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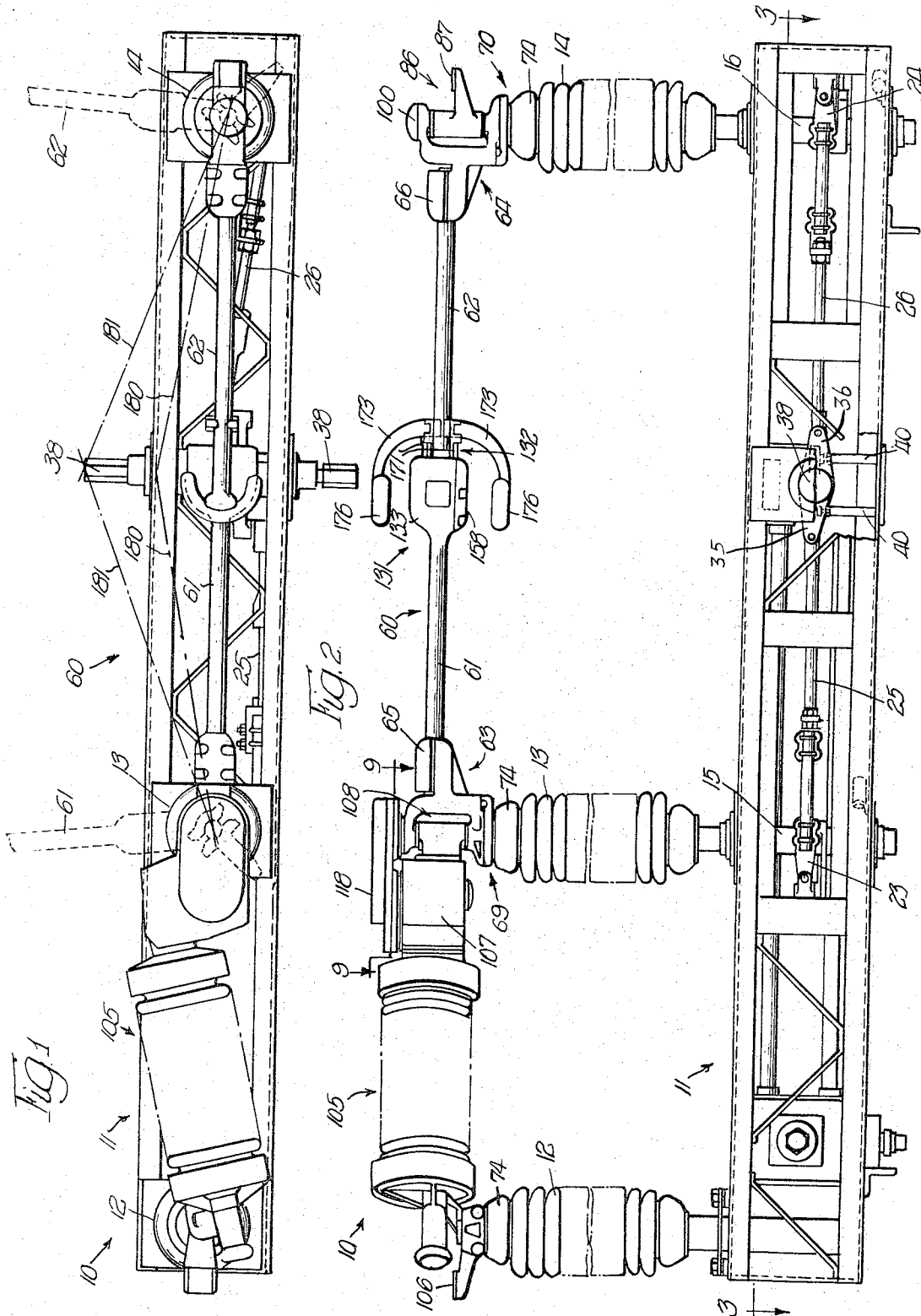
J. BERNATT ET AL

3,339,037

HIGH VOLTAGE SWITCH CONSTRUCTION

Filed July 12, 1965

5 Sheets-Sheet 1



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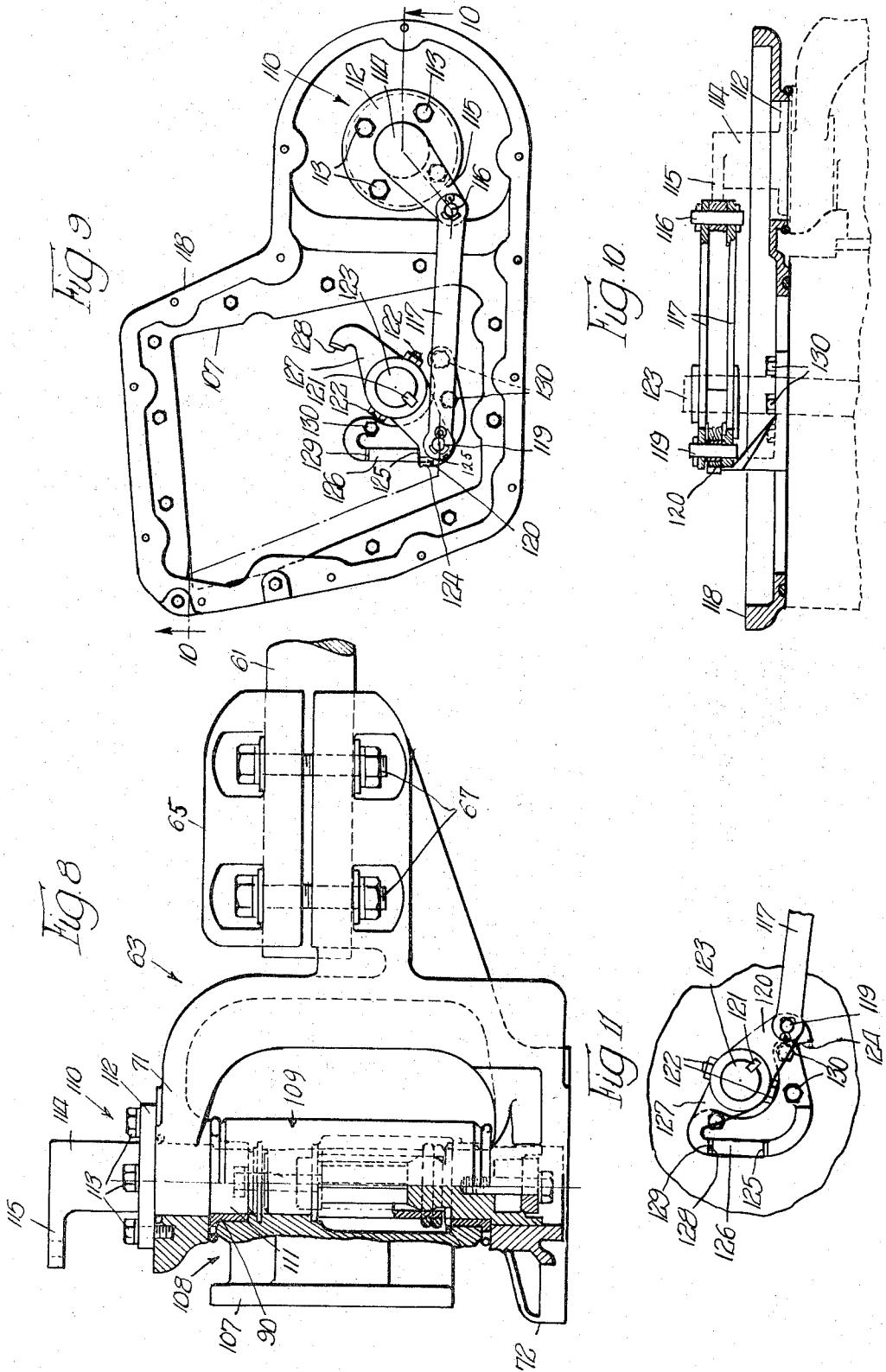
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HIGH VOLTAGE SWITCH CONSTRUCTION

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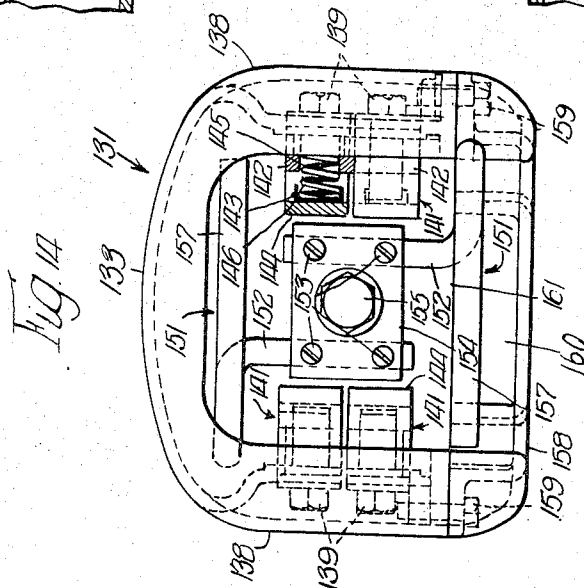
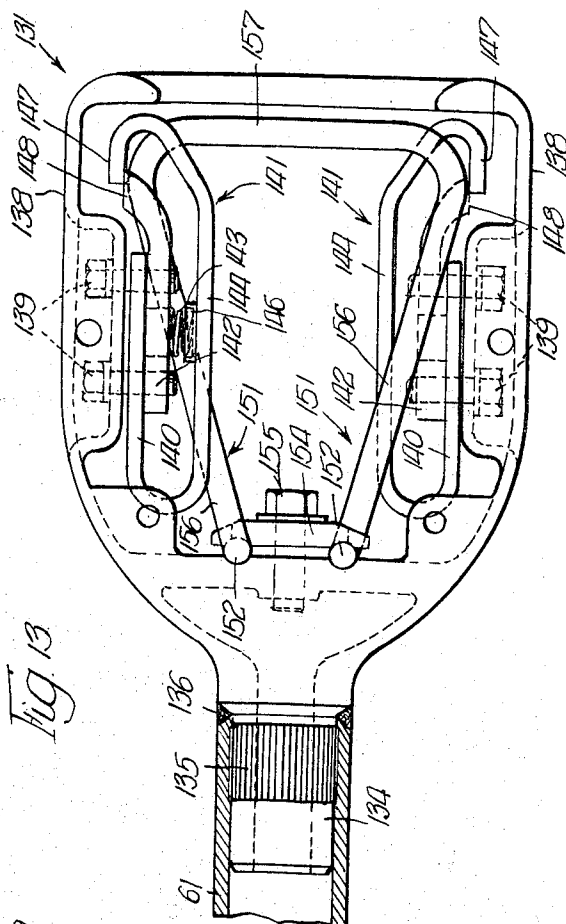
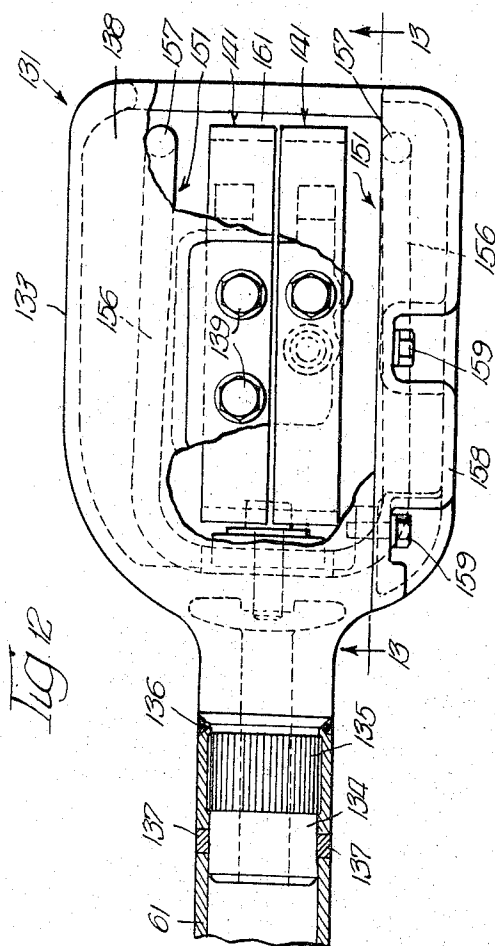
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HIGH VOLTAGE SWITCH CONSTRUCTION

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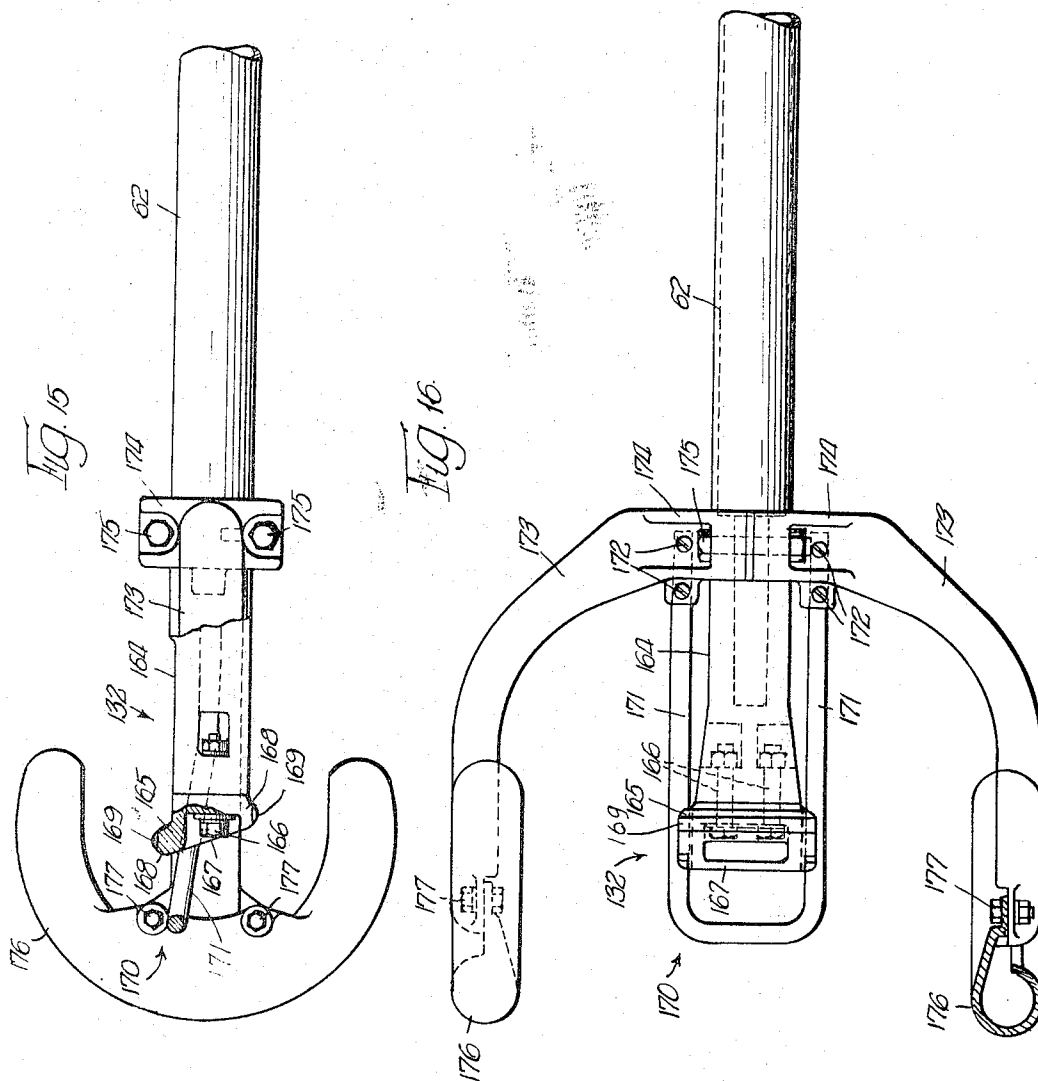
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HIGH VOLTAGE SWITCH CONSTRUCTION

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HIGH VOLTAGE SWITCH CONSTRUCTION
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12 Claims. (Cl. 200—48)

ABSTRACT OF THE DISCLOSURE

The blades of a center break disconnecting switch are stopped in their open and closed positions by energy absorbing stops. A circuit interrupter in series with the switch blades is operated through a linkage in conjunction with one switch blade.

This invention relates, generally, to switches for use on alternating current power transmission circuits operating at voltages ranging from 69 kv. to 700 kv. and it has particular relation to air break disconnecting switches alone and in combination with circuit interrupters. It constitutes an improvement over the switch constructions shown in Mikos et al. U.S. Patent No. 3,163,736, issued Dec. 29, 1964; Mikos U.S. Patent No. 3,194,928, issued July 13, 1965; and Bernatt U.S. Patent No. 3,244,826, issued April 5, 1966.

Among the objects of this invention are: To provide for controlling the inertial forces and kinetic energy incident to high speed rotation of an insulator stack and a switch blade carried thereby through an angle of 100 degrees in a time of one second minimum to 1.6 seconds maximum, with corresponding blade tip velocities of 3 to 5 ft. per second for 115 kv. ratings to 10 to 16 ft. per second for 500 kv. ratings, between the closed and open positions of the insulator stack and switch blade in order to reduce to a minimum vibration of the distal end of the switch blade at the ends of its opening and closing movements; to provide such control for a disconnecting switch of the center break type employing two switch blades engaging and disengaging at their distal ends and carried by individual rotatable insulator stacks; to operate a circuit interrupter in timed relation to the rotation of one switch blade by torque transmitted through the rotatable insulator stack on which it is mounted by a linkage interconnecting the operating mechanism for the circuit interrupter and the switch blades; to provide for adjusting the angular position of each switch blade with respect to the rotatable insulator stack on which it is mounted in order to accommodate misalignment therebetween and also misalignment between the switch blades of a center break disconnecting switch; to provide contact constructions at the distal ends of the switch blades of a center break disconnecting switch that are capable of opening and closing under sleet and ice conditions without requiring that repeated attempts be made to effect such operations; to employ main and auxiliary interfitted male and female contact structures at the distal ends of the switch blades; to enclose the female contact structure by a metallic housing that functions as a sleet hood and also is shaped to suppress corona discharge; to provide for suppressing corona discharge from the male contact structure; and to space the corona suppressing means on the contact structures in such manner as to reduce the likelihood of the assembly being so completely ice covered in closed position as to prevent opening and to reduce the likelihood of each assembly being so completely ice covered in open position as to prevent closing.

In the drawings:

FIG. 1 is a top plan view of one pole of a polyphase disconnecting switch and circuit interrupter assembly embodying the present invention.

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FIG. 2 is a view, in side elevation, of the construction shown in FIG. 1, certain parts being broken away in order to illustrate certain internal details of construction.

FIG. 3 is a horizontal sectional view taken generally along the line 3—3 of FIG. 2.

FIG. 4 is a top plan view, at an enlarged scale, of one of the energy absorbing stop means that is employed for arresting rotation of the associated insulator stack and disconnecting switch blade rotatable therewith.

FIG. 5 is a view, in side elevation with certain parts being broken away, of the mounting for the switch blade shown at the right side of FIG. 2.

FIG. 6 is a horizontal sectional view taken generally along the line 6—6 of FIG. 5 to illustrate the manner in which the mounting bracket is adjustably mounted on an adjusting plate that is secured to the upper end of the associated insulator stack, certain parts being shown in broken line outline to illustrate the relationship thereof.

FIG. 7 is a view, in side elevation, of a portion of the adjusting means, the view being taken generally along the line 7—7 of FIG. 6.

FIG. 8 is a view showing the mounting of the metallic mechanism housing on the mounting bracket for the switch blades shown at the left side of FIG. 2, certain parts being broken away in order to show the internal details of construction.

FIG. 9 is a top plan view, taken generally along the line 9—9 of FIG. 2, showing the operating linkage between the first rotatable insulator stack and switch blade thereon and the operating mechanism for the circuit interrupter.

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

FIG. 11 is a view, similar to a portion of FIG. 9, to illustrate the alternate position of the operating shaft and parts associated therewith corresponding to the open position of the switch construction.

FIG. 12 is a view, partly in side elevation and partly broken away, of the female contact assembly that is mounted on the distal end of the switch blade shown at the left side of FIG. 2.

FIG. 13 is a bottom plan view of the upper portion of the female contact assembly taken generally along the line 13—13 of FIG. 12.

FIG. 14 is a view, partly in end elevation looking from right to left and partly in section, of the female contact assembly shown in FIG. 12.

FIG. 15 is a top plan view of the male contact assembly that is mounted on the distal end of the switch blade shown to the right of FIG. 2, certain parts being broken away in order to show more clearly the details of construction.

FIG. 16 is a view, in side elevation, of the male contact assembly shown in FIG. 15, certain parts being broken away.

Referring now to FIGS. 1 and 2 of the drawings, the reference character 10 designates, generally, one pole of a polyphase switch and interrupter assembly embodying this invention. For three phase application three poles are employed.

The pole 10 includes a frame base 11 that can be constructed of welded rolled steel angle sections with suitable bracing. At the left end there is mounted a stationary insulator stack 12. Also mounted on the frame base 11 are first and second rotatable insulator stacks 13 and 14. Suitable bearings are provided for mounting the lower ends of the insulator stacks 13 and 14 for rotation about vertical axes on the frame base 11. The height of the insulator stacks 12, 13 and 14 varies depending upon the voltage of the system in which the pole 10 is con-

nected. For relatively low voltage application each insulator stack may comprise a single insulator, such as a porcelain insulator. For higher voltages a number of separate insulators having metallic fittings at their ends are bolted together endwise in order to accommodate the voltage used.

As shown in FIG. 3 shafts 15 and 16 extend downwardly from the rotatable insulator stacks 13 and 14 and each carries an operating arm 17 and 18. Mechanism is provided for rotating the operating arms 17 and 18 and thereby shafts 15 and 16 in opposite directions. This mechanism includes studs 19 and 20 carried by the distal ends of the operating arms 17 and 18 to each of which a clevis 21 and 22 is pivoted for receiving a clamp fitting 23 and 24 respectively. Links 25 and 26 interconnect the clamp fittings 23 and 24 with clamp fittings 27 and 28 each of which is connected by an adjustable clevis assembly 29 and 30 to a clevis 31 and 32 that is rotatably mounted on studs 33 and 34 that are carried by distal ends of crank arms 35 and 36 that extend radially from the crank shaft 37. The crank shaft 37 is suitably journaled in the frame base 11. Extensions 38 from opposite ends of the crank shaft provide for conjoint operation of the separate poles of a polyphase installation. Extending radially from the crank shaft 37 is a stop arm 39 that is arranged to engage one or the other of stops 40 for arresting further rotation of the crank shaft 37 in one direction or the other corresponding to the end of the closing or opening stroke of the associated switch assembly.

As pointed out above, the insulator stacks 13 and 14 and switch blades (to be described) carried thereby rotate at a relatively high speed between the switch closed and the switch open positions. Substantial kinetic energy is involved and must be dissipated rapidly with a minimum of shock at the end of each direction of travel. For this purpose stop arms 43 and 44, FIG. 3, are suitably clamped to the shafts 15 and 16, respectively. In the switch closed position here shown, the distal ends of the stop arms 43 and 44 are arranged to engage energy absorbing stop means 45 and 46. In the switch open position (not shown) the stop arms 43 and 44 are arranged to engage energy absorbing stop means 47 and 48. The energy absorbing stop means 45, 46, 47 and 48 are suitably stationarily mounted on the frame base 11.

FIG. 4 shows the preferred details of construction of one of the energy absorbing stop means 45. It includes a bumper pad 49 of resilient material that is located in a cavity 50 that is formed in a head 51 on a stop rod 52 that is slidable in a cylindrical body member 53. The body member 53 has a laterally extending integrally formed flange 54 that can be adjustably secured to the frame 11 by bolts 55. Within the cylindrical body member 53 bumper pads 56 are provided which, together with the bumper pad 49, serve to cushion the stopping of the respective stop arm 43 and 44 together with the respective rotatable insulator 13 and 14 and switch blades carried thereby. The endwise movement of the stop rod 52 is limited by a transverse pin 57 that extends through slots 58 in the cylindrical body member 53.

Referring to FIG. 2, it will be observed that the reference character 60 designates, generally, a center break disconnecting switch blade which comprises first and second switch blades 61 and 62 that are mounted directly on the insulator stacks 13 and 14, respectively, for conjoint rotation therewith. The present invention can be employed using only the center break disconnecting switch construction 60 without the circuit interrupter in series therewith (to be described). Each switch blade 61 and 62 is provided with a bifurcated mounting bracket shown generally at 63 and 64 the details of construction of the former being shown in FIG. 8 and of the latter in FIG. 5. Clamp fittings 65 and 66 cooperate with the mounting brackets 63 and 64 and are secured together by bolts 67

and 68 for mounting securely the respective ends of the first and second switch blades 61 and 62.

When the rotatable insulator stacks 13 and 14 are made up of a number of individual insulators bolted together, there is a likelihood that some misalignment may result between the upper and lower ends. In order to accommodate such misalignment, adjusting means, indicated generally at 69 and 70, are provided between the upper ends of the rotatable insulator stacks 13 and 14 and the mounting brackets 63 and 64 carried thereby for the purpose of adjusting the angular positions of the mounting brackets 63 and 64 with respect to the axes of rotation of the respective insulator stacks 13 and 14. Since the adjusting means 69 and 70 are identical in construction, the details thereof with respect to the adjusting means 70 associated with the mounting bracket 63 as shown in FIG. 5 will now be described.

As shown in FIG. 5 the mounting bracket 64 includes upper and lower furcations 71 and 72 with the lower furcation 72 being adjustably secured to an adjusting plate 73. The adjusting plate 73 is stationarily mounted on a metallic cap 74 that is secured to the upper end of the insulator stack 14. Bolts 75 extend from the adjusting plate 73 into the cap 74, one being illustrated, and preferably four being employed. For adjusting the angular position of the plate 73 and thereby of the insulator stack 14 with respect to the mounting bracket 64 about the axis of rotation of the former the lower furcation 72, as shown in FIG. 6, is provided with annular adjusting slots 76 of which there are preferably four in number. Clamp bolts 77 extend through the slots 76 in the lower furcation and are threaded into the adjusting plate 73. Once the desired angular position of the mounting bracket 64 is located with the respect to the adjusting plate 73, the bolts 77 are tightened. Additional adjusting and clamp means are provided by a lug 78, FIGS. 6 and 7, that extends upwardly from the adjusting plate 73 to a position between ears 79 that are mounted on the lower furcation 72 and extend downwardly therefrom. A large diameter adjusting screw 80 is threaded into the lug 78 and extends therefrom in one direction while a small diameter adjusting screw 81 is threaded into the large diameter adjusting screw 80 and extends therefrom in the opposite direction. Heads 82 and 83 on the adjusting screws 80 and 81 are arranged to engage the juxtaposed inner sides of the ears 79. With the bolts 77 loose, the adjusting screws 80 and 81 make it possible to accurately adjust the angular position of the mounting bracket 64 with respect to the adjusting plate 73. Also, they serve in addition to the bolts 77 to clamp or lock the adjustment once it has been made.

In order to insure proper axial alignment between the mounting bracket 64 and the adjusting plate 73, a depending annular pilot flange or centering hub 84 is provided as an integral part of the lower furcation 72. It is arranged to overlie an upstanding annular pilot flange or centering hub 86 on the adjusting plate 73. This piloting or centering arrangement together with the slots 76 in the lower furcation 72 facilitates angular adjustment of the mounting bracket 64 about the axis of rotation of the insulator stack 14 by the set screws 80 and 81 and securing it in position thereby and by the bolts 77.

A swivel terminal assembly, shown generally at 86, is mounted between the furcations 71 and 72 of the mounting bracket 64. The swivel terminal assembly 86 includes a line terminal pad 87 to which one conductor of the circuit can be connected. Also, it is provided with a bearing and contact portion, shown generally at 88, which includes a hollow hub 89 having upper and lower bearing sleeves 90. Also located within the hollow hub 89 is a contact sleeve 91 that is provided with a knurled section 91' which is pressed into the hollow hub 89 and is locked securely in place therein by a bolt 92. The contact sleeve 91 is longitudinally slotted as indicated at 93 at its lower

end and is there surrounded by garter springs 94 which bias the slotted construction into good contact engagement with a spherical contact portion 95 of a bearing and contact member 96 which forms a part of bearing and contact means, shown generally at 97, and mounted on the lower furcation 72 of the mounting bracket 64. A bolt 98 is employed for securing the bearing and contact member 96 to the lower furcation 72. The bearing and contact member 96 is provided with an annular bearing portion 99 that is journaled in the lower bearing sleeve 90 which is carried by the hollow hub 89. A hinge cover 100 is secured by bolts 101 to the upper furcation 71. The hinge cover 100 includes a depending annular bearing portion 102 which is journaled in the bearing sleeve 90 at the upper end of the hollow hub 89. In order to seal the upper and lower ends of the hollow hub 89 and the juxtaposed portions of the upper and lower furcations 71 and 72 against the entrance of dust, etc., O sealing rings 103 are provided as shown.

The cooperating bearing and contact portion 88 of the swivel terminal assembly 86 and the bearing and contact means 97 carried by the furcations 71 and 72 of the mounting bracket 64 provide for relative rotative movement therebetween and also a low resistance good current conducting path therebetween while the switch blade 62 is rotated between the switch closed and the switch open positions. The bearing and contact construction within the hub 89 is completely enclosed and sealed from contamination by the atmosphere. For greater and symmetrical current carrying ability the bearing and contact member 96 is duplicated on the upper furcation 71 of the mounting bracket 64 and the contact sleeve 91 is provided with the longitudinally slit construction at its upper end to engage a second spherical contact portion under the biasing action of additional garter springs.

Where the center break disconnecting switch 60 is connected in a circuit that must be opened while carrying load current, it is desirable that means be provided for interrupting the flow of such current before the switch blades 60 and 61 are disengaged. For this purpose there is provided a circuit interrupter that is indicated, generally, at 105. The details of construction of a preferred form of circuit interrupter are disclosed in the above mentioned Mikos et al. patent. It will be understood that other circuit interrupter constructions can be employed.

As illustrated in FIG. 2 the circuit interrupter 105 is mounted on the stationary insulator stack 12 and the rotatable insulator stack 13. It is connected in series circuit relation with the center break disconnecting switch 60 and more particularly in series with the first switch blade 61. Circuit connection to the interrupter 105 is provided by a line terminal pad 106 to which the line conductor can be connected. At the right end of the circuit interrupter 105 there is a metallic mechanism housing 107 in which the operating mechanism for the circuit interrupter 105 is located. It will be understood that the circuit interrupter 105 employs separable contacts which are arranged to be opened and closed by the mechanism within the metallic mechanism housing 107 in timed relation to the movement of the first switch blade 61 in such manner that the circuit is interrupted by the interrupter 105 before the switch blades 61 and 62 disengage at their distal ends.

The metallic mechanism housing 107 is provided with a bearing and contact portion, shown generally at 108, which extends, as shown in FIG. 8, between the upper and lower furcations 71 and 72 of the mounting bracket 63. The bearing and contact portion 108 includes a hollow hub 109 which is identical in construction with the hollow hub 89 that forms a part of the swivel terminal assembly 86. Also the associated bearing and contact construction is the same and, accordingly, a detailed description thereof will not be repeated. The bearing and contact portion 108 extending from the metallic mechanism housing 107 corresponds to the bearing and contact portion

88 on the swivel terminal assembly 86 while the bearing and contact portion 108 on the mounting bracket 63 corresponds to the bearing and contact means 97 on the mounting bracket 64. As described above, provision can be made for symmetrical current conduction to the upper furcation 71 of the mounting bracket 63 from the bearing and contact portion 108 in addition to that provided to the lower furcation 72 of this mounting bracket.

Instead of the cover 100, there is provided a cover fitting 110 for the mounting bracket 63. As shown in FIG. 8 the cover fitting 110 has a depending annular bearing portion 111 which is journaled in the upper bearing sleeve 90 that is carried by the upper end of the hollow hub 109. Formed integrally with the cover fitting 110 is an intermediate annular flange 112 which overlies the upper side of the upper furcation 71 of the mounting bracket 63 and is secured thereto by bolts 113 and is keyed thereto by pins (not shown).

As pointed out it is desirable to operate the circuit interrupter 105 in predetermined timed relation with respect to the movement of the first switch blade 61. Also it is desirable that there be a direct mechanical connection between the rotatable insulator stack 13 and the switch blade 61 rather than to have an indirect connection therebetween which has been used heretofore with the result that at the termination of the operating stroke of the switch blades 61 and 62, particularly at the end of the closing stroke, their distal ends were subject to severe vibration resulting from the requirement that certain inertial forces be counteracted. According to this invention there is a direct mechanical connection between each rotatable insulator 13 and 14 and its switch blade 61 and 62. For operating the circuit interrupter 105 torque is obtained from the rotatable insulator 13 through the mounting bracket 63 and particularly through the cover fitting 110 which has an upstanding extension 114 from which a lever 115 extends radially as seen more clearly in FIGS. 9 and 10. Pivotal connection at 116 to the distal end of the lever 115 is a pair of links 117 which extend within a two part cover 118 for the metallic mechanism housing 107 for pivotal connection at 119 to the distal end of a lever 120 which is secured against rotation by a key 121 to an operating shaft 123 on which the mechanism for operating the circuit interrupter 105 is mounted as described in the Mikos et al. patent above referred to. Set screws 122 also can be employed for securing the lever 120 in place on the operating shaft 123.

If desired, provision can be made for adjustably positioning the lever 120 on the operating shaft 123. This adjustment facilitates the timing of the operation of the contacts of the circuit interrupter 105 with respect to the rotation of the rotatable insulator stack 13.

In order to properly locate the position of the lever 120 in the closed and open positions of the circuit interrupter 105, a shoulder 124 is provided on the lever 120 that is arranged to engage or have a predetermined spaced relation with respect to one side 125 of a position reference stop 126 which is mounted on the metallic mechanism housing 107. In FIG. 9 the relationship of the parts is illustrated for the closed position of the contacts of the circuit interrupter 105 and for the closed position of the center break disconnecting switch 60. The position of the lever 120, corresponding to the open position of the switch blades 61 and 62, is illustrated in FIG. 11 where it will be observed that an extension 127 from the lever 120 carries a shoulder 128 that is arranged to be moved into predetermined relation with respect to the other side 129 of the position reference stop 126. Bolts 130 serve to hold the position reference stop 126 in place on the metallic mechanism housing 107. While the switch blades 61 and 62 are being swung to their full open position, the contacts of the circuit interrupter 105 are reclosed as described in the Mikos et al. patent above referred to.

As shown in FIG. 2 the switch blades 61 and 62 are arranged to have contact engagement at their distal ends.

Since current flow of many hundreds of amperes normally is expected to be carried by the switch blades 61 and 62, appropriate contact construction must be employed to accommodate it. Also the construction must be capable of opening and closing under unfavorable weather conditions, particularly those that result from an ice or sleet storm. The weather conditions may be such that with the switch blades 61 and 62 in the closed position, the assembly is encased in ice or sleet which must be broken loose to permit the opening operation. If the switch blades 61 and 62 are in the open position and are subjected to ice and sleet, the contact construction, if not properly arranged, may also be encased in ice which might interfere with the proper moving to the switch closed position. In accordance with this invention, a female contact assembly, shown generally at 131, is mounted on the distal end of the switch blade 61 and a male contact assembly, shown generally at 132, is mounted on the distal end of the switch blade 62. On rotation of the insulator stacks 13 and 14 in opposite directions, the contact assemblies 131 and 132 are caused to move in the same direction either out of or into contact engagement, depending upon the direction of rotation.

FIGS. 12, 13 and 14 show the details of construction of the female contact assembly 131. Here it will be observed that it comprises a metallic sleet hood 133 from which a support stub 134 extends for telescopic engagement with the distal end of the switch blade 61 which is preferably tubular in configuration. Near the base of the support stub 134 there is provided a knurled section 135 that is arranged to have a press fit with the adjacent portion of the tubular switch blade 61. An annular weld 136 is employed at the junction between the switch blade 61 and the base of the support stub 134 for securing these parts together.

In addition plug welds 137 are made through the wall of the tubular switch blade 61 as shown in FIG. 12. This construction provides for securely supporting the metallic sleet hood 133 on the distal end of the switch blade 61.

The sleet hood 133 has depending sides 138 through which bolts 139 extend for clamping one branch 140 of each of a pair of U-shaped contact fingers 141 against the inner side wall. The bolts 139 extend into and threadably engage a contact mounting plate 142 which overlies the two branches 140 of the associated pair of contact fingers 141. A coil compression spring 143 is provided between each branch 140 and the associated other branch 144 for urging the latter inwardly into good contact engagement with a contact member (to be described) on the male contact assembly 132. One end of each spring 143 extends into an opening 145 in the contact mounting plate 142 while the other end bears against the bottom of an insulating cup shaped spacer 146 that bears against the adjacent side of the other branch 144 as shown in FIG. 14. The outer end 147 of each branch 144 is turned rearwardly to overlie an extension 148 from the respective contact mounting plate 142. In this manner the coil compression springs 143 are pre-tensioned so that slight movement apart of the other branches 144 and lifting of the outer ends 147 off of the extension 148, the full forces of the springs 143 are then available to apply contact pressure.

In addition to the U-shaped contact fingers 141, which are considered main contact members and are intended to normally carry the full load current and to withstand for limited times relatively high short circuit current, there are provided generally L-shaped auxiliary contacts or arcing horns as indicated at 151. Two L-shaped auxiliary contacts or arcing horns 151 are employed, one being located generally above the other. Each includes an end section 152. The end sections 152 are arranged to extend in opposite directions as shown in FIG. 14. They are secured by set screws 153 to a clamp plate 154 which is secured by a clamp bolt 155 to the base of the metallic

sleet hood 133. Preferably the L-shaped auxiliary contacts or arcing horns 151 are formed of small diameter rod, such as 1/2 inch diameter, of good conducting material. Long arms 156 of the L-shaped auxiliary contacts or arcing horns 151 extend at right angles from the end sections 152 diverge as shown in FIG. 13 above and below the contact fingers 141. The shorter arms 157 of the L-shaped arcing horns 151 extend in opposite directions above and below the contact fingers 141. The shorter arms 157 extend parallel to each other at right angles to the longitudinal axis of the switch blade 61 and have ample mechanical clearance together with the longer arms 156 from the upper portion of the sleet hood 133 and from a U-shaped bottom closure member 158 which is secured in place by bolts 159 and provides an opening 160 at the bottom of the contact assembly 131. By this spacing the intermediate sections 156 and end sections 157, considerable flexibility thereof is provided which facilitates breaking loose of ice and sleet that may form thereon as well as permitting them to accommodate a substantial degree of misalignment with a cooperating auxiliary contact (to be described) that forms a part of the male contact assembly 132. An opening 161 is provided at the right end of the metallic sleet hood 133 to permit entry of the male contact assembly 132.

FIGS. 15 and 16 show the preferred details of construction of the male contact assembly 132. It employs a blade extension 164 that is secured to the tubular switch blade 62 in the same manner that the support stub 134 is secured to the tubular switch blade 61. The blade extension 164 carries a contact member or blade tip 165 which is secured thereto by bolts 166. The contact member 165 has an inclined end surface 167 to facilitate entry between the contact fingers 141 of the female contact assembly 131 as the switch blades 61 and 62 are swung toward the switch closed position. Also this configuration facilitates separation of the contact member 165 from the contact fingers 141 when the switch blades 61 and 62 are swung toward the open position. Rounded contact surfaces 168 are provided with silver inlays 169 for low resistance contact engagement with the juxtaposed surfaces of the branches 144 of the U-shaped contact fingers 141.

For cooperating with the generally L-shaped auxiliary contacts or arcing horns 151 of the female contact assembly 131 there is provided a U-shaped auxiliary contact or arcing horn 170 having branches 171 which are secured by set screws 172 to corona shield supports 173 which extend in a vertical plane above and below the switch blade 62. The auxiliary contact or arcing horn 170 is formed preferably of 1/2 inch diameter stainless steel rod and is inclined as shown in FIG. 15 to facilitate entry through the opening 161 into sliding and wiping contact engagement with and between the parallel short arms 157 of the auxiliary contacts or arcing horns 151. The arching horn 170 extends generally endwise from the switch blade 62 with its branches 171 generally parallel thereto in a vertical plane. Clamp sections 174 are formed integrally with the corona shield supports 173 for overlying the tubular switch blade 62 and receiving bolts 175 which serve to secure the clamp sections 174 securely in place. The corona shield supports 173 carry arcuate corona shields 176, which are secured thereto by bolts 177 and extend symmetrically in parallel planes above and below the switch blade 62.

It will be observed in FIG. 2 that the corona shields 176 are spaced substantial distances above and below the metallic sleet hood 133 when the switch blades 61 and 62 occupy the switch closed position. This arrangement not only functions to suppress the emission of corona from the parts energized at high voltage but also provides sufficient space to facilitate breaking loose of any ice or sleet that might be formed therebetween. The configuration of the metallic sleet hood 133 is such that it also functions to suppress the emission of corona from the

enclosed parts when energized at high voltage. In the open positions of the switch blades 61 and 62 the metallic sleet hood 133 and the corona shields 176 also act to suppress corona emission where the associated conducting parts are energized at high voltage.

In FIG. 1 the switch blades 61 and 62 are shown to be in endwise axial alignment in the switch closed position. On rotation of the crank shaft 37, the insulators 13 and 14 are rotated in opposite directions. The switch blades 61 and 62 start to rotate toward the positions shown by their center lines indicated by broken lines 180 through about 10°. During this rotation of the switch blades 61 and 62 the lever 114, FIG. 9, rotates sufficiently far to rotate the lever 120 and trip the contacts of the circuit interrupter 105. The continued rotation of the insulator stacks 13 and 14 swings the switch blades 61 and 62 to the positions indicated by broken line center lines 181 or about 21° from their initial positions. During this rotation the current flow is transferred from the contact member or blade tip 165 and contact fingers 141 to the auxiliary contacts or arcing horns 151 and 170. Prior to separation of the auxiliary contacts or arcing horns 151 and 170 the circuit interrupter 105 has completed its operation to interrupt the current flow in the circuit. Thus, on continued rotation of the insulator stacks 13 and 14 and separation of the auxiliary contacts or arcing horns 151 and 170 substantially no arcing takes place therebetween. The opening operation continues until the switch blades 61 and 62 have been swung to the positions shown by broken lines in FIG. 1 or through about 95° from their initial closed positions. During the continued movement of the switch blades 61 and 62 to the open positions, the operating mechanism within the metallic mechanism housing 107 is recocked and the contacts of the circuit interrupted are reclosed.

When the insulator stacks 13 and 14 are rotated in a reverse direction to swing the switch blades 61 and 62 to the switch closed position, shown by full lines in FIG. 1, if the circuit is completed under load conditions, arcing is likely to take place between the auxiliary contacts or arcing horns 151 and 170 as they approach each other. Because of the high speed of rotation of the insulator stacks 13 and 14, the time during which this arcing takes place before the auxiliary contacts or arcing horns 151 and 170 actually have metallic contact engagement is relatively short. The branches 171 of the U-shaped auxiliary contact member 170 move in a wiping and sliding manner into contact engagement with the short arms 157 of the auxiliary contacts 151. On continued movement of the switch blades 61 and 62 to the switch closed position in endwise alignment, the contact member or blade tip 165 comes into good contact engagement with the contact fingers 141 and the main flow of current is transferred thereto. In some instances the switch blades 61 and 62 may close in on fault circuit conditions in which case the current flow is relatively great.

When the center break disconnecting switch 60 is to be employed solely for circuit isolating purposes and is not required to be opened in conjunction with the interruption of current flow, the circuit interrupter 105 can be omitted. In such case a swivel terminal assembly, such as the swivel terminal assembly 86, is employed in conjunction with the mounting bracket 63 in lieu of the bearing and contact portion 108 of the metallic mechanism housing 107. Also the hinge cover 100 is provided instead of the cover fitting 110.

While the female and male contact assemblies 131 and 132 have been described as being mounted respectively at the distal ends of the first and second switch blades 61 and 62, it will be understood that their positions can be reversed.

The center break disconnecting switch 60 employs the two switch blades 61 and 62 principally for the higher voltages. For lower voltage application the second switch blade 62 and the rotatable insulator 14 on which it is

mounted need not be used. Instead of the rotatable insulator 14 a stationary insulator is substituted and provided with a female contact construction to cooperate with a male contact construction at the distal end of the rotating switch blade 61.

The switch construction and operating mechanism thereof of this invention have numerous advantages. The contact surfaces or ribs 168 on the contact member 165 with the silver inlays 169 have relatively small radii which facilitate small area high pressure contact wiping engagement and disengagement with and from the branches 144 of the U-shaped contact fingers 141 which are prestressed by the springs 143 against the stop provided by extensions 148. Engagement and disengagement of the L-shaped auxiliary contacts or arcing horns 151 with and by the U-shaped auxiliary contact or arcing horn 170 are readily effected since the short arms 157 of the former are horizontally parallel to each other above and below an extension of the longitudinal axis of the switch blade 61 and in a plane at right angles thereto while the branches 171 of the latter are parallel to each other above and below the extensions of the longitudinal axis of the switch blade 62 in a generally vertical plane and extend from a location rearwardly of the contact member or blade tip 165 to a position radially beyond it to engage the short arms 157 first and disengage them last. The branches 171 have slight clearance with transverse grooves in the ends of the contact member 165 to permit some degree of flexibility while adequately limiting its movement. Distortion caused by magnetic forces generated by heavy current flow is minimized by locating the line terminal pad 87 in endwise alignment in the same horizontal plane with the endwise aligned switch blades 61 and 62 which are likewise aligned with the bearing and contact portion 108 on the metallic mechanism housing 107. Adequate corona shielding is provided by the arcuate corona shields 176 carried by the supports 173 and secured to the switch blade 62 at a location spaced from the blade tip 165. In the switch open position the corona shields 176 serve their purpose for the male contact assembly 132. In the switch closed position they are spaced above and below the sleet hood 133 of the female contact assembly 131 to minimize corona emission therefrom. In the switch open position the sleet hood 133, which extends beyond the contacts 141 and 151, performs this function for the female contact assembly 131. Adequate weatherproofing for the links 117 interconnecting the operating levers 115 and 120 is afforded by the two part cover 118 which completely encloses them. Because of the height of the insulator stacks 12, 13 and 14, each pole 10 is usually shipped from the factory less these stacks. The adjusting means 69 and 70 employing the adjusting plates 73, slotted openings 76 in the lower furcations 72, clamp bolts 77, and adjusting screws 80 and 81 in the lug 78 make it possible for field assembly at an electric power station, where the switch is to be installed for operation, to align the switch blades 61 and 62 with a high degree of accuracy even though the metallic fittings at the ends of the insulator stacks 13 and 14 may be somewhat out of alignment and the initial factory alignment has been lost. Cooperating with this aligned relation of the switch blades 61 and 62 is the arrangement for absorbing the mechanical energy at the end of their closing stroke by the stop means 45 and 46. They are so located that the stop arms 43 and 44 engage the bumper pads 49 thereof a few degrees before the crank shaft 37 rotates past the center position to engage the stop arm 39 with one of the stops 40. The rotational energy is absorbed principally by the bumper pads 56 in the stop means 45 and 46 to the end that the switch blades 61 and 62 and the contact assemblies 131 and 132 thereon are stopped in aligned relation without vibration or oscillation and with the contact assemblies 131 and 132 in telescoped switch closed relation. At the end of the opening stroke the stop arms 43 and 44 engage the energy absorbing stop means 47 and

48 a few degrees prior to the crank shaft rotating past the center position in the opposite direction. The stop means 47 and 48 absorb the rotational energy of the moving parts and the switch blades 61 and 62 carrying the female and male contact assemblies 131 and 132 at their distal ends are stopped substantially without vibration or oscillation.

What is claimed as new is:

1. In a high voltage switch, in combination, support means, an insulator stack, means mounting said insulator stack at one end for rotation about its longitudinal axis on said support means, a switch blade having a bifurcated mounting bracket at one end one furcation of which is fixed to the other end of said insulator stack whereby said switch blade extends radially therefrom and is rotatable conjointly therewith between switch closed and switch open positions, means for rotating said insulator stack and said switch blade at relatively high speed between said open and closed positions requiring the dissipation of substantial kinetic energy at each position, a circuit interrupter connected in series circuit relation with said switch blade, mechanism for operating said circuit interrupter including a metallic mechanism housing having a bearing and contact portion extending therefrom between the furcations of said mounting bracket, bearing and contact means carried by said furcations journaling said bearing and contact portion thereon and providing contact engagement therewith, an operating shaft in said mechanism housing forming a part of said mechanism and rotatable about an axis parallel to the axis of rotation of said insulator stack, a lever secured to and extending radially from said operating shaft, a lever secured to and extending radially from said mounting bracket, a link interconnecting the distal ends of said levers to operate said circuit interrupter in timed relation to the rotation of said switch blade, and energy absorbing stop means on said support means cooperating with said one end of said insulator stack for arresting rotation thereof in the closed and open positions of said switch blade to dissipate said kinetic energy.

2. In a high voltage switch, in combination, support means, an insulator stack, means mounting said insulator stack at one end for rotation about its longitudinal axis on said support means, a switch blade having a bifurcated mounting bracket at one end one furcation of which is fixed to the other end of said insulator stack whereby said switch blade extends radially therefrom and is rotatable conjointly therewith between switch closed and switch open positions, an adjusting plate interposed between said one furcation and said other end of said insulator stack and rigidly secured to the latter, means for adjusting the angular position of said one furcation with respect to said adjusting plate to accommodate misalignment between said switch blade and said insulator stack, means for clamping said one furcation in adjusted position to said adjusting plate, means for rotating said insulator stack and said switch blade at relatively high speed between said open and closed positions requiring the dissipation of substantial kinetic energy at each position, a circuit interrupter connected in series circuit relation with said switch blade, mechanism for operating said circuit interrupter including a metallic mechanism housing having a bearing and contact portion extending therefrom between the furcations of said mounting bracket, bearing and contact means carried by said furcations journaling said bearing and contact portion thereof and providing contact engagement therewith, linkage means operatively interconnecting said switch blade and said mechanism to operate said circuit interrupter in timed relation to the rotation of said switch blade, and energy absorbing stop means on said support means cooperating with said one end of said insulator stack for arresting rotation thereof in the closed and open positions of said switch blade to dissipate said kinetic energy.

3. A high voltage switch comprising, in combination, support means, a stationary insulator stack and first and second rotatable insulator stacks mounted at one end of each stack in parallel spaced relation on said support means, first and second switch blades each having a bifurcated mounting bracket at one end one furcation of which is fixed to the other end of the respective first and second rotatable insulator stack whereby said switch blades extend radially therefrom and are rotatable conjointly therewith between switch closed and switch open positions for contact engagement and disengagement at their distal ends, a circuit interrupter and operating mechanism therefor mounted on the other ends of said stationary and first rotatable insulator stacks and connected in series circuit relation with said switch blades, a metallic housing for said operating mechanism having a bearing and contact portion extending therefrom between the furcations of the mounting bracket of said first switch blade, a terminal assembly having a bearing and contact portion extending therefrom between the furcations of the mounting bracket of said second switch blade, bearing and contact means carried by each pair of furcations and journaling the respective bearing and contact portion thereon, an operating shaft in said mechanism housing forming a part of said mechanism and rotatable about an axis parallel to the axis of rotation of said first insulator stack, a lever secured to and extending radially from the other furcation of the mounting bracket for said first switch blade, a link interconnecting the distal ends of said levers to operate said circuit interrupter in timed relation to rotation of said switch blades, means for rotating said rotatable insulator stacks about their longitudinal axes in opposite directions at relatively high speed between said open and closed positions requiring the dissipation of substantial kinetic energy at each position, and energy absorbing stop means on said support means cooperating with said one ends of said rotatable insulator stacks for arresting rotation thereof in said closed and open positions of said switch blades to dissipate said kinetic energy.

4. A high voltage switch comprising, in combination, support means, a stationary insulator stack and first and second rotatable insulator stacks mounted at one end of each stack in parallel spaced relation on said support means, first and second switch blades each having a bifurcated mounting bracket at one end one furcation of which is fixed to the other end of the respective first and second rotatable insulator stack whereby said switch blades extend radially therefrom and are rotatable conjointly therewith between switch closed and switch open positions for contact engagement and disengagement at their distal ends, an adjusting plate interposed between said one furcation of each mounting bracket and said other end of the respective rotatable insulator stack and rigidly secured to the latter, means for adjusting the angular position of said one furcation of each mounting bracket with respect to its adjusting plate to accommodate misalignment between the respective switch blades and rotatable insulator stack and between said switch blades, means for clamping each furcation in adjusted position to its adjusting plate, a circuit interrupter and operating mechanism therefor mounted on the other ends of said stationary and first rotatable insulator stacks and connected in series circuit relation with said switch blades, a metallic housing for said operating mechanism having a bearing and contact portion extending therefrom between the furcations of the mounting bracket of said first switch blade, a terminal having a bearing and contact portion extending therefrom between the furcations of the mounting bracket of said second switch blade, bearing and contact means carried by each pair of furcations and journaling the respective bearing and contact portion thereon, linkage means operatively interconnecting said first switch blade and said mechanism to operate said circuit interrupter in timed relation to rotation of said switch

blades, means for rotating said rotatable insulator stacks about their longitudinal axes in opposite directions at relatively high speed between said open and closed positions requiring the dissipation of substantially kinetic energy at each position, and energy absorbing stop means on said support means cooperating with said one ends of said rotatable insulator stacks for arresting rotation thereof in said closed and open positions of said switch blades to dissipate said kinetic energy.

5 5. In a high voltage switch, in combination, support means, an insulator stack, means mounting said insulator stack at one end for rotation about its longitudinal axis on said support means, a switch blade having a bifurcated mounting bracket at one end one furcation of which is fixed to the other end of said insulator stack whereby said switch blade extends radially therefrom and is rotatable conjointly therewith between switch closed and switch open positions, an adjusting plate interposed between said one furcation and said other end of said insulator stack and rigidly secured to the latter, means for adjusting the angular position of said one furcation with respect to said adjusting plate to accommodate misalignment between said switch blade and said insulator stack, and means for clamping said one furcation in adjusted position to said adjusting plate.

6. A high voltage switch comprising, in combination, support means, a stationary insulator stack and first and second rotatable insulator stacks mounted at one end of each stack in parallel spaced relation on said support means, first and second switch blades each having a bifurcated mounting bracket at one end one furcation of which is fixed to the other end of the respective first and second rotatable insulator stack whereby said switch blades extend radially therefrom and are rotatable conjointly therewith between switch closed and switch open positions for contact engagement and disengagement at their distal ends, an adjusting plate interposed between said one furcation of each mounting bracket and said other end of the respective rotatable insulator stack and rigidly secured to the latter, means for adjusting the angular position of said one furcation of each mounting bracket with respect to its adjusting plate to accommodate misalignment between the respective switch blade and rotatable insulator stack and between said switch blades, and means for clamping each furcation in adjusted position to its adjusting plate.

7. A high voltage switch comprising, in combination, support means, a stationary insulator stack and first and second rotatable insulator stacks mounted at one end of each stack in parallel spaced relation on said support means, first and second switch blades fixed to the other end of said rotatable insulator stacks respectively and extending radially therefrom and rotatable conjointly therewith between switch closed and switch open positions, male and female contact assemblies at the distal ends of said switch blades for contact engagement and disengagement in switch closed and switch open positions, each contact assembly including mutually engageable main current carrying contact means and auxiliary contact means arranged to have mutual contact engagement before engagement of said main current carrying contact means and to disengage after disengagement of said main current carrying contact means, corona shield and sleet hood means enclosing said female contact assembly, and corona shield means for said male contact assembly in spaced relation to said corona shield and sleet hood means when said contact assemblies are in the switch closed position, said auxiliary contact means of said female contact assembly including a pair of generally L-shaped contact rods having one section of each secured centrally to said corona shield and sleet hood means and extending in opposite directions to position the intermediate sections on opposite sides of said main current carrying contact means and the other end sections in parallel spaced relation for receiving therebetween and in contact engage-

ment therewith the branches of a U-shaped contact member of said male contact assembly comprising said auxiliary contact means thereof.

8. A high voltage switch comprising, in combination, center break isolator switch means including first and second horizontal switch blades each rotatably mounted at one end about a vertical axis for contact engagement with one another at their distal ends, a circuit interrupter connected in series circuit relation with said isolator switch means, first and second rotatable insulator stacks having said first and second switch blades respectively mounted directly thereon at one end to rotate conjointly therewith about the respective vertical axis, overcenter toggle means mechanically connected to the other ends of said insulator stacks to rotate them and said switch blades between switch open and switch closed position in which said switch blades are in endwise alignment, mechanism for operating said circuit interrupter mounted on said first rotatable insulator stack, linkage means operatively interconnecting said first insulator stack and said mechanism, said linkage means including a lever on said first insulator stack, a lever on said mechanism and a link interconnecting the distal ends of said levers, cover means enclosing said linkage means to protect the same from ice and sleet, and energy absorbing stop means cooperating with each insulator stack initially just prior to said toggle means reaching the center position for dissipating the kinetic energy of the moving parts when said toggle means reaches overcenter position with said switch blades stopped in endwise alignment substantially without vibration.

9. A high voltage switch comprising, in combination, center break isolator switch means including first and second horizontal switch blades each rotatably mounted at one end about a vertical axis for contact engagement with one another at their distal ends, mutually engageable and disengageable male and female contact and corona shield means on said distal ends of said switch blades, said male contact and corona shield means including a main contact member at the distal end of its switch blade having vertically extending small radius contact engaging surfaces on opposite sides in offset relation, and arcuate corona shield means in parallel relation above and below said main contact member, said female contact and corona shield means including facing prestressed contact finger means for receiving therebetween endwise and slidably said offset contact surfaces of said main contact member and a metallic sleet hood overlying said contact finger means and providing a corona shield therefor, first and second rotatable insulator stacks having said first and second switch blades respectively mounted directly thereon at one end to rotate conjointly therewith about the respective vertical axis, overcenter toggle means mechanically connected to the other ends of said insulator stacks to rotate them and said switch blades between switch open and switch closed position in which said switch blades are in endwise alignment, and energy absorbing means cooperating with each insulator stack initially just prior to said toggle means reaching the center position for dissipating the kinetic energy of the moving parts when said toggle means reaches overcenter position with said switch blades stopped in endwise alignment substantially without vibration.

10. The high voltage switch according to claim 9 wherein said male contact means includes a generally U-shaped auxiliary contact member of relatively small diameter rodlike metallic material with the branches located in parallel relation above and below said main contact member substantially in a vertical plane and extending therebeyond and mounted on the respective switch blade remote from said main contact member, and the female contact means includes a pair of generally L-shaped auxiliary contact members with the long arms secured at their free ends to said sleet hood and extending in diverging relation horizontally above and below the respective

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contact finger means and the short arms extending in opposite directions in a plane at right angles to the longitudinal axis of the respective switch blades for wiping and sliding contact engagement with said branches of said U-shaped auxiliary contact member.

11. A high voltage switch comprising, in combination, a pair of insulator stacks in parallel spaced relation and each rotatable about a vertical axis, means connected to the lower ends of said insulator stacks for rotating them in opposite directions, a switch blade secured at one end to the upper end of each insulator stack and extending radially therefrom in a horizontal plane, main and auxiliary contact means extending endwise from the distal end of each switch blade for mutual wiping and sliding contact engagement and disengagement, electrical connecting means for each switch blade located substantially in the horizontal plane thereof, and bearing and contact means mounting and interconnecting each electrical connecting means and the respective switch blade, said main and auxiliary contact means including spaced prestressed contact finger means on one of said switch blades having facing vertical contact surfaces for engagement by vertical small area contact surfaces on opposite sides of a main contact member on the other of said switch blades,

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and auxiliary small radius contact members resiliently mounted on one of said switch blades and extending in spaced apart relation in a vertical plane at right angles thereto for engagement by the small radius branches of a generally U-shaped contact member extending generally endwise and in a vertical plane from the other of said switch blades.

12. The high voltage switch according to claim 8 wherein said auxiliary contact members are supported on the respective switch blade in spaced relation from the distal ends thereof and in overlying relation to the respective main contact member.

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