This invention relates in general to improvements in a gang operated disconnecting switch, and more particularly to a three insulator switch in which the blade is moved vertically and which has a rotating insulator for operating the switch blade.

It has been the practice in the past for manufacturers of this type of switch to furnish a different switch depending upon how the switch is to be mounted. Switches of this type are usually mounted with their bases vertical, or horizontal in which case the insulators are either above the base or under slung below the base. Where different switches are furnished for the different mountings, the maintenance is very high, as it is not possible to mount one switch in any of the positions without having additional parts to adapt them for the different positions. In cases of emergency, it is very common to move a disconnecting switch from one location to another location where it may be mounted in a different position than originally mounted. It is, therefore, very important to have a switch which may be easily adapted for mounting in any position simply by reassembling the parts.

The service of the present forms of gang operated air break switches is limited to rupturing very small power loads which are usually little more than the charging current of transformers and lines. In the present day practice where electrical energy is transmitted over long lines at high voltages, this charging current becomes considerable. It has, therefore, been a problem to break the charging current with the ordinary type of disconnecting switch. Attempts to break these greater loads impose a hazard not only against the equipment, due to the possibility of short circuiting the phases by flaming arcs caused by the opening of the switches, but also against human life. It is, therefore, advantageous to have disconnecting switches which may be opened under load and which will not establish flaming arcs. Another important factor in the operation of high tension lines is to install disconnecting switches having a locking means which will hold the switch in the closed position and prevent it from being opened by short circuits or line surges. It has been a manufacturing problem, particularly with vertical break switches in which a rotating insulator is employed, to provide a successful bearing for the rotating insulators. It has been the practice with manufacturers to furnish a very long bearing in order to take care of horizontal stresses on the insulators. This bearing has the disadvantage of sticking through the supporting channel which forms the base and prevents the base from being mounted on a flat surface.

Various means have been used by manufacturers for transmitting the rotary motion of the revolving insulator to the switch blade which operates in a vertical plane. These schemes have ordinarily consisted of various linkages which require a considerable space between the hinge of the switch blade and the rotating insulator. This is a disadvantage as it requires more space for mounting the switch.

It is therefore an object of this invention to provide a gang operated disconnecting switch which may be mounted in any position by simply reassembling the parts of the switch.

It is also another object of this invention to provide a gang operated switch which is capable of breaking a loaded circuit without establishing a flaming arc.

A further object of this invention is to provide a gang operated switch which includes an operating mechanism that will hold it securely locked in a closed position.

Another object of this invention is to provide a gang operated disconnecting switch having a rotating insulator with an improved bearing.

Another object of this invention is to provide an improved means for transmitting the rotary motion of the revolving insulator to the vertical moving switch blade.

Other and further important objects of this invention will be apparent from the disclosures in the specification and the accompanying drawings.

This invention (in a preferred form) is illustrated on the drawings and hereinafter more fully described.

On the drawings:
Figure 1 is an enlarged elevational view of one leg of the gang operated switch.
Figure 2 shows the switch mounted on a sustaining structure with the base in the horizontal position and the insulators above the base.
Figure 3 shows a unit pole of the switch mounted upon a sustaining structure with the base in a vertical position and the insulators extending horizontally from the base.
Figure 4 shows one leg of the switch mounted upon a sustaining structure with the base in a horizontal position and the insulators below the base.
Figure 5 is an enlarged fragmentary view of the support for the revolving insulators and having a cut-out portion in section through the bearing.
Figure 6 is an enlarged fragmentary view of the air break contact having a cut-out portion showing the contact sheath in section.

Figure 7 is a plan view of the switch as shown in Figure 1, except that the sustaining structure is omitted.

Figure 8 is a view showing the relation of the universal swivel toggle mechanism to the switch blade and rotating insulator when the switch blade is in the open position.

Figure 9 is a transverse section through the air break contact.

Figure 10 is a plan view of the concentric grooves used on the final seal of the fluid break switch.

Figure 11 is a view showing the relation of the universal swivel toggle mechanism to the switch blade and rotating insulator when the blade is in the closed position.

Figure 12 is an enlarged fragmentary view showing the upper support for the rotating insulator having a cut-out section through the upper bearing.

Figure 13 is a schematic diagram showing two hermetically sealed tubes in parallel, each tube having its contacts connected in series.

Figure 14 is a schematic diagram showing one hermetically sealed tube having two rows of contacts in parallel, the contacts connected in series.

Figure 15 is a schematic diagram showing one hermetically sealed tube having two rows of contacts, the contacta connected in parallel.

Figure 16 is an enlarged view of the hermetically sealed fluid break switch in the position shown in Figure 2 and having cut away portions showing the contact mechanism.

Figure 17 is an enlarged view of the hermetically sealed fluid break switch in the position shown in Figure 4 having cut away portions to show the contact mechanism.

Figure 18 is an enlarged view of the hermetically sealed fluid break switch in the position shown in Figure 4 having cut away portions to show the contact mechanism.

Figure 19 is a transverse cross section through the hermetically sealed fluid break switch tube taken on line XIX—XIX of Figure 16.

Figure 20 is a fragmentary cross section through the final sealing screw, washer and screw seat.

As shown on the drawings:

A unit pole of the gang operated disconnecting switch is shown in Figure 1 mounted in a horizontal position with the insulator above a mounting base 1. Insulator pins 2, which support the conventional type of high tension insulator 3, are secured to the top of the mounting base near its end; by means of bolts 4 which extend through the base of the insulator pins, the mounting base, and a plate 5. This plate makes it possible to secure the cap end of the insulator to the mounting base by means of the cap bolts 6 and the insulator pins to the castings 45 and 72 by means of bolts 7, when the disconnecting switch is mounted in the underhung position as shown in Figure 4.

An insulator 7 having the same characteristics electrically as the insulator 3 is mounted upon an insulator pin 8 which is rotatably secured to a lower bearing by means of bolts 9, and the insulator pin to a cap casting 36 by means of bolt 10. A lever arm shaft casting 11 is designed so that it may be bolted to either the pin or cap of the insulator depending upon the position in which the switch is mounted.

A stationary supporting member 17 for the lever arm shaft casting is secured to the underflange of the channel by means of bolts 18. At the center of this member is an upwardly extending portion 19 which passes through an aperture 20 in the channel and forms an annular flange surrounding the stub shaft 15. The lower end of the stub shaft 15 is threaded for receiving a screw 22 which secures a revolving plate 23 to the end of the shaft. The upper portion of this plate follows the general contour of the stationary supporting member and is separated therefrom by a small clearance. The circumference of this plate is grooved to receive a band contacting the channel coatings with a depending annular flange 25 on the stationary plate to form a ball race for the balls 22. These balls protrude upwardly from the ball race groove 21 and engage the shoulder 16 of the lever arm shaft casting and also engage the stub shaft 15. The lower end of the stub shaft 15 is threaded for receiving a screw 22 which secures a revolving plate 23 to the end of the shaft. The upper portion of this plate follows the general contour of the stationary supporting member and is separated therefrom by a small clearance. The circumference of this plate is grooved to receive a band contacting the channel coatings with a depending annular flange 25 on the stationary plate to form a ball race for the balls 22. It is to be noted that the upper ball race is of smaller diameter than the lower ball race.

The upper ball race takes the thrust of the rotatable insulator, and also any axial forces exerted, whereas the lower ball race gives a stabilizing effect to the stub shaft 15 which is the equivalent of a very long shaft and gives the added advantages of allowing the supporting channel to be mounted on a flat surface. This would be impossible if a long shaft protruded below the channel. While the structure used in this particular case includes an upper ball race of small diameter, it is evident that either race may be of large diameter and still come within the intention of this invention. It is not the intent of this text to extend the scope of this invention to the use of ball-bearings, since it is contemplated that any suitable bearing may be used such as Babbitt metal and the like.

This arrangement of ball races to secure steady rotation of a shaft about its center will permit the use of plain surfaces similarly arranged to produce this same result is applicable to machine designs in general and it is not permitted to limit the invention to its use in electrical power switches only.

It is contemplated, that a plurality of the unit poles may be operated simultaneously when used as a gang switch. This operation may be either by hand or motor mechanism at a convenient location. In either method the operating force is transmitted to the switches through a vertical pipe 27 which may be of any convenient length and is supported at intervals by ring guides 38 which are secured to the switching structure. A crank 29 secured to the top end of the vertical pipe has a member 30a which is rotatably mounted at its outer end; this member having a lug pivotally attached to a clevis member 30b which is rotatably secured on one end of a link formed by a length of pipe 31. A similar clevis 32 is connected to the other end of the pipe by means of a swivel member 32a, which allows the clevis 32 to be angularly rotated relative to clevis 30. Clevis 32 is in pivotal engagement with a lug on
the member 33a, said member being rotatably mounted on the clamp 33 which is secured to the pipe 34. It should be noted that this arrangement effects a universal swivel toggle joint connection between the pipes 27 and 34, and produces an operating mechanism which can be used to operate the switch in any of its various positions, with mounting, and one in which the relative positions of the various members may be varied over a wide range. The elevin 13 of each unit pole is pivotally secured to a clamp 35 which is secured to the pipe 34. It is evident that in the gan... the rotating insulator of each pole will be simultaneously rotated upon the rotation of the vertical pipe 27 either by hand or motor mechanism.

The upper end of the rotating insulator has the cap casting 36, Figure 12, secured by cap screws 10. Integral with the cap casting 36 and centrally disposed in an upwardly extending short shaft 37, which passes through a bearing 38 in a hinge support casting 39. A shoulder 40 is formed on the shaft and co-acts with a depending flange 41 of the bearing 38 for the balls 42. This upper bearing of the rotating insulator serves a double purpose, the balls engaging the vertical sides and the horizontal sides of the ball race. This bearing will therefore take care of any axial forces exerted by the hinge support casting 39 and any transverse force exerted upon the rotating insulator.

A crank 43 is secured to the upper end of the shaft 37 by means of a pin 44. This crank will therefore be rotated simultaneously with the revolving insulator. The hinge support casting 39 is composed of integral diverging arms, one of which is secured to the hinge terminal casting 45 by the bolts 46. The hinge terminal casting is in turn secured to the stationary insulator 3 by means of cap screws 6. Bolted connections are provided on this terminal for the terminal end of the line and also for the flexible conductor 47. The blade bar is a tube 48 which threadedly engages the hinge blade casting 49 and is securely clamped therein by clamping screw 50. The hinge blade casting is pivotally secured by the pin 51 to the free pivot of the other universal swivel toggle support casting 39. A lug 52 disposed in angular relationship to the blade bar 48 forms a part of the hinge casting and is drilled at its outer end to receive the upper pivot member 53 of the universal swivel toggle. The upper pivot member is threaded for a standard hexagonal machine nut 54 and shoudered for a tight fitting washer under the nut so that the upper pivot member will just be free to move in the hinge blade casting lug. The upper fork castings 55 of the universal swivel toggle is pivoted to the upper pivot member by means of pivot pin 56 and an adjustable length swivel member 57 is threadedly secured to the lower portion of the upper fork casting 55 and held firmly in place with the lock nut 58. The lower portion of the swivel member is rotatably secured to the lower fork casting by means of the hexagonal nut 60 which tightened against a washer which bears against a shoulder on the swivel member. This swivel member also provides an adjustment for the switch blade to assure proper closing of switch contacts. The lower fork casting 59 is pivotally secured by means of pivot pin 61 to the lower pivot member 62 which is identical to the upper pivot member 53. The lower pivot member is rotatably secured to the outer end of the crank 43 by means of the hexagonal nut 63 which tightens a washer against a shoulder of the pivot member in such a manner that the lower pivot member is free to move with a rotary motion. It is important to observe the effect of the operating forces in the structure just described. Since the shaft 37 has a limited, if any, longitudinal movement through the bearing 38 which is integral with the arm of the casting 39, having its outer end secured to the casting 45; it follows that any longitudinal forces exerted on said shaft will be carried to said fixed arm. Therefore, when the crank 43 which is secured to the shaft 37 is rotated to operate the switch blade, forces are exerted by virtue of the universal swivel toggle mechanism, which tend either to increase or decrease the angle of divergence between the two arms of the casting 39. Now, it follows, that since the arm associated with the shaft 37 is fixed and the other arm is free at its outer end, stresses resulting from these forces are set up and confined to the casting 39 and are not communicated to the rotatable insulator through the shaft 37. By this arrangement large operating forces may be utilized without submitting the rotatable insulator to undue stresses.

The contact end of the blade bar 48 threadedly engages a fork casting 64 and is securely clamped therein by bolt 65. This fork casting is drilled with clearance holes for the support pins 66 of the full floating contact support casting 67, which is provided with a clamping means for making a solid connection to the flexible conductor 47 after it has been carried through the blade bar tube 48. Guide prongs 68 are secured to the full floating contact support casting and in an emergency operation these prongs become arcing fingers for breaking the circuit of the arcing blade guide horn 69. The full floating contact support casting is drilled and tapped to receive either the contact sheath 70 or the contact plunger 71. This interchangeability gives a contact which is thoroughly housed against weather in any position in which the switch may be mounted. A contact casting 72 is secured to the insulator by the cap bolts 6 and is drilled and tapped to receive either the contact plunger 71 as shown in Figure 6, or the contact sheath 70. The hinge support casting 39 acts as a support for the guide horn 69 and also provides a lug to which the line terminal connection may be bolted.

The female member of the contact comprises the sheath 78 having a plurality of sockets 73 for receiving conducting spheres 74 which are backed up by connector straps 75 solidly fastened to one end of the sheath by screws 76. These conductor straps are enclosed by a cylindrical close wound coil spring 77, which exerts spring pressure on the spheres, forcing them to the bottom of their respective sockets, where their further movement is arrested by an inturmed edge of the socket. It will be noted that in this position the spheres project slightly past the inner wall of the sheath and make contact with the contact plunger 71. The entrance end of the contact sheath has a tapered orifice, which forms a guide for the contact plunger as it enters the contact sheath. The entire contact sheath is enclosed by cylindrical tube 78 which is securely fastened at its ends to the sheath by means of the screws 79. This cylinder therefore protects the contact mechanism from the weather elements. It is to be observed that when the contact plunger enters the contact sheath, it forces the conducting spheres outwardly against the connector straps which in turn are forced firmly against the enclos-
ing spring; this spring being free to weave or float together with the connector straps and spheres. The result is that each sphere is under spring pressure and forms a spring contact between each sphere and the contact plug as well as between each sphere and its connector strap. The spheres being free to roll or float in their respective sockets, a wiping contact is secured, thus insuring a multiplicity of clean contact points each of which has a definite current carrying capacity. The capacity of the contact is therefore proportional to the number of points of contact, and permits of a definite current rating to be given the contact.

15 A fluid switching unit is supported on one end by a protecting arm or crank 80 which is securely bolted to the hinge casting 49 by means of bolts 81; and on the other end by a rotatable arm or crank 82 which is pivotally secured to a lug 83 forming a part of the contact casting 72. The respective ends of the fluid switching unit are designated by A and B. A supporting and terminal casting is provided at the A end of the fluid switching unit as shown in Figure 1, comprising a ferrule 84 having an arm 85 which is loosely pivoted to the crank 80 by means of bolt 86. The B end of the fluid switching unit as shown in Figure 1, has a similar part consisting of a ferrule 87 having an arm 88 which is loosely pivoted to the crank 82 by means of a bolt 89. Solidly bolted connections are provided to each end of the fluid switching unit; a flexible conductor 90 being secured to the arm 85 on one end and clamped on the other end to the flexible conductor 47, and a flexible conductor 91 secured on one end to the arm 88 and on the other end to the lug 83 on the contact casting 72. The contact mechanism of the fluid switching unit is hermetically sealed within a tube 92, preferably of a vitreous material but not necessarily, which is filled with an arc extinguishing fluid (not shown on the drawings). Each end of the tube is sealed into the respective ferrules 84 and 87.

These ferrules are similarly constructed and comprise a circular base portion 93, Figure 16, having a circumference of equal angles to each side thereof. The tube 92 is sealed into one of these flanges and the other flange is drilled to receive radially disposed screws for securing the ferrule to its associated supporting and terminal casting. A bracket 94 is secured by a screw 95 to the base portion 93 of the ferrule on the A end of the tube and by a screw 96 to an insulating bar 97 which supports a series of gaps in the arc extinguishing fluid; the bracket making electrical contact with the terminal side of the last gap. The other end of the insulating bar is free to move longitudinally on a guide pin 98, which is expanded or contracted by changes of temperature. This guide pin is secured to the base portion 93 on the B end of the tube and slidably engages the free end of the insulating bar. A flexible connector 99 completes the electrical circuit from the terminal side of the last gap to the base 93. A plurality of castings 100, constructed of a conducting material, are secured to the insulating bar by means of screws 101, Figure 19. These castings are spaced to form a series of gaps. Conducting spheres 102 of a non-magnetic material are disposed for closing being forced to move one to move parallel to the longitudinal axis of the tube or sockets 103 parallel to right angles to the longitudinal axis of the tube; such movement opening the gaps and consequently breaking the electrical circuit through the tube. Due to the arc extinguishing fluid in the tube, these spheres will move into and out of the sockets with plunger-like action. A means is provided on the B end of the tube for filling it with arc extinguishing fluid and making the final seal after it is filled. The base 93 is drilled and tapped to receive the hermaphrodite sealing screw 105, Figure 20. The base and seat of the screw head is provided with concentric grooves, as shown in Figure 10, so that when the screw is tightened against a soft metal washer 106, the grooves will cut into the washer and form a hermaphrodite seal.

Figures 2, 3, and 4 show a unit pole of the gang operated switch mounted in various positions upon a sustaining structure. The various parts of the switch which it would be necessary to reassemble in order to adapt the switch to a different mounting are clearly shown in these figures. Assuming that the switch was originally mounted as shown in Figure 2 and that it was desired to remount it in a vertical position as shown in Figure 3, the only changes which would be necessary would be to turn the tube end for end having the A end of the tube at the contact rather than the B end as shown in Figure 2, and also interchange the male and female members of the contact. In changing from the mounting shown in Figure 3 to that shown in Figure 4 the insulators 3 and 7 should be turned end for end and the tube rotated 180 degrees about its longitudinal axis. A slight change in the assembly of the operating mechanism may be necessary when changing from one mounting to another, but as the operating mechanism is readily adapted to each mounting no difficulty is experienced in making any change required. It is thus evident that the switch may be readily adapted for any mounting simply by a reassembly of a few parts. Enlarged views of the tubes 92 are shown in Figures 18, 19, and 10 with cut-out portions, the tubes being placed in their relative positions as shown respectively in Figures 2, 3, and 4.

The drawings show only one tube mounted on each unit pole of a gang operated switch. It is within the contemplation of this invention, however, to include alternate combinations of contacts within the tube and also one or more tubes mounted on each unit pole of the gang operated switch. For example, there is shown diagrammatically in Figure 13 one tube having the contacts in the tube connected electrically in parallel. An arc extinguishing mechanism is connected in parallel with the first tube. Instead of using the combination shown in Figure 13 the same effect might be accomplished by the use of one tube as shown in Figure 14 having two rows of contacts in series, each row being connected in multipole inside the tube. Electrically Figures 13 and 14 would be the same, except that in Figure 13 two tubes would be necessary, whereas in Figure 14 only one tube would be used. Another combination would be that shown in Figure 15, in which there is one tube with two rows of contacts, but instead of the contacts being electrically connected in series, they are connected in multiple. It is therefore evident that a large variety of connections are possible either within a single tube or by the use of a number of tubes. Since the mechanism of the operating mechanism is the same for each mounting of the switch, it will not be necessary to describe its operation in detail for the different mountings respectively of the switch. The operation of the switch is then as follows:
Referring to Figure 7, the switch being in the closed position, the clevis 13 is rotated through an angle of 120°. This movement of the clevis will rotate the insulator 7 through the same angle, and coincidently move the crank member 43 and the lower pivot member 62 through a corresponding angle. This movement of the lower pivot member draws the upper pivot member 52 downwardly in a vertical plane, thereby causing the switch blade 48 to swing through an angle of 90° in a vertical plane. The relative positions of the universal swivel toggle, when in the closed position of the switch, are pictorially represented by Figures 11 and 8 respectively. The opening of the switch blade moves the crank member 80 downwardly and by an angular displacement and translatory movement moves the fluid switching unit to a position which will cause the contact mechanism to open the electrical circuit. The detailed operation of the contact mechanism of the fluid switching unit is fully described in my co-pending application Serial No. 379,848, filed July 17, 1929. The closing of the switch is accomplished by rotating the clevis 18 back to its original position, which will in turn establish the circuit through the fluid switching unit and close the switch blade 48 thereby completing the electrical circuit through the switch.

It is to be observed that when the switch is in the closed position, the universal swivel toggle will be in the position shown in Figure 11. In this position, the toggle is in the vertical plane of operation of the switch blade and being on dead center will effectually lock the blade in the closed position.

The use of this invention provides a gang operated disconnecting switch which may be mounted in any position simply by a reassembly of parts. A switch is provided which may be opened under load without establishing a flaming arc and therefore does away with the hazards due to such arcs. This invention provides an operating mechanism which will be effective to lock the switch blade in the closed position. Improved means for supporting the rotating insulator is provided in a bearing which will permit the switch to be mounted on a flat surface. The universal swivel toggle provides an improved means for changing the rotary motion of the revolving insulator into the vertical motion for operating the switch blade.

I am aware that numerous details of construction may be varied through a wide range without departing from the principles of this invention, and therefore do not purport limiting the patent granted, otherwise than necessitated by the prior art.

I claim as my invention:

1. A switch comprising a base, an insulator support mounted rotatable on said base, a high-tension insulator secured at one end on said support, a switch blade supported on the other end of said insulator, means connecting said insulator and said blade for movement of said blade, said base being adapted to be positioned in normal horizontal, vertical, and inverted horizontal positions to position the switch in said support in said positions, a vertical rod, and means connecting said rod and said insulator support to rotate said insulator on its longitudinal axis in each of the operative positions thereof, said means comprising a lever on said insulator support extending parallel to said base, a lever on said rod extending substantially normally thereto, and articulated members connecting said levers.

2. A switch, comprising an elongated base, a first insulator vertically mounted on said base and being provided with a switch contact, a second insulator vertically mounted on said base, a said second insulator being rotatable on said base about its vertical axis, a third insulator mounted on said base and positioned rearwardly of said second insulator, a rigid member mounted supported on said second insulator, said member having an upwardly and rearwardly bent arm and having an extension extending rearwardly and connected to said third insulator, a switch blade fulcrumed on said bent arm, a rearwardly extending crank on said second insulator, and articulated link means connecting said crank and said switch blade whereby rotation of said second insulator produces movement of said blade in a plane parallel to the vertical axis of said second insulator.

3. A switch, a base, a first insulator vertically mounted on said base and mounted rotatable on its own vertical axis, a second insulator on said base and positioned rearwardly of said first insulator, a switch blade extending forwardly of said first insulator, a support for said blade mounted supported on said first insulator and including an upwardly and rearwardly inclined arm and another arm extending rearwardly and connected to said second insulator, said first insulator being journaled in said blade support, said blade being fulcrumed on said upwardly inclined arm, a rearwardly extending crank on said first insulator, and articulated link means connecting said crank and said blade, whereby rotation of said first insulator produces movement of said blade in a plane parallel to the vertical axis of said first insulator.

4. A switch, comprising a base, a vertical insulator, means connecting one end of said insulator to said base whereby said insulator is supportable turnable on its vertical axis, a bracket, a member secured on the other end of said insulator and including a shaft extending through and journaled in said bracket, a crank arm connected to said shaft, said crank arm having an upwardly extending end portion, a switch blade support hinged on said bracket and being provided with an upstanding terminal portion, insulator means on said base connected to said bracket to anchor said bracket against turning, and means connecting the up standing terminal portion of said switch blade support with the upstanding terminal portion of said crank arm whereby rotation of said insulator on its vertical axis produces movement of said blade support in a vertical plane, said means comprising pins connected turnable in each of said upstanding portions, respectively, said pins pivotally connected to each of said pins, respectively, and a vertically disposed link connecting said saddles and journaled for turning therein.

5. A switch having a base and a vertical insulator mounted thereon rotatable on its vertical axis, a switch blade, operating means connected to said insulator and to said switch blade for movement of the blade in a vertical plane upon turning of said insulator on its vertical axis, said means comprising a bracket mounted on said insulator, a shaft secured to said insulator and journaled in said bracket, a crank arm secured to said shaft and swingable in a plane normal to the vertical axis of said insulator, a switch blade support hinged on said bracket, and vertically disposed articulated link means connecting said crank arm and said blade support.

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