June 14, 1955 S. I. LINDELL 2,710,897

SWITCH CONSTRUCTION

Filed July 30, 1948 3 Sheets-Sheet 1

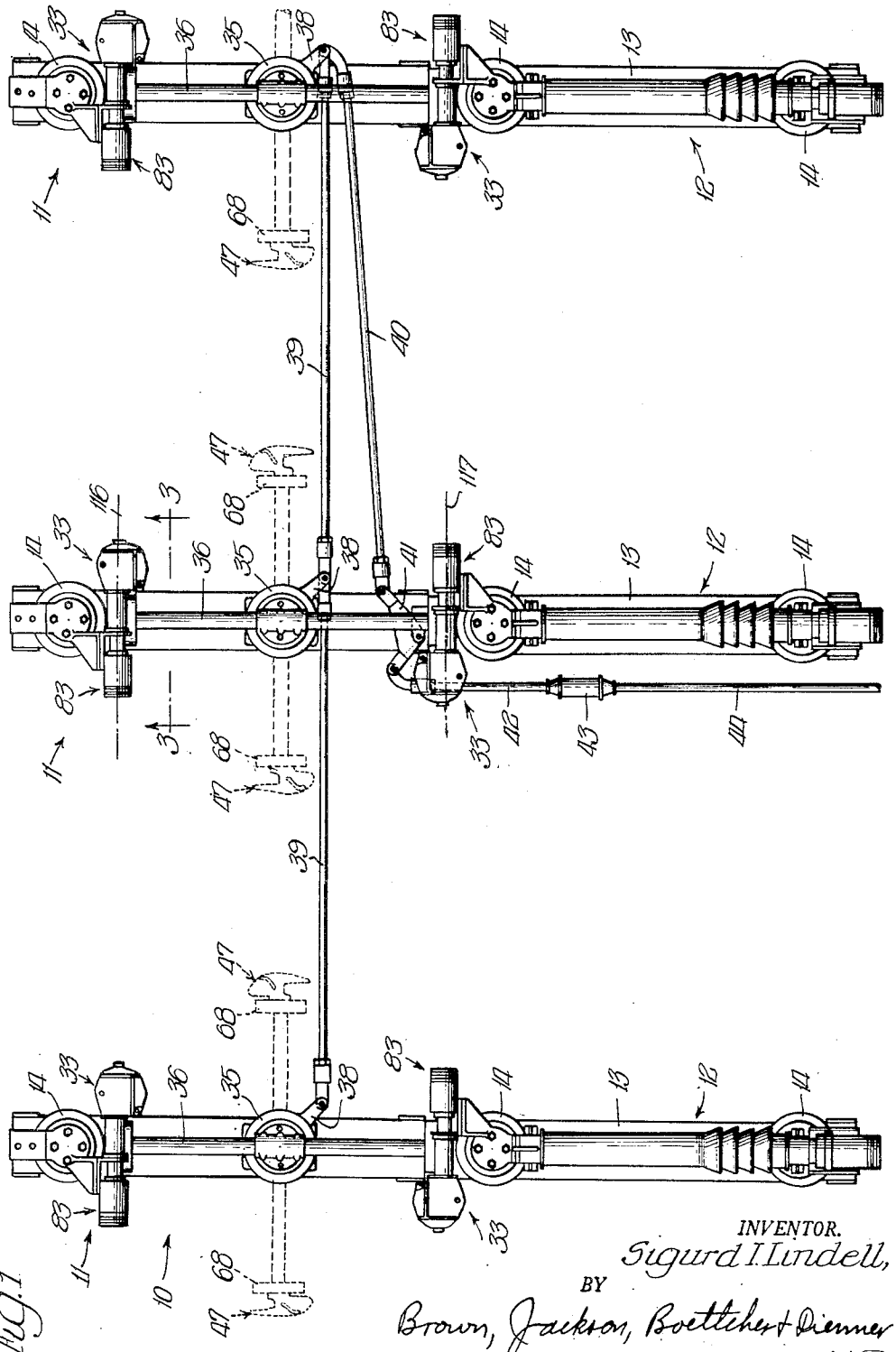


Fig. 1

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Filed July 30, 1948 3 Sheets-Sheet 2

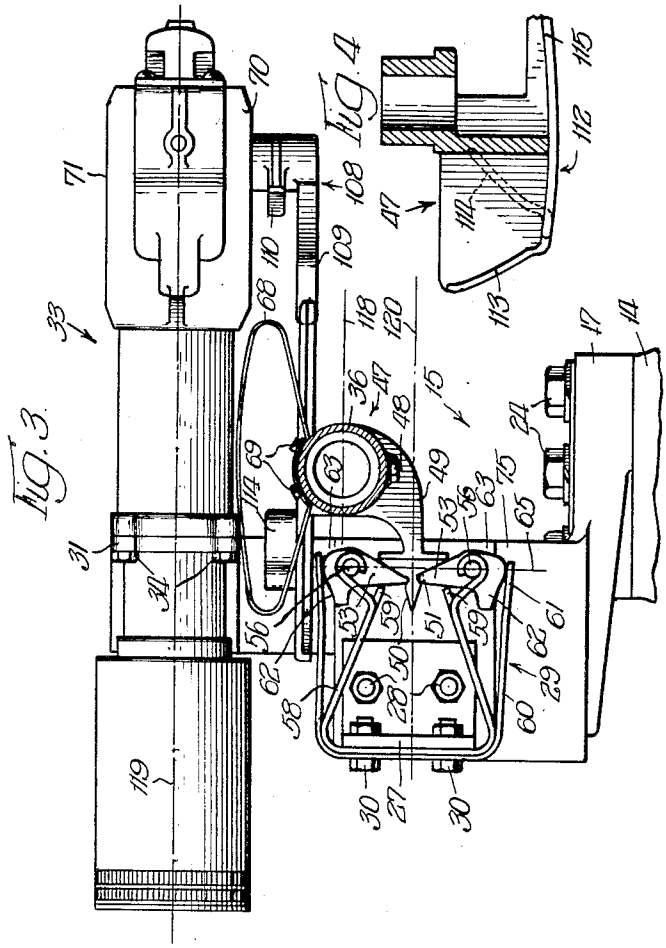


Fig. 3.

Fig. 4.

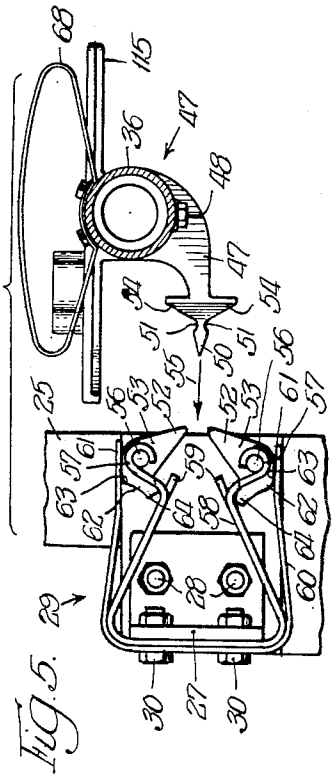


Fig. 5.

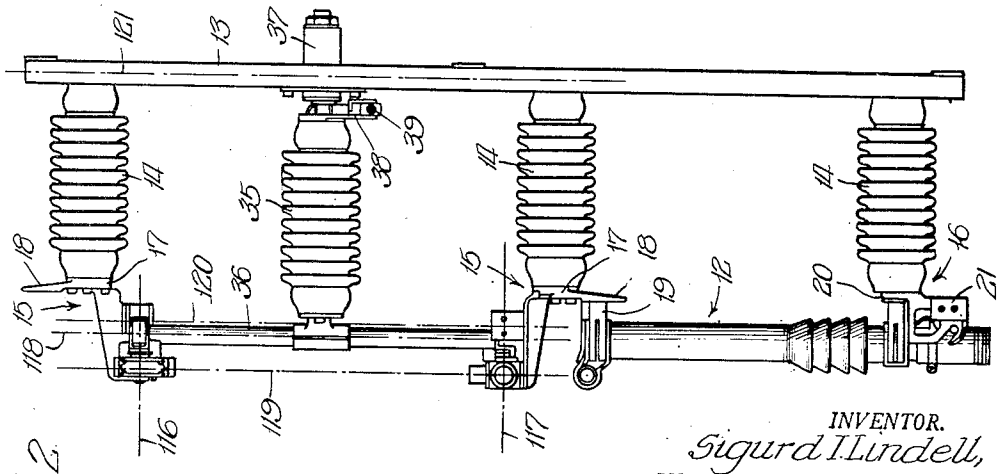


Fig. 2.

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Filed July 30, 1948. 3 Sheets-Sheet 3

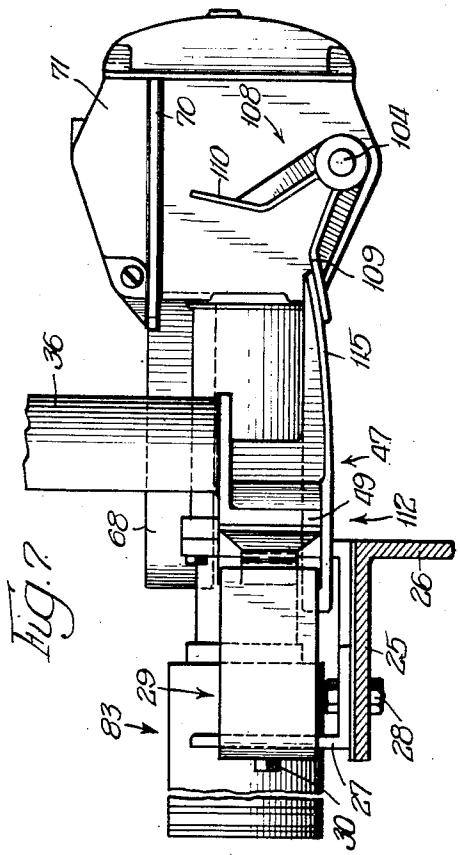


Fig. 7

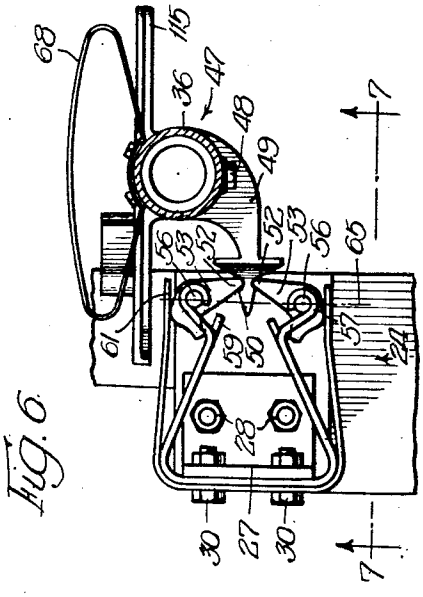


Fig. 6

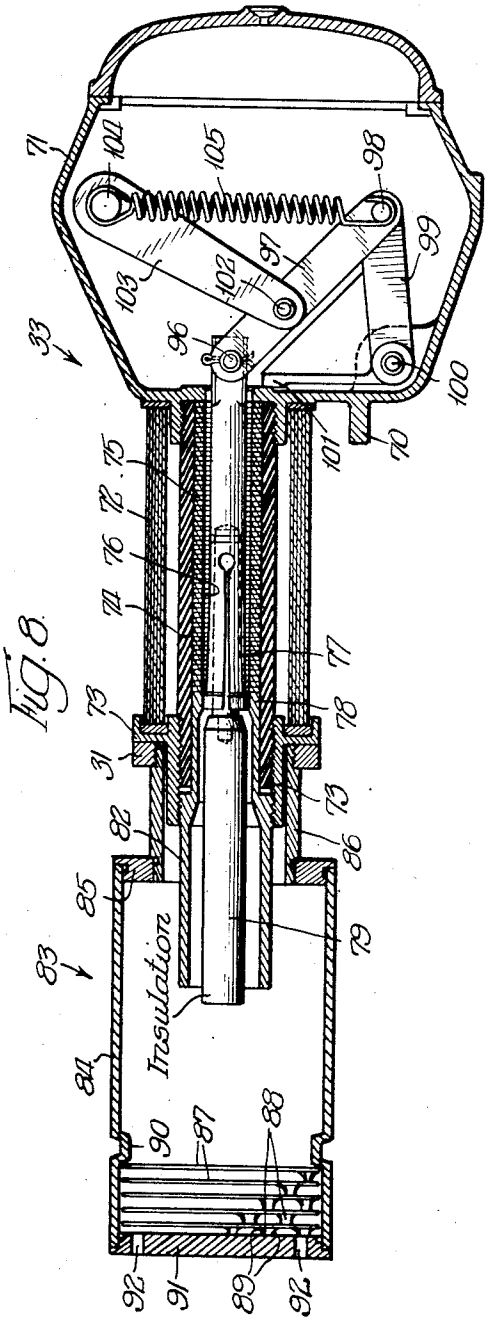


Fig. 8

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United States Patent Office 2,710,897 Patented June 14, 1955

2,710,897

SWITCH CONSTRUCTION

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Application July 30, 1948, Serial No. 41,597

20 Claims. (Cl. 200—146)

This invention relates, generally, to switches for opening high voltage alternating current circuits and it has particular relation to such switches that are capable of interrupting load current, magnetizing current, charging current, etc.

Among the objects of this invention are: To employ certain of the features of the switch construction shown in Lindell et al. Patent No. 2,351,826, issued June 20, 1944, and assigned to the assignee of this application, in a switch construction for use in alternating current power distribution systems operating at voltages of the order of 22 kv., 33.4 kv. and higher; to provide two breaks in each phase so as to draw two arcs simultaneously and to separate the arcing contacts at a speed high enough to prevent restriking of the arc; to accomplish this using a single switch blade arranged to open its circuit at each end and to employ a load interrupter at each end in which each arc is drawn and extinguished; to position the load interrupters and stationary switch contacts in planes parallel to their support and to rotate the switch blade in a parallel plane therebetween into and out of the switch closed position; to position the load interrupters horizontally whether the support is horizontal or vertical; to position each load interrupter and associated stationary switch contacts in a plane at right angles to the longitudinal axis of the switch blade in the closed position; to operate the load interrupter through an arm projecting from one side; to prevent accidental operation of the load interrupter to the open position when the switch is closed; to mount a plurality of these switches side by side for gang operation; to employ condensers for cooling and condensing the arc products; and to direct the discharge of the condensers toward the next phase switch and the discharge of the condensers of each phase switch in opposite directions.

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

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

Figure 1 is a view in front elevation of a gang operated switch construction in which the present invention is embodied and illustrating how it can be employed with high voltage fuses, the entire assembly being arranged for mounting in a vertical plane;

Figure 2 is a view, in side elevation, of the switch construction shown in Figure 1 with the fuses associated therewith;

Figure 3 is a detail sectional view, at an enlarged scale, taken along the line 3—3 of Figure 1, showing the outer end of the insulator which carries the stationary switch contacts and load interrupter, the switch blade being shown in the closed position;

Figure 4 is a view, partly in plan and partly in section, of the principal portion of the blade tip;

Figure 5 is a view, similar to Figure 3, the load interrupter being omitted, showing how the switch blade approaches the stationary switch contacts and their position before engagement by the switch blade;

Figure 6 is a view, similar to Figure 5, showing the switch blade in engagement with the stationary switch contacts just prior to its final movement to the switch closed position;

Figure 7 is a detail sectional view, taken along the line 7—7 of Figure 6, showing the load interrupter and the switch blade in the switch closed position; and

Figure 8 is a longitudinal sectional view of the load interrupter.

Referring now particularly to Figure 1 of the drawings, it will be observed that the reference character **10** designates, generally, a three phase gang operated switch construction. While this polyphase switch arrangement has been illustrated, it will be understood that the present invention can be employed in a single phase switch.

The gang operated switch construction **10** includes switches that are shown, generally, at **11** which are of identical construction. Accordingly, a description of one will suffice for all. The switches **11** may be connected in series circuit relation with fuses which are shown, generally, at **12**. The fuses **12** are provided to take care of short circuit protection, the switches **11** being arranged, as will appear in detail hereinafter, to open the circuit only when a normal load current is flowing therethrough. It is not intended that switches **11** will open the circuit under short circuit conditions.

As illustrated in Figure 2, each of the switches **11** and fuses **12** may be mounted in series on a channel iron support **13**. In Figures 1 and 2 of the drawings, the channel iron support **13** is shown as being located in a vertical position. In accordance with this invention the channel iron support **13** can be located either in the vertical position, as shown, or in a horizontal position with the switch **11** either above or below it. The fuses **12**, as shown in the drawings, are intended only for mounting in the vertical position shown. However, there are many instances where it is desirable to mount the switches **11** on a pole top where the switch **11** will be uppermost or in other installations where it will be underhung. As will appear hereinafter the present construction can be employed without change for any of these applications.

The channel iron support **13** carries three stationary insulators **14** the length of which is determined by the voltage of the circuit in which the switches **11** are connected. At their outer ends the insulators **14** are provided with contact and terminal mounting brackets that are indicated, generally, at **15** and **16**. The mounting brackets **15** are provided with intermediate sections **17** and end sections **18** which provide terminal pads. It will be understood that the upper terminal pad **18** may be connected to one terminal of the circuit in which the switch **11** is to be interposed. The other end section **18** is arranged to carry a fuse clip **19** in which is positioned the upper end of the fuse **12**. The mounting bracket **16** has a section **20** for attachment to the lowermost insulator **14** and also a terminal pad section **21** to which the other circuit terminal can be connected as will be understood readily. The fuses **12** may be any of the well known types now available. They are illustrated in Figures 1 and 2 of the drawings merely to show a typical installation of the switch **11** respecting which the present invention is particularly directed.

As shown in Figure 3 of the drawings, each of the contact and terminal mounting brackets **15** may be secured by bolts **24** extending through the intermediate section **17** to secure the same to the upper end of the associated insulator **14**. Each bracket **15** has an upstanding section **25** which is offset somewhat from the longitudinal axis of the insulator **14** and it has a flange **26**, Figure 7, extend-

ing at right angles from the rear side to provide additional strength and rigidity.

Intermediate the ends of the upstanding section 25 is an angle clip 27 which is secured thereto by bolts 28. The angle clip 27 has stationary contacts 29 secured thereto by bolts 30. The details of construction of the set of stationary contacts 29 will be described hereinafter. For the present it is pointed out that the stationary contacts 29 extend generally parallel to the upstanding section 25 and, in the particular construction shown, they extend horizontally.

At the outer end of the upstanding section 25 is another angle clip 31 which may be secured thereto by suitable bolts. One leg of the angle clip 31 extends at right angles to the upstanding section 25 and carries a load interrupter 33 which is secured thereto by bolts 34. The details of construction of the load interrupter 33 are generally the same as those shown in Patent No. 2,351,826, referred to above, and they will be set forth herein in amplified form in order to provide a more complete understanding of the present invention. It is pointed out here that the longitudinal axis of the load interrupter 33 is generally parallel to the face of the upstanding section 25 and that it extends horizontally. Because of this relationship the longitudinal axis of the load interrupter 33 will always extend horizontally regardless of whether the support 13 is positioned vertically, as shown, or occupies a horizontal position with the load interrupter 33 either above or below it as the case may be. This is important from a weather standpoint. Also, it provides a compact arrangement in which sufficient electrical clearances are established and maintained to isolate the main stationary contacts 29 and their associated line terminals 18 from the movable main contacts or switch blade to be described.

Intermediate the upper two insulators 14, as shown in Figure 2, there is a rotatable insulator 35 which carries a switch blade 36 at its outer end. The switch blade 36 in the present construction is tubular and is formed of hard drawn copper. Obviously it may have other shapes and be formed of other material as desired. As will appear hereinafter, the ends of the switch blade 36 are arranged to engage the stationary contacts 29 which are located at its ends and also to cooperate with the load interrupters 33 at its ends for opening the circuit at two places and drawing two arcs which are extinguished thereby.

The insulator 35 is rotatably mounted by a bearing 37 which is carried by the support 13. At the lower end of each of the rotatable insulators 35, as shown in Figure 1, there is an operating arm 38. As there shown the operating arms 38 are interconnected by connecting rods 39 so that conjoint movement of the insulators 35 and switch blades 36 carried thereby is effected. An operating rod 40 serves to interconnect the operating arm 38 of the right hand rotatable insulator 35 with one arm of a bell crank 41 which is rockably mounted on the intermediate support channel 13. The other arm of the bell crank 41 is connected by a rod 42 to a spring operator 43 which, in turn, is connected to an operating rod 44 that extends downwardly to a manually operable operating handle (not shown). The spring operator 43 is provided to effect the initial opening movement of the switch blades 33 and the final closing movement thereof with a snap action that is independent of the force exerted by a lineman on the operating handle which is connected to the operating rod 44.

Referring now particularly to Figures 3, 5 and 6 of the drawings, it will be noted that each outer end of the switch blade 36 carries a blade tip that is indicated, generally, at 47. The blade tip 47 may be a brass casting and it may be secured to the end of the switch blade 36 by a bolt 48. Each blade tip 47 has an offset integrally formed contact arm 49 with a wedge shaped blade 50 at its outer end provided with grooves 51 a slight distance from its outer edge for interfitting with the smaller ends 52 of pear-shaped contact fingers 53. The pear-shaped contact fingers 53 preferably are formed from extruded yellow brass that is silver plated and the smaller ends 52 are arranged to engage inlays of silver at the bottom of the grooves 51. Flanges 54 are formed integrally with the contact arm 49 for the purpose of picking up the contact fingers 53 when the blade 50 is moved toward the switch closed position in the direction indicated by the arrow 55.

The pear-shaped contact fingers 53 are rockably mounted by hinge pins 56 in the bifurcated hooked ends 57 of an inner U-shaped spring clip 58. Tongues 59 project between the hooked ends 57 to provide stops for limiting the rocking movement of the contact fingers 53 in the switch closed position as illustrated in Figure 3.

Nested with the inner U-shaped spring clip 58 is an outer U-shaped spring clip 60 the outer ends 61 of which bear against the larger ends 62 of the pear-shaped contact fingers 53.

With a view to holding the contact fingers 53 in the open position as shown in Figure 5, the larger ends 62 are provided with flattened surfaces 63, Figure 3, against which the outer ends 61 of the spring clip 60 rest for holding the contact fingers 53 in the position shown in Figure 5. In addition extensions 64 are formed integrally with the contact fingers 53 and, as shown in Figure 5, they are arranged to engage the outer surfaces of the inner spring clip 58 at the base of the tongues 59 to insure that the contact fingers 53 do not swing past their positions as shown in Figure 5.

It will be understood that each of the stationary contacts 29, referred to hereinbefore, is formed by the nested spring clips 58 and 60 and the pear-shaped contact fingers 53. The spring clips 58 and 60 are formed of good electrical conducting material such as beryllium copper which, in addition, has good resilient characteristics. Preferably they are bright silver plated. The construction of the stationary contact 29 is such that, when the contact arm 49 is swung to the switch closed position, the outer ends 61 of the outer spring clip 60 are required to move further than the outer ends of the inner spring clip 58. Accordingly, it is desirable that the resiliency of the outer spring clip 60 be greater than that of the inner spring clip 58. Accordingly, while the spring clips 58 and 60 are the same width, the thickness of the outer spring clip 60 is substantially less than that of the inner spring clip 58. For example, the inner spring clip 58 may be formed of a strip of beryllium copper having an initial length of 11¾ inches, a width of 1¾ inches and a thickness of 0.128 inch, while the outer spring clip 60 may be formed from a strip of beryllium copper having an initial length of 10$^{3}/_{16}$ inches, a width of 1¾ inches and a thickness of .102 inch. It will be understood that these dimensions are given for illustrative purposes only and that they may be changed as may be desired. The important point to be made here is that the cross-sectional area of the outer spring clip 60 is less than the cross-sectional area of the inner spring clip 58 for the reason above set forth.

As shown in Figure 5, the smaller ends 52 of the pear-shaped contact fingers 53 are held apart sufficiently far so that the wedge-shaped blade 50 can pass therethrough without engaging either of them. These smaller ends 52 engage the forward surfaces of the flanges 54 as the contact arm 49 continues to move in the direction of the arrow 55. As shown in Figure 6, the contact fingers 53 are rocked about the axes of the pins 56 past a line 65 joining their centers to the over center position shown in Figure 3. As the contact fingers 53 are swung to a position past the line 65, both of the spring clips 58 and 60 are stressed to provide such contact pressure between the contact members 53 and the spring clips 58 and 60 as to insure proper current distribution therebetween and thereby resist the closing movement of the

contact arm 49. Immediately after the contact fingers 53 have passed beyond the line 65 in the switch closing operation the spring clips 58 and 60 act to accelerate the final movement of the contact arm 49 to the fully switch closed position. The inward movement of the contact fingers 53 is limited by the tongues 59. In this position as shown in Figure 3, the spring clips 58 and 60 cooperate to lock the contact arm 49 in the switch closed position. Since the construction at each end of the switch blade 36 is identical it will be understood that it is held locked in the closed position at each end by the means just described.

It is not intended that the circuit shall be opened or closed by separation of the wedge-shaped blade 50 from the contact fingers 53 or engagement therewith so as to draw an arc therebetween. Instead the circuit is opened and closed by means of the load interrupter 33 that is associated with each of the stationary contacts 23 in a manner now to be described. It will be understood that, when the switch blade 36 is in the switch closed position, the circuit extends between the contact and terminal mounting brackets 15 through the stationary contacts 29 carried thereby and the switch blade 36 interconnecting the same. In this switch closed position the load interrupters 33 are out of circuit with the switch blade 36 although, if desired, they may be connected in parallel with the switch blade 36 and the stationary contacts 29 at its ends.

The circuit is transferred to the load interrupter 33 at each end of the switch blade 36 by a disconnecting contact 68 which is carried thereby and secured thereto by bolts 69. The disconnecting contact 68 preferably is in the form of a strip of Phosphor bronze which is highly resilient and yet has good electrical conducting characteristics. It is bow-shaped and its outer surface is arranged to engage a flange 70 that is formed integrally with a housing 71 of electrically conducting material, such as brass, which forms a part of each of the load interrupters 33.

As shown more clearly in Figure 8 of the drawings, the housing 71 is supported at one end of a porcelain insulator 72 which is secured at its other end to a fitting 73 which is secured by the bolts 34 to the angle clip 31 referred to hereinbefore. Within the porcelain insulator 72, which is tubular in form, is a sleeve 74 of insulating material, such as a phenolic condensation product, which carries a stack 75 of fiber washers that are positioned so as to provide a bore 76 therethrough. Within the bore 76 there is a plug-like bifurcated contact 77 which, in the circuit closed position, is arranged to have contact engagement with a ring-like stationary contact 78 that is threaded, as shown, into the fitting 73 and thus connected through the angle clip 31 to the upstanding section 25 of the associated contact and terminal mounting bracket 15. It will be observed that one end of the sleeve 74 is threaded into the fitting 73 while its other end is threaded into a suitable boss which extends from the housing 71. Near its outer end a plug or follower 79 of insulating material is attached to the contact 77 and is arranged to be moved therewith into the bore 76 formed in the stack 75 of fiber washers. As the contact 77 is drawn into the bore 76 and separates from the ring-like stationary contacts 78 an arc is drawn therebetween if the load current is flowing in the circuit. The arc is drawn into the bore 76 and between it and the outer surface of the plug 79 which together constitute arc extinguishing means that, under the heat of the arc, are arranged to evolve an arc extinguishing medium which flows into the arc space and deionizes the same.

The products of the arc drawn in this manner and the arc extinguishing medium flow through a cylindrical extension 82 of the stationary contact 78 and into a condenser that is shown, generally, at 83. The condenser 83 is provided for cooling and condensing the products

of the arc, so that, when the same escape to the atmosphere, their temperature will be such as not to sustain combustion or to create an ionized conducting path between adjacent phases of the switch 10.

As shown in Figure 1, the condensers 83 at opposite ends of each of the switches 11 extend in opposite directions while the condensers 83 of adjacent switches 11 extend toward the next switch 11. With this arrangement of the condensers 83 there is a minimum of likelihood of an arc over between the adjacent switches 11 resulting from the discharge from the condensers 83.

As illustrated in Figure 8 each of the condensers 83 comprises a sleeve or housing 84 of metal. For example, the sleeve or housing 84 may be formed of a seamless tube. At its inner end it is secured to a ring 85 that, in turn, is secured to an adapter sleeve 86 which is threaded into the angle clip 31. Near its outer end the sleeve or housing 84 is provided with a plurality of condenser plates 87 which extend transversely thereof. The plates 87 are formed of metal, such as brass, and they have apertures 88 that are formed therein by a stabbing operation which produces slivers 89 that extend therefrom and serve to space the condenser plates 87 apart. The condenser plates 87 are positioned in the sleeve or housing 84 so that the apertures 88 are out of registry with each other. The reason for this is to avoid a straight path therethrough for the products of the arc which flow into the sleeve or housing 84. The stack of condenser plates 87 is held in position in the sleeve or housing 84 at one end by a shoulder 90 which is formed by externally rolling a groove therein. It will be noted that the innermost plate of the stack of plates 87 reacts or bears against the adjacent surface of the shoulder 90. The outer end of the sleeve or housing 84 is provided with a closure plate 91 against which the slivers 89 of the outermost plate 87 engage. The plate 91 is provided with apertures 92 through which the pressure generated within the sleeve or housing 84 can escape to the atmosphere.

The plug-like bifurcated contact 77 is moved through the bore 76 by a linkage which will be described now. At its inner end the contact 77 is secured by a pin 96 to a first link 97 which, in turn, is pivoted by a pin 98 on a second link 99. The second link 99 is pivotally mounted at 100 on a suitable boss extending inwardly from the housing 71. The link 99 has an extension 101 which bears against the adjacent surface of the housing 71 and thereby serves to limit the extent of inward or outward movement of the contact 77 as the case may be. The first link 97 is connected intermediate its ends by pin 102 to a third link 103 that is fast on a rock shaft 104. A coil tension spring 105 extends between the rock shaft 104 and the pin 98 so as to provide an over center toggle construction which is effective to bias the contact 77 toward either the closed position shown in Figure 8, or the alternate position where it is separated from the stationary contact 78 and occupies the open position. In the open position the contact 77 is withdrawn through the bore 76 into the housing 71.

As shown in Figure 7 the rock shaft 104 extends to one side of the housing 71 and it carries a bifurcated operating arm or lever that is indicated, generally, at 108. The arm or lever 108 has branches 109 and 110 which are offset from each other as shown in Figure 3. The branches 109 and 110 are arranged to be engaged by an operator, shown generally at 112 in Figure 4, which is carried at the outer end of the switch blade 36 and forms an integral part of the blade tip 47. The operator 112 includes a forwardly extending flange 113 which is shaped to conform to the shape of the branch 109 of the operating arm or lever 108 and is arranged to engage the same as the switch blade 36 is swung toward the switch closed position to rock the shaft 104 and move the contact 77 from the open position to the closed position as shown in Figure 8. The operator 112 also includes a transversely extending flange 114, Figure 3, which is ar-

ranged to engage the other branch 110 when the switch blade 36 is moved toward the switch open position. This serves to rock the shaft 104 so as to move the contact 77 from the position shown in Figure 8 of the drawings to the open position in the housing 71.

It is desirable that the operating arm or lever 108 be locked in the position shown in Figure 7 of the drawing so that the load interrupter 33 cannot be operated accidentally to the open position while the switch blade 36 occupies the closed position. Accordingly, there is provided a tail extension 115 as an integral part of the blade tip 47. As shown in Figure 7, the tail extension 115 is arranged to be positioned in the path of the branch 109 of the operating arm or lever 108 and thereby insures that the latter cannot be moved as long as the switch blade 36 occupies the switch closed position.

In describing the operation of the gang operated switch construction 10 which is made up of the switches 11, it will be assumed first that they are in the closed positions as shown in Figure 1. The insulators 35 are rotated simultaneously by movement of the operating rod 44 to swing the switch blades 36 from their positions shown by full lines in Figure 1 to their positions shown by broken lines in this same figure. During the initial movement of each of the switch blades 36 to the open position the pear-shaped contact fingers 53 at each end of each switch blade 36 are rocked about the axes of their respective hinge pins 56 toward the line 65, Figure 6, joining the same. This flexes the outer ends of the spring clips 58 and 60 to stress the same additionally. During this interval the disconnecting contact 68 at each end of each switch blade 36 moves into engagement with the flange 70 of the associated housing 71 which forms a part of the associated load interrupter 33. This places the contacts 77 and 78 of each of the load interrupters 33 in parallel with the associated stationary contacts 29 and end of the switch blade 36. As the switch blade 36 moves to such a position that the pear-shaped contact fingers 53 move past the line 65, the energy which has been stored in the spring clips 58 and 60 is released and serves to accelerate the movement of the ends of the switch blade 36 toward the switch open position. Thereafter the wedge-shaped blade 50 disengages the smaller ends 52 of the contact fingers 53 and the entire current flow is then transferred to the load interrupter 33 at each end of the switch blade 36. As the switch blade 36 continues to swing toward the open position propelled by the accelerating spring in the spring operator 43 and the stored energy in the moving parts, the tail extension 115 is moved out of register with the branch 109 of the operating arm or lever 108 and thereafter the transversely extending flange 114 engages the branch 110 of the operating arm or lever 108 to rock the shaft 104 toward the open position to carry with it the plug-like contact 77. The continued movement of the switch blade 36 to the switch open position finally causes the contact 77 to separate from the stationary contact 78 and to draw the arc therebetween into the bore 76 where it is extinguished by the evolution of arc extinguishing material from the stack 75 of fiber washers and the outer surface of the trailer plug 79. It is pointed out here that the rigid connection provided by the switch blade 36 between the operating mechanisms for the contacts 77 and 78 of the load interrupters 33 at the ends of the switch blade 36 serves to synchronize their operation so that they separate at substantially the same instant. Tests with an oscillograph show that the contacts 77 and 78 of the load interrupters 33 at the ends of a switch blade 36 operate within one-tenth of a half cycle of 60 cycle alternating current. Tests also show that an arc is drawn simultaneously in each bore 76 of each of the load interrupters 33 so that each interrupter 33 is called to interrupt the load current at substantially one-half of the line voltage.

The construction of the load interrupters 33 is such that the arcs will be drawn and extinguished therein while the disconnecting contacts 68 remain in engagement with the housings 71. Thereafter, on continued movement of the switch blade 36 to the open position, the disconnecting contact 69 at each end disengages the associated housing 71. The switch blades 36 finally are swung to their positions as shown by the broken lines in Figure 1 where they are located at right angles to their initial switch closed positions. In this manner two air gaps are provided for each phase since no connections remain between the contact and terminal mounting brackets 15 and parts associated therewith, the two air gaps being provided therebetween and the switch blade 36 in the transverse open position.

When the switch blade 36 is moved to the closed position the operations just described take place in reverse sequence. That is, the disconnecting contact 68 at each end of the switch blade 36 first engages the associated housing 71. Thereafter the forwardly extending flange 113 of each of the blade tips 47 engages the corresponding branch 109 of the associated operating arm or lever 108 and rocks the shaft 104 past the over center position and effects movement of the contact 77 into engagement with the contact 78, thereby completing the circuit between the contact and terminal mounting brackets 15 through the load interrupter switches 33. The wedge shaped blade 50 of the contact arm 49 at each end of the switch blade 36 then engages the smaller ends 52 of the pear-shaped contact fingers 53, in the manner described hereinbefore, and they are moved to the position shown in Figure 3. In the fully closed position the contact fingers 53 are biased by the spring clips 58 and 60 to lock the contact arm 49 and ends of the switch blade 33 in the switch closed position. During its final movement the switch blade 36 shifts the disconnecting contacts 68 out of engagement with the housings 71 at each end, thereby removing the load interrupters 33 from the circuit.

Referring now particularly to Figures 1 and 2 of the drawings, it is pointed out that the stationary contacts 29 and load interrupter 33 at each end of the switch blade 36 are located substantially in parallel horizontal planes 116 and 117 which are at right angles to the longitudinal axis of each switch blade 36 when it occupies the closed position. The horizontal planes 116 and 117 are indicated by the broken lines in Figures 1 and 2. The broken line 118 in Figure 3 designates both the longitudinal axis of the switch blade 36 and also the vertical plane in which it moves. By positioning the stationary contacts 29 and load interrupter 33 in substantially the same plane at each end of the switch blade 36 when it is in the closed position so that its longitudinal axis is at right angles thereto, the contact and terminal mounting brackets 15 and parts carried thereby may be located at a minimum spacing with respect to each other for a given line voltage. This provides a minimum length of switch blade 36 and thus reduces the torque which must be applied to each of the insulators 35 for rotating it and the switch blade 36 carried thereby.

As shown in Figure 2 the load interrupters 33 at each end of each switch blade 36 are located in the same vertical plane which is indicated by the broken line 119. Likewise the stationary contacts 29 at each end of each switch blade 36 are located in a vertical plane which is indicated by the broken line 120. The plane, indicated by the broken line 118, in which the switch blade 36 rotates is between the planes represented by the broken lines 119 and 120. Also it will be noted that the planes represented by the broken lines 118, 119 and 120 are parallel to the plane represented by the broken line 121 through the channel iron support 13.

In copending application Serial No. 164,702, filed May 27, 1950, now Patent No. 2,644,878, July 7, 1953, as a division of this application, the details of construction of the contacts 29 and blade tips 47 are claimed.

Since certain changes can be made in the foregoing construction and different embodiments of the invention

can be made without departing from the spirit and scope thereof, it is intended that all matter shown in the accompanying drawings and described hereinbefore shall be interpreted as illustrative and not in a limiting sense.

What is claimed as new is:

1. In a switch for opening high voltage circuits under load, in combination, a pair of stationary contacts in insulated spaced relation, a self-contained load interrupter connected to each of said contacts, said contacts and load interrupters being disposed respectively in coplanar relation in parallel spaced planes, and a switch blade separate and distinct from said load interrupters and operatively related to said contacts and said load interrupters to complete a circuit through said contacts when it is in the closed position and through said load interrupters prior to its separation from said contacts during its initial movement to the open position for interrupting said circuit at two points by operating said load interrupters, said switch blade being movable in a plane parallel to and between the planes in which said load interrupters and stationary contacts are located.

2. In a switch for opening high voltage circuits under load, in combination, a support, a pair of stationary contacts carried in insulated spaced relation by said support in a plane parallel thereto, self-contained load interrupters connected to said contacts and located in a plane parallel to said support and further removed therefrom than said plane containing said contacts, and a switch blade separate and distinct from said load interrupters and rotatable intermediate its ends in a plane parallel to and between the aforesaid two planes and operatively related to said contacts and said load interrupters to complete a circuit through said contacts when it is in the closed position and through said load interrupters prior to its separation from said contacts during its initial movement to the open position for interrupting said circuit at two points by operating said load interrupters.

3. In a switch for opening high voltage circuits under load, in combination, a switch support disposed to be mounted in either a vertical or a horizontal position, an elongated load interrupter including separable load interrupting contacts and arc extinguishing means therefor in tandem, insulating means carrying said load interrupter in parallel transverse spaced relation to said support to position the former horizontally when the latter is in either the vertical or the horizontal position, a stationary switch contact assembly carried by said insulating means adjacent said load interrupter, a switch blade mounted in insulated spaced relation on said support for rotation in a plane parallel thereto to engage said switch contact assembly and complete a circuit therethrough and to disengage the same to open said circuit, a disconnecting contact carried by said switch blade for engaging said load interrupter to maintain said circuit therethrough after separation of said switch blade from said switch contact assembly during its initial rotation away therefrom, and an operator on said switch blade for operating said load interrupter on further rotation of said switch blade to open its load interrupting contacts and draw an arc therebetween to be extinguished by said arc extinguishing means.

4. The invention, as set forth in claim 3, wherein the stationary switch contact assembly is positioned parallel to the load interrupter and between it and the support.

5. The invention, as set forth in claim 3, wherein there is a load interrupter carried by each end of the support with a stationary switch contact assembly associated therewith, and the switch blade is rotatably mounted intermediate its ends on said support.

6. In a switch for opening and closing high voltage circuits under load, in combination, a stationary switch contact, an elongated load interrupter connected to said contact and including separable load interrupting contacts and arc extingishing means therefor in tandem, the longitudinal axes of said switch contact and said load interrupter being in the same plane, an arm extending from one side of said load interrupter and operatively connected to its contacts to separate and close them, a switch blade swingable in a plane parallel to said longitudinal axis of said load interrupter adjacent its side from which said arm extends to engage said switch contact and complete a circuit therethrough and to disengage the same to open said circuit, the longitudinal axis of said switch blade in its closed position extending at right angles to said plane containing said switch contact and load interrupter, a disconnecting contact carried by said switch blade and extending at right angles to its plane of movement for engaging said load interrupter to maintain said circuit therethrough after separation of said switch blade from said switch contact during its initial movement away therefrom, and an operator carried by said switch blade for engaging said arm to open said load interrupting contacts on further movement of said switch blade to draw an arc therebetween to be extinguished by said arc extinguishing means, said disconnecting contact disengaging said load interrupter on still further movement of said switch blade, said switch blade when swung in the reverse direction effecting the aforesaid operations in reverse sequence.

7. The invention, as set forth in claim 6, wherein the arm is bifurcated with one branch being removed from the adjacent side of the load interrupter further than the other and the operator is arranged to engage one branch when the switch blade is swung to disengage the stationary switch contact and to engage the other branch when the switch blade is swung to engage said stationary switch contact.

8. The invention, as set forth in claim 7, wherein a locking arm is carried by the switch blade and extends into the path of the branch engaged by the operator when said switch blade is swung to engage the stationary switch contact to prevent operation of the load interrupter except as the same is effected by said switch blade to disengage said switch contact.

9. In a switch for opening and closing high voltage circuits under load, in combination, a pair of stationary switch contacts in insulated spaced relation, an elongated load interrupter connected to each of said contacts and including separable load interrupting contacts and arc extinguishing means therefor in tandem, the longitudinal axes of each switch contact and associated load interrupter being in the same plane and said planes being parallel, an arm extending from one side of each load interrupter and operatively connected to its contacts to separate and close them, a switch blade rotatable intermediate its ends in a plane parallel to the longitudinal axis of said load interrupters and adjacent the side thereof from which the associated arm extends to engage said switch contacts and complete a circuit therethrough and to disengage the same to open said circuit, the longitudinal axis of said switch blade in its closed position extending at right angles to each plane containing a switch contact and load interrupter, a disconnecting contact carried at each end by said switch blade and extending at right angles to its plane of movement for engaging the adjacent load interrupter to maintain said circuit therethrough after separation of said switch blade from said switch contacts during its initial rotation away therefrom, and an operator carried at each end by said switch blade for engaging the adjacent arm to open the associated load interrupting contacts on further rotation of said switch blade to draw an arc therebetween to be extinguished by said arc extinguishing means, said disconnecting contacts disengaging said load interrupters on still further rotation of said switch blade, said switch blade when rotated in the reverse direction effecting the aforesaid operations in reverse sequence.

10. In a switch for opening and closing high voltage circuits under load, in combination, a support, a stationary switch contact carried in insulated spaced relation by said support in a plane parallel thereto, an elongated load

interrupter connected to said contact and including separable load interrupting contacts and arc extinguishing means therefor in tandem, the longitudinal axes of said switch contact and said load interrupter being in the same plane at right angles to said support with said switch contact being nearer said support, an arm extending from one side of said load interrupter and operatively connected to its contacts to separate and close them, a switch blade swingable on said support in a plane parallel thereto adjacent the side of said load interrupter from which said arm extends to engage said switch contact and complete a circuit therethrough and to disengage the same to open said circuit, the longitudinal axis of said switch blade in its closed position extending at right angles to said plane containing said switch contact and load interrupter, a disconnecting contact carried by said switch blade and extending at right angles to its plane of movement for engaging said load interrupter to maintain said circuit therethrough after separation of said switch blade from said switch contact during its initial movement away therefrom, and an operator carried by said switch blade for engaging said arm to open said load interrupting contacts on further movement of said switch blade to draw an arc therebetween to be extinguished by said arc extinguishing means, said disconnecting contact disengaging said load interrupter on still further movement of said switch blade, said switch blade when swung in the reverse direction effecting the aforesaid operations in reverse sequence.

11. In a switch for opening and closing high voltage circuits under load, in combination, a support, a pair of stationary switch contacts carried in insulated spaced relation by said support in a plane parallel thereto, an elongated load interrupter connected to each of said contacts and including separable load interrupting contacts and arc extinguishing means therefor in tandem, the longitudinal axes of each switch contact and associated load interrupter being in the same plane and said planes being parallel and at right angles to said support with said switch contacts nearer to said support, an arm extending from one side of each load interrupter and operatively connected to its contacts to separate and close them, a switch blade rotatable intermediate its ends on said support in a plane parallel thereto adjacent the sides of said load interrupters from which said arms extend to engage said switch contacts and complete a circuit therethrough and to disengage the same to open said circuit, the longitudinal axis of said switch blade in its closed position extending at right angles to each plane containing a switch contact and load interrupter, a disconnecting contact carried at each end by said switch blade and extending at right angles to its plane of movement for engaging the adjacent load interrupter to maintain said circuit therethrough after separation of said switch blade from said switch contacts during its initial rotation away therefrom, and an operator carried at each end by said switch blade for engaging the adjacent arm to open the associated load interrupting contacts on further rotation of said switch blade to draw an arc therebetween to be extinguished by said arc extinguishing means, said disconnecting contacts disengaging said load interrupters on still further rotation of said switch blade, said switch blade when rotated in the reverse direction effecting the aforesaid operations in reverse sequence.

12. In a switch for opening polyphase high voltage circuits under load, in combination, a stationary switch contact for each phase mounted in insulated spaced relation; an elongated load interrupter connected to each contact and including in tandem separable load interrupting contacts, arc extinguishing means therefor, and a condenser for cooling and condensing the arc products, each condenser having discharge openings directing the blast toward the load interrupter of the next phase; a switch blade operatively related to each of said switch contacts and the associated load interrupter to complete a circuit through the contact of each phase in the closed position and through the associated load interrupter prior to its separation from said contact during its initial movement to the open position for interrupting said circuit by operating said load interrupter, and gang operating means for moving said switch blades conjointly.

13. In a switch for opening polyphase high voltage circuits under load, in combination, a pair of stationary switch contacts for each phase in insulated spaced relation, all of said contacts being located in a common plane and each pair of contacts being located in a plane perpendicular to said common plane; an elongated load interrupter connected to each contact including in tandem separable load interrupting contacts, arc extinguishing means therefor, and a condenser for cooling and condensing the arc products, the condensers associated with each pair of contacts being arranged to discharge in opposite directions and toward the load interrupter of the next phase; a switch blade rotatably mounted between its ends and operatively related to each pair of contacts and their associated load interrupters to complete a circuit through the contacts of each phase in the closed position and through their load interrupters prior to its separation from said contacts during its initial rotation to the open position for interrupting said circuit by operating said load interrupters simultaneously, and gang operating means for rotating said switch blades conjointly.

14. In a switch for opening high voltage circuits under load, in combination, a switch support disposed to be mounted in either a vertical or a horizontal position, a pair of stationary switch contacts carried by said switch support in insulated spaced relation, a switch blade mounted intermediate its ends on said support for rotation in a plane parallel thereto to engage said switch contacts and complete a circuit therethrough and to disengage the same to open said circuit, an elongated load interrupter mounted with at least one of said switch contacts and including separable load interrupting contacts and arc extinguishing means therefor in tandem, said load interrupter being disposed in parallel transverse spaced relation to said support to position the former horizontally when the latter is in either the vertical or the horizontal position, a disconnecting contact carried by said switch blade for engaging said load interrupter to maintain said circuit therethrough after separation of said switch blade from said one switch contact during its initial rotation away therefrom, and an operator on said switch blade for operating said load interrupter on further rotation of said switch blade to open its load interrupting contacts and draw an arc therebetween to be extinguished by said arc extinguishing means.

15. In a switch for opening polyphase high voltage circuits under load, in combination, a stationary switch contact for each phase mounted in insulated spaced relation; an elongated load interrupter connected to each contact and including in tandem separable load interrupting contacts, arc extinguishing means therefor, and a condenser for cooling and condensing the arc products, each condenser having discharge openings; a switch blade operatively related to each of said switch contacts and the associated load interrupter to complete a circuit through the contact of each phase in the closed position and through the associated load interrupter prior to its separation from said contact during its initial movement to the open position for interrupting said circuit by operating said load interrupter, the discharge openings in each condenser being positioned to direct the arc products away from the air gap between the respective switch contact and switch blade when the latter is swung to the open position, and gang operating means for moving said switch blades conjointly.

16. In a switch for opening high voltage circuits under load, in combination, a support, a pair of contacts carried

in insulated spaced relation by said support in a plane parallel thereto, self-contained load interrupters connected to said contacts and located in a plane parallel to said support and further removed therefrom than said plane containing said contacts, and a switch blade separate and distinct from said load interrupters and rotatable intermediate its ends in a plane between said support and said load interrupters and operatively related to said contacts and said load interrupters to complete a circuit through said contacts when it is in the closed position and through said load interrupters prior to its separation from said contacts during its initial movement to the open position for interrupting said circuit at two points by operating said load interrupters.

17. In a switch for opening high voltage circuits under load, in combination, a support, a pair of contacts carried in insulated spaced relation by said support in a plane parallel thereto, self-contained load interrupters connected to said contacts and located in a plane parallel to said support and further removed therefrom than said plane containing said contacts, and a switch blade separate and distinct from said load interrupters and rotatable intermediate its ends in a plane between said support and said load interrupters, said switch blade carrying near each end a disconnecting contact and load interrupter operating means, said switch blade in closed position engaging said contacts to complete the circuit therethrough and each disconnecting contact being disconnected from the respective load interrupter so that the circuit is completed only through said contacts and switch blade when it is in said closed position, movement of said switch blade from said closed position causing each disconnecting contact to be connected to and to complete the circuit through its load interrupter prior to separation of said switch blade from said contacts, further movement of said switch blade causing operation of said load interrupters by said load interrupter operating means and interruption of said circuit at two points, still further movement of said switch blade causing each disconnecting contact to disengage its load interrupter.

18. In a switch for opening and closing high voltage circuits under load, in combination, a support, a switch contact carried in insulated spaced relation by said support; a self-contained load interrupter connected to said contact and located more remotely from said support than said contact and including separable load interrupting contacts, arc extinguishing means therefor, operating means for said contacts, and a conducting housing enclosing said operating means having a rock shaft connected to said operating means and projecting from one side of said housing with an operating arm fast on the outer end thereof; and a switch blade carried in insulated spaced relation to said support and swingable along said one side of said housing between said support and said load interrupter into and out of engagement with said switch contact, said switch blade carrying a disconnecting contact extending transversely to its plane of movement for engaging said housing along said one side to maintain a circuit through said load interrupter after separation of said switch blade from said switch contact during its initial movement away therefrom and carrying an operator for engaging said operating arm to open said load interrupter contacts on further movement of said switch blade to draw an arc therebetween to be extinguished by said arc extinguishing means, said disconnecting contact disengaging said housing in still further movement of said switch blade, said switch blade when swung in the reverse direction effecting the aforesaid operations in reverse sequence.

19. In a switch for opening and closing high voltage circuits under load, in combination, a support, a switch contact carried in insulated spaced relation by said support; a self-contained load interrupter connected to said contact and located at a greater distance from said support than said contact and including separable load interrupting contacts, arc extinguishing means therefor, operating means for said contacts, and a conducting housing enclosing said operating means having a rock shaft connected to said operating means and projecting from one side of said housing toward said support, a bifurcated operating arm fast on the outer end of said shaft, and a flange extending from said one side of said housing; and a switch blade carried in insulated spaced relation by said support and swingable along said one side of said housing between said support and said load interrupter into and out of engagement with said switch contact, said switch blade carrying a disconnecting contact extending transversely to its plane of movement for engaging said flange to maintain a circuit through said load interrupter after separation of said switch blade from said switch contact during its initial movement away therefrom and carrying an operator for engaging said bifurcated operating arm to open said load interrupter contacts on further movement of said switch blade to draw an arc therebetween to be extinguished by said arc extinguishing means, said disconnecting contact disengaging said flange on still further movement of said switch blade, said switch blade when swung in the reverse direction effecting the aforesaid operations in reverse sequence.

20. In a switch for opening and closing high voltage circuits under load, in combination, a switch contact; an elongated load interrupter connected to said contact and including in tandem separable load interrupting contacts, arc extinguishing means therefor, and operating means for said contacts, and a conducting housing enclosing said operating means having a rock shaft connected to said operating means and projecting from one side of said housing, a bifurcated operating arm fast on the outer end of said shaft, and a flange extending from said one side of said housing; and a switch blade swingable along said one side of said housing into and out of engagement with said switch contact, said switch blade carrying a disconnecting contact extending transversely to its plane of movement for engaging said flange to maintain a circuit through said load interrupter after separation of said switch blade from said switch contact during its initial movement away therefrom and carrying an operator for engaging said bifurcated operating arm to open said load interrupter contacts on further movement of said switch blade to draw an arc therebetween to be extinguished by said arc extinguishing means, said disconnecting contact disengaging said flange on still further movement of said switch blade, said switch blade when swung in the reverse direction effecting the aforesaid operations in reverse sequence.

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