April 18, 1939. C. CHRISTENSEN 2,154,665

SWITCH

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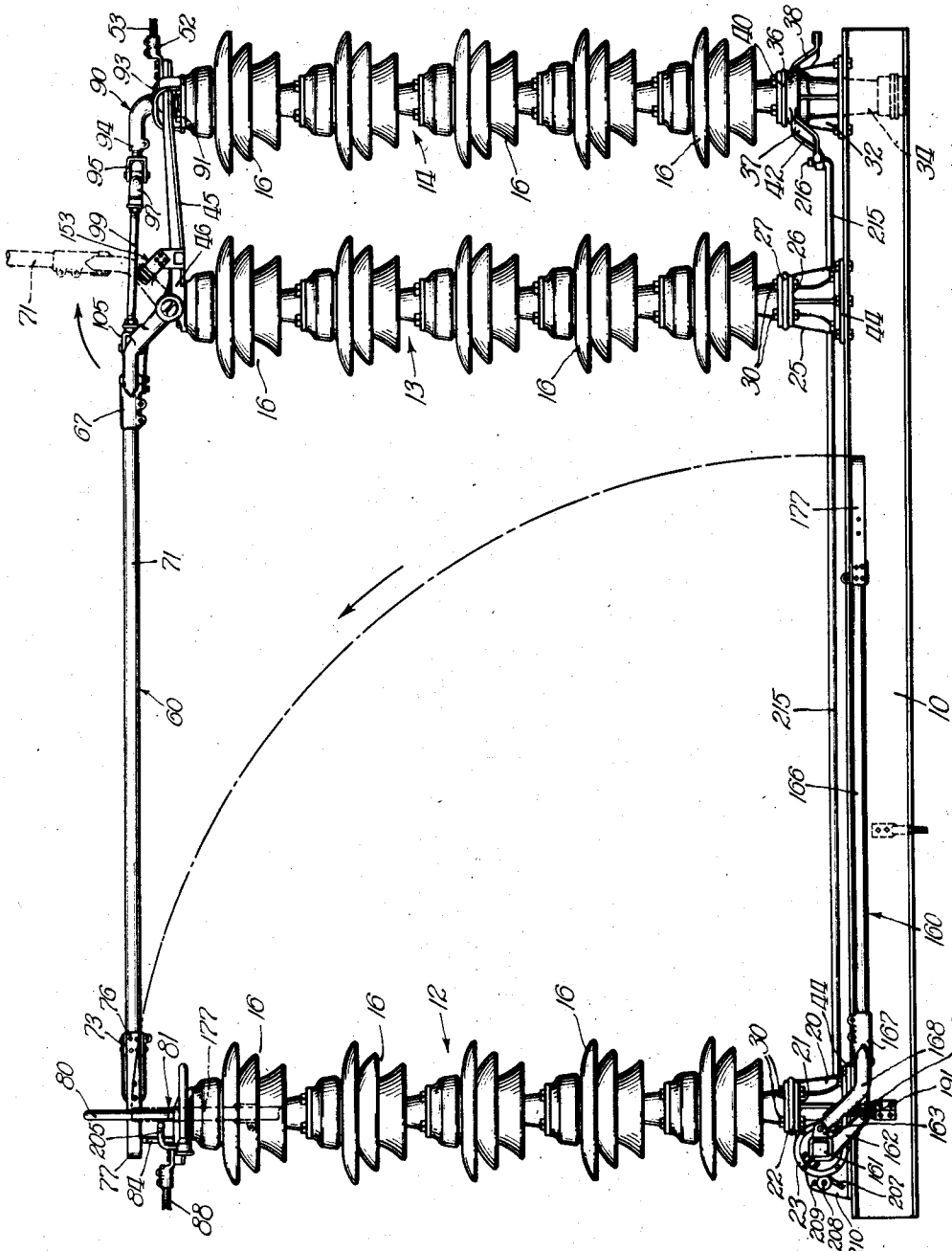

Fig. 1.

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SWITCH

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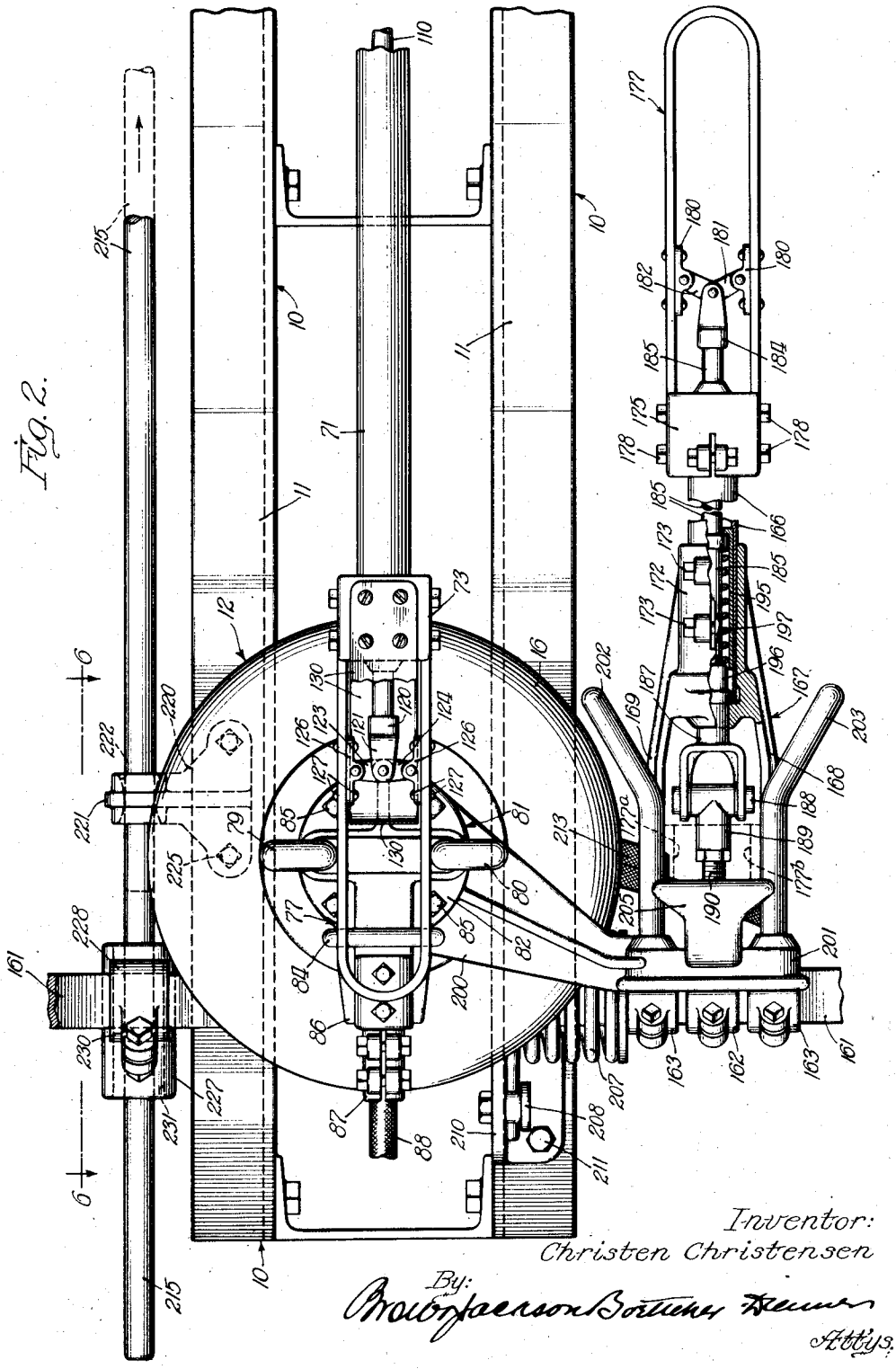
Fig. 2.



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SWITCH

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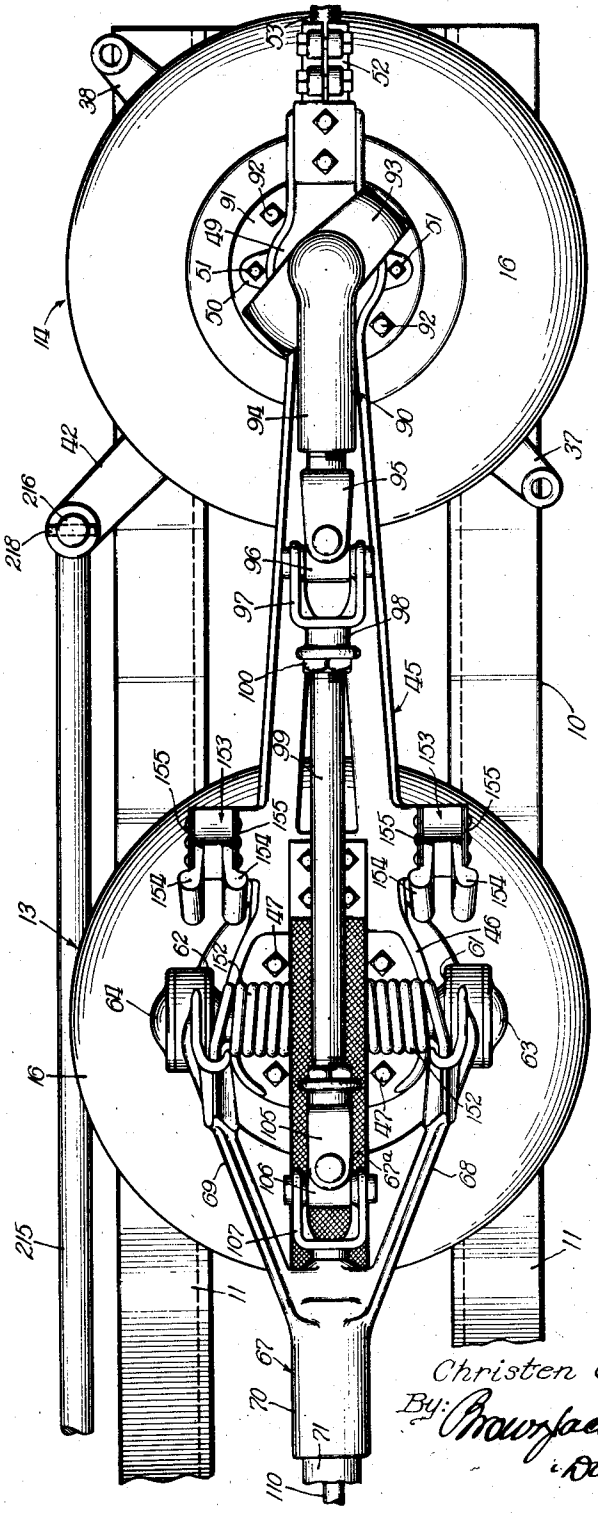

Fig. 3.

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Fig. 4.

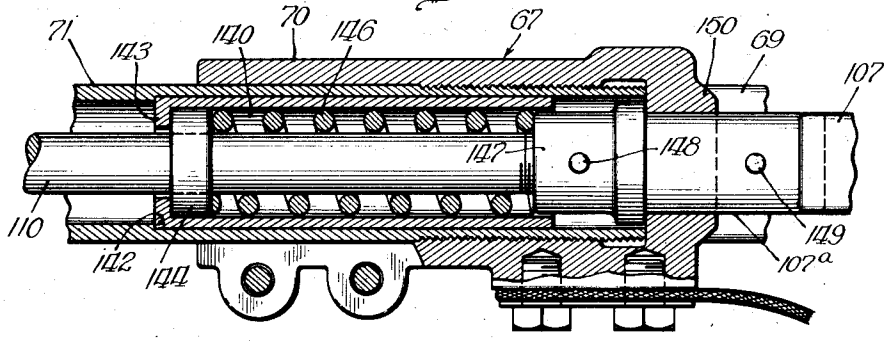


Fig. 5.

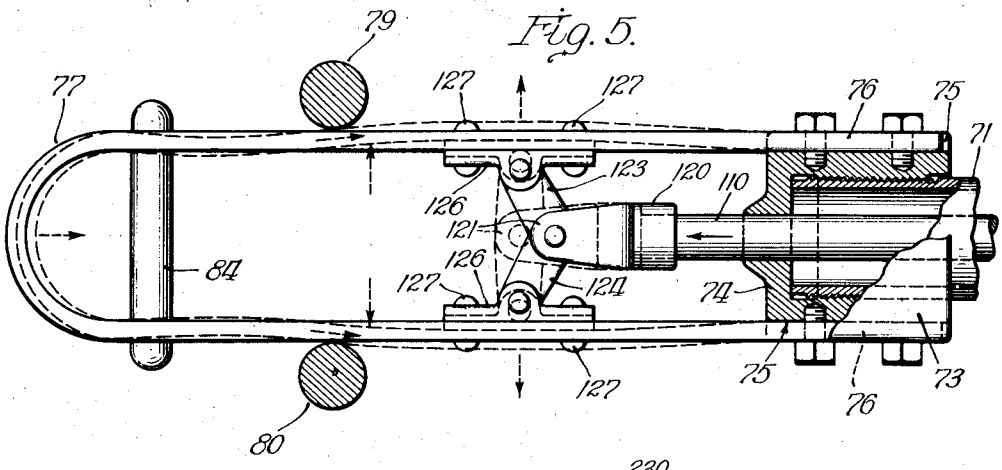
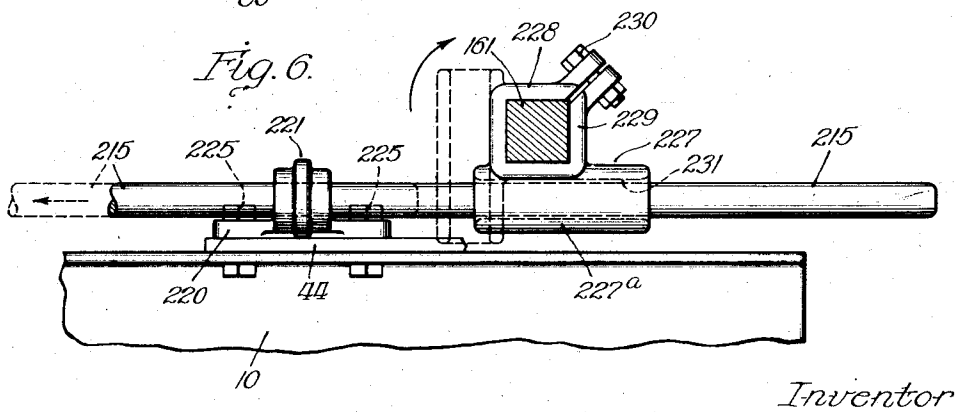


Fig. 6.



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SWITCH

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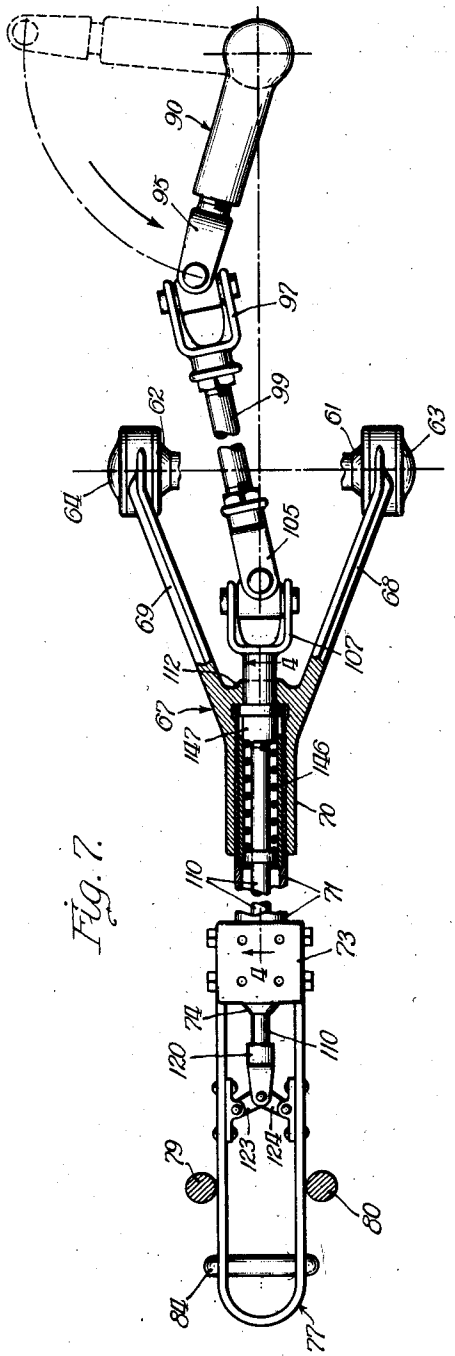

Fig. 7.

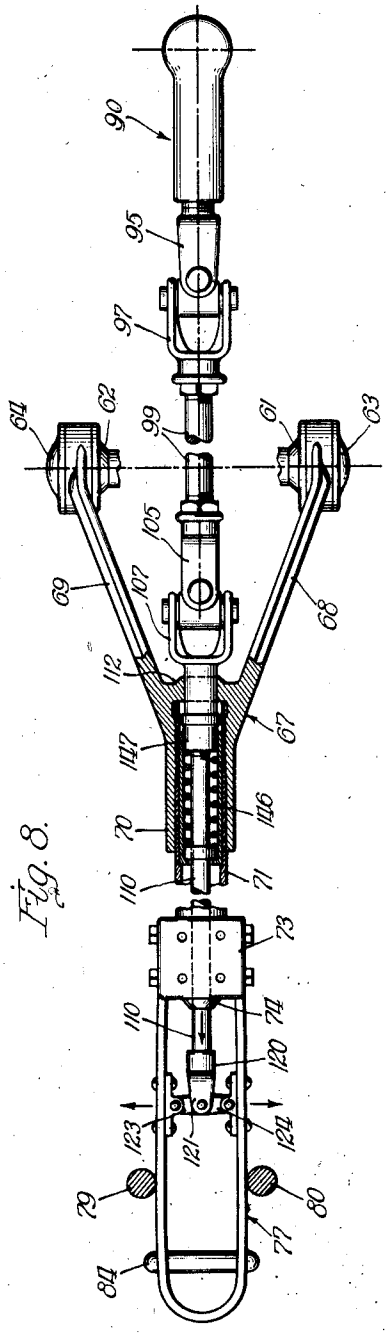

Fig. 8.

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Patented Apr. 18, 1939

2,154,665

UNITED STATES PATENT OFFICE

2,154,665

SWITCH

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Application January 2, 1936, Serial No. 57,186

18 Claims. (Cl. 200—48)

The present invention relates to disconnect switches in general and more particularly to switches of the type arranged to accommodate high tension current and having, first, means insuring a good conductive contact when the switch is closed and, second, sufficient clearance when the switch is open so as to establish the relatively wide gap or clearance required by the high voltage at which the current is transmitted.

Heretofore, various switches have been designed for securing both the desired conductivity and the necessary clearance between the high tension side and the ground. In one type of switch high pressure contacts were mounted on one end of a relatively long arm or blade, necessary to secure the required clearance when the switch is open, the high pressure being secured by pinching the blade in a generally U-shaped contact. Since these contacts were at the end of a relatively long arm or blade, it became difficult to exert the required amount of force, especially where long slender insulator stacks were used. Another type of switch secured the desired high degree of conductivity by the use of silver plated contacts. However, since a certain amount of scraping or rubbing is frequently desirable in operating the switch so as to clear the surface fouling, due to atmospheric conditions or the like, such silver plating tends to be worn away after a short time.

With the above factors in mind, one of the principal objects of the present invention is the provision of means for securing the desired high degree of conductivity without the use of silver plated contacts or the like and without complicated mechanism or other means imposing any excessive stresses on the elongated switch blade or insulator stacks. More specifically, it is an object of the present invention to provide a switch blade having only a single degree of motion and carrying contact means adapted to have two kinds of motions, one a forward movement carrying the contact into its proper position and the other a lateral motion for establishing or relieving a high unit pressure between the blade contact means and the associated stationary contact means. According to the principles of the present invention, in closing the switch, the blade carrying the contact means is moved in only one direction from an open or clear position to a closed position, but after the switch blade is closed then the contact means is expanded laterally so as to secure relatively high pressure between the movable and stationary contacts. In many cases, it is desirable that the first movement of the contact involve a light engagement for the purpose of scraping and cleaning the contact surfaces, but in other cases, especially where severe sleet conditions are encountered, it may be desirable to have the movable contact move into position with an appreciable initial clearance.

Another object of the present invention is the provision of operating means for the switch blade which is so inter-connected with the switch blade contact means that in closing the switch the movement of the operating means through its initial range of movement first completes the movement of the switch blade into its closed position and thereafter forces the switch blade contact means into firm engagement with the stationary contact, and in opening the switch the operating means first relaxes the high pressure contact and then swings the switch blade into its open position. An additional object of the present invention in this connection is the employment of toggle mechanism for securing the desired contact pressure and the provision of means ensuring that the switch blade will be moved into its fully closed position before the toggle mechanism will be actuated to secure the desired high pressure contact and the use of parts movable into dead center relation for the purpose of retaining such high pressure contacts against influences tending to relax the same.

Still further, another object of the present invention is the provision of a main or line switch with which is associated a grounding switch and means interlocking the latter with the line switch so as to put ground on either the blade end or the stationary contact end of the switch when the line switch blade is open and, further, to ensure that neither of the switches can be closed unless the other is in its open position.

These and other objects and advantages of the present invention will be apparent to those skilled in the art after a consideration of the following detailed description of the preferred structural embodiment, taken in conjunction with the accompanying drawings illustrating such embodiment.

In the drawings:

Figure 1 is a side view of switch mechanism embodying the principles of the present invention;

Figures 2 and 3 are enlarged top views of the switch mechanism shown in Figure 1;

Figure 4 is an enlarged section taken through a portion of the swingably mounted switch blade and showing the spring means for ensuring that the switch blade will be closed before the contact means is expanded;

Figure 5 is a fragmentary enlarged view, illustrating the operation of the toggle mechanism in forcing the switch blade contact means into firm engagement with the stationary contact so as to secure a relatively high unit pressure and good conductivity;

Figure 6 is a view taken along the line 6—6 of Figure 2 and looking in the direction of the arrows, showing the interlock betwen the line and ground switches; and

Figures 7 and 8 are fragmentary views illustrating the action of the operating means in forcing the switch blade contact means into firm engagement with the stationary contact member.

Referring now more particularly to Figure 1 which illustrates the preferred form of the entire switch assembly, the reference numeral 10 indicates a grounded base comprising a pair of spaced channels 11 upon which is mounted a pair of stationary insulator stacks 12 and 13 in spaced position thereon, and a rotatable insulator stack 14. Each of the insulator stacks consists of a series of insulators 16 secured one to the other and mounted upon a suitable supporting bracket. For the first insulator stack 12 the supporting bracket takes the form of an adapter 20 including a pedestal portion 21, receiving an adjusting insulator shim 22, and an extension 23 serving as a bearing housing for the ground switch which will be referred to later. The supporting bracket for the second fixed insulator stack 13 is indicated by the reference numeral 25 and preferably takes the form of an adjusting adapter formed with a pedestal portion 26 and an adjusting shim 27 practically identical with the corresponding parts of the base bracket 20. The upper surface of each of the pedestal portions 21 and 26 is generally spherical and the corresponding face of the associated adjusting shim is concave. These parts are provided with openings to receive bolts 30, the openings in the adjusting shims 22 and 27 being larger than the diameter of the bolts, whereby it is possible to change the position of the shims so as to bring the insulator stacks to the proper position.

The supporting base for the rotatable insulator stack 14 is indicated in its entirey by the reference numeral 32 and is similar to the parts 20 and 25 just described except that it is formed with a bearing extension 34 which is hollow and is formed to receive the spindle section of a stack rotating member 36 having oppositely extending operating arms 37 and 38. The upper surface of the stack rotating member 36 is formed like the upper surfaces of the pedestal portions 21 and 26 described above and receives an adjusting shim 40 which is preferably of the same construction as the adjusting shims 22 and 27. A third arm 42 is formed on or carried by the stack rotating member 36 and is a part of the ground switch interlocking means which will be described later. The outermost ends of the operating arms 37 and 38 are apertured to receive actuating rods or other means, well known in the art, for rotating the insulator stack 14 through a limited angle.

Generally, switches of the type shown in Figure 1 are arranged for gang operation, in which case the group of switches, usually three, have their arms 37 and 38 connected together for simultaneous operation. Plates 43 are carried by the channels to support the several base members 20, 25 and 32.

A brace 45 connects the upper ends of the insulator stacks 13 and 14 and preferably takes the form of a bronze casting having a cap section 46 at one end adapted to be bolted, as at 47 (Figure 3), to the upper end of the fixed insulator stack 13, and at its other end the brace 45 is formed with an apertured portion 49 which receives the shank of a spindle member 50 bolted, as at 51, to the upper end of the rotatable insulator stack 14. The shiftable insulator stack 14 is thus firmly supported at its upper and lower ends. The outermost end of the brace 45 is formed to receive a connector or line terminal 52 attached to one of the line conductors 53.

The upper end of the fixed insulator stack 13 pivotally supports a switch blade 60 (Figure 1) for swinging movement into and out of engagement with a stationary contact member carried at the upper end of the other fixed insulator stack 12. For this purpose the cap portion 46 of the brace 45 is formed with a pair of spaced lugs 61 and 62 suitably apertured to receive pins 63 and 64 which receive and pivotally support a hinge member 67 connected by a flexible cable 67a with the brace 45 and line cable 53 and having arms 68 and 69 mounted on the pins 63 and 64. The shank, indicated at 70, of the hinge member 67 serves as a sleeve to receive the inner end of a tubular member 71. The outer end of the tubular switch blade member 71 is received within a collar or clamp 73 having a central boss section 74. Opposite side walls of the collar 73 are recessed, as at 75, to receive the ends 76 of a generally flexible U-shaped spring contact member 77, best shown in Figure 2. The switch blade contact member 77 has its laterally spaced sections arranged to be brought into engagement with the arms 79 and 80 of a stationary contact member, indicated in its entirety by the reference numeral 81. The member 81 preferably includes a base section 82 of cast metal formed about the rods or sections 79 and 80, which are preferably copper or brass rods, the latter being firmly held in rigid relationship with respect to each other by their connection with the base 82. The latter is formed with an integral stop member 84. The stationary contact is preferably secured to the uppermost insulator 16 of the stack 12 by bolt means 85, and the portion of the base 82 carrying the stop 84 is extended, as at 86, to receive the connector 87 to which a line conductor 88 is connected.

In accordance with the principles of the present invention, the operating means for opening and closing the switch blade 60 is so arranged that, in closing the switch, the blade is first moved into a position determined by the stop 84, and thereafter continued movement of the operating means serves to expand or spread apart the spring contact member 77 and firmly urge the side sections thereof into firm contact with the stationary contact members 79 and 80 with a relatively high degree of pressure. The operating means will now be described.

A crank 90 is rigidly mounted upon the top of the insulator stack 14 so as to be rotated thereby. The crank or operating lever 90 includes a base portion 91 ground to fit against the upper end of the topmost insulator 16, being fastened thereto by any suitable means, such as bolts 92. The base section 91 supports the spindle member 50 referred to above as including a portion disposed for rocking movement in the apertured portion 49 of the brace 45. In order to accommodate the brace 45, the operating crank or lever 90 includes a forked section 93 spanning the outer end of the brace 45 and terminating upwardly and laterally in an internally threaded sleeve section 94 which receives the shank of a clevis 95. The bifurcated end of the member 95 is pivoted to a trunnion block 96 pivotally receiving a companion clevis 97 which has an internally threaded portion 98 receiving one end of a connecting link 99. An adjusting nut 100 serves to fix the clevis 97 to the associated end of the link 99.

At the other end of the link 99 is fixed a clevis

105 substantially identical with and in the same manner as the clevis 97. The clevis 105 is pivoted to a trunion block 106 to which a push rod clevis 107 is connected in substantially the same manner as the clevis 95. A longitudinally extending push rod 110 is slidably mounted within the tubular switch blade member 71, being received in the apertured boss 74 at the outer end of the switch blade and in a similar apertured boss section 112 in the forked hinge member 67. As will be apparent, the two pairs of pivotally interconnected clevises 95, 97 and 105, 107 constitute, in effect, universal joint means connecting the intermediate link 99 with the inner end of the push rod 110 and the operating arm or crank 90.

The outer end of the push rod 110 carries a bifurcated yoke 120 having a pair of apertured lugs 121 between which is pivoted a pair of toggle links 123 and 124 which extend in opposite directions therefrom. The outer end of each of the toggle links 123 and 124 is pivoted to a bracket 126 which, in turn, is riveted at 127 to the opposite sections of the U-shaped spring contact 77 at points closely adjacent to but spaced from the stationary contact members 79 and 80. A toggle link shield 130 encloses the toggle mechanism just described and is securely attached to the collar or clamp 73, as best shown in Figure 2, and serves to protect the toggle mechanism from the weather.

The push rod 110 is biased by suitable means for movement to a given position relative to the switch blade, so that the switch blade can be opened and closed by means acting against the push rod. To this end, a sleeve 140 is disposed within the inner end of the tubular switch blade member 71 against a stop shoulder 142 formed integrally thereof. The sleeve 140 has an internal flange 143 against which a collar 144, within which the push rod 110 is slidably mounted, is disposed. The collar 144 serves as an abutment for a compression spring 146 which bears at one end against the collar 144 and at its other end against a stop collar 147 suitably secured, as by a pin 148, to the inner end of the push rod 110. The clevis 107 is also secured to the inner end of the push rod 110 by similar means, such as a pin 149, the shank of the clevis 107 being elongated, as at 107a, and disposed for sliding movement in the apertured boss section 150 of the blade hinge member 67.

The operation of the switch mechanism so far as has been described is as follows. With the switch blade parts disposed in the position shown in Figure 7 but with the switch blade in vertical or separated position, indicated in dotted lines in Figure 1, when the operating arm 90 is turned from the dotted line position shown in Figure 7 to the full line position, the link 99 exerts a thrust on the inner end of the push rod 110. Since, however, the spring 146 holds the push rod in its retracted position, with the stop collar 147 up against the boss 112, the thrust exerted by the link 99 is effective to swing the switch blade downwardly into the full line position shown in Figure 1, the crank arm or operating member 90 and the link 99 acting by this means upon the pivotally mounted switch blade just as if there was a direct connection between the link and the blade itself. When the switch blade reaches the position shown in Figure 1, the tip or contact member 77 of the switch blade comes into engagement with the stop lug 84. This prevents any further downward movement of the switch blade and positions the contact member 77 in between the forks 79 and 80 of the stationary contact member 81. As mentioned above, even though the toggle mechanism is retracted, the spacing of the sides of the spring contact member 77 is such that in moving the switch blade 60 to the full line position shown in Figure 1, the sides of the contact member 77 engage the arms 79 and 80 lightly but with sufficient force to clear the parts of surface fouling, as indicated in Figure 7. This is not, however, the final position of the operating crank 90, for after the switch blade 60 has been brought up against the stop 84, the crank arm 90 is swung further in the same direction until it is in straight line relation with respect to the link 99, as indicated in Figure 8. Since, after the switch blade has been moved into the position shown in full lines in Figures 1 and 7, any further movement thereof is prevented, the continued movement of the crank arm 90 from the position shown in Figure 7 to the position shown in Figure 8 serves to compress the spring 146 and to force the push rod 10 to the left as viewed in this figure. This motion of the push rod 110 serves to swing the toggle links 123 from the position shown in Figure 7 to the position shown in Figure 8, the toggle links being straight, or preferably slightly over center, in the latter position. This straightening of the toggle links 123 and 124 expands the sides of the switch blade contact member 77 and forces them into firm high pressure engagement with the stationary contact elements 79 and 80. It will thus be seen that, although when the switch blade is first moved into its closed position there was only a light engagement between the movable contact element and the stationary contact element, just enough to clear the surface of scale, ice and the like, but with the movement of the crank arm 90 to its straight line position (Figure 8) the sides of the movable contact member 77 are pressed firmly into engagement with the stationary contacts. There is thus no material restriction to the movement of the switch blade as a whole into its closed position, and therefore the operating mechanism in moving the switch blade to its closed position does not have to overcome any great amount of friction, as would be the case if the movable and stationary contact elements were so arranged that full current carrying pressure was had the moment the movable contact part or parts first touched the stationary contact. It is not until the final movement of the switch element has occurred that the full pressure of the contacts is established.

In expanding the movable contact element 77 and spreading the sides thereof laterally and forcing them into firm engagement with the stationary contact arms, the toggle mechanism controlled by the shifting movement of the push rod 110 serves an important function in addition to the attainment of sufficient pressure between the contacts to efficiently conduct heavy current flow. Referring now to Figure 5 in which the parts are shown in full lines in the position that they occupy when the switch blade has been brought into its closed position but before the toggle mechanism has been extended, when the toggle links 123 and 124 are straightened they force the associated portions of the spring contact member 77 laterally outwardly into a position corresponding to that shown in dotted lines. This outward bending of the contact member causes the outermost or bight portion thereof to yield, and this results in bending the spring contact member 77 about the stationary contact elements 79 and 80

and forcing the member 77 to shift its points of contact with the stationary contact elements 79 and 80 across the elements with a scraping action generally longitudinally of the switch blade 60, as indicated by the dotted arrows adjacent the elements 79 and 80. This is highly effective in securing a good electrical connection between the movable and stationary contact parts, but what is of equal if not greater importance, this shifting and scraping action takes place under increasingly high pressure, due to the movement of the toggle links into their straight line position. This movement of the parts is indicated in Figure 5 by the use of the arrows, it being understood that the extent of movement is somewhat exaggerated in order to better illustrate the principles and functions involved. Also, as best illustrated in Figure 5, when the straightening of the toggle links has been completed, they are preferably moved into a slight overcenter position. This is for the purpose of overcoming any tendency for the spring 146, which it will be remembered is under compression after the crank arm 90 has been moved into the position shown in Figure 8, to relax the toggle pressure. In other words, once the toggle links have been moved into their straightened, or slightly overcenter, position to force the sides of the spring contact 77 firmly against the stationary contacts 79 and 80, the spring 146 is not strong enough to start the toggle back toward its retracted or relaxed position. In addition to this safeguard, it is also to be noted that any inadvertent retracting movement of the push rod 110 is prevented by the fact that the crank arm 90 and the link 99 (Figure 8) are in a straight line or dead center relation. Thus, even if the spring 146 should tend to release the toggle, the link 99 and the crank arm 90 would effectively resist any such movement of the push rod. By this means, therefore, the switch blade is locked in its closed position by means that is, in effect, the same as two separate mechanisms acting independently of one another for holding the switch closed. Thus, if the operating mechanism should break, the switch will remain closed.

A pair of torsion springs 152 are provided to assist in swinging the switch blade 60 to open position but the springs 152 are not strong enough to cause the compression of the spring 146 when the arm 90 swings the switch blade 60 downwardly. Stop brackets 153 limit the open position of the switch, the brackets consisting of lugs 154 mounted on the brace 45 by flat spring members 155.

In order to put ground on the line side of the switch, leading to the device or system to be connected and disconnected from the source of power, when the main switch or line switch is open, I provide a grounding switch indicated in its entirety by the reference numeral 160 and which is preferably of substantially the same construction as the switch 60 described above. Referring now more particularly to Figures 1 and 2, the supporting bracket 20 for the fixed insulator stack 12 has the bearing section 23, mentioned above, formed to receive a ground switch shaft 161 having a squared portion projecting from the supporting section 23 of the bracket 20 and carrying a lever 162 and a pair of brackets 163 on opposite sides of the lever 162, as best shown in Figure 2. The ground switch includes a switch blade 166 of tubular formation and secured at its inner end to a yoke 167 having spaced arms 168 and 169 pivotally connected, respectively, to the brackets 163 carried on the ground switch shaft 161. The shank of the yoke member 167 is in the form of a split sleeve 172 which is adapted to be clamped about the inner end of the tubular switch blade 166, as by bolts 173. The outer end of the tubular switch blade 166 carries a collar or bracket 175 to which the inner ends of a contact member 177 are connected, as by bolts or cap screws 178. The ground contact member 177 is preferably of substantially the same formation as the switch blade contact member 77 described above. The side portions of the ground contact member 177 carry brackets 180 to which the outermost ends of a pair of toggle links 181 and 182 are connected. The inner ends of the toggle links are pivoted to a yoke 184 fixed to the outer end of a longitudinally shiftable push rod 185, the inner end of which is fixed to a clevis 187 pivoted by pins 188 to a pivot block 189 having an interior threaded portion which receives the threaded end of a link 190. The latter is pivotally connected, as at 191 (Figure 1), to the end of the arm 162.

The push rod 185 is biased for movement against a stop, determining the relaxed position of the toggle mechanism, by spring means substantially the same as that shown in Figure 4 and provided for the switch blade 60. Referring now particularly to Figure 2, it will be noted that the inner end of the tubular switch blade 166 carries a sleeve 195 and that the inner end of the push rod 185 carries a collar 196. Between the flanged outer end of the sleeve 195 and the collar 196, a spring 197 is disposed and arranged to urge the push rod 185 for movement toward the left as viewed in Figure 2, bringing the collar 196 up against a stop shoulder formed on the blade hinge or yoke member 167, which is substantially the same operation as the spring 146 shown in Figure 4 and described above. The spring 197 is strong enough so that in the position of the operating shaft 161 shown in Figure 1, the weight of the switch blade and associated parts is not sufficient to overcome the tendency of the spring 197 to hold the push rod 185 in its retracted position, shown in Figure 2.

The stationary contact 81, mounted at the top or outer end of the insulator stack 12 as described above, carries a ground switch contact support in the form of a casting 200 which extends laterally of the insulator stack and terminates in a section 201 carrying a pair of contact arms 202 and 203, the outer ends of which are flared, in a manner similar to the contact arms 79 and 80. The section 201 also carries a stop lug 205, preferably but not necessarily formed integral with the contact support 200. The stop lug 205 is so disposed relative to the contact arms 202 and 203, which preferably are copper or brass rods imbedded in the casting 200 in the formation thereof, that when the ground switch is swung upwardly into a vertical position, indicated by the dotted lines in Figure 1, the side portions of the contact element 177 lie closely adjacent to, and preferably in light engagement with, the straight portions of the contact arms 202 and 203, as indicated at 177a and 177b in Figure 2.

A torsion spring 207 encircles the shaft 161 and has one end secured to the latter and the other end engaging a collar 208 carried in one of several holes 209 (Figure 1) in a bracket 210 bolted, as at 211, to one of the base channels 11. The spring 207, as well as the springs 152, serve to counterbalance the weight of the associated switch blades. A flexible ground cable 213 is con-

nected to the base 10 and to the switch blade yoke 167.

When it is desired to put ground on the stationary contact member of the main line switch, the shaft 161 is actuated in any suitable manner, and if the switch is one of a set of three, the ground switch shaft of each is operated simultaneously, preferably by means of a common operating means. Referring to Figure 1, rocking movement of the ground switch shaft 161 in a counterclockwise direction causes the arm 162 to act against the spring 197, but since this spring is stronger than the weight of the switch blade and associated parts, continued rocking movement of the shaft 161 in a counterclockwise direction raises the switch blade up to the position shown in dotted lines in the upper left hand portion of Figure 1 without forcing the push rod 185 to move longitudinally against the action of the spring 197. Thus, just as in the case of the main line switch 60, the switch blade is moved into its closed position with the contact member in retracted position. This brings the member 177 up into engagement with the stop 205. After this engagement has occurred, continued rocking movement of the ground switch shaft 161 swings the arm 162 secured thereto relative to the yoke or hinge member 167 of the switch blade, and this forces the push rod 185 outwardly and compresses the spring 197. Movement of the push rod 185 outwardly straightens the toggle links 181 and 182 and brings them to a straight line or preferably a slightly over-center position, and thereby forcibly extending or spreading the sides of the contact member 177 into firm engagement with the stationary contact arms 202 and 203. The movement of the toggle links 181 and 182 into their straight line or slightly over-center position disposes these parts so that the spring 197 will not retract them unless a positive retraction movement is applied to the push rod, as by a subsequent swinging of the ground switch shaft 161 in a clockwise direction as viewed in Figure 1.

It will thus be seen that in the case of either the ground switch 160 or the line switch 60, the switch is moved into its closed position before the contact element carried thereby is expanded, and then after the switch is in its fully closed position, the associated contact member is expanded and forced outwardly into a firm high pressure engagement with the stationary contact.

A further feature of the present invention embodies an interlock between the line switch and the ground switch so that neither of the switches can be closed unless the other is opened. Referring now more particularly to Figures 1, 2, 3 and 6, the third arm 42, carried on the operating lever 36 the swinging of which rocks or rotates the insulator stack 14 (Figure 1), is connected at its outer end with an interlocking rod 215 that extends longitudinally of the base 10 to a point adjacent the supporting means 20 for the stationary insulator stack 12. One end of the interlocking rod 215 is bent, as at 216, and is disposed in an opening formed in the end of the arm 42, as best shown in Figure 3, and the rod 215 is held in position by a pin 218 or the equivalent. The other end of the rod 215 is supported in the guide bearing in the form of a casting 220 having a lug section 221 formed with an enlarged and rounded aperture 222 therein to receive the rod 215 for both sliding movement and the rocking movement resulting from the angular movement of the arm 42 (Figure 3). The guide bracket 220 is preferably mounted by any suitable means, such as bolts 225, on the plate 44 which is secured to the base channels 11. The rod 215 extends beyond the guide bracket 220 and in a position closely adjacent to the ground switch shaft 161, as best shown in Figure 6. The shaft 161 carries an interlock sleeve 227 having split clamping sections 228 and 229 terminating in lugs receiving a clamping bolt 230 by which the interlock member is securely fixed to the shaft 161. The sleeve section 227a is arranged with its internal bore 231 preferably larger than the shaft or rod 215, this being for the purpose of accommodating the angular movement of the rod when the arm 42 is rotated. As best shown in Figure 6, in one position of the shaft 161 and the interlock member 227, shown in full lines in Figure 6, the opening 231 is in axial alignment with the rod 215, and in the other position, shown in dotted lines, the interlock member 227 is disposed at right angles to and in the path of movement of the rod 215.

In operation, when the ground switch is open and is in the position shown in Figure 1, the interlocking member 227 is disposed as indicated in full lines in Figure 6, with its opening in alignment with the rod 215. Assuming now that the main line switch is being moved from open position (dotted lines, Figure 1) to its closed position, by rocking the insulator stack 14 in a direction to swing the operating crank 90 from the dotted line position shown in Figure 7 to the full line position shown in Figure 8, the movement of the interlocking arm 42 will cause the rod 215 to be shifted to the left as viewed in Figure 2 and to the right as viewed in Figure 6, from the dotted line position to the full line position. Since the ground switch is open, the aperture 231 in the interlocking member 227 is in line with the rod 215 so that the latter will pass into and through the opening 231 as the line switch is being closed. Thus, when the line switch is closed and its contact member expanded into firm current carrying engagement with the associated stationary contact, the rod member 215 will be disposed in the opening in the interlocking member 227, and will thus hold the ground switch in its open position and will effectively prevent any inadvertent movement of the ground switch toward its closed position so long as the line switch is closed. This makes it necessary, therefore, to open the line switch before the ground switch can be closed.

When the line switch is opened, the opening movement withdraws the interlocking rod 215, shifting the same from the full line positions shown in Figures 2 and 6 to the dotted line positions, in which the member 227 is now free to rock since the rod is no longer engaged in the sleeve opening 231. It is to be noted in this connection, particularly from Figure 6, that before the ground switch is released, it is necessary that the line switch be opened practically to its full extent, for the rod 215 did not move free of the interlocking member 227 until the clear position of the line switch. After the line switch has been opened, the ground switch can then be closed by swinging the same upwardly to the dotted line position shown in Figure 1. This causes a rocking movement of the interlocking member 227 from its full line position to its dotted line position (Figure 6) in a clockwise direction. It will be noted that the sleeve section 227a is extended in such a manner that when the ground switch is closed a portion of the sleeve section 227a is disposed in the path of

movement of the interlocking rod 215 and closely adjacent to the outer end thereof. Therefore, as long as the ground switch is closed, any attempt to close the line switch will be opposed by the engagement of the outer end of the interlocking rod 215 with the end portion of the sleeve section 227a.

While I have shown and described above the preferred structure in which the principles of the present invention have been embodied, it will be apparent to those skilled in the art that the present invention is not to be limited to the specific details shown and described above, but that, in fact, widely different means may be employed in the practice of the broader aspects of my invention, as defined by the appended claims.

What I claim and desire to secure by Letters Patent is:

1. A switch comprising a swingably mounted switch blade member having only one plane of movement, contact means carried at the outer end of said switch blade member and laterally movable with respect thereto, a stationary contact structure adapted to receive said relatively movable switch blade contact means, and means forcing said switch blade contact means laterally into firm engagement with said stationary contact structure and simultaneously shifting portions of said movable contact means across said stationary contact structure generally longitudinally of the switch blade member and in the same direction relative thereto.

2. A switch comprising a swingably mounted switch blade unit having only one plane of movement, laterally flexible contact means movably carried at the outer end of said switch blade unit, a stationary contact structure adapted to receive said relatively movable switch blade contacts, and means for expanding said switch blade contacts, laterally outwardly against said stationary contact structure, said expanding means comprising rigid link means acting against said laterally flexible contact means at points spaced longitudinally of the switch blade unit from said stationary contact structure, whereby extension of said laterally flexible contact means draws both of them in the same general direction across said stationary contact structure.

3. A switch comprising a stationary contact structure including spaced arms, a movably mounted switch blade carrying at its outer end a resilient U-shaped contact having its ends fastened to said switch blade and adapted to pass loosely into position between the arms, and means acting against said resilient switch blade contact at points spaced from said arms for forcing the resilient switch blade contact into firm engagement with the stationary contact member arms and simultaneously shifting said resilient contact across said arms.

4. A switch comprising a swingably mounted switch blade including a rigid tubular section, a stationary contact structure including a forked contact member, a U-shaped spring contact mounted with its end portions fixedly secured to the outer end of said tubular section, a pair of toggle links pivoted, respectively, to opposite portions of said U-shaped spring contact, a push rod mounted for longitudinal movement within the tubular switch arm and having its outer end connected to the inner ends of said toggle links to shift the same longitudinally of the tubular section and force said opposite portions of the U-shaped contact into firm engagement with said forked contact member, and operating means connected with the other end of said push rod.

5. A switch comprising a tubular switch arm pivoted for swinging movement about its inner end, a stationary contact structure including a forked contact member, spring contact means secured to the outer end of said tubular switch arm, a pair of toggle links pivoted, respectively, to opposite portions of said spring contact means, movement of the inner ends of said toggle links longitudinally of said switch arm serving to expand and contract said opposite portions of said spring contact means, a push rod mounted for longitudinal movement within the tubular switch arm and having its outer end connected to the inner ends of said toggle links to shift the same longitudinally of the switch arm, a collar fixed to the inner end of said rod, spring means carried within said tubular arm around said push rod adjacent the pivoted end of said arm and reacting against said tubular arm and said collar for relaxing said toggle links and pulling said spring contact portions toward one another, a shoulder on said tubular arm engageable by said collar and serving as a stop for said rod, and operating means connected with said other end of said push rod.

6. A switch structure comprising a pair of separated insulator stacks, one carrying contact means, a switch blade pivoted to the other insulator stack and swingable into and out of engagement with the contact means of said first insulator stack, generally longitudinally movable means pivotally connected with said switch blade at a point spaced from its pivot axis for operating the same, and means carried on said other insulator stack for receiving the switch blade in its open position and holding the switch blade in a position so that a generally longitudinal movement of said operating means can return the switch blade to a position engaging the contact means on said one insulator stack.

7. A switch structure comprising a pair of separated insulator stacks, one carrying contact means, a tubular switch blade carrying contacts at its outer end, a yoke member fixed to the inner end of said tubular member and including separated portions pivoted to the outer end of the other insulator stack, a pair of toggle links pivoted, respectively, to the contacts carried by said tubular switch blade, a push rod mounted for longitudinal movement within said tubular switch blade and having its outer end connected to the inner ends of said toggle links, means connected with the inner end of said push rod and between the spaced portions of said yoke member for swinging said switch blade, and a pair of spaced stops carried on said other insulator stack and cooperating with said yoke member for receiving said switch blade in the open position of the latter.

8. A switch comprising a movably mounted line switch carrying contact means, a stationary contact structure adapted to be engaged by said line switch contact means, a ground switch movable into and out of engagement with said stationary contact structure, a member movable with each of said switches, and means on each member adapted to be moved into and out of engagement with the means on the other member to prevent either switch from being closed when the other is in its closed position.

9. Switch mechanism comprising a grounded base, a pair of separated insulator stacks, a line switch comprising a switch blade pivoted to one

of said stacks, stationary contact means carried by the other insulator stack and adapted to be engaged by said line switch blade, means for swinging said line switch blade from one position to another including an arm, a rod movable generally longitudinally on said grounded base and connected at one end to said arm, a grounding switch for connecting said stationary contact means with said grounded base and comprising a rockably mounted shaft journaled on said base, a switch blade movable into and out of contact with said stationary contact means, a sleeve member mounted for rocking movement with said shaft and arranged in one position in line with said rod to receive the same when the line switch is closed so as to prevent the movement of the ground switch blade to closed position, movement of said line switch to open position serving to withdraw said rod and free said sleeve and movement of said ground switch to closed position shifting said sleeve so as to prevent movement of said rod and hold said line switch in open position so long as said ground switch is closed.

10. Switch mechanism comprising a base, a pair of separated insulator stacks, a line switch comprising a switch blade pivoted to one of said stacks, a stationary contact means carried by the other insulator stack and adapted to be engaged by said line switch blade, operating means for swinging said line switch blade from one position to another, a rod movable generally longitudinally on said grounded base and connected with said operating means, a grounding switch for connecting said stationary contact means with said grounded base and comprising a rockably mounted shaft journaled on said base, a switch blade movable into and out of contact with said stationary contact means, a sleeve member mounted for rocking movement with said shaft and arranged in one position in line with said rod to receive the same when the line switch is closed so as to prevent the movement of the ground switch blade to closed position, movement of said line switch to open position serving to withdraw said rod and free said sleeve, and movement of said ground switch to closed position shifting said sleeve so as to prevent movement of said rod and hold said line switch in open position so long as said ground switch is closed.

11. In a switch, a pair of fixed contacts rigidly supported in spaced apart relation, a movable contact comprising a flexible U-shaped member and a movable switch blade to which the ends of said flexible member are fixed, and means reacting against the sides of said flexible contact members at a point adjacent but spaced from the points of contact of the latter with said fixed contacts, whereby when said contact member is expanded to establish a high pressure contact said side portions of the U-shaped contact member are deflected and their points of contacts shifted about the fixed contacts with a scraping action and under considerable pressure.

12. In a switch, in combination, two pairs of separable contact members, means for moving said contact members into cooperative relation, and means for moving said pairs of contact members into mutual contact engagement by applying pressure thereto and simultaneously shifting both contact members of one pair in the same direction relative to the other pair of contact members.

13. In a switch, in combination, a pair of spaced apart fixed contact members, a pair of movable contact members for individually engaging said fixed contact members, and operating means for applying pressure to said pair of movable contact members along a line generally parallel to the plane containing said spaced apart fixed contact members and slightly removed from a line joining the zones of contact engagement between said contact members to provide wiping contact engagement between said members in the same general direction.

14. In a switch, in combination, a pair of spaced apart fixed contact members, a pair of spaced apart resilient contact members movably mounted for individually engaging said fixed contact members, and operating means and including rigid link means for applying pressure between said pair of movable contact members along a line slightly removed from a line joining the zones of contact engagement between said contact members, said rigid link means also acting against said resilient contact members to shift them in the same general direction across said fixed contact members.

15. In a high voltage high contact pressure disconnecting switch, in combination, a rotatably mounted rigid contact arm, a pair of laterally flexible contact members fixed to the outer end of said arm, a pair of spaced apart fixed contact members for cooperating with said laterally flexible contact members, operating means for rotating said arm to widely separate said contact members, and additional operating means carried by said rigid arm to apply pressure laterally to said resilient contact members outside of the zone of contact engagement with said fixed contact members so that said resilient members are deflected and their points of contacts shifted about the fixed contacts with a scraping action and under considerable pressure.

16. Interlocking means for a pair of switches, comprising a rotatable sleeve movable with one switch, and an axially shiftable member movable with the other switch into a position within said sleeve for holding said one switch in a given position so long as the other switch is in one position.

17. Interlocking means for a pair of switches, comprising an apertured part movable with one of said switches from one position to another, and another part movable with the other switch and adapted to engage in the aperture in said first part for the purpose of holding said one switch against movement until the other switch has been actuated to withdraw said other part from said aperture.

18. A switch structure comprising a pair of separated insulator stacks, one carrying contact means, a switch blade unit including a tubular member, a yoke member fixed to the inner end of said tubular member and including separated portions pivoted to the other insulator stack, means carried by said tubular member and including relatively movable portions at the outer end thereof adapted to be brought into engagement with said contact means, counterbalancing spring means disposed between the separated portions of said yoke member and serving to counterbalance the weight of said blade unit, and operating mechanism for swinging said tubular member and also moving said contact portions into and out of high pressure engagement with said contact means.

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