

Jan. 31, 1956

T. E. CURTIS
ELECTRIC SWITCH

2,733,322

Filed Aug. 22, 1952

4 Sheets-Sheet 1

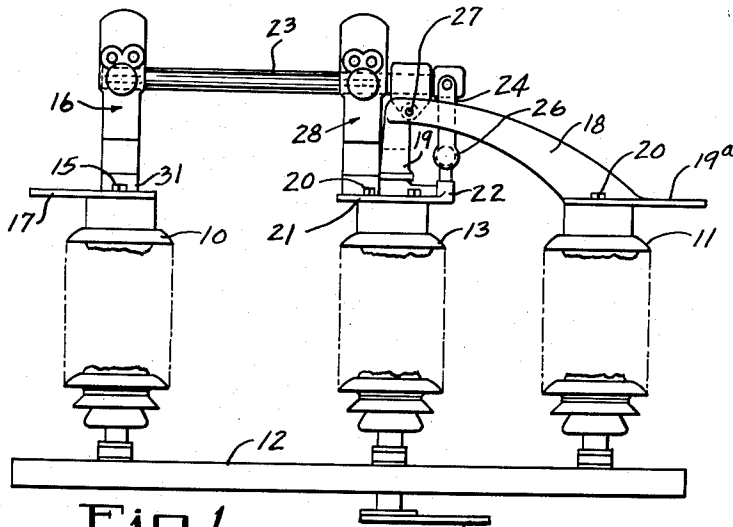


Fig. 1

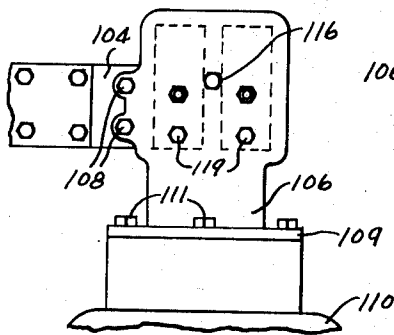


Fig. 7

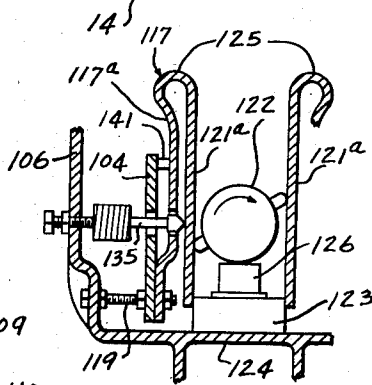


Fig. 8

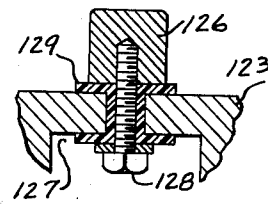


Fig. 10

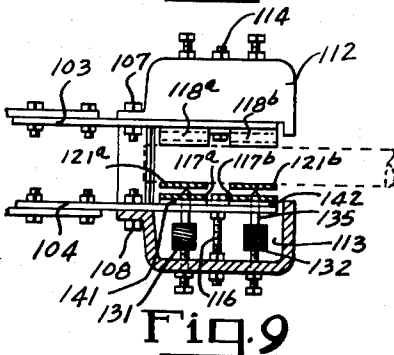


Fig. 9

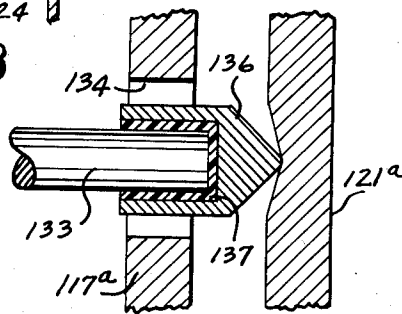


Fig. 11

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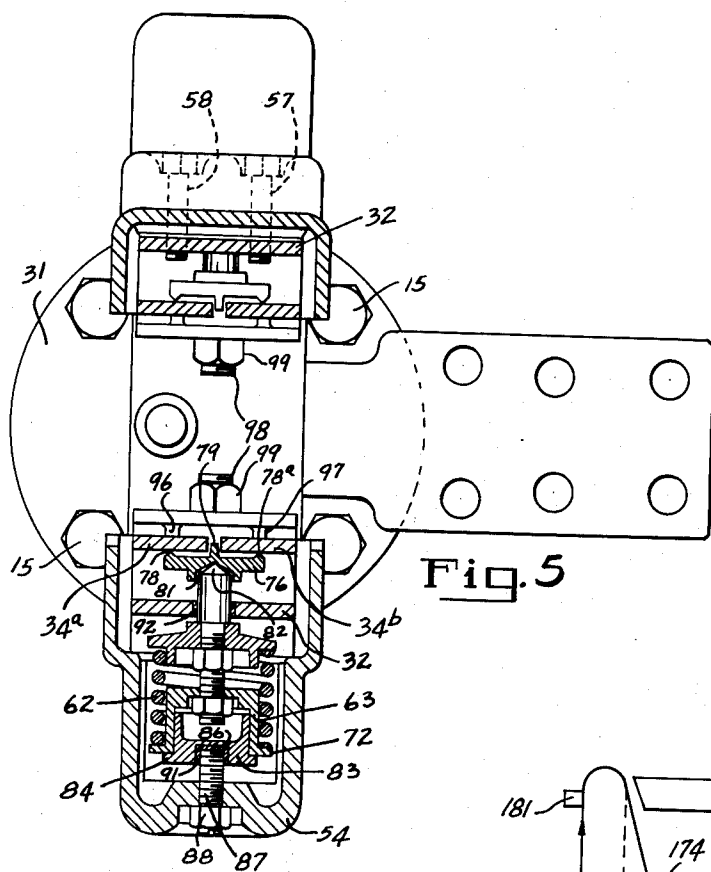


Fig. 5

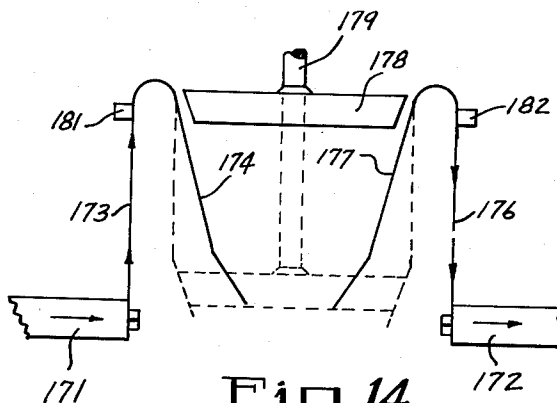


Fig. 14

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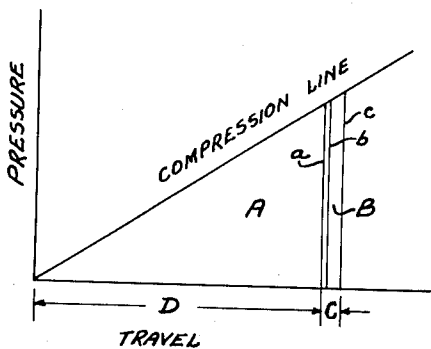
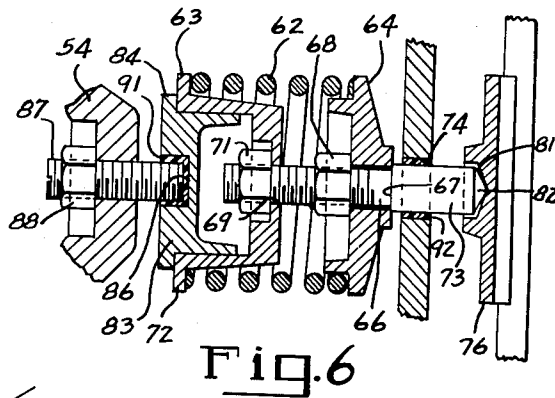
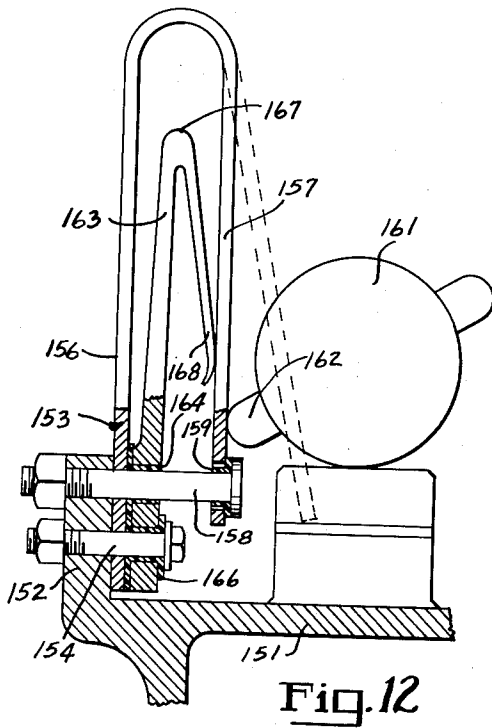
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ELECTRIC SWITCH

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Application August 22, 1952, Serial No. 305,739

3 Claims. (Cl. 200—170)

This invention relates to electric circuit breakers for high voltage and maximum short circuit capacities and has for an object the provision of an electric switch which shall be capable of withstanding the most severe service conditions repeatedly without damage being caused to the switch.

A further object of my invention is to provide an electric switch in which the severe electro-magnetic forces which accompany overloads in high voltage circuits are utilized to aid in maintaining the necessary high pressure contacts between the switch blade and its jaws.

Another object is to provide a high voltage switch which shall be capable of safely transmitting higher short circuit loads than any switch heretofore known to me and which shall be capable of resisting the heavy reactive forces produced in such switches by the flow of such overload current therethrough.

A still further object of my invention is to provide a high voltage switch having resilient reverse bend jaws with which the switch blade engages and in which the jaws are buttressed by pre-stressed springs whereby the full pressure between the jaws and the blade required to carry the current is established with a minimum of movement of the jaws.

A further object of my invention is to provide a high voltage electric switch having resilient reverse bend jaws buttressed by pre-stressed springs and in which the line side of each jaw is restrained against bending a short distance from the line of engagement of the blade with the jaw.

A still further object of my invention is to provide a high voltage electric switch having resilient reverse bend jaws and in which an insulated stop member is disposed in position to be solidly engaged by the switch arm when in fully closed position whereby to counteract the heavy reactive forces in the switch due to overloads.

As is well known in the art, current flowing in a conductor produces electro-magnetic stresses surrounding the conductor. Where the electric current is flowing through a continuous straight conductor there are an infinite number of curved lines of force which encircle the conductor as long as current flows therethrough. These forces are greatest close to the conductor, and the greater the electric current, the more intense are the electro-magnetic forces. Where there is a sharp angle in the conductor the forces are compressed by the angle into a much smaller space. The mechanical effect is a violent tendency to straighten the conductor or, if this can not be done, to break the conductor apart at the angle. The stresses are most severe close to the angle.

Two parallel conductors, both transmitting currents of electricity, are either mutually attractive or repellant, depending on the relative directions of their currents. If the currents are flowing in the same direction in both conductors, the lines of force tend to surround both conductors and contract, thus causing the conductors to attract each other. If, however, the currents are flowing in opposite directions, the lines of force lying between the con-

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ductors have the same direction, and therefore the conductors repel each other. The present invention relates to apparatus for counteracting the distortion, or magnifications, of such forces especially those produced by overloads.

In modern high capacity electric transmission systems the short circuit load, such as may occur, is so heavy that the magnetic forces mentioned above have a violent explosive effect between contacts. It is my belief that contact explosions are secondary reactions; the contacts are first separated by severe electro-magnetic forces; electric arcs are then established, and the resulting tremendous heat suddenly volatilizes the metal contacts in an explosive manner. A principal purpose of this invention is to minimize the damage thereby threatened to circuit breaking devices.

In the accompanying drawings forming a part of this application:

Fig. 1 is an elevational view of a switch constructed in accordance with my invention;

Fig. 2 is a diagrammatic view of one form of my invention in which the electro-magnetic forces established in a high capacity switch are indicated graphically;

Fig. 3 is an end elevation, partly in section, showing a preferred embodiment of my invention;

Fig. 4 is a side elevational view of the contacts shown in Fig. 3;

Fig. 5 is a sectional plan view taken along the line V—V of Fig. 3;

Fig. 6 is a detail view of a prestressed spring unit removed from its housing;

Fig. 7 is a side elevational view showing my improved jaw contact assembly secured on the extensions of bus bars;

Fig. 8 is a fragmentary, detail transverse sectional view of the assembly shown in Fig. 7, drawn to a larger scale;

Fig. 9 is a plan view of Fig. 7 partly in section;

Fig. 10 is a detail sectional view of the stop means for the switch blade;

Fig. 11 is a detail sectional view showing the bearing of the buttressing assembly against the movable side of a contact;

Fig. 12 is a sectional elevation showing diagrammatically a modified form of my invention;

Fig. 13 is a view illustrating graphically the operation of the prestressed spring employed with my invention; and

Fig. 14 is a diagrammatic view showing the manner in which my invention may be applied to the contact elements of an oil circuit breaker.

Referring first to Fig. 1 of the drawing, I show for the purpose of illustration one form of twist blade, high capacity switch, to which my invention is particularly applicable. The switch therein shown is in general similar to that shown, described and claimed, in the patent to W. A. Gussow and T. E. Curtis, No. 2,520,036, dated August 22, 1950, and assigned to Southern States Equipment Corporation. It comprises essentially, two stationary insulators 10 and 11 mounted on a common base 12, and a rotary insulator 13 mounted on the base 12 between the insulators 10 and 11. The rotary insulator 13 is operated by means of an operating arm 14. Mounted on the insulator 10 is a stationary jaw contact 16 which is joined to a terminal pad 17, secured to the insulator 10 by means of bolts 15 and to which is connected the incoming line, not shown. Mounted on the insulator 11 by bolts 20 is a frame 18 to which is joined a terminal pad 19a to which the outgoing line, not shown, is connected. The frame 18 extends to a point over the insulator 13, the end of the frame forming a bearing 19 in which a base 21 secured to the insulator 13 is adapted to rotate. Forming a part of the base 21 is a crank 22 which is

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connected to the outer end of a switch blade 23 by means of a link 24 and ball and socket joint 26. The switch blade 23 is pivotally mounted in the frame 13, at 27, whereby, when the insulator 13 is rotated by means of the crank arm 14, it first rotates the blade 23 to free it of its contacts, and then pulls the outer end downwardly to raise the blade to its open position, all as described in the patent to W. A. Gussow and T. E. Curtis, aforesaid. Also mounted on the frame 13 is a fixed contact 28 constructed similar to the jaw contact 16 and with which the blade 23 is engaged when in its closed position.

This invention is concerned chiefly with the construction and arrangement of the stationary contact members 16 and 28 of the switch, and as will appear from the specification, is applicable to types of high capacity electric switches other than the type shown in Fig. 1.

Referring now to Fig. 2 of the drawing, I show by means of a line diagram, the essential elements of the jaw contact such as 16 shown in Fig. 1 of the drawing. The base of the contact member is indicated at 31 with the incoming line indicated at 17. At the ends of the member 31 and electrically connected thereto are two outer jaw portions 32 and 33 with the lower end thereof fixedly secured on the base 31. The outer jaw portions 32 and 33, being connected directly to the incoming line may be referred to as the line side of the jaw contacts. The other ends 34 and 36 are bent over and extend downwardly and are free to move outwardly each toward its associated jaw portion 32 or 33. Each of the jaw portions 32 and 33 are made of resilient conductive material and it is contemplated that the contact portions 34 and 36 may be pre-stressed each by being pulled toward each other to a position somewhat beyond that indicated in the drawing and that a detent 37 be positioned inwardly of each of the members to limit its inward movement with respect to the switch when the switch is in open position.

The switch blade is indicated by the numeral 38 and engages the contact portions 34 and 36 at 39 and 41, respectively. It has been found to be highly important that there be a high pressure contact between the switch blade and the contact members 34 and 36, possibly in the neighborhood of 300 pounds, in order to carry the current to which the switch is subjected. The incoming current, as before stated, is indicated at 17 and flows through the jaw contacts in the direction indicated by the arrows and out through the switch arm 38 as shown by the arrow 42.

The flow of current through the switch, as just described, creates electro-magnetic forces which tend to separate the outer and inner sides of the jaw contact portions 32 and 34, and 33 and 36 as indicated by the heavy arrows 43 and 44. The abrupt change of direction of the current flowing down each jaw contact portion and then at right angles into the switch blade 38, creates at each side a heavy electro-magnetic force, downwardly and outwardly as indicated at one side by the heavy arrow 45 in Fig. 2. When overload conditions occur, the forces thus created might, without some means to counteract them, bring about a violent explosive effect.

In order to counteract this heavy reactive force, I arrange the sides of the loop close together so that the forces represented by the heavy arrows 43 and 44 shall resist the outward forces indicated by the arrow 45, and the greater the force at 45 the greater will be the opposing force at 43. In addition, I provide a buttressing element for each of the jaw contact members which elements are indicated at 46 and 47. Each of the elements, to be described in detail hereafter, is designed to impose an initial heavy resistance to outward movement of the contact portions 34 and 36 to help resist the heavy reactive forces between the switch blade and said contact portions. In addition, I provide stationary abutments 48 and 49 which prevent outward movement of the outer jaw portions at the upper ends of the jaw portions 32 and 33. The buttressing members 46 and 47 are mounted so as to

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engage the contact portions 34 and 36 at points which are generally opposite the lines of engagement of the switch blade 38 with contact portions. In order to counteract the electro-magnetic forces acting downwardly against the switch blade, I provide a stop member 51 which extends upwardly from base 31 and upon which the switch blade rests when in its closed location.

Referring now to Figs. 3, 4 and 5 of the drawing I show in detail one embodiment of a jaw contact assembly embodying my invention. The jaw portions 32 and 33 are secured to the base 31 by means of bolts 53 each of which also serves to retain a housing 54. Both housings are identical in construction and only one will be described. The bolts 53 pass through appropriate openings in the housing 54, through openings in the jaw portion 32 and are threaded into the base as shown at 56. The housing 54 extends upwardly alongside the outer jaw portion 32 to a point above and over the upper end of the outer jaw portion 32. A pair of bolts 57 and 58 rigidly secures the upper end of the jaw portion 32 to the housing so that the housing serves as the upper abutment to the member 32 as described at 48 in Fig. 2. The bolts 57 and 58 and the jaw contact portion 32 may be each insulated electrically from the housing 54 as shown at 59 and 61. Insulation need not be provided if housing 54 is made of low conductivity metals.

Mounted within the housing 54 is a pre-stressed spring assembly which comprises a coil spring 62 mounted between two abutments 63 and 64. A bolt 66 passes through the abutment 64 and is provided with a shoulder 67 which engages the side of the abutment adjacent the jaw contact portion 32. A lock nut 68 secures the abutment 64 in position. The abutment 63 is cup shaped in cross section and the bolt 66 passes through an opening 69 therein. A nut 71 on the outer end of the bolt 66 bears against the abutment 63. The abutment 63 is provided with a flange 72 which engages the spring 62 and by tightening the nut 71, the spring is thus placed in initial predetermined compression. The enlarged, or shouldered end 73 of the bolt 66 passes through an opening 74 in the jaw contact portion 32 and engages an abutment 76 which bears against the inner movable portion 34 of the jaw contact. Preferably, the jaw contact is split at its top as shown at 77 so that the downwardly extending portion forms two contact portions 34a and 34b, as shown more clearly in Fig. 5. The abutment member 76 spans the two movable contact portions and is provided with vertical ribs 78 and 79a which bear directly against the contact portions 34a and 34b close to the center of each. A rib 79 on the abutment member 76 enters the space between the contact portions 34a and 34b and prevents lateral displacement of the abutment. The abutment is also provided with a socket 81 for receiving the pointed end 82 of the enlarged or shouldered head portion 73 of the bolt 66.

Fitting within the abutment 63 is a flanged cup-shaped member 83, the flange 84 of which bears against the flange 72 of the abutment 63. The outer side of the cup-shaped member 83 is provided with a socket 86 which receives the end of a bolt 87, screwed through the outer end of the housing 54 and which is held in position by means of a nut 88. The bolt 87 thus serves to position the pre-stressed spring assembly in the housing and with respect to the contact portions 34a and 34b. The preferred position is to have bolt 87 so adjusted that end 82 of shouldered head 73 transmits some pressure from spring 62 against blade sides 34a and 34b, these last being held in place by detent 96. When so adjusted, the pressure on nut 71 would be slightly lessened, and there would be no lost motion between the parts.

Instead of spring 62 being prestressed by nut 71, the spring might be installed unstressed and with nut 71 omitted. Bolt 87 may then be screwed inwardly until spring 62 reaches the desired tension, meanwhile inward motion of blade sides 34a and 34b being pre-

vented by detent 96. Preferably, the bolt 87 is insulated from the spring assembly as shown at 91 and the enlarged shouldered head 73 of the bolt 66 is insulated from the jaw portion 32 as shown at 92. Where high resistance metal is used in the spring assembly, insulation may be omitted.

The initial stress placed upon the spring 62 is preferably considerably more than the maximum pressure required normally between the switch blade 38 and the contact portions 34a and 34b when the switch is in its closed position. As shown in Fig. 3, the switch blade is preferably generally circular, or cylindrical in cross section and is provided with ribs 93 and 94 thus creating, in effect, a longer transverse dimension through the blade at that point. As is well understood, the blade 38, when the switch is being closed, moves down between the jaw contact portions 34 and 36 and is rotated to cause the ribs 93 and 94 to engage the jaw contact members pressing them outwardly a short distance. Inasmuch as the initial stress on the spring assembly approximates the maximum pressure required between the blade and the jaw contact portions, a very slight movement of the jaw contact portions 34 and 36 establishes that pressure.

In addition to the initial load or strain on the contact portions 34 and 36 imposed by the prestressed spring assembly, the members themselves may be placed under initial strain. The jaw portions are made of resilient spring metal and could be so designed that, if free, they would assume the dotted line position indicated in Fig. 3 of the member 34a. In assembling the contacts the portions 34a and 34b are held in place by means of detents 96 and 97 which are secured in place by means of a bolt 98 and nut 99. The bolt 98, as shown, passes through the housing 54, the jaw contact member 32, and the flange portion 100 of the base 31. When the switch is in its closed position, as shown in Fig. 3 of the drawing, the jaw contact portions are forced away from the detent, as shown, by the engagement of the ribs 93 and 94 on the switch blade 38 against the jaw contact portions.

The jaw contact portions 34a and 34b may be provided with lugs, such as 101, which engage the rib 93, when the switch blade is in its closed position, and prevent undesired upward movement of the blade between the jaw contacts.

The stop member 51, upon which the blade 38 rests when in its closed position, is preferably insulated from the base 31, as indicated at 102. Where high resistance metal is employed, this insulation may be omitted.

Referring now to Figs. 7 to 11 inclusive, I show a modified form of my invention in which the jaw contact members and housings therefor are bolted to bus bar extensions 103 and 104. A housing 106 is connected to the bus-bar extensions and is secured thereto by means of bolts 107-108. The housing is provided with a base 109 which is secured to a supporting insulator 110 by means of bolts 111. The housing 106 is constructed to provide prestressed spring assembly chambers 112 and 113. Securing bolts 114 and 116 pass through the chambers 112 and 113 and through the extensions of the bus bars 103 and 104 to further secure the bus bars 103 and 104 to the housing 106.

Reverse bend, resilient jaw contact members 117a and 117b and 118a and 118b are secured to the bus bars as indicated for the jaw contact member 117a shown in Fig. 8, by means of bolts 119. Each of the inner movable contact portions 121a and 121b of each of the jaw contact members is placed under initial stress, and when the switch blade 122 has not yet been rotated to closed position, as indicated in Fig. 8, the lower ends are engaged with a detent 123 mounted on the bottom wall 124 of the housing 106. An insulated stop member 126 is mounted on the detent 123 and is positioned to be engaged by the switch blade 122 when

in its closed position. As shown in Fig. 10 the detent 123 may be made with a recess 127 and the blade stop member 126 be mounted thereon by means of a screw 128 which passes through insulating material 129 to insulate it from the housing wall 124.

An important feature of this form of my invention is the provision of an elongated, outwardly turned loop 125 at the upper end of each jaw contact. This obviates the necessity of any abrupt bends in the jaw contact and enables me to bring the inner blade sides 121a and 121b down closely adjacent the outer or line sides of the jaw contact 117a and 117b. Placing the two sides of each jaw contact thus closer together enables me to take advantage of the greater electro-magnetic forces created in the switch to increase the pressure between the blade and its contacts.

Mounted in each of the spring unit chambers 112 and 113, are a pair of pre-stressed spring units 131 and 132 which are constructed and arranged substantially as already described in connection with the pre-stressed spring assembly shown in Figs. 3 and 6 of the drawing. Each of the assemblies includes the enlarged shouldered end 133 of the tensioning bolt 135, similar to the bolt 66 shown in Figs. 3 and 6 and which, for example, passes through an opening 134 in the line side, or secured side, 117a of the jaw contact member to engage the movable jaw contact portion 121a. Preferably the end 133 is provided with a contact engaging member 136 which surrounds the end 133 of the bolt and is insulated therefrom as indicated at 137.

As previously described and as shown in Fig. 9 of the drawing, the jaw contact member 117 is preferably divided on the line side into the units 117a and 117b and on the movable, or blade side to separate contact portions 121a and 121b. Each of the pre-stressed spring assemblies, as shown in Fig. 9, bear against its associated movable contact portion. If desired, a single spring assembly could be used instead of assemblies 131 and 132. In such case an abutment member similar to member 76 in Figs. 5 and 6 would be included, and the bolt 66 shown in Fig. 6 would pass between the two blade sides 17a and 17b shown in Fig. 9. Also, if desired to obtain additional contacts, the jaw contact members 117a, 117b, 118a, and 118b may be split and an abutment similar to member 76 shown in Figs. 5 and 6 used in conjunction with a bolt similar to member 66 in Fig. 6.

Mounted along the upper edge of each of the bus bar extensions 103 and 104 are lugs 141 and 142 which bear against the fixed, or line sides 117a, 117b of the jaw members to limit outward movement thereof upon rotation of the switch blade 122 to its closed position.

Referring to Fig. 12 I show a fragmentary sectional view of a modified form of jaw contact in which a base member 151, corresponding to the base member 31 of Fig. 3, is provided with an upstanding flange 152 to which is bolted a jaw member 153 by means of bolts 154. The jaw member extends upwardly and is bent over to provide a downwardly extending, outwardly movable contact portion 157. Contact portion 157 is placed in initial strain by being moved from its normal position indicated by dotted line to the position shown in the drawing and there held against movement toward the switch blade 161 by means of a bolt 158 which passes through it and which is insulated therefrom as indicated at 159. As shown, the contact portion 157, upon rotation of the blade 161 to its closed position is engaged by ribs 162 and is moved outwardly toward the secured outer, line side, of the jaw contact portion 156.

In order to buttress the resilient contact portion 157 with an additional initial load, I may provide a flat spring 163 which is mounted adjacent the jaw contact member 153 and is held in place by means of the bolts 154 and 158 passing through said member 163 and in-

sulated therefrom as shown at 164 and 166. The other end of the spring 163 is bent over and downwardly at 167 with its free end 168 bearing against the associated movable, or blade side of the contact portion 157. As in the other embodiment of my invention hereinbefore described it will be apparent that the jaw contact member 153 may be divided or split to provide a plurality of contact portions.

Referring now to Fig. 13 of the drawing, I indicate graphically the manner in which the movable contact portions of the jaw contact members are buttressed by the prestressed spring units. As is well known, a spring, within its working limits, resists compression or tension in direct proportion to its extension or compression. In Fig. 13 of the drawing, the pressure, or load on a prestressed unit is indicated by the vertical lines and the travel or compression by the horizontal line. When the spring, such as 62 shown in Fig. 3, is compressed, the work done by the tensioning bolt 66 is indicated by the area A. The movable contact portion of the jaw contact is thus buttressed by the work done in the area marked A. When the switch is moved to closed position and the switch blade is rotated to move the movable contact portions outwardly and free them from their detents, the first movement indicated by the two closely adjacent lines *a* and *b* transfers the entire load of the prestressed unit into pressure between the movable contact portions of the jaw contact member and the blade as indicated by the vertical line *b*. Further movement of the spring the distance C, develops pressure between the movable contact portions and the blade as indicated by the line *c*, while the total work done in compressing the spring is indicated by the areas A and B and the small space between them. The area B and the small area between A and B represent the total work done in applying contact pressure.

Referring to Fig. 14, I show diagrammatically the contact elements of an oil circuit breaker, other parts being omitted. In accordance with this modification, the incoming line is shown at 171 and the outgoing line at 172, it being understood that the members 171 and 172 are rigid members. Secured to the member 171 is a reverse bend contact member embodying an outer, fixed, or line side 173, and an inner, movable, or contact side 174. Rigidly mounted on the member 172 is a jaw contact member embodying an outer, fixed, or line side 176, and an inner, movable, or contact side 177. The brush, or bridging member 178, as is well understood, is connected to an operating rod 179 for vertical movement to engage, and disengage it from the contact portions 174 and 177. The contact members are prestressed so that the contact portions 174 and 177 when the circuit is broken, assume the positions shown in full lines, and when the bridging member 178 is moved to the position to close the circuit, they assume the positions shown in the dotted lines. The outer or fixed sides 173 and 176 of the jaw contacts are restrained at their upper ends against outward movement by means of abutments 181 and 182, while at their lower ends, they are restrained against outward movement by their fixed connections to the stationary members 171 and 172.

From the foregoing it will be apparent that I have devised an electric switch capable of withstanding the most severe service conditions and in which the electromagnetic forces created by the flow of current through the switch are utilized to counteract the effects of overload conditions. It will also be seen that I have devised an electric switch in which the movable contacts are so buttressed that the maximum contact pressure is attained with a minimum compressive movement between the switch blade and its contacts.

While I have shown my invention in several forms, it will be obvious to those skilled in the art that it is not so limited but is susceptible of various other changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are specifically set forth in the appended claims.

What I claim is:

1. In a high voltage twist blade electric switch, a jaw contact comprising a resilient reverse loop with the line connected to the outer fixed end of said loop and a blade rotatable about its longitudinal axis engaging the inner movable side of said loop, a prestressed spring assembly engaging the inner movable side of said loop to exert yielding resistance to outward movement thereof when engaged by the blade, means limiting inward movement of said movable side of the jaw, a relatively fixed abutment for the line side of said jaw on the opposite side of the prestressed spring assembly from the secured end of the line side of the jaw, and means to rotate the blade about its longitudinal axis during opening and closing of the switch.
2. A switch as set forth in claim 1 in which the prestressed spring assembly is located entirely outside the line side of the jaw contact and in which a member connected to said assembly passes through an opening provided in the line side of the jaw contact to engage the movable blade engaging side.
3. In an electric switch of the twist blade type, a pair of resilient reverse loop jaws, the line being connected to the outer side of each jaw and the other side being bent over inwardly to form a U-shaped loop and being movable outwardly, a switch blade having one transverse dimension larger than the other for engaging the movable sides of the jaws, means to rotate the switch blade to engage the jaws, prestressed spring assemblies bearing against the movable sides of both jaws opposite the line of engagement of said larger dimension, stationary abutments for the line sides of both jaws above and on opposite sides relative to the line of engagement between the switch blade and the movable portions of the jaws, and a detent limiting inward movement of the free end portions of the jaw.

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