May 9, 1939. P. B. HOYE 2,157,174

SWITCH

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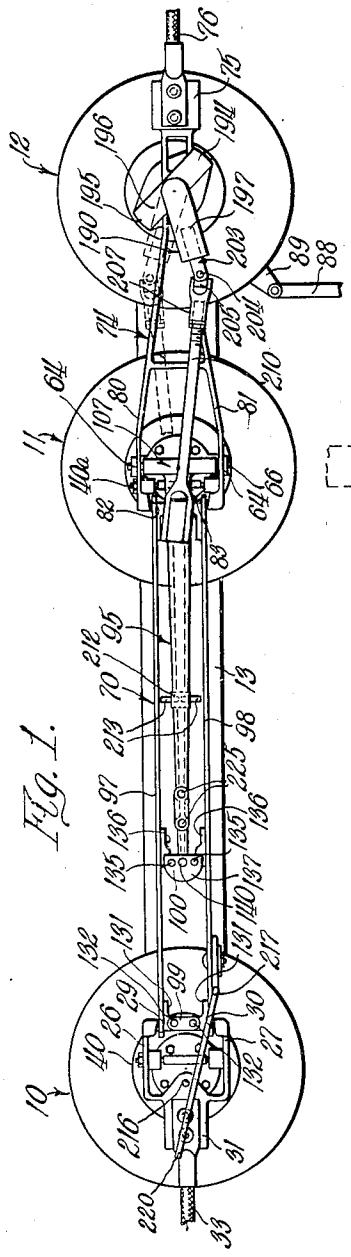


Fig. 1.

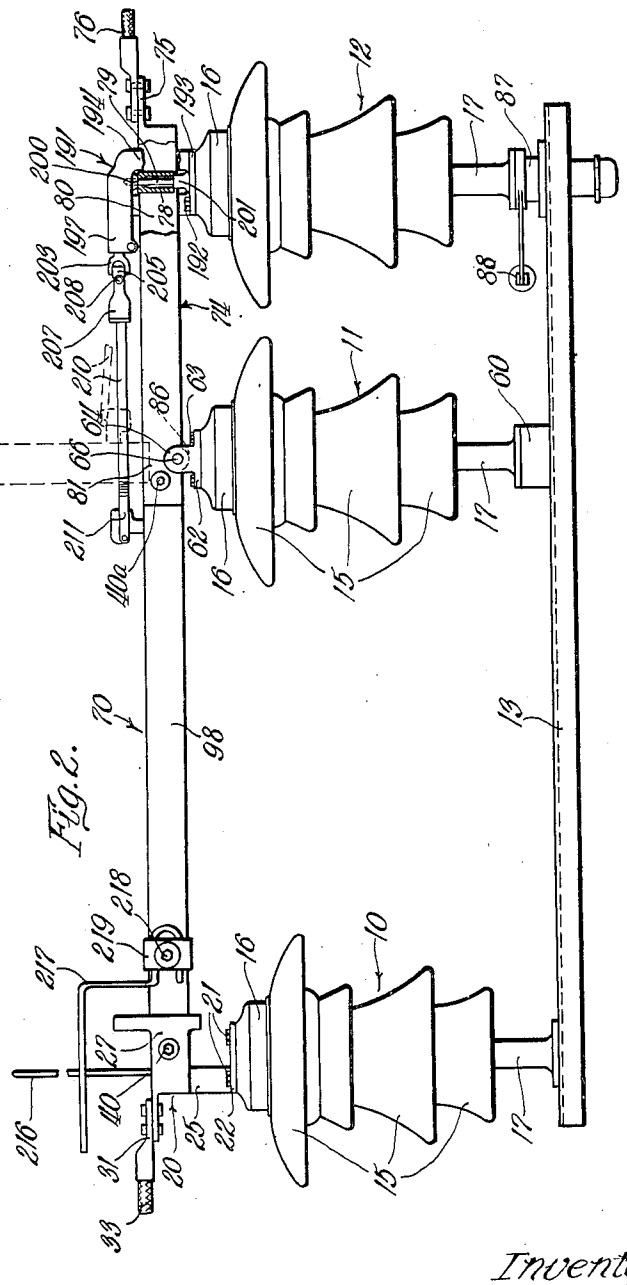


Fig. 2.

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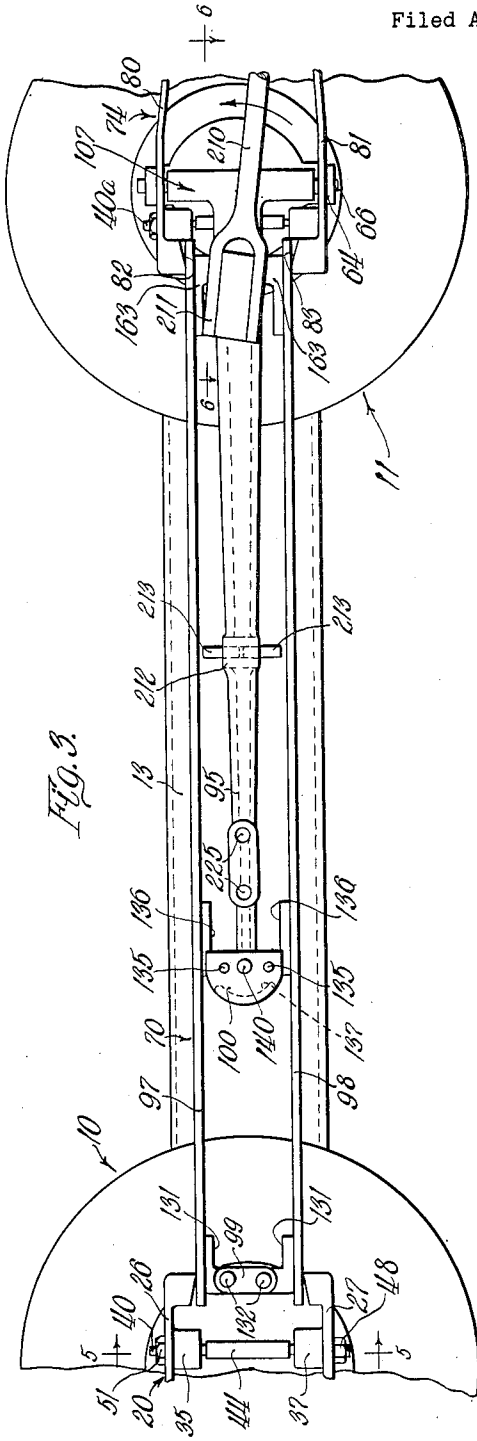


FIG. 3.

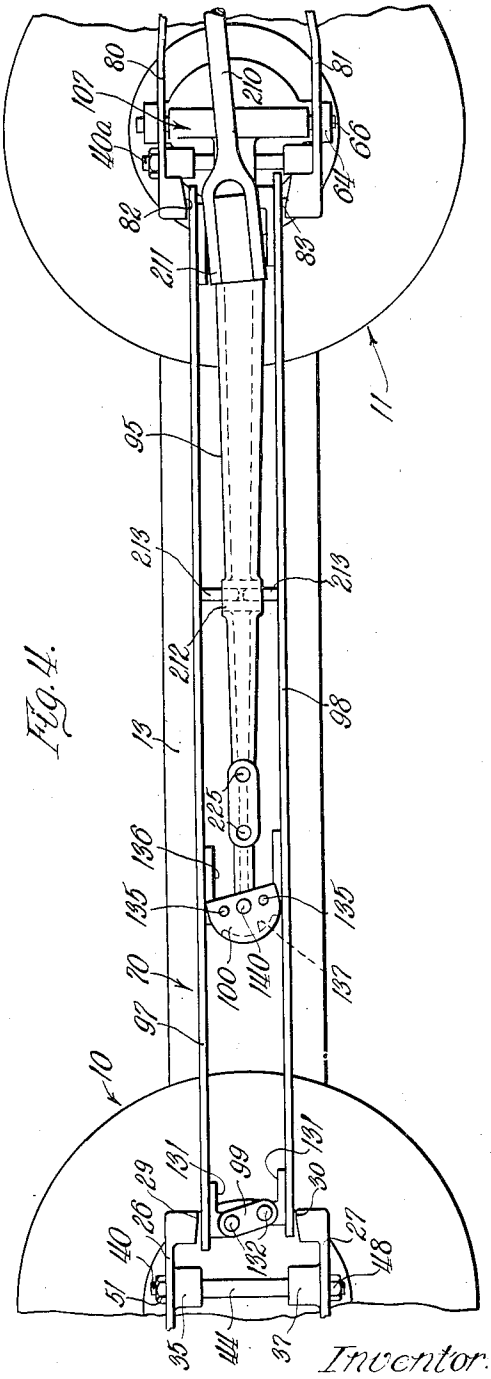


FIG. 4.

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Fig. 5

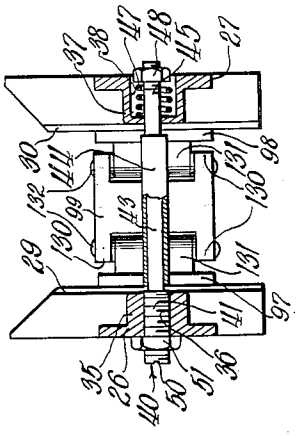


Fig. 6.

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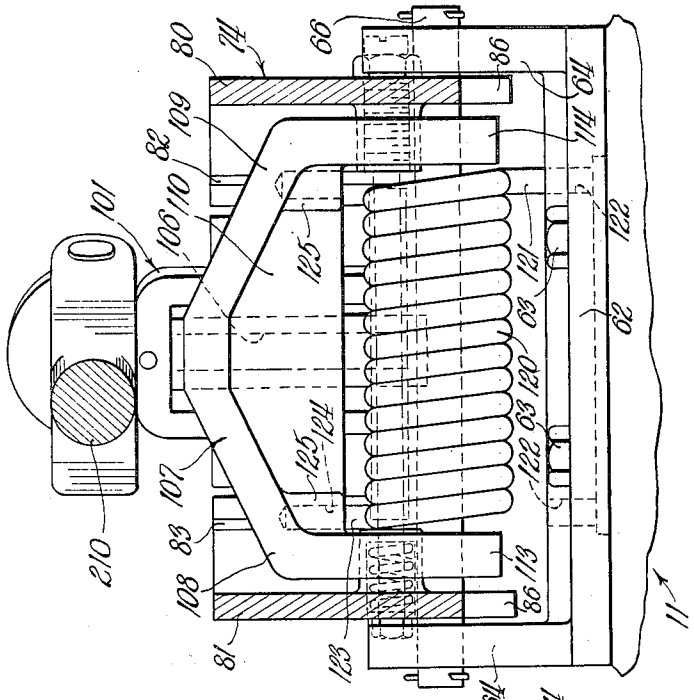


Fig. 8.

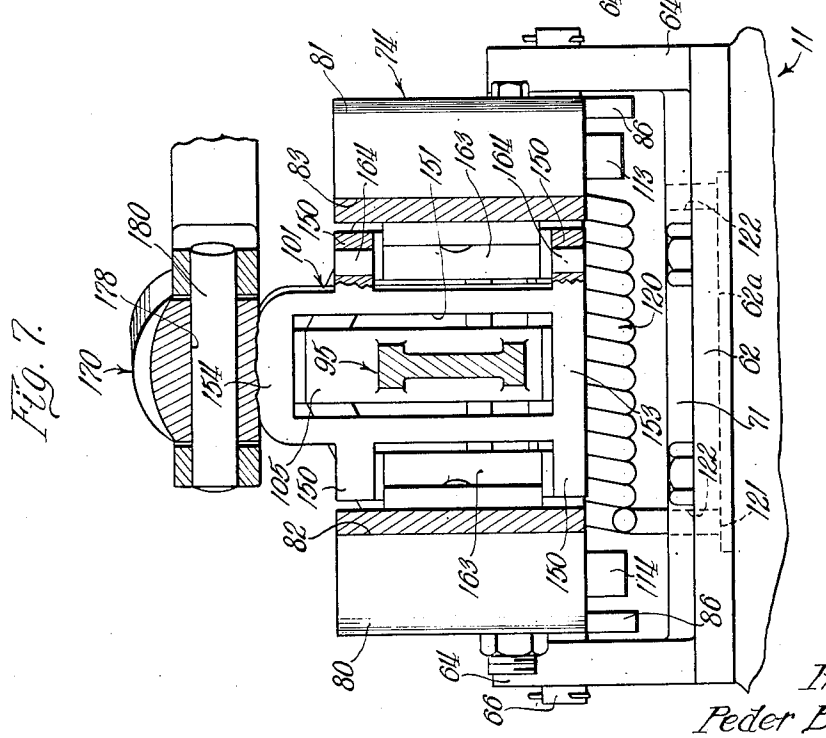


Fig. 7.

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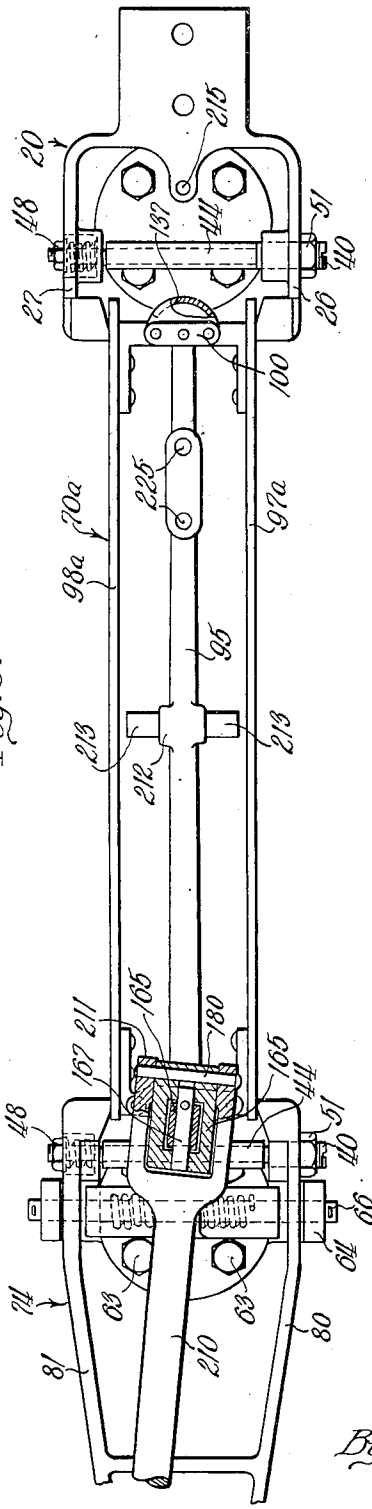


Fig. 9.

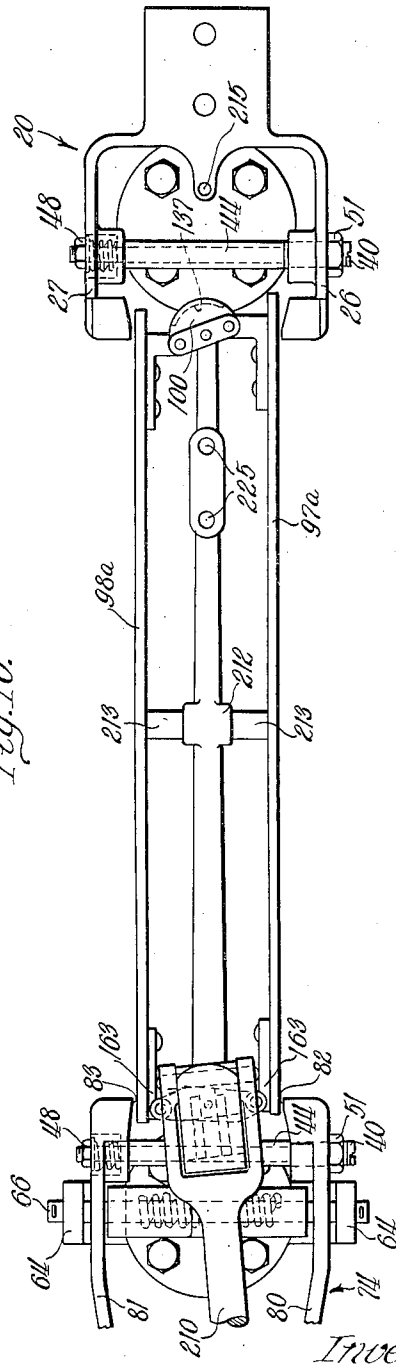


Fig. 10.

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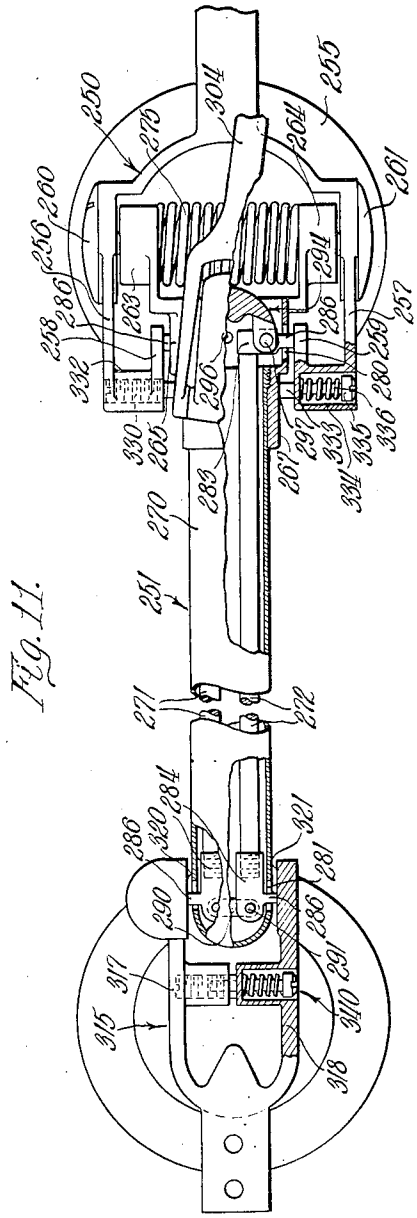


Fig. 11.

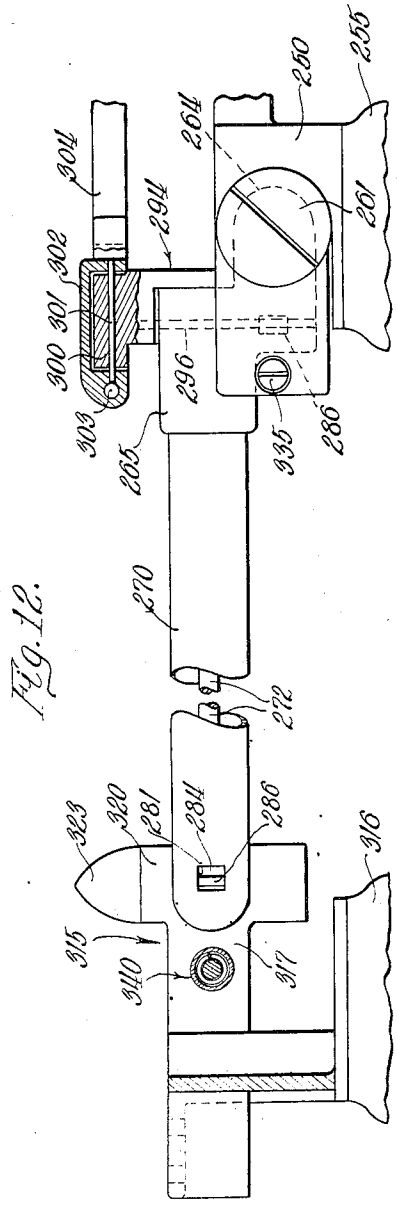


Fig. 12.

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Patented May 9, 1939

2,157,174

UNITED STATES PATENT OFFICE

2,157,174

SWITCH

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Application April 11, 1938, Serial No. 201,285

24 Claims. (Cl. 200—48)

The present invention relates generally to electrical switches and more particularly to disconnect switches for use with high voltage circuits. The switch of my invention is useful for either indoor or outdoor service but it is particularly applicable to outdoor service.

Outdoor disconnect switches are generally mounted in exposed locations where they are subjected to all kinds of weather conditions. Also, disconnect switches are usually operated only at infrequent intervals, yet it is desirable to insure their positive action whenever desired, regardless of the conditions to which the switches are exposed, and it is also desirable to secure good electrical contacts between the contact structures bridged by the disconnect switch when the line is closed.

The present invention is particularly applicable to the type of three insulator switch wherein a rotary insulator, through the operation of a crank and connecting rod, causes the actuation of a vertical blade or arm to cooperate with connecting contacts on the other two insulators, but it is to be understood that the invention is not limited to the specific form of switch shown and that separate insulators, as such, are not of the essence of the invention.

The chief object of the present invention is to provide an improved method of and means for connecting and disconnecting a pair of electrical terminals suitable for high tension disconnect switch purposes.

It is known in the switch art that to secure electric conductivity between two metallic contacts it is necessary to bring the two metallic surfaces into actual engagement without an intervening layer of oxide or foreign matter, and to secure a high unit pressure of the surfaces.

Various forms of so-called high pressure contacts have been developed and have successfully demonstrated the correctness of the aforesaid requirements. In general the metal-to-metal engagement is secured by a wiping or scraping motion of the surfaces relative to each other while they are put under pressure.

A common fault of known schemes of securing the so-called high pressure contact is inability to provide an appreciable area of engagement. While it has been demonstrated that the area under high pressure need not be great, that is, the conductivity of a unit area under high pressure is relatively high, nevertheless any scheme of securing high pressure contact which cannot secure more than point or line contact is subject to a serious limitation.

In my copending application, Serial No. 155,633, filed July 26, 1937, I have disclosed a method of and means for making contact between two stationary terminals and a bridging arm which involves the shifting of one blade contact member relative to the engaged terminal to produce simultaneously the desired scraping or wiping action and high pressure contact over a substantial area.

It is an object of the present invention to coordinate this general method of making a bridging contact between two terminals with operating mechanism which will avoid any uncertainties in operation.

I have combined a movable blade or arm member, cooperating with one or more stationary contacts, with an operating linkage in such manner that the entire intended movement of the arm and its high pressure contact is controlled at every position. That is to say, the operating linkage which brings the switch arm into position to cooperate with and produce the desired high pressure engagement consists of a series of pin connected members so proportioned and coordinated that movement of the operating crank on its shaft or axis positively produces the desired motions required to swing the arm into place and thereafter to shift the blade contact relative to the stationary terminals so as to produce the desired high pressure contact and vice versa. Consequently, since at no point is a motion or action merely permissive, but positive, misoperation or failure of operation, short of breakage of the parts, cannot occur. The result is a structure of great utility and certainty of operation which, because of the positive force available to produce every movement, is able to free itself of the encumbrances of sleet and the like and to produce the desired positive high pressure contact under weather conditions which would block the operation of switches of the prior art.

Preferably, I secure this action through the use of a crank, a link, and a swinging arm having one or more shiftable contacts which are cammed or forced into engagement through the angular motion of the connecting rod or link. The action of my switch is not dependent upon stoppage of the motion of any part, or any lost motion or any spring takeup, but is secured solely through the inherent change of relation of a number of links pivotally connected to each other.

More specifically, it is an object of the present invention to provide a disconnect switch in

which high pressure engagement and wiping action are secured at both ends of a swingable switch blade unit and in which both the relative movement necessary to secure the wiping action and the opening and closing of the switch are secured by a simple and effective operating mechanism.

A further object of the invention is the provision of a switch construction in which a crank is employed for opening and closing the switch and is connected with the switch unit by a connecting link which functions both to open and close the switch and also, at the proper time, to shift the switch blade sections and to force them into high pressure engagement with the associated stationary contact structures. A further object of the present invention in this connection is the provision of an improved switch blade unit which includes a rigid load sustaining member and two blade sections movable relative thereto and relative to each other into and out of high pressure engagement with associated stationary contacts. A further object of the present invention in this connection is the provision of such a rigid member in the form of a tubular structure within which the two relatively movable conducting blade members are mounted.

Another object of the present invention is the provision of improved contact structures, particularly adapted to be associated with switch blade structures in which the contact portions are movable into and out of high pressure engagement with associated contacts, the particular feature of this phase of the invention being the provision of spring biasing means acting against the contact surfaces of the stationary contact structure so as not only to provide but also to determine the amount of the high pressure engagement secured when the switch is closed.

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 forms which the present invention may take, in conjunction with the accompanying drawings.

In the drawings:

Figure 1 is a top view of a horizontally disposed disconnect switch embodying the principles of the present invention;

Figure 2 is a side view of the switch shown in Figure 1;

Figures 3 and 4 are views similar to Figure 1 but at an enlarged scale and showing two positions of the switch blade;

Figure 5 is a section taken along the line 5—5 of Figure 3;

Figure 6 is an enlarged detail view taken along the line 6—6 of Figure 3 and showing the pivot mounting of the switch blade unit and the hinged connection between the operating mechanism and the relatively shiftable switch blades;

Figure 7 is a section taken along the line 7—7 of Figure 6;

Figure 8 is a section taken along the line 8—8 of Figure 6;

Figures 9 and 10 are two views illustrating the application of the present invention to a modified form of disconnect switch, which can be arranged for vertical mounting;

Figure 11 is a top view of another modified form of switch; and

Figure 12 is a side view of the switch shown in Figure 11.

Referring now more particularly to Figures 1 to 8, inclusive, the form of the invention shown in these figures is of the three-insulator, vertical break type. The three insulators are indicated at 10, 11 and 12, and are mounted in any suitable manner from a base 13, which is preferably in the form of a channel iron or the like. Each insulator is a stack containing a number of porcelain units 15 and has a cap 16 at one end and a mounting fixture 17 at the other end. The insulator stack 10 carries a stationary contact structure 20 secured in any suitable manner, as by cap screws 21, to the upper end of the insulator unit 10. The stationary contact 20 includes a base 22 fastened to the insulator 10 as aforesaid, a supporting neck 25, and two contact sections 26 and 27 which have a certain amount of resiliency and are provided with two spaced apart contact surfaces 29 and 30 (Figure 4) which are milled to the desired dimensions. The stationary contact 20 is also provided with a lug 31 to receive the terminal or the current carrying cable 33 associated therewith.

The sections 26 and 27 of the stationary contact carrying the contact surfaces 29 and 30 are arranged to be forced toward one another by means of a spring and are limited in their movement under the influence of the spring. As best shown in Figure 5, the contact section 26 carries an apertured boss 35 which is threaded, as at 36, and the other contact section 27 carries a boss 37 which is provided with an exteriorly opening recess 38. A bolt 40 has an enlarged threaded head portion 41 screwed into the opening 36 in the boss 35. The shank 43 of the bolt 40 extends through a limit sleeve 44 to the other side of the contact and into the recess 38. This end of the bolt 40 is reduced in diameter and is threaded, as at 45. A spring 47 is seated in the recess 38 and bears at one end against the bottom of the recess and at the other end against an adjusting nut 48 screwed onto the threaded end 45 of the bolt 40. At one end, the limit sleeve 44 is adapted to seat against the enlarged threaded section 41 of the bolt 40, and the spring 47 acts against the contact section 27 and forces the inner end of the boss 37 against the other end of the limit sleeve 44 when the switch is opened, as shown in Figure 4, thus limiting the inward movement of one contact section relative to the other. The head of the bolt 40 has a kerf 50 which provides for turning the bolt 40 in the boss 35 to bring the contact section 26 closer to or move it farther away from the other contact section 27. A lock nut 51 serves to retain the bolt 40 in adjusted position. This provides a prestressed contact which has a definite spring loading. This loading is fully applied as soon as the spreading blade contacts spread the contacts the minute amount required to relieve the pressure upon the ends of sleeve 44. In other words, the pressure of the spring 47 is transferred completely to the blade contacts with substantially no travel of the contacts 29—30.

The insulator stack 11 is mounted on the channel 13 by means that includes a suitable spacer 60, and the cap 16 of the insulator stack 11 has a plate 62 fastened thereto, as by the usual cap screws 63. The plate 62 has a pair of upstanding apertured lugs 64 which serve to receive the pivot pin 66 by which the blade unit, indicated in its entirety by the reference numeral 70, is mounted for swinging movement on the insulator 11 toward and away from the stationary contact structure 20 on the insulator 10, as will be referred to later. The base of the insulator cap 62 is recessed, as at 62a (Figure 7), and is pro-

vided with a reinforcing rib 71 extending from one end of lug 64 to the other.

The insulators 11 and 12 are connected together by a bridge piece 74 which, at its outer end, is provided with an apertured lug 75 to receive a cable 76. The bridge adjacent its outer end is provided with a vertically apertured section 78 which receives the pivot 79 of the insulator unit 12 which is rotatable and which forms an operator for swinging the blade unit as will be referred to later. The inner portion of the bridge piece 74 flares laterally (Figure 1) and terminates in two contact sections 80 and 81 which have contact surfaces 82 and 83 of substantially the same construction as the sections 26 and 27 described above. The bridge piece 74, with its portions 80, 81, 82 and 83, thus forms a stationary contact structure for the insulator 11 to which the switch blade unit 70 is pivoted at 66. The sections 80 and 81 of the bridge piece 74 have apertured lugs 86 which receive the pivot pin 66 and thus connect the two insulators 11 and 12 together at their upper or outer ends. Immediately adjacent the contact surfaces 82 and 83 the contact sections 80 and 81 are provided with biasing spring and bolt means indicated by the reference numeral 40^a in Figure 1, by which the contact surfaces 82 and 83 are pressed toward one another. The means 40^a is of substantially the same construction as the biasing means 40 shown in Figure 5 for the other pair of stationary contact surfaces 29 and 30, and hence a further description is unnecessary. In the drawings, the same reference numerals have been used for the biasing means of the stationary contacts at both the hinge end and the outer end of the switch blade unit.

At its lower end the rotatable insulator 12 is carried in a suitable fitting 87 and is moved from one position to another by an operating link 88 connected to an arm 89 that is fixed to the lower end of the insulator 12 in any suitable manner.

The switch blade unit 70 of the present invention is of the type which includes relatively movable blade means that, by virtue of the relative movement, is capable of being forced into high pressure engagement with the associated stationary contacts. Each blade unit 70 consists of a rigid load sustaining member 95, best shown in Figures 1, 3, 4 and 6, which extends longitudinally, a pair of conducting bars or blades 97 and 98 arranged longitudinally of the rigid member 95, and three links 99, 100 and 101 (Figure 7), which connect the switch blade or bars 97 and 98 together and which are adapted to spread the switch blades apart when they are moved relative to each other in one direction and to draw them toward one another when they are moved relative to the other in the other direction. If desired, the rigid member 95 of the switch blade unit 97 may extend the entire distance of the blade unit or, it may extend somewhat less than the entire length of the blade unit, as shown in Figure 1. The inner end of the rigid member 95 is formed with an enlarged portion 105 (Figures 6, 7 and 8), which is provided with a vertical bore 106 and a rear forked portion 107 having branches 108 and 109 (Figure 8) that are connected by a lateral reinforcing web 110. The branches 108 and 109 extend downwardly and terminate in hinge lugs 113 and 114 which are apertured to receive the pivot pin 66, the latter thereby defining the pivot axis about which the rigid member 95 and the switch blade unit 70 as a whole swings relative to the insulator 11 and the stationary contact and bridge member 74. The downwardly disposed lugs 113 and 114 are disposed just inwardly of the lugs 86 on the member 74, and the latter are disposed inwardly of the lugs 64 carried on the insulator plate 62.

Disposed between the lug portions 113 and 114 of the hinge end of the rigid member 95 is a torsion spring 120 having one end 121 seated in a recess 122 formed in the upper insulating plate 62 and the other end 123 of the spring 120 is seated in a recess 124 formed in a boss 125 on the rear face of the transverse web 110. As best indicated in Figure 8, the cap 62 has two recesses 122 and the member 95 has two recessed bosses 125 so that the spring 120 may be arranged to counterbalance the weight of the switch blade unit whether the switch is disposed vertically or horizontally. That is, if the switch is arranged for horizontal mounting, the spring 120 is so arranged to exert a force tending to open the switch, and if the switch is arranged for vertical mounting, the spring 120 is arranged to tend to close the switch, acting against gravity in both cases.

At least two of the links 99, 100 and 101 which pivotally connect the switch blades 97 and 98 for movement relative to one another are also pivotally connected at their intermediate points to the rigid load sustaining member 95. Where the latter does not extend the entire length of the switch blade unit, the outer link 99 is not connected to the rigid load sustaining member, as best indicated in Figure 1. The form of the link 99 is best shown in Figure 5, and from this figure it will be seen that the link 99 includes two pairs of apertured ears 130. A pivot bracket 131 is fixed in any suitable manner to the outer end of each of the switch blades 97 and 98, and each bracket 131 includes an apertured section which is received between the ears 130, and a pair of pivot pins 132 serve to connect the ends of the link 99 to the blade brackets 131.

The pivot link 100 is constructed similarly to the link 99, having apertured ears to receive pivot pins 135 by which the link 100 is pivotally connected to pivot brackets 136 fixed in any suitable manner to the blades 97 and 98, as best indicated in Figures 1, 3 and 4. The link 100 differs from the link 99 in having a curved or arcuate hood 137 (Figures 3 and 4) which serves the important purpose of protecting the pivot 140 which is in the central portion of the link 100 and which connects the link 100, as well as the switch blades 97 and 98, to the outer end of the rigid load sustaining member 95. By thus protecting the pivot 140, ice, sleet or the like, is not so likely to interfere with the opening and closing of the switch, particularly in cases where the switch is mounted vertically as in Figures 9 and 10, as will be referred to later.

The inner link 101 has two important functions. Not only does it cooperate with the links 99 and 100 in accommodating the longitudinal movement of the blade members 97 and 98 relative to one another and also relative to the rigid supporting member and causing the latter to move toward and away from one another in the switch closing and opening operations, but also the inner link member 101 serves as a part of the operating mechanism by which the blade members are forced outwardly into high pressure engagement with the associated stationary contacts at the end of the switch closing movement and

are moved out of said high pressure engagement at the beginning of the switch opening movement. This expansion and contraction of the switch blade members preferably is accomplished by the same mechanism that opens and closes the switch but is controlled positively according to the angularity of the operating linkages so that the switch blade members will not be moved relative to one another in the closing operation until the switch blade unit is in the proper position, and that no tendency to open the switch will be exerted until after the switch blades have been released from their high pressure engagement.

Referring more particularly to Figures 6, 7 and 8, the inner pivot 101 for the switch blade unit comprises a generally rectangular member having four apertured ears 150 (Figure 7), an open center 151 which receives and embraces the hinge end 105 of the rigid member 95, and lower and upper transverse sections 153 and 154, these sections having vertical bores (Figures 6 and 7) 156 and 157 to receive the vertical pivot pin 158 which is received in the bore 106 formed in the portion 105 of the member 95. The pivot pin 158 is held in position by virtue of a pin or key 160 disposed in a bore 161 in the upper portion of the pivot link member 101, the key passing through a transverse opening 162 formed in the upper portion of the pin 158. The inner end of each of the blades 97 and 98 carries a pivot bracket 163 disposed in between the ears 150 at that side of the link 101, and a pin 164 pivotally connects each blade bracket 163 to the link 101 for swinging movement. Thus, by virtue of the pins 158 and 164, the link 101 can swing about a vertical axis with the other links 99 and 100 in providing for longitudinal movement of the blade members 97 and 98 relative to each other and relative to the rigid load sustaining member 95, and as the links 99, 100 and 101 swing about their pivots, the blade members 97 and 98 are drawn toward one another or forced outwardly away from one another with a toggle action in that the links are disposed generally at right angles to the planes of the blade members 97 and 98 (Figure 3).

The upper portion of the link member 101 is provided with a longitudinally extended sleeve section 165 which has a bore 166 formed therein to receive a longitudinal pivot pin 167 the ends of which extend outwardly of the section 165 and receive a pivot cap 170. The member 170 has longitudinally spaced downwardly extending lugs 171 and 172 which are apertured, as at 173 and 174, to receive the ends of the pivot pin 167. The member 170 is rounded on its upper side 176 and, at the end having the bore 174, is provided with a transverse bore 178 in which a pin 180 is disposed, the ends of which extend laterally outwardly of the member 170 (Figures 6 and 7). The longitudinal pin 167 is held in place by virtue of an extension 177 of reduced diameter that is formed on or carried by the upper end of the pivot pin 168 and is received in a bore in the horizontal pivot 167. Thus, the key pin 160 serves to hold both the pins 158 and 167 in position.

Referring now to Figures 1 and 2, the operating mechanism for swinging the switch blade unit 70 and tightening and releasing the blade members in their associated contacts is indicated in its entirety by the reference numeral 190 and comprises the rotatable insulator 12, to the upper end of which a crank member, indicated in its entirety by the reference numeral 191, is fixed in any suitable manner, as by bolts 192. The crank member 191 comprises a vertical generally rectangular structure embracing the contact bridge 74 and a base 193 which is bolted to the upper end of the insulator 12. The vertical arm portions 194 and 195 that extend upwardly on opposite sides of the member 174 are joined at the upper ends by a horizontal section 196 which has integrally formed therewith a crank 197. The member 191 includes bosses 200 and 201 which are bored to receive the pivot pin 79 which passes through the sleeve or tubular portion 78 of the member 74. The crank proper 197 is drilled to receive the threaded end of a clevis 203, the other end of which is forked and receives a pivot 204 which connects a block 205 to the clevis 203. A companion clevis 207, also forked, is connected by a pivot 208 to the block 205 and is drilled and threaded to receive the threaded inner end of an operating link 210 having an outer forked portion 211 which embraces the pivot cap 170 and is hingedly connected to the latter by means of the pivot pin 180, as best indicated in Figures 4 and 6. Thus, by virtue of two pivots 167 and 180, the operating link 210 is hingedly connected to the upper end of the inner toggle link 101 so that an angular movement of the link 210, from the position shown in Figure 4 to the position shown in Figure 3, swings the link 101 about its pivot 158 on the rigid member 95 to shift the blades 97 and 98 relative to one another and relative to the rigid member 95 from a retracted position into a position which the blades are forced into high pressure engagement with the contact surfaces at the stationary contact structures 20 and 74.

The rigid member 95 carries an apertured boss section 212 in substantially its central portion, which receives one or more pins or studs 213, which serve as stops engaging the switch blade members 97 and 98 when the switch is opened to steady them against vibration or the like. This feature is entirely optional and may be omitted.

The operation of the switch so far described is as follows:

Assuming that the switch has already been closed and the switch blades 97 and 98 forced into the desired high pressure engagement with the associated stationary contacts and it is desired to open the switch, the rotatable insulator 12 will be rocked by the desired mechanism, swinging the crank 197 in a clockwise direction, as viewed in Figure 1, from its full line position to its dotted line position. This movement swings the operating link 210 in a counterclockwise direction but does not have any effect so far as opening the switch is concerned since the link 210 and the crank 197 are substantially in a straight line position and when these parts move through their straight line position the usual manufacturing tolerances in the links, pivots and associated parts are sufficient to accommodate this swinging movement of the parts 197 and 210 without exerting any thrust or pull upon the switch blade unit 70. However, the angular movement of the link 210 is substantial, as will be clear by referring to the dotted line position of the crank 197 and link 210 which these parts take by virtue of the initial rotation of the insulator 12, and since the operating link 210 is hingedly connected to the toggle link 101 the angular movement of the link 210 is transmitted through the toggle link 101 to the switch blades 97 and 98, moving them relative to one

another in the manner best illustrated in Figures 3 and 4.

In Figure 3, the blades 97 and 98 are shown in their high pressure engagement with the stationary contacts, and the toggle links 99, 100 and 101 are shown in a position in which they are slightly past dead center relation with respect to their pivot connections with the blades 97 and 98, by virtue of which relation the blades are automatically maintained in the aforesaid high pressure engagement with the stationary contacts. The rotation of the crank 197 from the full line position in Figure 1 to the dotted line position serves to swing the link 210 in the direction of the arrow shown in Figure 3. This movement of the operating link 210 shifts the blades 97 and 98 relative to one another, and by virtue of the aforesaid toggle links the blades are also moved toward one another and also toward the rigid supporting member 95 and away from the contact surfaces of the stationary contacts 20 and 74, the release being completed by the time the link 210 has been swung to the position shown in Figure 4 and in dotted lines in Figure 1. At this time the aforesaid lost motion in the operating linkages between the crank 197 and the switch blade 70 has been taken up so that continued rotation of the crank 197 in a clockwise direction (Figure 1) now exerts a direct pull through the link 110 against the switch blade unit 70, whereupon the latter is swung laterally about the pivot 66 (Figure 2) away from the stationary contact 20 and into a full open circuit position, indicated in dotted lines in Figure 2.

It will be observed that in the initial opening movement of the crank 197, in which the blade members 97 and 98 are shifted relative to one another, the operating link 210 pivots about the pin 158 carried by the rigid member 95, to release the high pressure engagement of the switch blades, and in doing so the links 101 and 210 react against the rigid load sustaining member 95. As a result of this arrangement, there is no tendency to move the upper end of either of the insulator stacks 10 or 11 toward or away from one another, since the imposition of the releasing reaction against the rigid member 95 insures that each of the blade members 97 and 98 will be shifted, and that if it should occur that one blade should be held to its contacts with a greater force than the other blade there is no possibility that the other blade will take up all of the movement by virtue of the angular displacement of the operating link 210.

It will also be noted that there is a definite zone in the movement of the crank 197 in which the switch blades are shifted relative to one another and relative to the rigid load sustaining member 95 and in which there is no force exerted tending to open the switch blade unit at this time. After the crank 197 has passed through this zone, represented as between the full line and dotted line positions shown in Figure 1, and therefore after the switch blades have been retracted out of their high pressure engagement with the associated stationary contacts, the further rotation of the crank 197 swings the blade unit 70 into its open circuit position with a positive action. In this latter zone of movement of the crank 197, there is a further angular displacement of the link 210 about the pivot 158, causing a further swinging of the links 99, 100 and 101, but this is of no concern since the blade unit 70 has already been retracted out of its contacting engagement.

In the operation of the switch, when the crank comes well toward its forward position the connecting rod reaches approximately the horizontal position, that is, lies in the plane of the crank, and although the connecting rod does not thrust directly in line with the switch arm, it is nearly enough so that the slight forward travel caused by the crank moving to its full dead center produces very little travel of the switch arm. The blade and the connecting rod may obviously be constructed in such manner that they will lie in alignment if desired. However, the final angular motion of the crank arm when the connecting rod is in its horizontal position and the final angular motion of the connecting rod is so nearly a pure cranking action upon the spreading links 99, 100 and 101 that there is no serious internal stress in the linkage. The slight travel of the switch arm as a whole as the contacts are being expanded provides an excellent shock absorbing friction even if the switch is thrown violently into closed circuit position. No lost motion connection is necessary when the relation of the various arms and link is as above explained and illustrated.

In closing the switch, the reverse action takes place. The crank 197 is first swung back in a counterclockwise direction into the dotted line position shown in Figure 1, thereby swinging the blade unit 70 back into its closed circuit position and between the contact surfaces of the associated stationary contacts 20 and 74, which movement is aided by the weight of the blade unit itself. Due to the fact that the operating link 210 is held in an angular position, such as indicated in dotted lines in Figure 1 or at a greater angular displacement, the blade members 97 and 98 are positively held in their retracted position (Figure 4) so that there is no possibility of the blade unit 70 approaching its closed circuit position with the blade members already expanded. Instead, the link 210 positively holds the blade members in a position to pass freely into the stationary contacts and thereafter the blade unit 70 is in the proper position, the continued movement of the crank 197 then swings the link 210 from its dotted line position in Figure 1 into its full line position, thereby rocking the toggle links 99, 100 and 101 and expanding or spreading the blade members 97 and 98 into high pressure engagement with the contacts 20 and 74. Thus, in both opening or closing the switch, the blade members are shifted longitudinally with respect to one another so as to secure a scraping or wiping action against the associated contact surfaces, thereby clearing the same of any fouling, corrosion, ice, sleet or the like, and insuring a good electrical connection. By virtue of this toggle link control of the blade unit 70 by the crank 197, there is no necessity to provide stops or the like to limit or define the closed position of the switch blade unit. This position may be adjusted by threading the link member 210 inwardly or outwardly of the clevis 207, and similarly it may also be adjusted by threading the member 203 inwardly or outwardly of the crank 197.

The switch described above is one arranged for horizontal mounting, but the switch may, of course, be disposed for vertical mounting, simply by changing the position of the torsion counterbalancing spring 120, as described above. Figures 9 and 10 illustrate a switch that is intended to be arranged for vertical mounting. In

Figures 9 and 10 the switch shown embodies substantially the same construction as described above and hence the same reference numerals have been employed. However, in this switch the blade unit, indicated at 70ª, is somewhat shorter than the blade unit 70 of the switch shown in Figures 1 and 2. However, the same rigid member 95 has been employed, this being done by eliminating the toggle link 99 shown in Figure 1 and connecting the link 100, with the hood 137, at the outer ends of the blade members 97ª and 98ª. In this switch construction the hood 137 is of particular importance since the switch is disposed vertically and the hood effectively protects the pivots at the outer end of the blade unit 70ª. The operation of the switch shown in Figures 9 and 10 is substantially the same as has been described, and hence further explanation is unnecessary, the only difference being that if the switch is mounted vertically the rotatable insulator will be supported for movement about a horizontal axis instead of a vertical axis as in Figure 2.

The provision of the spring biased contact sections for the stationary contact structures is of particular importance in securing the exact degree of high pressure engagement that is desired while accommodating a movement of the toggle links 99 and 101 through and slightly past their dead center relationship, whereby the spring bias acting against the stationary contact sections not only accommodates the slight retraction of the blade ends and the blade members move past the dead center position, but also the spring bias acts against the blades to retain the desired high pressure engagement. The degree of high pressure engagement can be adjusted at any time by turning the adjusting nuts 48, and the position between the spaced contact surfaces of the stationary contact structures when the switch is open can be adjusted at any time by loosening the lock nut 51 and turning the bolt 40 in any suitable manner, as by inserting a screw driver in the slot 50.

The stationary contact 20 is provided with a threaded opening 215 (Figure 9), to receive a vertically disposed acting horn 216 (Figure 1) if it is desired to provide arcing horns for the switch. The other arcing horn 217 can be attached by a bolt 218 and a clip 219 to one of the switch blades, preferably to the switch blade 98 that moves toward the hinge pivot 66 when the blade is opened. The arcing horn 217 includes a portion 220 (Figure 1) which is so angled that once the switch blade 98 is shifted longitudinally to release the high pressure engagement, the angular deflected arcing horn section 220 is brought into contact with the vertical arcing horn 216. By virtue of this arrangement, in opening and closing the switch the arcing horns 216 and 220 are in contact with one another, but when the switch is fully closed and the desired high pressure engagement secured, the arcing horns are moved out of engagement and do not carry any current. The rigid member 95 is also provided with one or two threaded openings 225 to receive an arcing horn if it should be desired to mount a horn on the rigid member 95 instead of on one of the shiftable blade members. The arcing horn 216 on the stationary contact 20 may be bent at its outer end to facilitate guiding the companion horn into the proper position in the operation of the switch.

Figures 11 and 12 illustrate a modified form of the present invention but one in which substantially all of the above mentioned features have been incorporated. Referring now to these figures it will be noted that the blade construction shown is of the protected type, the relatively movable blade sections all being disposed within a protecting tubular member whereby there is little likelihood of ice and sleet formations interfering with the operation of the switch.

The reference numeral 250 indicates a stationary contact structure, similar to the member 74 described above, which serves as a hinge support for a swingably mounted switch blade unit 251. The stationary contact 250 is fastened in any suitable manner to the top or outer end of an insulator stack 255 and includes laterally spaced yoke sections 256 and 257 which terminate in contact sections 258 and 259. The yoke sections 256 and 257 receive pivot means 260 and 261 which support the sleeve ends 263 and 264 of a pivotally mounted yoke 265 by any suitable means, such as sealed ball bearing units of known construction. The shank portion 267 of the pivoted yoke 265 is threaded and receives a tubular member 270 within which two conducting bars 271 and 272 are mounted for longitudinal movement relative to one another and relative to the enclosing tubular member 270. One or more torsion springs 275 are provided and arranged to counterbalance the weight of the switch blade unit 251.

The shank portion of the yoke member 265 is slotted, as at 280, and the outer end of the enclosing tubular member 270 is slotted at 281. The conducting bars or switch blade members 271 and 272 carry contact pieces 283 and 284 at their ends, and each of these parts is provided with an extending contact lug 286, there being two of such lugs projecting outwardly at each end of the switch blade unit 251, as will be clear from Figure 11.

The outer contact pieces 284 are pivotally connected together by a toggle link 290, pivoted thereto by pins 291 or the like. The inner contact pieces 283 are connected together by a toggle link structure indicated in its entirety by the reference numeral 294 which is pivoted to the yoke member 265 by a pivot pin 296. The link member 294 is pivoted, as at 297, to each of the contact pieces 283 for shifting the blade bars 271 and 272 longitudinally relative to each other and relative to the rigid tubular member 270. The upper portion of the link member 294 carries a sleeve section 300 (Figure 12) which receives a longitudinal pivot pin 301 by which a pivot cap 302 is mounted for lateral rocking movement. The member 302 is of substantially the same construction as the member 170 described above and is provided with a transverse pin 303 by which an actuating link 304 is hingedly connected to the pivot cap 302 and hence to the toggle link 294. The link member 304 is connected to be actuated by a crank like that shown in Figures 1 and 2.

The outer end of the switch blade unit 251 moves into and out of operative association with a stationary contact structure 315 which is mounted on an insulator 316 in any suitable manner and embodies spaced portions 317 and 318 which have some resiliency and at their outer ends carry contact surfaces 320 and 321 with which the contact lugs 286 are adopted to engage. The upper portions of the contact arms 317 and 318 may be flared, as at 323 in Figure 12, to facilitate the passage of the switch blade unit 251

into a position between the contact surfaces 320 and 321.

The arm sections 256 and 257 are resilient, and in order to adjust the spacing between the stationary contact elements 258 and 259, a pin 330 is threaded into a portion 332 of the arm 256 of the stationary contact structure 250 and has an end 333 which not only abuts against the inner surface of a recessed boss 334 formed on the other arm 257 but is threaded to receive an adjusting screw 335 which passes through the bottom of the recessed boss 334 and into the end of the bolt 333. A spring 336 is disposed in a recess in the boss 334 and is biased between the latter and the head of the adjusting screw 335. The effect of the spring 336 is to bias the arms 256 and 257 for movement toward one another and to determine the pressure with which the contact lugs 286 at the hinge end of the switch blade unit bears against the contact elements 258 and 259, and the abutment of the portion 334 of the arm 257 against the end 333 of the pin 330 determines the inward movement of the stationary contact arms under the influence of the spring 336 when the switch is open. The stationary contact structure 315 at the other end of the switch blade unit 251 is provided with substantially the same biasing means, indicated in its entirety by the reference numeral 340, and hence a further description is believed to be unnecessary.

The operation of the switch shown in Figures 11 and 12 is substantially the same as the operation of the switch shown in Figures 1 and 2. The first movement of the operating crank, in opening the switch, swings the link member 304 angularly, causing the toggle link 294 to shift the conductor blade bars 271 and 272 longitudinally with respect to one another and with respect to the enclosing tubular member 270, thereby releasing the high pressure engagement between the contact lugs 286, or the blade members 271 and 272, and the associated stationary contacts. Following this operation, the continued rotation of the operating crank exerts a pull through the hinged connection 301, 303 between the outer end of the operating link 304 and the switch blade unit 251, swinging the latter clear of the stationary contact structure 315. In the reverse or circuit closing movement, the rotation of the contact surfaces disposes the switch blade unit 251 in position, and then as the crank and operating link 304 pass through their dead center position and into the angular position shown in Figure 10, the blade bars 271 and 272 are shifted so as to force the switch blade contacts into high pressure engagement with a sliding or wiping action with the stationary contacts.

The operation of the switch of my invention requires no stops or springs to cause a change in motion or operation but obviously stops may be employed to avoid overtravel, particularly where a gang of switches is connected to a common operating member.

It will be apparent from the above that I have disclosed a novel form of prestressed contacts which contains a simple common means for securing adjustment of the spacing and of the spring loading. The combination of expanding blade contacts with prestressed contacts is, I believe, new in the present structure. Another feature of novelty resides in the connection of the connecting rod between the crank and the movable switch arm, which connection involves, in addition to the universal connection at the crank pin, a free axis pivotal connection between the adjacent part of the connection rod and the movable blade or arm. This connection serves to permit turning of the blade through a portion of the angular travel of the crank to place it in register with the stationary contact and then permit moving one blade contact relative to the other or relative to the stationary contact or contacts as the crank and connecting rod approach a common plane of movement. The switch also provides a novel relation of connecting rod and blade arm and blade contacts for swinging the main switch arm until the arm has substantially completed its angular travel into closed position and then, by further angular travel of the connecting rod, to shift the blade contacts relative to one another or to the stationary contacts to produce the high pressure engagement.

The switch further exhibits the novel combined bridge piece and contacts at the hinge end of the switch whereby no pig tails or flexible conductors are required to bridge the hinge of the switch arm.

While I have shown and described above the preferred means in which the principles of the present invention have been embodied, it is to be understood that my invention is not to be limited to the specific structure described, but that widely different means may be employed in the practice of the broader aspects of my invention.

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

1. In a switch, a pair of supporting insulators, a rigid member hinged to one of said insulators for swinging movement toward and away from the other, a pair of links pivoted at their intermediate portions to the ends of said rigid member, and a pair of switch blades pivotally connected at their ends to the ends of said links.

2. A switch comprising a swingably mounted switch blade unit including a rigid load sustaining member, a pair of relatively movable contact sections connected to one end of said rigid member, a stationary contact structure adapted to receive said contact sections, and means disposed adjacent the other end of and reacting against said rigid member for swinging said unit and shifting said contact sections.

3. In an electric switch, a pair of supporting insulators, a stationary contact mounted on each of said insulators, a pair of blade members mounted on one of said insulators for swinging movement into and out of operative position with respect to both of said stationary contacts and said insulators, actuating means supported independently of said insulators for moving said blade members into and out of engagement with said contacts and including means for shifting said blade members longitudinally relative to one another, and a link joining said blade members adjacent each end so that when said blade members are moved longitudinally with respect to each other during the circuit closing operation the ends of said blade members firmly engage both of said contacts with relatively high pressure.

4. A disconnect switch comprising a pair of separated insulators, a load sustaining member pivoted to one of said insulators, means forming a pair of spaced apart contact surfaces on the other insulator, a pair of generally parallel conductor bars, toggle link means connecting said bars to one another and to said load sustaining member, whereby longitudinal movement of one

bar with respect to the other causes said bars to move longitudinally of said load sustaining member and toward or away from one another, a rotatable insulator carrying a crank arm, and a link pivotally connected to the outer end of said crank arm and hingedly connected with one of said toggle means, whereby one portion of the movement of said arm causes said conductor bars to shift longitudinally with respect to one another, other movement of said arm serving to swing said conductor bars and said load sustaining member about the pivot axis of the latter on said one insulator.

5. In an electric switch, a pair of separated contact means, a rigid member pivoted on one of said contact means for swinging movement toward and away from the other contact means, a pair of conductor bars disposed generally alongside one another and longitudinally of said rigid member, means connecting adjacent end portions of said bars to the corresponding end portions of said rigid member whereby generally longitudinal movement of the bars relative to the member moves said bars toward and away from each other, means forming a pair of spaced stationary contact surfaces on each of said contact means, one pair being adapted to receive one end of each bar and the other pair being adapted to receive the other end of each bar, and means reacting against said rigid member for shifting said bars relatively thereto so as to force the latter into firm engagement with said stationary contact surfaces.

6. In a switch, a pair of supporting insulators, a rigid member hinged to one of said insulators for swinging movement toward and away from the other, a pair of links pivoted at their intermediate portions to the ends of said rigid member, a pair of switch blades pivotally connected at their ends to the ends of said links, and a pair of contact structures carried by each insulator, each of said contact structures including a pair of spring-connected contact surfaces arranged to engage said blades when the switch is closed substantially at the ends connected by said links, said contact surfaces being biased for movement into relatively high pressure engagement with said switch blades.

7. In a switch, a stationary contact structure including a pair of spaced apart contact surfaces, a stationary supporting member, a blade unit pivoted to said stationary supporting member for swinging movement toward and away from said stationary contact structure, said blade unit including a rigid member pivoted to said stationary supporting member, a pair of switch blades disposed in spaced apart relation in planes extending generally at right angles to the axis of said pivoted member, a pair of link means connecting the ends of said switch blades, the inner of said link means being mounted for swinging movement on said pivoted member about an axis perpendicular to the axis of the latter so that movement of the inner link means about its axis serves to shift said blades relative to one another, and means for swinging said blade unit and shifting said blades with respect to one another, comprising a crank mounted for swinging movement about an axis substantially parallel with respect to the pivot axis of said link means in the closed position of the switch, a rod extending from the outer end of said crank to said blade unit, and means connecting the end of said rod to said blade unit comprising a first member hingedly connected to the inner link means for movement relative thereto about an axis that is perpendicular to both said first mentioned pivot axis and the pivot axis of said inner link means and a second member hingedly connected to said first member about an axis at right angles to the axis of said first member but parallel with respect to the pivot axis of said rigid member.

8. In a switch, the combination of a plurality of blades extending alongside one another in generally parallel relationship, switch contacts arranged to receive the ends of said blades, and a rigid load sustaining member disposed between said blades and to which said blades are connected for movement relative to said load sustaining member and to each other.

9. In an electric switch, a pair of supporting insulators, a switch blade unit hingedly connected to one of said insulators for swinging movement toward and away from the other insulator, a stationary contact structure carried by said other insulator and including a yoke member having spaced apart contact surfaces and spring means for urging said surfaces for movement toward each other, said switch blade unit including a pair of longitudinally shiftable switch blades having inner and outer link means pivoted to the ends of said blades whereby when said blades are shifted longitudinally the blades are forced outwardly into high pressure engagement with said contact surfaces and against the bias of said spring means, a third insulator rotatable about its axis and carrying an operating crank, a brace and current conducting member connecting said rotatable insulator with said first mentioned insulator, a portion of the brace and current conducting member adjacent said first insulator having spaced apart portions provided with contact surfaces and spring means for urging said surfaces toward one another, and means operatively connecting said crank with the inner of said link means, whereby rotation of said rotatable insulator swings said blade unit and shifts said blades relative to one another.

10. In an electric switch, a stationary contact structure comprises a pair of spaced apart sections having contact surfaces, each of said sections having an aperture therein, a connecting member extending through said apertures and connected at one end with one of said sections, a biasing spring connected between the other end of said member and said sections, and a sleeve surrounding said member between said sections and serving to limit the relative movement thereof under the influence of said biasing spring.

11. In a switch, a movable switch unit comprising a swingably mounted rigid member, a pair of switch blades disposed generally longitudinally of said member, a link pivotally connected to said rigid member and to said switch blades, and means serving as a hood carried by said link member and embracing certain of the pivots between the link member and associated parts.

12. An electric switch comprising a stationary contact structure, a swingably mounted switch blade unit including a pair of relatively movable switch blade sections adapted to be moved into and out of engagement with said stationary contact, means for operating said switch blade unit including mechanism for moving said switch blades relative to one another before opening and after closing the switch, and a pair of arcing horns, one mounted on said stationary contact structure and the other carried by and movable with one of said switch blade sections, said horns being so disposed that movement of the switch

blade section carrying said other horn relative to the other section before opening or after closing the switch shifts the movable arcing horn into and out of operative engagement with the fixed arcing horn.

13. A switch comprising a stationary contact having spaced apart contact surfaces, a swingably mounted switch blade unit including a pair of laterally spaced switch blade sections, a toggle link connecting the ends of said switch blade sections together and adapted when one blade is shifted longitudinally relative to the other to cause said blade sections to move toward and away from one another into and out of high pressure engagement with said contact surfaces, and means for operating said switch blade unit, including a crank and a connecting member between said crank and said unit and hingedly connected with one of said toggle links, said crank, operating member and switch blade units being so angularly disposed with respect to each other that in the circuit closing operation said crank exerts a thrust through said connecting member to swing said switch blade into position between said contact surfaces and as said crank and connecting member approach and pass through their dead center position the angular movement of the connecting member acts through said toggle links to cause said blade sections to shift longitudinally with respect to each other and to be forced simultaneously into high pressure engagement with said contact surface so that said high pressure engagement is effected by a wiping action between the blade sections and said contact surfaces.

14. A switch comprising a pair of stationary contact structures, each including a pair of spaced contact surfaces, a switch blade unit pivotally mounted adjacent one end on one of said stationary contact structures in a position between the pair of contact surfaces thereof for swinging movement toward and away from the other contact structure, said switch blade unit comprising a protecting tube having slots in its opposite sides at each end, conducting bars disposed alongside one another within said tube and each having movable contacts extending outwardly of the tube through said slots, and means for operating said unit including mechanism for shifting said conducting bars in said tube relative to one another so as to secure a wiping engagement between said movable contacts at opposite ends of said tube and the contact surfaces at each of said stationary contact structures.

15. A switch comprising a stationary contact including a pair of spaced contact surfaces, a swingable switch unit including a protecting tubular member pivoted at one end and at the other end adapted to swing into and out of operative position relative to said stationary contact, a stationary contact structure disposed at the pivoted end of said tube and having a pair of spaced contact surfaces, a pair of conducting bars disposed for relative longitudinal movement within said protecting tube and each having contacts at its ends extending outwardly of said tube, link means connecting the ends of said conducting bars so that when one is shifted longitudinally in said tube relative to the other said contacts are forced laterally outwardly into high pressure engagement with said stationary contacts, and operating means for said switch unit including a member hingedly connected with the inner of said link means for both swinging the connecting bars into and out of switch closing position and shifting said bars relative to one another.

16. A switch structure comprising a pair of separated insulators, one carrying a stationary contact including spaced contact surfaces, a switch blade unit swingable on the other insulator and including a tubular member having a yoke fixed to the inner end thereof and provided with separated portions pivoted to said other insulator to provide the aforesaid swinging movement, a pair of conducting bars mounted for longitudinal movement within said tubular member, operating means for swinging said blade unit and including mechanism acting through said conducting bars for shifting them into high pressure engagement with said contact surfaces, and counterbalancing spring means disposed between the separated portions of said yoke and acting against the latter to counterbalance the weight of said blade unit.

17. In a switch, a pair of switch blades disposed alongside one another and swingable toward and away from closed circuit position about an axis, a toggle link pivoted to said blades whereby angular movement of said link shifts the blades toward and away from each other, a crank having a crank arm mounted for movement about an axis disposed generally at right angles to and spaced from the axis of swinging movement of said blades, and a connecting rod hingedly connected to said toggle link and operatively connected to said crank arm whereby the latter during one range of movement swings the toggle link to move said switch blade toward and away from each other and during another range of movement exerts a thrust through said rod against said switch blades to shift the latter about their axis of swinging movement.

18. In a switch, a pair of spaced apart switch blades disposed in generally parallel relationship alongside one another and swingable as a unit about an axis into and out of a circuit closing position, a crank mounted for rotation about an axis extending generally at right angles to and spaced from the axis of said switch blades and having a crank arm, a toggle link connected at its opposite ends to said switch blades for pivotal movement relative thereto about axes extending generally in parallel relation with respect to the axis of said crank, and a connecting rod extending from said crank arm to said toggle link and hingedly connected to the latter about an axis generally parallel with respect to the axis of said blades, whereby during one range of movement of said crank when said crank arm and connecting rod are in approximate alignment, rotation of said crank swings said toggle link angularly and shifts said switch blades toward and away from one another, rotation of said crank arm beyond said range carrying the arm and connecting rod out of approximate alignment and serving to exert a thrust or pull through said connecting rod and toggle link against said switch blades for swinging the latter bodily about their axis of swinging movement.

19. In a switch, a stationary contact structure, a swingably mounted blade unit including a rigid member pivoted at one end and its other end adapted to be swung toward and away from said stationary contact structure, a pair of blade sections, and means connecting said sections with said rigid member whereby longitudinal movement of said blade sections shifts the latter into and out of high pressure engagement with said

stationary contact structure, and operating means for said switch blade unit comprising a rotatable crank and a link operated by the crank and hingedly connected with said connecting means, the angular relation between said crank and said link being such that in one portion of the rotation of said crank said link is moved angularly to actuate said connecting means and shift said blade sections relative to said rigid member and during another portion of the rotation of the crank the link exerts a force on said rigid member acting to swing said blade unit relative to said stationary contact structure.

20. In a switch, a switch blade unit mounted for swinging movement and including blade sections movable toward and away from one another, a crank mounted for rocking movement about an axis perpendicular to the axis of swinging movement of said blade unit, a connecting rod swingable angularly by said crank, and means connecting said connecting rod with said switch blade unit so that angular movement of said rod moves said blade sections relative to one another and a pull by said connecting rod on said switch blade unit swings the latter about its pivot axis.

21. A switch comprising a swingably mounted switch blade unit including two relatively movable contact sections, a stationary contact structure adapted to receive such sections, means for operating said switch blade unit including a rotatable crank and a link connecting the crank with said unit whereby the crank can exert a force on the switch blade unit generally longitudinally of the link to swing the blade unit into and out of operative engagement with said stationary contact, and means operated by the angular movement of said link relative to said switch blade unit for moving said blade sections into and out of high pressure engagement with said stationary contact structure.

22. In a switch, a pair of insulators, a stationary contact structure carried by each of said insulators, each of said contact structures including spaced apart contact surfaces, a rigid member swingably mounted on one of said insulators, longitudinally disposed relatively movable contact blades carried by said rigid member and swingable therewith into and out of engagement with the contact surfaces of both of said stationary contact structures, and means reacting against said rigid member for shifting said blades relative thereto and relative to said contact surfaces.

23. In a switch, a pair of insulators, a stationary contact structure carried by each of said insulators, each of said contact structures including spaced apart contact surfaces, a rigid member swingably mounted on one of said insulators, longitudinally disposed relatively movable contact blades carried by said rigid member and swingable therewith into and out of engagement with the contact surfaces of both of said stationary contact structures, connecting means acting between the ends of said blades and said rigid member for causing said blades to be shifted into and out of high pressure engagement with said contact surfaces, and a stop member carried by said rigid member intermediate the ends thereof and engageable with the intermediate portions of said blade members for limiting the inward movement of the latter relative to said rigid member.

24. A switch comprising a stationary contact structure including a pair of spaced contact surfaces, a pivoted switch blade unit swingably mounted at one end for moving the other end toward and away from a position between said contact surfaces, said switch blade unit comprising a protecting tube having slots in the sides thereof adjacent said other end, conducting bars disposed alongside one another within said tube and each having movable contacts extending laterally outwardly of the tube through said slots for engagement with said contact surfaces laterally outwardly of the tube in opposite directions through said slots, and means for operating said unit including mechanism for shifting said conducting bars in said tube relative to one another so as to secure a wiping action between said movable contacts at said other end of the tube and the spaced apart contact surfaces between which said other end of the tube is disposed when the switch is closed.

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