured by bolts 210 to the blade carrier 186 and is movable therewith as the switch blade 29 moves between the closed and the open position.

In Figure 16 of the drawings there is shown a gear mechanism that can be positioned on top of the rotatable insulator 38 to operate the switch blade 29 in lieu of the constructions shown in Figures 1 and 13 of the drawings. Instead of driving the first arm 47 conjointly with the insulator 38, a reduction gear mechanism is interposed therebetween as will now be described.

A terminal bracket 20' is employed, corresponding to the terminal bracket 20, previously described, and it has formed integrally therewith a cylindrical casing 213 that is coaxially disposed with respect to the insulator 38. On the upper side of the casing 213 are the stops 48 and 61 which are employed for limiting the movement of the first arm 47 in the switch closed and switch open positions, respectively. The underside of the casing 213 is closed by a bottom 214. A fitting 215 is secured by bolts 216 to the top of the insulator 38 and has a flange 217 which is secured to a flange 218 by bolts 219. The flange 218 is formed integrally with a hub 220 which extends upwardly through the bottom 214 and journaled in a bearing 221 formed integrally therewith. The hub 220 is secured by a key 222 to a hub 223 which has a radial flange 224 formed integrally therewith that is provided with an upwardly extending annular flange 225 having gear teeth 226 formed integrally therewith. The gear teeth 226 and the annular flange 225 together comprise a driving gear and the gear teeth 226 are arranged to engage the teeth of a planet pinion 227 which is journaled on a shaft 228 that depends from the upper side of the casing 213 and is secured thereto against rotation by a pin 229. The pinion 227 has driving engagement with a driven gear 230 that is secured by a key 231 to a shaft 232 which is rotatably mounted within the hub 220 and a bearing 233 formed integrally with the cover of the casing 213. It will be observed that the first arm 47 is fast on the shaft 232 and that it rotates therewith. The driven gear 230 and shaft 232 here constitute the switch blade operator in the same sense that the insulator 38, shown in Figure 1, functions as the switch blade operator.

The gear ratio between the driving gear provided by the flange 225 and the gear teeth 226 and the driven gear 230 is about 2:1 so that for rotation of the insulator 38 through approximately 90°, the shaft 232 and the first arm 47 are rotated through approximately 180°. This effects movement of the switch blade 29 from and to the switch closed position as described previously.

By positioning the gear drive between the upper end of the insulator 38 and the first arm 47, it is unnecessary for the gear drive to support the weight of the insulator 38 as is the case when the construction shown in Figures

7 and 8 is employed. Thus it is possible to use a much lighter weight of gear mechanism than would otherwise be the case.

Reference with respect to the various embodiments of the switch construction disclosed herein has been made to movement of the switch blade 29 through an arc of 90° that is effected by a movement of the first arm 47 through 180°. It will be understood that these references are for illustrative purposes and that the movement of the switch blade 29 may be slightly more than 90° and that the movement of the first arm 47 may be slightly more than 180°. As a matter of fact, in the switch closed position, it is desirable to provide for moving the first arm 47 slightly past a position in alignment with the switch blade 29. Likewise, when the switch blade 29 has been swung to the switch open position shown by the broken lines in Figure 1 of the drawings, it is desirable to swing the first arm 47 a few degrees past a position diametrically opposed to the line terminal 17 at the remote end of the switch 10.

While the mechanism for operating the switch blade 29 has been described as employing a movement of the first arm 47 through approximately 180°, it will be understood that many of the features of the present invention can be employed with switch operating mechanism where the movement of the switch blade is effected as the result of movement of an operating member only through substantially 90°. Moreover, other operating mechanisms can be employed in lieu of the particular mechanisms disclosed herein.

Since certain further changes can be made in the foregoing constructions and different embodiments of the invention can be made without departing from the spirit and scope thereof, it is intended that all matter shown in the accompanying drawings and described hereinbefore shall be interpreted as illustrative and not in a limiting sense.

What is claimed as new is:

1. A switch comprising, in combination, a switch contact, a switch blade rotatable about its longitudinal axis for engaging said switch contact at one end, a switch blade carrier swingable through 90° about an axis transverse to said longitudinal axis for swingably mounting said switch blade, a switch blade operator rotatable through 180° about an axis perpendicular to said longitudinal axis when said switch blade is in the switch closed position and spaced from said transverse axis on the side away from said switch contact, a first arm rotatable with said switch blade operator and extending therefrom toward said switch contact and in alignment with said switch blade when it is in the closed position, a second arm secured to the other end of said switch blade and extending transversely therefrom in a plane containing the axis of rotation of said switch blade operator, and a link pivoted to said second arm and universally connected to said first arm whereby on rotation of said operator with said switch blade in the switch closed position said switch blade is first rotated about its longitudinal axis to disengage said switch contact and continued rotation of said operator through 180° swings said switch blade about said transverse axis through 90° in which position said link overlies said first arm and the latter cooperates therewith to lock said switch blade in the open position.

2. A switch comprising, in combination, a pair of switch contacts in insulated spaced relation, a switch blade rotatable about its longitudinal axis for high pressure engagement at its ends with said switch contacts, a switch blade carrier swingable adjacent one of said contacts through 90° about an axis transverse to said longitudinal axis for swingably mounting said switch blade, a switch blade operator rotatable through 180° about an axis perpendicular to said longitudinal axis when said switch blade is in the switch closed position and spaced from said transverse axis on the side away from the other of said contacts, a first arm rotatable with said switch

blade operator and extending therefrom toward said other switch contact and in alignment with said switch blade when it is in the closed position, a second arm secured to said switch blade adjacent said transverse axis and extending transversely therefrom in a plane containing the axis of rotation of said switch blade operator, and a link pivoted to said second arm and universally connected to said first arm whereby on rotation of said operator with said switch blade in the switch closed position said switch blade is first rotated about its longitudinal axis to disengage at least said other switch contact and continued rotation of said operator through 180° swings said switch blade about said transverse axis through 90° in which position said link overlies said first arm and the latter cooperates therewith to lock said switch blade in the open position.

3. A switch comprising, in combination, a pair of generally U-shaped switch contacts, a switch blade rotatable about its longitudinal axis for high pressure engagement at its ends with said switch contacts, a switch blade carrier swingable adjacent one of said contacts through 90° about an axis transverse to said longitudinal axis for swingably mounting said switch blade, a switch blade operator rotatable through 180° about an axis perpendicular to said longitudinal axis when said switch blade is in the switch closed position and spaced from said transverse axis on the side away from the other of said contacts, a first arm rotatable with said switch blade operator and extending therefrom toward said other switch contact and in alignment with said switch blade when it is in the closed position, a second arm secured to said switch blade adjacent said transverse axis and extending transversely therefrom in the plane containing the axis of rotation of said switch blade operator, and a link pivoted to said second arm and universally connected to said first arm whereby on rotation of said operator with said switch blade in the switch closed position said switch blade is first rotated about its longitudinal axis to disengage said U-shaped switch contacts and continued rotation of said operator through 180° swings said switch blade about said transverse axis through 90° in which position said link overlies said first arm and the latter extends away from said other switch contact and cooperates with said link to lock said switch blade in the open position.

4. A switch comprising, in combination, a generally U-shaped contact, a butt contact, means mounting said contacts in insulated spaced relation, a switch blade rotatable about its longitudinal axis for high pressure engagement with said U-shaped switch contact at one end, a switch blade carrier swingable through 90° about an axis transverse to said longitudinal axis for swingably mounting said switch blade and moving its other end into high pressure engagement with said butt contact, a switch blade operator rotatable through 180° about an axis perpendicular to said longitudinal axis when said switch blade is in the switch closed position and spaced from said transverse axis on the side away from said U-shaped contact, a first arm rotatable with said switch blade operator and extending therefrom toward said U-shaped contact in alignment with said switch blade when it is in the closed position, a second arm secured to said switch blade near said other end and extending transversely therefrom in a plane containing the axis of rotation of said switch blade operator, and a link pivoted to said second arm and universally connected to said first arm whereby on rotation of said operator with said switch blade in the switch closed position said switch blade is first rotated about its longitudinal axis to disengage said U-shaped contact and continued rotation of said operator through 180° swings said switch blade about said transverse axis out of engagement with said butt contact and through 90° in which position said link overlies said first arm and the latter cooperates therewith to lock said switch blade in the open position.

5. A switch comprising, in combination, a switch contact, a switch blade rotatable about its longitudinal axis for engaging said switch contact at one end, a switch blade carrier swingable through 90° about an axis transverse to said longitudinal axis for swingably mounting said switch blade, a switch blade operator rotatable through 360° about an axis perpendicular to said longitudinal axis when said switch blade is in the switch closed position and spaced from said transverse axis on the side away from said switch contact, and means operatively interconnecting said switch blade and said switch blade operator whereby on rotation of said operator with said switch blade in the switch closed position said switch blade is first rotated about its longitudinal axis to disengage said stationary contact and continued rotation of said operator through 180° swings said switch blade about said transverse axis through 90°, continued rotation of said switch blade operator in the same direction causing reverse movement of said switch blade as aforesaid.

6. A switch comprising, in combination, a switch contact, a switch blade rotatable about its longitudinal axis for engaging said switch contact at one end, a switch blade carrier swingable through 90° about an axis transverse to said longitudinal axis for swingably mounting said switch blade, a switch blade operator rotatable through 360° about an axis perpendicular to said longitudinal axis when said switch blade is in the switch closed position and spaced from said transverse axis on the side away from said switch contact, means operatively interconnecting said switch blade and said switch blade operator whereby on rotation of said operator with said switch blade in the switch closed position said switch blade is first rotated about its longitudinal axis to disengage said stationary contact and continued rotation of said operator through 180° swings said switch blade about said transverse axis through 90°, continued rotation of said switch blade operator in the same direction causing reverse movement of said switch blade as aforesaid, drive means operatively connected to said switch blade operator for rotating the same through 360°, and means cooperating with said switch blade operator and said drive means for stopping the former at positions corresponding to the extreme positions of said switch blade when open or closed.

7. A switch comprising, in combination, a generally U-shaped contact, a butt contact, means mounting said contacts in insulated spaced relation, a switch blade rotatable about its longitudinal axis for high pressure engagement with said U-shaped contact at one end, a switch blade carrier swingable about an axis transverse to said longitudinal axis for swingably mounting said switch blade and moving its other end into high pressure engagement with said butt contact, said butt contact being generally U-shaped with one arm thereof being fastened to the mounting means individual to said butt contact and the other arm arranged to be engaged by said other end of said switch blade whereby the magnetic forces generated by heavy current flow cause said arms to tend to move apart and correspondingly increase the contact pressure on said other end of said switch blade, a switch blade operator rotatable about an axis perpendicular to said longitudinal axis when said switch blade is closed and spaced from said transverse axis on the side away from said U-shaped contact, and means operatively interconnecting said switch blade and said switch blade operator whereby on rotation of the latter with said switch blade in the switch closed position said switch blade is first rotated about its longitudinal axis to disengage said switch contact and continued rotation of said operator swings said switch blade about said transverse axis out of engagement with said butt contact and to switch open position.

8. A switch comprising, in combination, a generally U-shaped contact, a butt contact, means mounting said contacts in insulated spaced relation, a switch blade rotatable about its longitudinal axis for high pressure en-

gagement with said U-shaped contact at one end, a switch blade carrier swingable about an axis transverse to said longitudinal axis for swingably mounting said switch blade and moving its other end into high pressure engagement with said butt contact, said butt contact being generally U-shaped with one arm thereof being fastened to the mounting means individual to said butt contact and the other arm arranged to be engaged by said other end of said switch blade whereby the magnetic forces generated by heavy current flow cause said arms to tend to move apart and correspondingly increase the contact pressure on said other end of said switch blade, spring means biasing said other arm of said butt contact into high pressure contact engagement with said other end of said switch blade, stop means carried by said mounting means individual to said butt contact for limiting the movement of said other arm away from said one arm whereby the same is prestressed, a switch blade operator rotatable about an axis perpendicular to said longitudinal axis when said switch blade is closed and spaced from said transverse axis on the side away from said U-shaped contact, and means operatively interconnecting said switch blade and said switch blade operator whereby on rotation of the latter with said switch blade in the switch closed position said switch blade is first rotated about its longitudinal axis to disengage said switch contact and continued rotation of said operator swings said switch blade about said transverse axis out of engagement with said butt contact and to switch open position.

9. A switch comprising, in combination, a generally U-shaped contact, a butt contact, means mounting said contacts in insulated spaced relation, a switch blade rotatable about its longitudinal axis for high pressure engagement with said U-shaped contact at one end, a switch blade carrier swingable about an axis transverse to said longitudinal axis for swingably mounting said switch blade and moving its other end into high pressure engagement with said butt contact, said butt contact being formed by an outer generally U-shaped contact leaf of good conducting material and in inner generally U-shaped contact spring, means clamping one arm of said contact leaf and one arm of said contact spring to the mounting means individual to said butt contact, the other arm of said contact leaf having contact engagement with said other end of said switch blade and the other end of said contact spring urging the same into said contact engagement, a switch blade operator rotatable about an axis perpendicular to said longitudinal axis when said switch blade is closed and spaced from said transverse axis on the side away from said U-shaped contact, and means operatively interconnecting said switch blade and said switch blade operator whereby on rotation of the latter with said switch blade in the switch closed position said switch blade is first rotated about its longitudinal axis to disengage said switch contact and continued rotation of said operator swings said switch blade about said transverse axis out of engagement with said butt contact and to switch open position.

10. A switch comprising, in combination, a generally U-shaped contact, a butt contact, means mounting said contacts in insulated spaced relation, a switch blade rotatable about its longitudinal axis for high pressure engagement with said U-shaped contact at one end, a switch blade carrier swingable about an axis transverse to said longitudinal axis for swingably mounting said switch blade and moving its other end into high pressure engagement with said butt contact, said butt contact being formed by an outer generally U-shaped contact leaf of good conducting material and an inner generally U-shaped contact spring, means clamping one arm of said contact leaf and one arm of said contact spring to the mounting means individual to said butt contact, the other arm of said contact leaf having contact engagement with said other end of said switch blade and the other end of said contact

spring urging the same into said contact engagement, stop means limiting the movement of said other arm of said contact leaf as biased by said contact spring whereby the same is prestressed, a switch blade operator rotatable about an axis perpendicular to said longitudinal axis when said switch blade is closed and spaced from said transverse axis on the side away from said U-shaped contact, and means operatively interconnecting said switch blade and said switch blade operator whereby on rotation of the latter with said switch blade in the switch closed position said switch blade is first rotated about its longitudinal axis to disengage said switch contact and continued rotation of said operator swings said switch blade about said transverse axis out of engagement with said butt contact and to switch open position.

11. A switch comprising, in combination, a generally U-shaped contact, butt contact, means mounting said contacts in insulated spaced relation, a switch blade rotatable about its longitudinal axis for high pressure engagement with said U-shaped contact at one end, a switch blade carrier swingable about an axis transverse to said longitudinal axis for swingably mounting said switch blade and moving its other end into high pressure engagement with said butt contact, said butt contact being formed by outer and inner generally U-shaped contact leaves of good conducting material and outer and inner generally U-shaped contact springs within said contact leaves, means clamping one arm of each of said contact leaves and one arm of each of said contact spring to the mounting means individual to said butt contact, the other arms of said inner and outer contact leaves having individual contact engagement with said other end of said switch blade and the other arms of said contact springs individually urging the same into said contact engagement, a switch blade operator rotatable about an axis perpendicular to said longitudinal axis when said switch blade is closed and spaced from said transverse axis on the side away from said U-shaped contact, and mean operatively interconnecting said switch blade and said switch blade operator whereby on rotation of the latter with said switch blade in the switch closed position said switch blade is first rotated about its longitudinal axis to disengage said switch contact and continued rotation of said operator swings said switch blade about said transverse axis out of engagement with said butt contact and to switch open position.

12. A switch comprising, in combination, a generally U-shaped contact, a butt contact, means mounting said contacts in insulated spaced relation, a switch blade rotatable about its longitudinal axis for high pressure engagement with said U-shaped contact at one end, a switch blade carrier swingable about an axis transverse to said longitudinal axis for swingably mounting said switch blade and moving its other end into high pressure engagement with said butt contact, said butt contact being formed by outer and inner generally U-shaped contact leaves of good conducting material and outer and inner generally U-shaped contact springs within said contact leaves, means clamping one arm of each of said contact leaves and one arm of each of said contact springs to the mounting means individual to said butt contact, the other arms of said inner and outer contact leaves having individual contact engagement with said other end of said switch blade and the other arms of said contact springs individually urging the same into said contact engagement, insulating means between said other arms of said contact springs and the respective other arms of said contact leaves whereby no current is carried by the former, a switch blade operator rotatable about an axis perpendicular to said longitudinal axis when said switch blade is closed and spaced from said transverse axis on the side away from said U-shaped contact, and means operatively interconnecting said switch blade and said switch blade operator whereby on rotation of the latter with said switch blade in the switch closed position said switch blade is first rotated about its longi-

tudinal axis to disengage said switch contact and continued rotation of said operator swings said switch blade about said transverse axis out of engagement with said butt contact and to switch open position.

13. A switch comprising, in combination, a generally U-shaped contact, a butt contact, means mounting said contacts in insulated spaced relation, a switch blade rotatable about its longitudinal axis for high pressure engagement with said U-shaped contact at one end, a switch blade carrier swingable about an axis transverse to said longitudinal axis for swingably mounting said switch blade and moving its other end into high pressure engagement with said butt contact, said butt contact being formed by outer and inner generally U-shaped contact leaves of good conducting material and outer and inner generally U-shaped contact springs within said contact leaves, means clamping one arm of each of said contact leaves and one arm of each of said contact springs to the mounting means individual to said butt contact, the other arms of said inner and outer contact leaves having individual contact engagement with said other end of said switch blade and the other arms of said contact springs individually urging the same into said contact engagement, stop means limiting the movement of said other arms of said contact leaves as biased by the respective contact springs whereby the same are prestressed, a switch blade operator rotatable about an axis perpendicular to said longitudinal axis when said switch blade is closed and spaced from said transverse axis on the side away from said U-shaped contact, and means operatively interconnecting said switch blade and said switch blade operator whereby on rotation of the latter with said switch blade in the switch closed position said switch blade is first rotated about its longitudinal axis to disengage said switch contact and continued rotation of said operator swings said switch blade about said transverse axis out of engagement with said butt contact and to switch open position.

14. A switch comprising, in combination, a switch contact, a switch blade rotatable about its longitudinal axis for engaging said switch contact at one end, a switch blade carrier swingable about an axis transverse to said longitudinal axis for swingably mounting said switch blade, a switch blade operator rotatable through 180° about an axis perpendicular to said longitudinal axis when said switch blade is in the switch closed position and spaced from said transverse axis on the side away from said switch contact, means operatively interconnecting said switch blade and said switch blade operator whereby on rotation of the latter with said switch blade in the switch closed position said switch blade is first rotated about its longitudinal axis to disengage said switch contact and continued rotation of said operator through 180° swings said switch blade about said transverse axis to switch open position, a crank arm extending from said switch blade operator, a generally C-shaped operating arm pivoted to rotate through 90° adjacent the axis of rotation of said switch blade operator and in one extreme position thereof having both branches extending beyond said axis of rotation, and a link pivotally interconnecting the outer end of said C-shaped operating arm and the outer end of said crank arm whereby on rotation of said C-shaped operating arm through 90° said switch blade operator is rotated through 180°.

15. A switch comprising, in combination, a switch contact, a switch blade rotatable about its longitudinal axis for engaging said switch contact at one end, a switch blade carrier swingable through 90° about an axis transverse to said longitudinal axis for swingably mounting said switch blade, a switch blade operator rotatable through 180° about an axis perpendicular to said longitudinal axis when said switch blade is in the switch closed position and spaced from said transverse axis on the side away from said switch contact, driving means rotatable through less than 180°, reduction gear means interposed between said driving means and said switch blade operator whereby

movement of the former through less than 180° effects movement of the latter through 180°, a first arm rotatable with said switch blade operator and extending therefrom toward said switch contact and in alignment with said switch blade when it is in the closed position, a second arm secured to the other end of said switch blade and extending transversely therefrom in a plane containing the axis of rotation of said switch blade operator, and a link pivoted to said second arm and universally connected to said first arm whereby on rotation of said operator with said switch blade in the switch closed position said switch blade is first rotated about its longitudinal axis to disengage said switch contact and continued rotation of said operator through 180° swings said switch blade about said transverse axis through 90° in which position said link overlies said first arm and the latter cooperates therewith to lock said switch blade in the open position.

16. A switch comprising, in combination, a switch contact, a switch blade rotatable about its longitudinal axis for engaging said switch contact at one end, a switch blade carrier swingable through 90° about an axis transverse to said longitudinal axis for swingably mounting said switch blade, a switch blade operator rotatable through 180° about an axis perpendicular to said longitudinal axis when said switch blade is in the switch closed position and spaced from said transverse axis on the side away from said switch contact, an insulator rotatable conjointly with said switch blade operator, driving means rotatable through less than 180°, reduction gear means interposed between said driving means and said insulator whereby movement of the former through less than 180° effects movement of the latter through 180°, a first arm rotatable with said switch blade operator and extending therefrom toward said switch contact and in alignment with said switch blade when it is in the closed position, a second arm secured to the other end of said switch blade and extending transversely therefrom in a plane containing the axis of rotation of said switch blade operator, and a link pivoted to said second arm and universally connected to said first arm whereby on rotation of said operator with said switch blade in the switch closed position said switch blade is first rotated about its longitudinal axis to disengage said switch contact and continued rotation of said operator through 180° swings said switch blade about said transverse axis through 90° in which position said link overlies said first arm and the latter cooperates therewith to lock said switch blade in the open position.

17. A switch comprising, in combination, a switch contact, a switch blade rotatable about its longitudinal axis for engaging said switch contact at one end, a switch blade carrier swingable through 90° about an axis transverse to said longitudinal axis for swingably mounting said switch blade, a switch blade operator rotatable through 180° about an axis perpendicular to said longitudinal axis when said switch blade is in the switch closed position and spaced from said transverse axis on the side away from said switch contact, an insulator rotatable between said insulator and said switch blade operator whereby movement of the former through less than 180° effects movement of the latter through 180°, a first arm rotatable with said switch blade operator and extending therefrom toward said switch contact and in alignment with said switch blade when it is in the closed position, a second arm secured to the other end of said switch blade and extending transversely therefrom in a plane containing the axis of rotation of said switch blade operator, and a link pivoted to said second arm and universally connected to said first arm whereby on rotation of said operator with said switch blade in the switch closed position said switch blade is first rotated about its longitudinal axis to disengage said switch contact and continued rotation of said operator through 180° swings said switch blade about said transverse axis through 90°

in which position said link overlies said first arm and the latter cooperates therewith to lock said switch blade in the open position.

18. A switch comprising, in combination, a switch contact, a switch blade rotatable about its longitudinal axis for engaging said switch contact at one end, a switch blade carrier swingable through 90° about an axis transverse to said longitudinal axis for swingably mounting said switch blade, a switch blade operator rotatable through 180° about an axis perpendicular to said longitudinal axis when said switch blade is in the switch closed position and spaced from said transverse axis on the side away from said switch contact, and means operatively interconnecting said switch blade and said switch blade operator whereby on rotation of the latter with the former in the switch closed position the same is first rotated about its longitudinal axis to disengage said switch contact and continued rotation of said operator swings said switch blade about said transverse axis through 90° and sinusoidally decelerates the same substantially to zero at the end of such movement.

19. A switch comprising, in combination, a pair of stationary insulators and an intermediate rotatable insulator, a bracket fastened to one of said stationary insulators and journaled on said rotatable insulator, a switch blade rotatable about its longitudinal axis of engaging said switch contact at one end, a switch blade carrier swingable on said bracket about an axis transverse to said longitudinal axis and to the axis of rotation of said intermediate insulator and between the latter axis and said switch contact for swingably mounting said switch blade, and means operatively interconnecting said switch blade and said rotatable insulator whereby on rotation of the latter with the former in switch closed position said switch blade is first rotated about its longitudinal axis to disengage said switch contact and continued rotation of said intermediate insulator swings said switch

blade about said transverse axis to switch open position.

20. A switch comprising, in combination, a pair of stationary insulators and an intermediate rotatable insulator, a bracket fastened to one of said stationary insulators and journaled on said rotatable insulator, a switch contact on the other of said stationary insulators, a switch blade rotatable about its longitudinal axis for engaging said switch contact at one end, a switch blade carrier swingable on said bracket about an axis transverse to said longitudinal axis and to the axis of rotation of said intermediate insulator and between the latter axis and said switch contact for swingably mounting said switch blade, a first arm rotatable with said intermediate insulator and extending therefrom toward said switch contact and in alignment with said switch blade when it is in closed position, a second arm secured to the other end of said switch blade and extending transversely therefrom in a plane containing said axis of rotation of said intermediate insulator, and a link universally connected to said first arm and pivoted to said second arm whereby on rotation of said intermediate insulator with said switch blade in switch closed position said switch blade is first rotated about its longitudinal axis to disengage said switch contact and continued rotation of said intermediate insulator swings said switch blade about said transverse axis to switch open position.

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